ST. MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF PROJECT MANAGEMENT

VARIATION ORDER AND ITS EFFECT ON CONSTRUCTION PROJECT PERFORMANCE: IN THE CASE OF ROAD CONSTRUCTION PROJECTS IN ADDIS ABABA

BY

HAIMANOT CHALCHISSA

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A THESIS SUBMITTED TO ST. MARY'S UNIVERSITY SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ARTS IN PROJECT MANAGEMENT

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DECLARATION

I, Haimanot Chalchisssa the undersigned, declare that this thesis is my original work, prepared under the guidance of Dr. Muluadam Alemu. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of learning any degree.

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Name Signature

St. Mary's University, Addis Ababa **February, 2021**

ENDORSEMENT

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

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February, 2021

ACKNOWLEDGMENT

First and for most my deepest gratitude goes to the almighty GOD who guided me throughout my life and this journey and made all of these possible. Next I would like to express my sincere gratitude to my advisor Dr. Muluadam Alemu for the continuous support of my research, for his motivation, patience, and immense knowledge. Dr. Muluadam Alemu's office was always open whenever I had any question. He consistently allowed this paper to be my own work, and directed me in the right direction. His guidance helped me all the time of research and writing of this thesis.

Besides my advisor, I must thank Dr. Misganaw Solomon for giving us supplementary report writing class which was very much helpful in writing this paper.

I would also like to thank all the experts who were involved in this thesis and in the survey for this research, without their participation the survey could not have been successfully conducted.

Finally, I must express my very profound gratitude to my parents Ato Chalchissa Debel and W/ro Woderyelesh Abebe, to my Sisters & brothers and to all my friends for providing me with unfailing support and constant encouragement during my years of study and through the process of researching and writing this thesis. This would not have been possible without them.

Thank you all!!

Researcher
Haimanot Chalchissa

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ABSTRACT

The purpose of this research was to identify the major causes of variation order and their effects on road construction project performance in Addis Ababa. Variation order is pointed out as one of the major reasons that lead to poor construction project performance. The research was explanatory and the research design was survey design. A quantitative research approach was adopted and the hypothesis was also tested. The study used both primary and secondary data sources. A structured close-ended questionnaire was designed and distributed to the client (ACCRA), contractor and consultants working under ACCRA. Since the target population was small respondents were selected using the census method. Out of 60 questionnaires, 52 were able to be retrieved with a response rate of 86.7%. The data gathered using the questionnaire was analyzed with the help of Statistical Package for Social Sciences (SPSS version 20) using descriptive statistics and regression analysis. The descriptive analysis was done to identify major causes of variation order and major effects on project performance. The findings showed that right of way/difficulties faced in land acquisition by the client was the first major cause of variation order and that time extension (time overrun) was the first major effect of variation orders on road construction project performance in Addis Ababa. Regression analysis was also conducted and the result revealed that variation order has a significant effect on project performance with a p-value of 0.002 <0.05 and regarding the hypothesis, the alternative hypothesis was accepted based upon the obtained a value of β =.524 and $p<0.05$. The study concludes that variation order is a statistically significant predictor of project performance and represents the value change in project performance is associated with a unit change in variation order. Therefore, increased variation order results in an increased effect on project performance (increased time extension, cost and claim and dispute and etc…). The research finally recommends for all parties to be involved and work to minimize change orders starting from the initial design stage and manage the variation order at the construction stage using effective change management system and furthermore adopt different technologies to facilitate the change management process.

Key words: Construction projects, Variation, Variation order, project performance

LIST OF ACRONYMS AND ABBREVIATIONS

AACRA	Addis Ababa City Road Authority
ANOVA	Analysis of Variance
BOQ	Bills of Quantity
COMS	Change Order Management System
DBB	Design Bid Build
DB	Design Build
ERA	Ethiopian Road Authority
FIDIC	Federation Internationale Des Ingenieurs-Conseils
GDP	Gross Domestic Products
MoWUD	Ministry of Works and Urban Development
PMBOK	Project Management Book of Knowledge
RSDP	Road Sector Development
SPSS	Statistical Package for Social Sciences
VORS	Variation Order Reducing by Solution

CHAPTER ONE

INTRODUCTION

This chapter presents an overview of the entire study. In this chapter, the researcher introduces the readers to the background of the study, the statement of the problem, the objective of the study, the significance of the study, the scope and limitation of the study, the entire organization of the study and the definition of terms.

1.1 Background of the Study

The construction industry involves the construction or refurbishing of buildings, infrastructures and civil engineering structures in an economy (Nyangwara & Datche, 2015). This industry is a large and most complex industry consisting of different parties such as owners/clients which includes government, industry, private parties, and investors, consultants which include designers (architects) and construction monitors (engineers), contractors including field managers, supervisors, and craftsmen (Habenom, 2017).

In a developing country, the construction industry plays a very important role in the economy as it significantly affects the development of a nation by being the major contributor to the economic development and economic activities (Durdyev & Ismail, 2012). Similarly, Habenom (2017) stated that developing countries greatly depend on the growth and development of physical infrastructures suggesting that there is a significant linkage between the construction industry and both the economic and social sectors.

According to the National Bank of Ethiopia (2018), the Ethiopian economy had recorded a 7.7% growth in real GDP in the 2017/18 fiscal year. The growth was mainly credited to 8.8% growth in services, 3.5 % in agriculture and the major contributor to the growth was recognized to be the industry sector (primarily construction) contributing 12.2%.

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

Project performance is associated with the perceived success of a project (Bakert, Murphy, & Fisher, 1988). According to Pheng and Chuan (2006) project performance is a serious

issue in the construction industry. An efficient performance fulfills the overall objectives by attaining the three critical success factors that are meeting the cost, time and quality requirements. Project completion on budget, time, within the specified quality and client satisfaction are often used as measures to determine the success of a project (Nyangwara & Datche, 2015).

In developing countries, it is presumed that a well-established road transport sector would drive the growth process of a nation; therefore, to ensure an increased road network of the country, the Ethiopian government is making a persistent effort towards the construction industry (Worku, 2011). The Poor condition of the existing road network has been a barrier to economic recovery and economic growth. Recognizing this limited road network coverage, the government of Ethiopia has launched the Road Sector Development Program (RSDP) in 1997 in order to address the problems in the road sector. Since then, four phases of RSDP were implemented over the period of 1997-2015 and the fifth phase; RSDP V has been on the go since July 2015 (ERA, 2016).

The Addis Ababa City Roads Authority was established on March 15 1998, to construct, maintain and manage the road works in Addis Ababa by the city Administration. The authority has done significant progress in the city road expansion and upgrading since its establishment (AACRA, 2020). However, according to Fetene (2008), most of the road projects in the city are not completed within the original contract time and original contract price and the researcher also noted that one of the contributing factors for cost overrun is variations. Likewise, Tadesse (2009) quoting Abdo (2006) also indicated that variation is one of the factors for delays in construction projects.

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

Fisk (1997) quoted in Halwatura and Ranasinghe (2013) stated that any deviation from an agreed and well-defined scope of a project is termed as a variation. Variations may include any changes to plans, specifications or any other documents in the contractual agreement provided to the contractor by the owner or owner's representative (Hammadi, 2006).

Soares (2012) stated one of the major issues in construction contracts is change orders which require successful negotiations to avoid claims and possible litigation. Similarly, Varghese *et al.* (2018) stated that critical change may cause continuous delays in the project schedule, re-estimation of work statement, and requires additional equipment, supplies, manpower, and time. Lokhande and Ahmed (2015) pointed out that every player involved in construction projects is affected by the consequence of change order. Assbeihat and Sweis (2015) also added that most projects suffer from substantial delays mainly due to change orders and lead to an extended initial time and cost estimates.

Even though, the nature and frequency of variations differ from one project to another depending on various factors nearly every construction project encounters major variations (Arain & Pheng, 2006). Road construction projects as one of the major infrastructure projects in the industry; it is seriously affected by different uncertainties leading to changes which in return lead to the request of variation orders to be made to the original agreement which must be managed carefully (Varghese *et al.* 2018).

Over the years, a substantial portion of the construction literature on variation and variation orders has been written but the majority of this research has been conducted in Europe, the Arab countries and Western Africa. But scarce research has been conducted here in Ethiopia. Since an increasing number of construction projects are taking place in the country, and given that road construction projects mostly undergo extensive changes which often lead to deviation from the agreed-upon scope of work and pre-planned construction methods the industry has significant issues with project performance and has not yet received sufficient attention from researchers which marks the need for such study to be carried out.

The findings from a few studies on variation and variation orders in Ethiopia showed that the prevalence of the problem in Ethiopian road construction is significant. Tadesse (2009) found that the magnitude of variations in Ethiopian road projects ranges from 0.72 % to 109%. Similarly, Tewodros (2015) showed all projects faced variation orders ranging from 1 to 7 and an increase of 24.11 % of the original project contract amount and time overrun of 126.50% of the original contract period.

The purpose of this study is therefore to identify the major causes of variation order and their effects on road construction project performance in order to take a step in mitigating the consequential impact.

1.2 Statement of the Problem

As stated in the PMI (2000), for a project to be successful, it requires an effective and efficient performance that fulfills overall objectives by attaining the three critical success factors, that is meeting the cost, time and quality requirements within the defined scope. Any variations from these objectives in most cases cause projects to be delayed and additional costs to the project implementing agent and project owner (Hammadi, 2006).

Ibbs (1997) argued that changes and variation orders are pointed out as one of the major reasons that construction project performance suffers from, as it is expected to result in scope creep, extended time, increased cost and dispute among the parties.

Construction projects by nature are complex and possess a series of processes (Desai *et al.* 2015a). Hanif, Khurshid, Malik and Nauman (2014) studied that change in the construction projects are very common, unwanted and mostly occurs during the execution phase of a project from different sources and different causes, leading to variation order, and added that it has considerable negative impacts on the performance of the project concerning cost, time and quality resulting in cost & time overruns, quality degradation, and loss in productivity on construction projects.

According to Fetene (2008) in Ethiopia aside from the economic inflation and change in foreign exchange rate one of the major causes for cost overrun is variation orders and lack of control on excessive variation orders, which is frequently occurring and becoming a common practice.

In previous studies, Tadesse (2009) studied the causes and effects of variations in the ERA projects, which focused on the existence of variation, its cause and effect but as the researcher himself indicated it was difficult to realize the objective of the study because the questionnaire was not comprehensive to address the objective of the research. It left out some important questions and included some unnecessary questions which don't fit with any of the researcher's objectives.

In another study conducted by Tewodros (2015) the researcher has covered the cause and effect of a variation order. In his study, the researcher had not defined the target population, sample size as well as sampling techniques. Both studies did not rigorously examine the relationship between variation and project performance and only presented the rankings of the factors.

Both of the researchers who conducted their study on variation and variation order recommended that further studies on this issue are needed. Similarly, variation order was also recognized to be one of the major problems in the road construction projects which haven't received much attention during preliminary discussion with colleagues and a contract administrator at the Addis Ababa city road authority and Ethiopian road authority,

Therefore, this study attempt to identify the major factors causing variations leading to variation orders and their effects on the overall road construction project performance in Addis Ababa, and rigorously reveal the effect of variation order on project performance with a view of making recommendations that could help towards effective variation order management.

1.3 Research Questions

1. What are the major causes of variations leading to variation order in road construction projects?
2. What are the major effects of variation order on road construction project performance?
3. How can variation orders be managed in order to minimize the adverse effects on road construction project performance?

1.4 Objective of the Study

1.4.1 General Objective

The objective of this research is to study variation order and its effects on the overall project performance in the road construction projects in Addis Ababa.

1.4.2 Specific Objectives

- To assess the prevalence and the nature of variation order in road construction projects;
- To identify the causes of variations leading to variation order in road construction projects;
- To identify the potential effects of a variation order in road construction project performance and;
- To forward possible a solution and recommendation to reduce the adverse effects of a variation order in road construction project performance.

1.5 Significance of the Study

As variation orders have many negative impacts on project cost and schedule performance, it is essential to identify the major causes that contribute to variation orders and study the effect of variation orders and possible strategies to minimize and better manage change orders during the implementation of road construction projects. Therefore, through studying the current practice of variation order, exhaustively reviewing related literature, and collecting data from the professionals on the matter, the findings of this paper identifies the major causes and effects of variation orders and forward a possible recommendation that will assist contract administration of the implementing agent and the road construction stakeholders in general. It will contribute to the improvement of construction variation order management and help in minimizing the adverse impact of variation orders on a construction project. This study will help the Addis Ababa City Road Authority and the Federal Ethiopian Road Authority in assessing and taking remedial measures for reducing the impact of variation orders. It will also be a foundation for future studies.

1.6 Scope of the Study

There are many major road sector initiatives, including new, upgrading, rehabilitation, gravel or asphalt road construction projects being undertaken by the Ethiopian government through its agencies to increase the road network in the country but the scope would be too broad to address all areas. Therefore, to achieve the above objective, the study has limited itself to focus on variation order and its effect on project performance of new asphalt road projects that are delivered by Design Bid Build project delivery method and implemented under Addis Ababa City Road Authorities (AACRA).

1.7 Limitation of the Study

The limitation of this study was the current global situation (Covid -19 Pandemic) which restricted the researcher to distribute the questionnaires and meet key informants in person as the ideal study would have been the combination of questionnaires and key informants interview. As a result of Covid -19 Pandemic, the researcher could not perform one on one interview and most of the questionnaires were distributed through electronic mail (E-mail), telegram and some in person. The process was time-consuming given the current situation and also the fact that most respondents were dispersed in different sites, and they require the presence of the researcher to return their responses quickly.

1.8 Organization of the Study

The study is organized into five chapters, where:

Chapter One: Introduction- This chapter is an introduction to the study comprising the background, statement of the problem, research questions, objectives of the study, scope and limitations, organization of study, and definition of terms.

Chapter Two: Literature Review-This chapter reviews previous studies related to variation orders. The potential causes and effects of variation orders on project performance are discussed in this section.

Chapter Three: Research Methodology- This chapter discusses the research approach, research design, population, sampling, data collection tools and method of data analysis.

Chapter Four: Analysis and Interpretation of Data– In this chapter data gathered at the survey stage of the research are analyzed using SPSS (Statistical Package for Social Sciences) and the findings are discussed based on research objectives.

Chapter Five: Summary of findings, Conclusions and Recommendations– In this section conclusions and recommendations are drawn based upon data analysis, linking them to the objectives of the study.

1.9 Definition of Terms

Client in this research is referred as the owner and project initiator who establishes the scope and quality of works and plays a major role in their project from the beginning until the project is completed.

Consultant in this research is referred as the owner/client representative usually consist of an architect, designers, specialist engineers, project managers, and cost consultants.

Contractor in this research is referred as the one who is responsible for the construction of physical infrastructure.

Design Bid Build (DBB) in this research is referred as is a project delivery method that allows the owner to divide the design and construction of projects into two main contracts and hires a designer for the design and a contractor for the construction.

Design Build (DB) in this research is referred as is a project delivery method that allows the owner to create a contractual agreement with one firm who will both design and construct the project.

The terms '**variation**' and '**change**' or '**variation order**' and **'change order**' are used interchangeably in most of the literature, hence in this research the researcher also used 'variation' and 'change' or 'variation order' and 'change order' interchangeably.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

In the construction industry even though the scope of the projects and the extent of construction processes vary significantly, they tend to have one thing in common which is change (Staiti *et al.* 2016). Desai *et al.* (2015b) explained that most of the change orders are issued during the construction execution period.

To better understand the nature of variation and variation order, the major causes and its effects on project performance and attain the research objectives, this section will exhaustively review related literature focusing on identifying the major causes of variations, their effects on project performance and explore possible solutions to minimize variations and manage variation orders.

2.2 Definition

2.2.1 Variation /Change

Variation according to Hammadi (2006) is defined as any modification whether it is additions, deletions, or other adjustments to project goals and scope that may increase or decrease the cost or schedule of the project. In agreement with Hammadi (2006); Arain and Pheng (2005) and Hanna *et al.* (2002) defined change as any incident resulting in the addition, deletion, or revision of the original scope, time, and cost of a project.

Similarly, Sun and Meng (2009) referred to a change in construction projects as changes to design, construction process, and modifications to the project program in preexisting conditions, assumptions, or requirements. Park and Peña-Mora (2003) also stated that any activity, procedures, or methods that deviate from the original construction plan or specification can be defined as construction change. Desai *et al.* (2015b) described that change may be in the amount and type of work, quantity and type of material, method of construction, and amount and type of labor.

Contractual clauses relating to changes allow contracting parties to initiate variation orders within the scope of the works without altering the original contract (Ndihokubwayo & Haupt, 2008b).

According to FIDIC (1987) and MoWUD (1994) variation is defined in clause 51 as Alterations, Additions, and Omissions.

> Any variation of the form, quality or quantity of the works or any part thereof that may be necessary and appropriate for that purpose, the engineer have the authority to instruct the contractor to do and the contractor shall do any of the following:
> (a) Increase or decrease the quantity of any work included in the contract,
> (b) Omit any such work
> (c) Change the character or quality or kind of any such work,
> (d) Change the levels, lines, position, and dimensions of any part of the works,
> (e) Execute additional work of any kind necessary for the completion of the works, or
> (f) Change any specified sequence or timing of construction of any part of the works.

In this research, change is defined as any addition, deletion, modification, or substitution of the original design drawings, plans, and documentation requested by the project's owner or owner's representative.

2.2.2 Variation /Change Order

Change order as defined by Varghese *et al.* (2018) and Gokulkarthi and Gowrishankar (2015) is a written order issued after execution of the contract, authorizing a change in the scope of work, or revision to contract terms during the execution of work that is signed by the owner/owner representative and given to the contractor. In agreement with this Keane, Sertyesilisik, and Ross (2010) and Halwatura and Ranasinghe (2013) referred to change order as a formal document used to amend the original contractual agreement that will later be a part of the projects documents.

Ndihokubwayo and Haupt (2008b) and Eigbe (2016) similarly explained that any variations or modifications such as addition, omission, alterations, or substitutions in terms of quality, quantity, or schedule of the project are regularized by the issuance of variation orders.

Desai *et al.* (2015b) stated that change orders are typically issued to cover any kind of variations from the original agreement whether in the scope of work, material quantities, design errors, and unit rate. No single party can change any of the terms and conditions of a validly executed contract unless the contract contains provisions that specifically allows for changes. Hence, construction contracts mostly contain a change order procedure (Hao, Shen, & Neelamkavil, 2008).

According to FIDIC (1987) and MoWUD (1994), clause 51.2 orders for variations should be in writing

> No such variations shall be made by the contractor without an order in writing of the engineer. Provided that no order in writing shall be required for increase or decrease in the quantity of any work where such increase or decrease is not the result of an order given under this clause but is the result of the quantities exceeding or being less than those stated in the bill of quantities.

2.2.3 Project Performance

In construction projects, project performance is defined as the set of measures used for evaluating the success of the project. Time and cost are measured indicators of performance (Memon, Rahman, & Jamil, 2014). According to Nyangwara and Datche (2015), project performance in the construction industry is a critical issue and the success of construction projects depends mainly on the success of performance

In the construction industry, performance has been measured in terms of cost, time, and quality (Ankrah & Proverbs, 2005). Enshassi, Arain, and Al-Raee (2010) stated that the maximum project performance would be attained if the work is executed invariably and smoothly within time limits and an estimated budget.

Similarly, Kaviya and Hema (2015) mentioned that the success of a project depends on how well the team can work effectively to achieve objectives within scope, cost, and quality constraints. According to Karlsen and Gottschalk (2002), as cited by Haq, Liang, Gu, and Ma (2016) the concept of an iron triangle comprising of time, cost and quality relate to project performance that can be assessed during project execution.

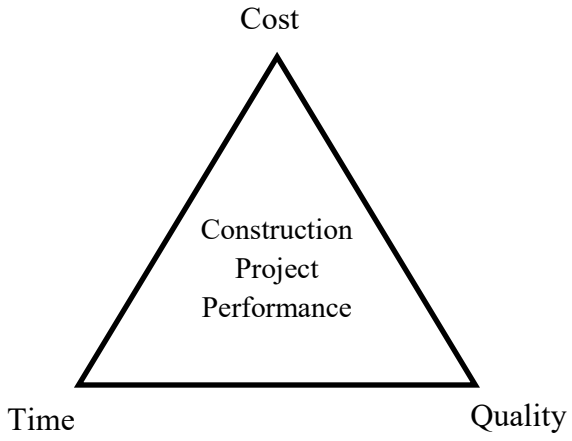


Figure 2.2.1 The 'iron triangle' of Construction Project Performance Measurement

Source (Ankrah & Proverbs, 2005)

2.3 Theoretical Framework

2.3.1 Prevalence and Nature of Variation Order in Construction Projects

According to Desai *et al.* (2015b) and Ibn-Homaid, Eldosouky, and Al-Ghamdi (2011), change orders in the construction industry are not new; they are a well-known aspect of the industry as changes occur regularly on most of the project. Likewise, Ibbs (1997) and Hanna *et al.* (2002) mentioned that in most construction projects change is unavoidable due to the complex nature and novelty of a project along with time and money resources limitation required for planning.

According to Hackman, Acheampong, Agyekum, and Ayarkwa (2015) construction projects involve complex procedures that cannot be accurately determined in advance resulting in variation orders. In agreement with this Varghese *et al.* (2018) pointed out that the involvement of many human and non-human factors along with the uncertain conditions makes construction projects complex requiring very close teamwork and coordination among stakeholders. It is because of this complex nature construction projects encounter several variations, delays on completion time, or poor workmanship upon completion.

The occurrence of change orders according to Soares (2012) depends on the level of integration of design and construction. There is no necessarily one form of variation order; different projects usually have different forms and procedures that must be followed to process a variation (Jawas, Abdulkader, & Ali, 2009).

The method used to deliver a project differs from one project to another. A project delivery method in road and highway projects can be defined as a system of managing the procurement and coordination of project services such as planning, designing, construction, right-of-way acquisition, utility adjustments, financing, operations, maintenance, etc. (Shrestha, Migliaccio, O'connor, & Gibson, 2007).

According to Ndihokubwayo (2008a), the type of procurement method used may result in more variation orders from one another. Supporting these Shrestha *et al.* (2007) citing Bennett *et al.* (1996) added that design-build (DB) projects perform better than design bid build projects (DBB) projects in terms of cost and schedule. Similarly, Soares (2012) pointed out that change in design-build projects are considered as a refinement or an improvement to the project. In this delivery method, there will not be an increase in cost due

to change orders in addition to the claim and dispute proceedings. Since design bid build projects separates design from construction any adjustments generated during project execution will be switched into change orders to compensate for the crack due to disintegration. Therefore, this research studies variation order and its effect on design bid build projects because according to the above-mentioned scholars DBB projects mostly suffer from variation order.

2.3.2 Types of Variation Orders

According to Mirshekarlou (2012), changes could be classified as required or elective changes, compensable/excusable or non-excusable changes, and controllable or uncontrollable changes.

- **Required or Elective changes:** required change is obligatory due to the nature of the problem and should be evaluated and processed. On the other hand, elective changes are not compulsory. When the project team has many alternatives for change management, the change is considered elective.
- **Compensable, Excusable, or Non-excusable changes:** the project's owner in response to its needs or required modifications in the project suggest compensable changes. The consultant proposes excusable changes in reply to technical problems or possible document errors. Non-excusable changes are entirely the responsibility of the contractor and there would not be any payment for them.
- **Controllable or Uncontrollable changes:** Controllable changes are those where the source of their cause is under the control of the contractor, such as labor productivity or material procurement. The contractor is the only person responsible for controllable changes and cannot ask for extra funds. Uncontrollable changes are those where the contractor has no effective control of them, such as weather conditions, inflation, and unforeseen ground conditions.

To cover and regularize these changes, change orders are issued. According to Cox (1997), change orders may be categorized as a formal change order, constructive change order, and cardinal or scope change order. However, it must be in line with the contract changes procedure

- **Formal change order** is initiated by the owner or his representative to modify the contract conditions, expressions, strategy, and specifications.

- **Constructive change order** issued to overcome incomplete or inaccurate contract documents which is extra contract work performed either with oral or implied owner directives or as a result of problems for which the owner is responsible.
- **Cardinal or scope change order** issued for a substantial amount of work required outside the scope of the original contract.

According to Arain and Pheng (2005), variation orders are either beneficial or detrimental.

- **Beneficial variation order;** A variation order issued to enhance the project's quality, cut cost, time, or degree of difficulty is called beneficial variation order. Similarly, Ndihokubwayo (2008a) stated that beneficial variation order aims to balance the welfares of clients with the resource input by excluding unnecessary costs. According to Ibbs, Wong, and Kwak (2001), it is very important to encourage and to support the beneficial changes.
- **Detrimental variation order:** A variation order that negatively affects the value of the client or the performance of the project is referred to as detrimental variation order (Arain & Pheng, 2005). Enshassi *et al.* (2010) described detrimental variations as the major causes of conflict and dispute in the construction sector. Ibbs *et al.* (2001) suggested that the project team should be discouraged and work to avoided detrimental changes.

In this research, the causes of detrimental variation order, and their effects on project performance is studied.

2.3.3 Causes of Variations/Variation order

To study the effect of variation orders on project performance, a thorough understanding of the root causes of variations is needed. Soares (2012) stated that changes are frequently made to contract documents during the execution phase of a construction project. Drawings and specifications often contain errors and omissions that need corrections, and changes in the client's needs or market demand leading the client to change their preferences. Weather and soil conditions and failures in the supply of resources also cause alteration. Arain and Pheng (2006) categorized the causes of variations into four major categories based on the originator of the variation as

- Owner related changes,
- Consultant related changes,
- Contractor related changes and
- Other changes.

The client is the project initiator and plays a major role in their project from the beginning until the project is completed (Arain & Pheng, 2006). It is the client who establishes the scope of works and the required quality standards. According to Donold (2013), a poorly defined scope will not provide a clear baseline leading to variation order that will be evaluated within or outside the scope. Similarly, Ndihokubwayo (2008a) stated that inadequately defined project objectives will lead clients to change their minds along the way.

Donold (2013) argued that consultants should understand the overall scope and goals of a project. Failing to interpret the requirements and needs of their client, results in design error which eventually leads to variation orders. Ndihokubwayo (2008a) explained that if there are any errors, omissions, or discrepancies in a design or a conflict between contract documents, the consultant is responsible to provide a remedial solution.

According to Shrestha (2015) awarding a project to the lowest bidder may be one of the factors causing variation order. Soares (2012) further supported this idea as change orders are perceived as one opening of opportunity to increase profit in the contract by the contractors selected based on low bid analysis and for this reason, the contractor will search extensively to find justification to start a change order.

In construction projects, the contractor is responsible to recommend the consultant to issue a variation order when a technical problem is discovered. A contractor may also suggest an alternative construction method where his knowledge in the field will work better and fit the desired qualification and function of the design than the method proposed by the client or consultant (Donold, 2013).

The causes of variation orders as reviewed from previous related literature are summarized in the tables below along with their respective sources (indicated by numbers representing the following scholars)

[1] Halwatura and Ranasinghe (2013), [2] Varghese *et al.* (2018), [3] Shrestha (2015), [4] Ismail *et al.* (2012), [5] Enshassi *et al.* (2010), [6] Arain and Pheng (2006), [7] El-Sadek (2016)

Table 2.3.1 Owner Related Factors Causing Variation

No	Owner related factors	Source
1	Change project purpose or scope by owners	[1], [3],[4],[6]&[7]
2	Change of implementing schedule by owner	[6]
3	Unrealistic contract durations imposed by client	[1]
4	Owner's financial problems	[2],[4],[5],[6]&[7]
5	Weakness in prompt decision making process	[2],[6]&[7]
6	Inflexible nature of owner	[6]&[7]
7	Change in specification by owner	[5],[6]&[7]
8	Inadequate experience of owner's staff	[6]&[7]
9	Owner instructs additional works	[7]
10	Design change originated by owner	[4]
11	Right of way (Difficulties faced in land acquisition by the client)	[1], [2] &[6]
12	Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing.	[1] & [2]

Table 2.3.2 Consultant Related Factors Causing Variation

No	Consultant related factors	Source
1	Change in design by consultant	[5],[6]&[7]
2	Errors and omission in design	[1],[3],[4],[5],[6]&[7]
3	Conflicts between contract documents (insufficient detail)	[1],[4],[5],[6]&[7]
4	Lack of coordination among project parties	[1],[2],[4],[5] & [6]
5	Lack of consultant's knowledge of available materials and equipment	[5],[6]&[7]
6	International consultant using inadequate specification to be followed in local conditions	[5],[6]&[7]
7	Failure by the consultant to provide adequate and clear information in the tender documents	[1],[4]&[7]
8	Failure by the consultant to perform design and supervision effectively	[7]
9	Substitution of material or procedures	[1] &[4]
10	Award project to the lowest bid price	[3]
11	Unreasonable project time frame	[3]
12	Changes in specifications	[1],[3] & [4]
13	Unforeseen changes in grade of work, Deviation from original scope of work during extension.	[1],[2] & [3]
14	Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study	[1], [2] & [4]
15	Incomplete bill of quantities (BOQ).	[1] & [2]
16	Consultant’s lack of judgment and experience	[1]
17	Poor estimation	[1]

Table 2.3.3 Contractor Related Factors Causing Variation

No	Contractor related factors	Source
1	Unfamiliarity of international contractor with local conditions	[6]
2	Lack of specialized construction manager	[2] & [6]
3	Poor procurement process	[6]&[7]
4	Misunderstanding of tender documents during cost estimate stage	[6]
5	Contractor desire to improve his financial conditions based on contract gaps	[1],[4]&[7]
6	Contractor's financial difficulties	[1],[4]&[7]
7	Technical incompetency of contractor and unavailability of the required labor skill	[1],[4]&[7]
8	The required equipment and tools not being available	[1],[4]&[5]
9	Workmanship or material not meeting the specifications	[1] & [4]
10	Lack of equipment efficiency,	[2] & [3]
11	Rework because of errors during construction	[3] & [4]
12	Improper construction methods.	[2] & [3]
13	Value engineering (mechanism of saving cost for mutual benefit)	[1] & [4]
14	Poor performance of subcontractors	[1]

Variation beyond the control of the contractual parties that give rise to variation orders are categorized as others (Arain & Pheng, 2006). Therefore, in this research, these factors are considered as a controlled group to get a precise result that is under the control of any of the three parties.

Table 2.3.4 Other Factors Causing Variation

No	Other Factors	Source
1	Weather conditions	[1],[3],[4]&[6]
2	Safety consideration	[1],[2],[4] &[6]
3	Change in governmental regulations	[1],[2],[4]&[6]
4	Change in economic conditions	[2]&[6]
5	Socio-cultural and political factors	[1],[2],[5]&[6]
6	Unforeseen problems / Natural disasters	[1]&[6]
7	Lack of construction materials and equipment & spare parts due to closure and siege	[5],[6]&[7]
8	Technology change	[1]&[4]

2.3.4 Effects of Variation Order

Ndihokubwayo and Haupt (2008b) and Eigbe (2016) described a construction contract as a business agreement that is subjected to variability/change. Depending on the level of the change, changes can affect a project positively or negatively, but in most cases, it has negative effects (Moayeri, 2017). Ibbs (1997) added that variations in construction projects can cause substantial adjustments to the contract duration, total direct and indirect costs, or both, i.e. cost and time overrun. According to Sun *et al.* (2006), one of the main criteria for a construction project team is to complete a project on schedule and within budget, but in reality, many projects experience delays and cost overruns as a result of frequent changes and the failure of the project teams to manage these changes effectively.

According to Ndihokubwayo (2008a), high project performance can only be achieved if the work invariably flows smoothly within time limits and anticipated budget, which is very rare for projects to be carried out precisely according to their original schedule for various reasons. The researcher argued that one of the reasons for this is that the occurrence of variation orders which have an adverse impact on project performance.

Based on several researchers findings Oladapo (2007) revealed that variation orders often cause significant disruptions to a construction project, which may decrease the labor productivity of the contractor and extend the project duration leading to material wastage and marginalizes project quality, which results not only in cost overruns but also initiates claims and disputes in construction contracts.

Hao *et al.* (2008) also stated that changes can become a major source of contract disputes, and therefore a risk of project failure if not resolved through the change management process.

According to Hammadi (2006) the most common effect of variations, during the construction phase, is the increase in project cost. The researcher also mentioned that any major additions or alterations in the design may eventually increase the project cost, project completion time and affect the quality.

The most important effects of variation orders in construction projects as indicated in Ismail *et al.* (2012) research are an increase in project cost, delay in completion schedule, disputes between owner and contractor, decrease in quality of work, and additional revenue for the contractor.

Moghaddam (2012) classified the effect of variation order as a direct and indirect effect. Change to specification, addition or deletion (demolition of work), rework, time lost in stopping and restarting current task to make the variation, revisions to project reports, drawing and documents, and reschedule to make up for the lost time are some of the direct effects.

Decreased morale of teams through disputes and blaming among various members, loss of productivity due to loss of rhythm and reprogramming, increased risk of coordination failures and errors, loss of float in the master plan which leads to increased sensitivity to further delays and change in cash flow are some of the indirect effects *(Ibid).*

The effects of variation order that are highly rated from the previous related literature review are cost overrun, time overrun, quality degradation, rework and demolition, productivity, degradation and disputes among professionals; these effects are discussed and summarized as follows;

2.3.4.1 Cost-Related Effects

Cost Overrun (Increase in project cost); according to Assaf, Al-Khalil, and Al-Hazmi (1995), any major changes or modifications to the design could eventually increase project costs. Likewise, Arain and Pheng (2005) stated that variations are known to be a typical source of additional work for the contractor, and the contractor looks forward to variations in the construction project due to additional payments. Additional work is any added work to the scope of the project which was not covered in the original bill of quantities (BOQ) (Smith, 2016).

A contingency sum is usually allocated in every construction project to accommodate for possible project variations while keeping the overall project cost unaltered. Priyantha, Karunasena, and Rodrigo (2011) investigated 39 projects which have exceeded the cost of the project in the final contract sum to find out that the variation amounts in lots of projects are similar or greater than half the amounts of cost overruns, they have identified variations causes at least 9.9% mean change of initial contract sum which implies that variations greatly impact cost overruns which may incur additional costs to the client. According to Ndihokubwayo (2008a), the effect of variance orders on costs is both direct and indirect. The researcher further elaborated these costs by citing Bower (2000)

Direct cost associated with variation orders

- Time and material charges related to directly affected tasks;

- Recalculation of increased time-related charges and overheads;
- Reworks and standing time;
- Seasonal effects for example winter time;
- Inflation, changes to cash flow and loss of earnings; and
- Management time, head office, and site charges.

Indirect costs associated with variation orders

- Rework and making good on affected trades other than the actual variation order;
- Change in cash flow due to the effect on inflation and financial charges;
- Loss of productivity due to interruption where the gang has to familiarize with new working condition, tools, and material;
- Cost for redesign and administration of the variation order; and
- Litigation-related costs in case disputes arise due to the variation order.

2.3.4.2 Time-Related Effects

Time overruns (Completion schedule delay); according to Ibbs (1997) variations in construction projects often result in completion schedule delay. Hanna *et al.* (2002) mentioned that variation orders increase productivity losses, and productivity is defined by the amount of output over a unit of time. The loss of productivity thus entails a loss of time and related delays. Priyantha *et al.* (2011) also realized that due to the additional works, changes to sequences and levels/dimensions variations result in the requirement of additional time to complete the works.

Similarly, Arain and Pheng (2005) claimed that the delay in payment for variation in construction projects leads to delays in payment to the subcontractors because main contractors may not be able to pay the subcontractors unless they get paid by the owner first; this in return may hinder the project progress by leading to delays in achieving the targeted milestones during construction. In their study, the researchers described that 50% of the projects surveyed were delayed because of variations.

2.3.4.3 Quality-Related Effects

Quality degradation; Fisk (1997) as cited by Arain and Pheng (2005) pointed out the quality of work is adversely affected by frequent variations in a project since contractors tended to compensate for the losses by cutting corners.

2.3.4.4 Disputes among Professionals

Changes in construction are a major source of construction dispute. The disputes over variation orders and claims are inevitable and the variation clauses are often the source of project disputes (Arain & Pheng, 2005).

According to FIDIC (1987) and MoWUD (1994) clause 52 valuation of variation;

> All extra or additional work done or work omitted by order of the Engineer shall be valued at the rates and prices set out in the Contract if, in the opinion of the Engineer, the same shall be applicable. If the Contract does not contain any rates or prices applicable to the extra or additional work, then suitable rates or prices shall be agreed upon between the Engineer and the Contractor. In the event of disagreement, the Engineer shall fix such rates or prices as shall, in his opinion, are reasonable and proper.

During the negotiations for the new price and time extension, disputes may arise and the contractor will then submit the details of any claim for extension of time, or additional money after the possibility of such a claim becomes apparent. According to Yogeswaran, Kumaraswamy, and Miller (1998) variation order was found to be a major reason for a claim for extension of time next to the weather condition.

2.3.4.5 Productivity Degradation

According to Ibbs (1997) productivity of workers is expected to be greatly affected in cases where they were required to work overtime for prolonged periods to compensate for schedule delays. Arain and Pheng (2005) argued that interruption, delays, and redirection of work that are associated with variation orders have a negative effect on labor productivity. Labor maybe directly or indirectly affected by changes to the project scope as extra work or redoing work that has already been completed mostly influence the morale of the labor negatively and low morale may cause the labor productivity to drop (Smith, 2016).

2.3.4.6 Rework and Demolition

Hao *et al.* (2008) defined rework as re-doing an activity that was implemented incorrectly at first, mostly as a result of quality defects, variance, negligence or poor design, and on-site management which is usually pure waste. Rework and demolition are potential effects of construction variations, depending on when the variations occur. As Arain and Pheng (2005) cited Fisk (1997) variations imposed when construction is underway or even completed often lead to reworks and delays in completion of the project.

Sun and Meng (2009) summarized the above-mentioned scholars Arain and Pheng (2005), Hanna *et al.* (2002), and Bower (2000) and developed a categorization for change effect using a hierarchical structure in dividing the effects into three levels, which is further

described in this research as Output (Level 3), Outcome (Level 2) and Impact (Level 1) adopted the taxonomy for change effect

Table 2.3.5 Taxonomy for Change Order Effect

Output of variation order	Outcome	Impact/Effect
• Addition of work • Deletion of work • Rework/redesign • Work duration extension	Time extension	Time Effect
• Productivity degradation • Procurement delay • Logistic delays • Unbalanced rhythm	Loss of productivity	
• Acceleration measures • Interruption of flow of work • Loss of float • Increased sensitivity to further delays	Increased risk	
• Waste on abandoned work • Demolition and Rework costs • Increase in overheads • Additional equipment and materials • Additional payment to contractors	Direct cost increase	Cost Effect
• Making good on affected trades • Interrupted cash flow • Increased retention/ contingency sum • Overtime costs • Litigation costs	Indirect cost increase	
• Claim and dispute • Arbitration and litigation • Team change • Poor co-ordination	Relationship related	Relationship and People Effect
• Revision to work method • Site congestion • Poor safety conditions	Working conditions	
• Loss of learning curve • Lower morale • Staff turnover	Staff related	
• Quality degradation • Damage to reputation	Quality related	

Adopted form Sun & Meng (2009)

2.3.5 Variation Order Management

According to Egan, Seder, and Anderson (2012), effective management of project changes can significantly minimize the risk of overruns of costs and schedules which often lead to conflicts and claims. Establishing effective management of construction change is a challenging task; it requires an integrated system to coordinate everything involved in the change management issue (Hao *et al*., 2008).

Sun *et al.* (2006) noted that the purpose of project change management is not to eliminate project changes but to reduce the consequential impact of essential changes and to prevent redundant ones.

Moghaddam (2012) stated that change management is an application-oriented procedure that involves both engineering and project management. According to this researcher, there are two approaches towards change management the first one is reactive, which improves efficiency in handling the change after its occurrence and the other one is proactive which identifies and forecasts potential changes and develops solutions before the change occurs.

Ahmed (2013) argued that the change management process must approximate the impact of change, facilitate, document the decision, and incorporate the change by identifying and noticing any modifications from design to terms and conditions, and provide a mechanism for project approval and authorization. Any variation management system's core concept is to predict, identify, evaluate, solve, monitor, document, and learn from previous variations in a way that helps the overall project viability (Arain & Pheng, 2007).

Love *et al.* (2002) suggested that to reduce the changes in the design phase, a design freeze should be applied as early as possible. Furthermore, the researchers recommended that the project manager should exert their overall control of a project by setting contingencies and subsequently control their release. By controlling, management establishes standards and methods for measuring performance (cost, quality, time, behaviors, etc.). The performance measurements are reported periodically and compared with performance standards, and thus deviations are identified.

Ibbs *et al.* (2001) suggested a systematic approach to manage project change consisting of five principles;

- The first one is a balanced change culture; he argues that such activities can reduce the potential of conflicts between team members through communication and

documentation of the critical project success factors since they will become part of the scope of the project.

- The second principle for effective change management is to recognize the change, recognizing changes before they occur will help the team to handle changes easier and earlier in the life cycle of a project.
- The next principle is evaluation, evaluating change allows the team to define whether the proposed change should be accepted and implemented.
- The fourth principle for effective change management proposed was implementation, the change will be implemented after all parties affected directly or indirectly have been informed of the pending change and the upper management approves the changes.
- Continual improvement from experiences is the fifth principle which mainly identifies the root causes and evaluates the issues so that mistakes can be systematically corrected.

Hao *et al.* (2008) also proposed a change process model that contains five stages that are identify, evaluate, and propose, approve, implement, and review.

- Identifying change is about building up the relationships of the requirements, symptoms, malfunctions, and various other aspects of changes.
- Evaluating and proposing changes involves assessing all potential impacts on time and cost that identified changes may have on other processes and also on team members and decide whether to go forward with any of the change options or to conduct further investigations.
- The third step is to approve the changes, in this step the changes identified will go through a pre-defined approval process where all the parties concerned have to agree on a change in work described in the proposed change order through a change review process, and then the client will give the final approval. The decision will accept, improve, or reject changes, and when the change is approved the contract will be modified.
- Then the change will be implemented, in this step, an operational system is required to ensure that all aspects are revised, all parties are informed, and all operations are carried out properly and well-coordinated, and records of all relevant information on change are documented to facilitate the following change analysis procedures.
- The last step in the proposed change process model is to analyze the changes, all change and system performance is assessed based on the data collected throughout the implementation phase.

Motawa, Anumba, Lee, and Peña-Mora (2007) and Moghaddam (2012) had developed a change management process model based on previous literature and suggested that using this model will help the project team to identify changes and evaluate their impacts as early and accurately as possible. The model has four steps

- The first step is to Start-Up; at this stage, a set of criteria will be established, which are necessary for effective management of change. Such criteria enable the project team to respond to change, efficiently handle change, and promote contingency plans for any unexpected changes.
- In the second step, changes are identified and evaluated; this step will actively identify the potential changes that might occur in the future activities of the project. Change identification must include the nature, causes, and impact of change. The evaluation step involves alternative evaluation, impact assessment, and optimal selection of change alternatives, this leads to create a proposal to change order that is a brief description of the change, its effect, and the expected cost and time factors action plans.
- After the Proposal change order is prepared, appropriate team members shall approve it. Client approval is a crucial step in the process. The rest of the process involves integration between documentation and communication facilities.
- Finally, the changes are implemented and reviewed; once the change is approved it should be communicated to all the teams and disciplines whose work will be impacted by the approved change and should keep a record of all the communications. The project management team should review and comment on the proposed timetables, tasks, and plans. Preparing a lessons-learned log at this stage can contribute to better implementation of future projects and will create a priceless piece of knowledge.

Hao *et al.* (2008) noted that an integrated change management system requires technical support from different technologies, such as collaborative workflow, system integration and communication technology, modeling, web-based interactive project management software, and electronic document management tools.

Doriani (2012) as cited in Getu (2014) research; indicated that there is a web-based project management tool called Build Tools. It is accessible from anywhere and provides a foundation for all parties (contractor, subcontractor, client, and architect) communication. Build tools manages all the activities through e-mail, project documents, site photos, daily

and weekly reports, change orders, material selections, payment requests, and other necessary documents.

Charoenngam, Coquinco, and Hadikusumo (2003) also argued that internet technology has a potential advantage to deliver information in a timely, remote, and accurate manner for complex projects, for instance in construction projects it can be utilized to manage the change order process. Adopting this technology in the change order management process has advantages of using a standard set of forms for each activity in facilitating the process, prompting delivery of the documents to the addressed construction participant, confirmation that the other party has read the sent document, record-keeping through a common centralized database, therefore all parties have the same documents and no conflicts arise regarding the loss of particular forms, and avoids mismanagement of documents. On the bases of this, the researchers had proposed a web-based change order management system (COMS) which was designed

- To aid change order transaction by
  - Facilitating the timeliness of related change order documents submission,
  - Facilitating better communication between the construction participants,
  - Acting as a proactive tool for the prevention of costly disputes, and
  - Reducing cost in business processing compared to the previous paper-based system.
- Offers data storage and structure by
  - Supporting proper structured documentation providing an integrated data source,
  - Enabling to file change order requests and all related documents systematically, so that access to such documents can be facilitated.
- To Facilitate change order procedure by
  - Setting the process to follow in change orders, thereby giving the process a set of procedures, and hence control and uniformity.

Fadl (2017) similarly developed a website called Variation Order Reducing by Solutions (VORS) and it can be accessed through www.variation order.com where everyone using it has the same information and the last update, the website was designed to guide all parties involved in the construction field by identifying the most important and common causes of variation orders in the construction projects in Egypt. All data and results in VORS are obtained using a questionnaire. This website could help owners, project managers, and other parties to monitor the project perfectly by defining every cause and its weight and how to

solve or how to avoid especially for the top causes of variation order. This website was tried by five different companies from different places and commented on the VORS as it can make a new revolution in the construction projects by reducing the variation order causes.

Getu (2014) also developed a simple and friendly website oriented at real-time communication, information storage, retrieval, manipulation, transmission, and decision making. The research "Web-based construction communication in Ethiopia" includes variation orders, as one of its structural components; the researcher describes that even though variation orders are parts of written communications, separating from other letters will allow parties to pay special attention to changes in project cost and time. Moreover, unlike letters variation orders are displayed online for ease of reference.

2.4 Empirical Framework

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

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

Tewodros (2015) in his research "Causes and effects of Variation orders in road construction projects" also ranked the top five most frequently occuring causes of variation

orders as right of way (access to the site) problem, change in design, errors, and omissions in design, lack of coordination, change of plans or scope. The researcher also identified the top five effects of variation order as cost overrun, time overrun, quality degradation, disputes, and professional relations.

Tadesse (2009) also identified the five most significant causes of variation order In his study "causes and effects of variations in Ethiopian federal road projects conducted as the right of way or access to site problem, change in defined scope, lack of proper planning, lack of proper evaluation of tender documents at tendering phase by contractors, contractors financial problems. Furthermore, the researcher found that the five most significant effects of variation order are delay in project completion time, increase in project cost, suspension or hold on works, decrease in productivity, and dispute among parties.

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

An exploratory study done on residential and shopping apartment complexes by Ndihokubwayo and Haupt (2008c) found that both projects increased to 33% and 9% of the initial completion time, and many modifications during the construction phase affected time overruns. On the two projects, the variation orders occurred is 8% and 4% of the contract sum on average. Ibn-Homaid *et al.* (2011) study on "Change orders in Saudi linear construction projects" revealed that overall construction project costs increase around 11.3% on average due to changes orders.

The results of the study conducted by Alaryan, Emadelbeltagi, Elshahat, and Dawood (2014) on "Causes and Effects of Change Orders on Construction Projects in Kuwait" showed 6 to 10% of the contract value cost overrun on average due to changes and the schedule overrun was shown to be in the range of 10 to 20%. Senouci, Alsarraj, Gunduz, and Eldin (2016) also pointed out that change orders in the civil work caused 42% of the project cost overrun. According to Sunday (2010) study on the "Impact of Variation Orders

on Public Construction Projects", an approximate cost overrun of 25.29% and an increase in the duration of the projects with an average of 27.25% time overrun was obtained.

In a research made by Hanif *et al.* (2014) on "Impact of Variation Orders on Time and Cost in Mega Hydropower Projects of Pakistan" three case studies were conducted, and only a few key variation orders were found to cause the majority of the total impact, in the first case four variation order initiated by a change in design, discrepancies between documents, change of scope and error and omissions in design lead to 50% of the total time and 56% cost overrun of the project, the second case had encountered 40% time overrun and 63% cost overrun of the project's total cost due to variation orders and in the third case variation order had 94% and 71% of the total time impact on cost and time respectively.

Aneesa, Mohamed and Razek (2013) in the study "Evaluation of change management efficiency of construction contractors" concluded that the average cost overrun due to change orders was between 11 and 15% of the original contract value whereas the average time overrun was between 10 and 20% of the original project duration. Hsieh, Lu, and Wu (2004) in their study also found that the ratio of change order cost to total project cost is typically 10–17% in metropolitan public works

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

The study result of Tadesse (2009) based on his study on 12 projects in the Ethiopian Federal Road Projects shows that the magnitude of variations in these projects ranges from 0.72 % to 109 % with 38 variation orders. In another study made by Tewodros, (2015) the findings from 16 randomly selected city road projects showed all projects faced variation orders ranging from 1 to 7 and an increase of 24.11 % of the original project contract amount and time overrun of 126.50% of the original contract period.

2.5 Synthesis

The literature review shows that researchers have identified variations in more than one way. However, it would be reasonable to generalize and summarize variations as any addition, deletion, modification, or a substitution on the original design drawings, plans, and documentation requested by the project's owner or owner's representative. According to the literature variations in the construction sector are common but unwanted. Variations, their causes, and effects have been studied by a wide range of researchers in different

geographical locations and with different analytical methodologies, tools, and techniques but not many in Ethiopia.

In one study conducted by Ndihokubwayo (2008a) the researcher obtained that more than 85% of site instructions were variation orders. Smith (2016) also revealed that 75% of the projects had about 3 or more variation orders and 25% of the projects had about 9 or more variation orders, he mentioned that not only did all projects have a variation order, but multiple variation orders were common in most construction projects. Aneesa *et al.* (2013) concluded that on average 11-15% of the original contract of cost overrun was due to change order whereas the average time overrun was between 10 and 20% of the original project duration. The effect of variations on the project time is also observed to be considerable in Yogeswaran *et al.* (1998) study in which 50% of the projects surveyed had been granted an extension of time due to variations.

2.6 Conceptual Framework

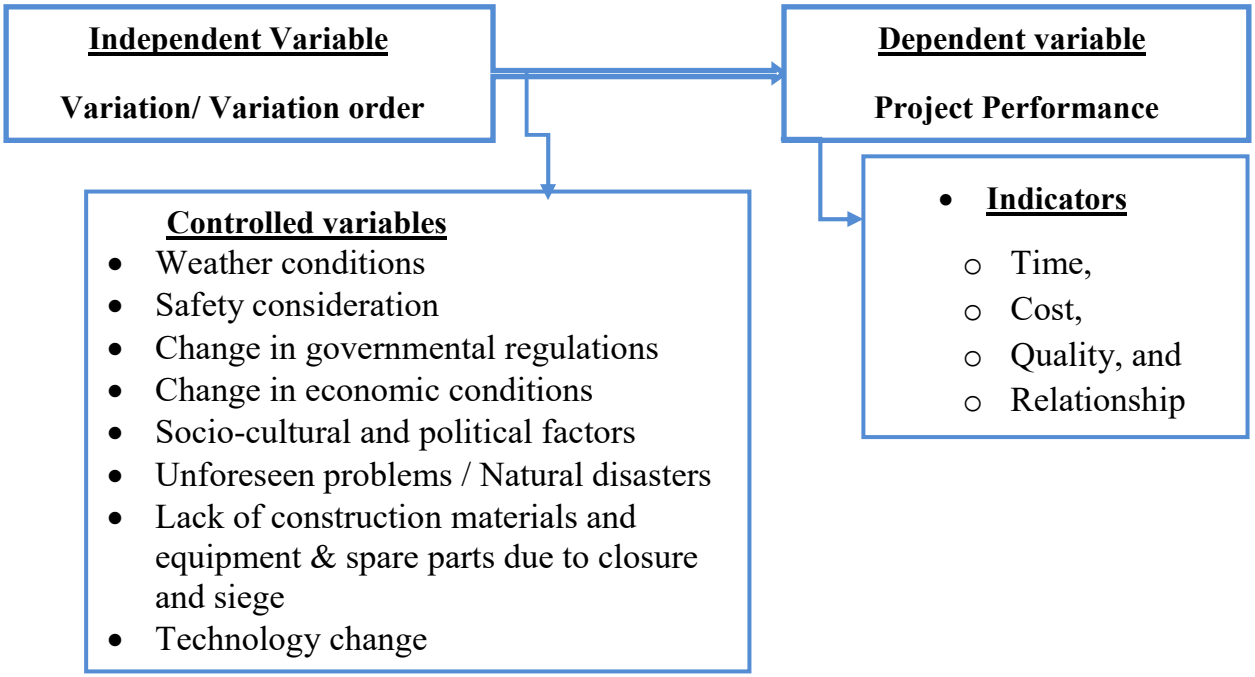


Figure 2.6.1 Conceptual Framework

2.7 Chapter Summary

This chapter reviewed the literature on variation orders and their effect on project performance. Based on the above literature review, the researchers have identified a large number of factors causing variation order which may be responsible for affecting construction projects performance and identified effects of variation order that leads to delays, variations, and cost impacts affect the overall project performance. The researcher further developed a conceptual framework for the study based on the reviewed literature.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the method used to conduct this research. The chapter starts by defining the research approach and research design used for this research. Following that the target population for the study, the sample size, sampling techniques are discussed. Furthermore, the data source, data collection methods, instruments, and methods of data analysis are covered.

3.2 Research Approach and Design

3.2.1 Research Approach

This research has adopted a quantitative approach to find answers to the research questions and test the hypothesis. The quantitative research approach as discussed by Creswell (2014) is an approach for testing objective theories by testing the relationship between variables. The researcher explained that quantitative data is needed to identify factors that affect an outcome in research. Since the objective of this research is to study variation orders and their effects on road construction projects, this approach is chosen to aid the researcher in understanding the relationship between variation order and project performance and develop a causal explanation.

3.2.2 Research Design

Kothari (2004) described research design as the conceptual structure in which research is conducted; it provides the direction for the collection, measurement, and analysis of data. This study has adopted a survey research design which according to Fowler (2008) as cited by Creswell (2014) is suitable for those studies that seek to determine relationships between variables in which it will provide a quantitative description of trends and opinions of a population by studying a sample of that population.

As described by O'Leary (2004) survey can be either a descriptive or explanatory survey. To attain the objectives of the study the researcher carried out an explanatory survey that goes beyond description and seeks to explain why and how things are the way they are. Explanatory surveys not only would describe attitude or opinion, but aim to establish what

might be the cause and the effect that would create more concrete understandings and goes beyond description, or even correlation, to determine cause and effect.

This design involves using questionnaires for primary data collection to generalize from a sample to a population to rigorously study and develop causal explanations of variation orders and their effect on project performance.

3.3 Population, Sample Size, and Sampling Technique

3.3.1 Population

The population for this research includes different parties involved in road construction projects, i.e. professionals working for clients, contractors, and consultants. For this study, the target population includes

1. Professionals working for clients: The target client for this study is the governmental organization responsible for the construction of new asphalt roads in Addis Ababa, which is Addis Ababa city road authority (AACRA).
2. Professionals working for consulting firms: The target consulting firms for this study are road and bridge consultants working on asphalt road projects in the city under Addis Ababa city road authority (AACRA).
3. Professionals working for construction companies: The target construction companies for this study are road and bridge contractors and general contractors working on new asphalt road projects in the city under Addis Ababa city road authority (AACRA).

3.3.2 Sample Size

In this study there are three parties involved these are the clients, road and bridge consultant, and grade one general and road contractors. There were about 22 construction sites in the city at the time of the data collection. Out of those sites, two of them were given to an international contractor with a DB contract and the other two are being constructed by AACRA's own force. Therefore, the study took the 18 DBB projects under study and for these projects, there are 10 contract administrators in Addis Ababa city road authority, 11 consultants working on asphalt road projects under AACRA, and 16 roads and bridge contractors and general contractor currently working under the authority (AACRA). Since the target group is small in size and believed that they can provide adequate information about the study subject, the researcher chose the census method and includes the professionals from the three parties working in the 18 projects under the study.

3.3.3 Sampling Technique

In this study given the nature of required data to be gathered from the anticipated cooperation of selected participant, the client was selected using purposive sampling which according to Kumar (2011) considers the researcher's judgment as to who can provide the required information and in the position to provide the required information. Greener (2008) added that purposive sampling can be used when the samples and population are very small.

Therefore, using purposive sampling the selected client was a governmental organization that is authorized to construct, maintain, and administer the road and highway construction works in Addis Ababa that is Addis Ababa City Road Authority (ACCRA). The target population for road contractors and consultants that work under Addis Ababa City Road Authority (ACCRA) were also selected using purposive sampling because it is believed they can provide the required information.

3.4 Data Collection Techniques and Procedures

3.4.1 Data Source

To fulfill the purpose of the study, the researcher used both primary and secondary data.

Primary data: preliminary discussions were made with two professionals from the client's side and one consultant to obtain the prevalence of variation order initially then preceded by a structured close-ended questionnaire through the samples selected for further representative data.

Secondary data: was gathered through desk study from the client's office records on the previous works and reports to obtain the actual effects of a variation order.

3.4.2 Data Collection Instrument

The researcher first collected data about the prevalence of variation and its effect on project performance through preliminary discussions, extensive literature review, and conducted a desk study to study the existing situation. Based on the review of literature and desk study, the researcher produced questionnaires to obtain first-hand information for the subject matter to understand the main concerns and attitudes of respondents towards the variation order issues.

3.4.2.1 Desk Study

A desk study was conducted to evaluate the existence and extent of variation orders for selected completed road projects in the city of Addis Ababa under the Ababa City Road Authority (ACCRA). Documents surveyed include project progress reports, contract documents, and other complementary documents. Based on the data, the total amount of variation is compared to their corresponding original contract amount and time.

3.4.2.2 Questionnaire

Based on the review of related literature and the variables that were identified as the cause of variation orders and their effects on road construction project performance a structured questionnaire was designed to determine the opinion of the client, contractors, and consultants regarding the causes, effects of variation order on road construction projects in Addis Ababa.

The questionnaire starts with a brief covering letter that contains general information about the research as well as the researcher, explains the purpose of the study, and assures the strict anonymity of the respondents. The questionnaire contains closed-ended questions that require short responses and are easy to ask and quick to answer, it requires little writing by respondents. It can be answered easily by just ticking in the boxes given.

The questionnaire was designed based on the variables that were identified in the review of literature as the causes of variation order and their effects on road construction project performance. The questionnaire was composed of three parts to accomplish the objectives of the research namely Part I, Part II, and Part III. Part I consists of General information (company and respondent profile), Part II is about the prevalence of variations in the road construction projects, Part III consists of cause and effect of variation orders. The sample of the questionnaire survey used in this study is attached in Appendix A.

The items on part II and III of the questionnaire are measured on a 5-point Likert scale. Likert-type responses are known as psychometric item scoring system for attempting to quantify people's opinions on different issues (Bishop & Herron, 2015). According to Joshi *et al.* (2015), in Likert scale, a set of statements (items) offered for a real or hypothetical situation under study, and participants are asked to show their level of agreement (from strongly disagree to strongly agree) with the given statement (items) on a metric scale and reveal the specific dimension of the attitude towards the issue. In this research 5 point Likert scale is used, in which 5 stands for strongly agree, 4 for agree, 3 for neutral, 2 for disagree, and 1 for strongly disagrees.

3.4.3 Data Collection Procedure

Once the questionnaire was designed and written, a pre-testing (Pilot) questionnaire was conducted before distributing the final questionnaire to 15 professionals in the industry. A pilot test according to Creswell (2014) is necessary to ensure that the questionnaire can be administered without variability to the experimental group. Therefore, the objective of the pilot study was to verify the reliability and completeness of the questionnaire. Following the return of the questionnaires some modifications were made such as some factors were merged (rearranged) based on the response of the professionals to give more suitable and consistent meaning and reliability of the questionnaire were tested by Cronbach's Coefficient Alpha method. Then the final version of the questionnaires was prepared as shown in Appendix A.

The questionnaires for the target governmental organization (referred to here as a client) were hand-delivered and then distributed to the 10 contract administrators in the department. Then these respondents sent out these questionnaires to their respective projects through E-mail and telegram for both consultants and contractors to fill due to the current global situation (Covid -19 Pandemic). The process was time-consuming given the current situation and that most respondents require the presence of the researcher to return responses quickly.

3.5 Data Analysis

To meet the specific objectives of the study the data collected from both primary and secondary sources require interpreting and analysis to provide complete and meaningful results.

To analyze quantitative data from primary sources, simple statistical methods were adopted by using Statistical Package for Social science (SPSS). According to Field (2009) SPSS is the most commonly used statistical package for statistical analysis in social science. According to Kothari (2004) in the case of survey data, quantitative data analysis involves estimating the values of unknown parameters of the population and testing hypotheses to conclude. Hence, analysis can be categorized as descriptive analysis and inferential analysis or statistical analysis. Therefore, descriptive analysis such as frequencies, percentages, mean, standard deviation, and inferential/ statistical analysis/ regression analysis was used to analyze the data obtained from the questionnaire.

Descriptive statistics is used to describe and summarize the basic features of the data in research, and are used concisely and coherently to provide quantitative explanations.

Descriptive statistics provides measures of central tendency, dispersion, and distribution shape (O'Leary, 2017). Creswell (2014) added that a descriptive analysis of data is used for all independent and dependent variables in a study. Therefore, the descriptive statistics for factors causing variation orders and their effects are computed and presented using tables. And the most important factors of variation order and the most important effects of variation order are ranked using the relative importance index formula and presented with discussion.

According to Kothari (2004) regression analysis is concerned with analyzing how changes in another variable influence the other variables. Therefore, the effect of the independent variable (variation order) on project performance was tested using a regression model. The inferential statistics results were used to test the hypotheses stated in this study. This method helps in assessing the probability that the findings observed are not just an accident or by chance. It is about conducting statistical tests that can show statistical significance (O'Leary, 2017).

3.6 Description of Study Variables

- Dependent Variable (Y): - Effect on Project Performance
- Independent Variables (X): - Variation Order

Linear Regression Model

$$Y= \alpha+ \beta X +e$$

Where Y = Effect on Project performance
α = constant
β = Coefficient of X
X= Variation order
e= sampling error

3.7 Research Hypothesis

H_1= Variation order has effect on road construction project performance

H_0= Variation order has no effect on road construction project performance

3.8 Validity

According to Kothari Validity is the extent to which alterations are found with a measuring tool that reflects true alterations among those being tested. Therefore, a pilot test was conducted to check the validity of the instrument if it provides adequate coverage of the topic under study, whether the content of the items will be relevant in helping answer the research questions as well as to check the clarity of the questions through discussion with experts.

3.9 Reliability

The test of reliability is a necessary test of good measurement. An instrument is said to be reliable if it provides consistent results (Kothari, 2004). According to Kumar (2011), a research tool is said to be reliable if it is consistent and stable, hence predictable and accurate in which a test is reliable to the extent that if repeated under constant conditions will give the same result.

The technique applied to assess the reliability of the data collection instrument in this study is Cronbach's Coefficient Alpha (α). Cronbach's alpha (α) indicates the overall reliability of a questionnaire and values around 0.8 are good or must be equal/greater than 0.7 to reach the reliability of an acceptable instrument (Field, 2009).

The Cronbach's alpha coefficient was calculated using SPSS and the subsequent relationship between the individual items was examined. The results obtained are summarized as follows and the output tables of the SPSS are attached in Appendix B.

Table 3.9.1 Reliability Test Result

Variables	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Prevalence	0.737	0.738	2
Owner related factors	0.731	0.73	12
Contractor related factors	0.809	0.818	13
Consultant related factors	0.835	0.835	16
Effects on project performance	0.873	0.862	16
Over all reliability	0.906	0.908	59

Source: Own Survey (2020)

The above table shows that the Cronbach's alpha reliability result (internal consistency) for each question is above 0.7 therefore using the rule of thumb, the Cronbach's alpha value of the study is within the acceptable level. This indicates that the variables are reliable. The variables consist of sub variables or responses in the questionnaire that rolled up into the variable.

3.10 Ethical Consideration

This research has taken ethical consideration into account throughout data collection. The research tool had an introduction on the first page with a clear elaboration of the objectives of the study and indicates that the participant's identities were kept anonymous. Each selected respondent was informed that her/his response is voluntary and only those who provided written consent were taken part in the study. Moreover, the study was conducted by the ethics of social research ranging from professional ethics to those concerning the researcher-respondent relationship. Other scholars' works were acknowledged throughout the research process and all who assisted the researcher in any way were given due respect.

3.11 Chapter Summary

In this chapter, the research methods used are presented. The research approach adopted for this study was quantitative research method and the research design was a survey design which allows the researcher to study the nature, causes, and effects of variation orders by asking the opinions of professionals. The sources and data collection methods for primary and secondary data were outlined. These included the literature review, survey, sampling, and desk study. Methods for data analysis and appropriate tests were also discussed in this chapter.

CHAPTER FOUR

ANALYSIS AND INTERPRETATION OF DATA

4.1 Introduction

This research studied the causes and effects of variation orders on road construction project performance in Addis Ababa. This chapter presents the output of the analysis and discusses major findings. The data collected were analyzed using the Statistical Package for Social Science (SPSS) version 20. The data analysis and discussion were carried out and organized according to the objectives of the research. The analysis output is presented in form of figures and tables. The major findings are discussed and the results are compared to the literature review.

4.2 Response Rate

A total of 60 questionnaires were distributed to all parties that are client (Addis Ababa City Road Authority) consultants, and contractors that work under the Addis Ababa city road authority. Since there are approximately 2- 3 professionals from contractor and consultants at the respective sites the researcher has sent out 25 questionnaires each to the contractors and consultants and 10 were given to the client. Out of these questionnaires, 52 were filled properly and returned. As a result, the overall response rate was 86.7 percent which is acceptable for data analysis and discussion of the study.

4.3 Respondents' Profile

The target respondents of the questionnaire survey were engineers from different parties involved in the road construction industry in Addis Ababa working in projects belonging to the Addis Ababa city road authority.

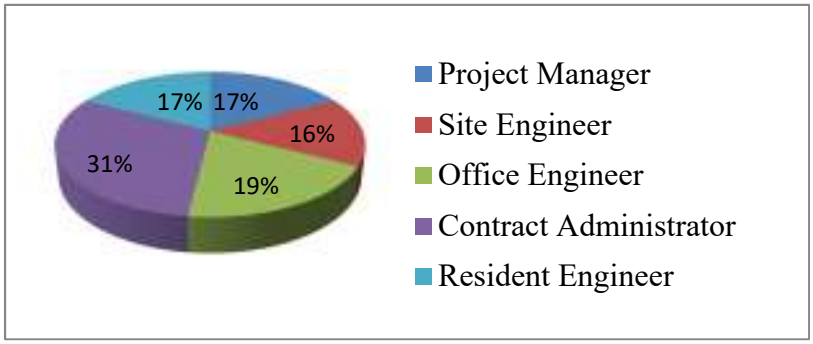
Among the respondents, 20 (39 %) were contractors, 22 (42%) were consultants and the rest 10 (19%) were client or representative of the owner as shown below in table 4.3.1.

Table 4.3.1 Nature of Organization

Organization	No of distributed questionnaires	No of Returned questionnaire	
Contractor	25	20	39%
Consultant	25	22	42%
Client	10	10	19%
Total	60	52	100%

Source: Own Survey (2020)

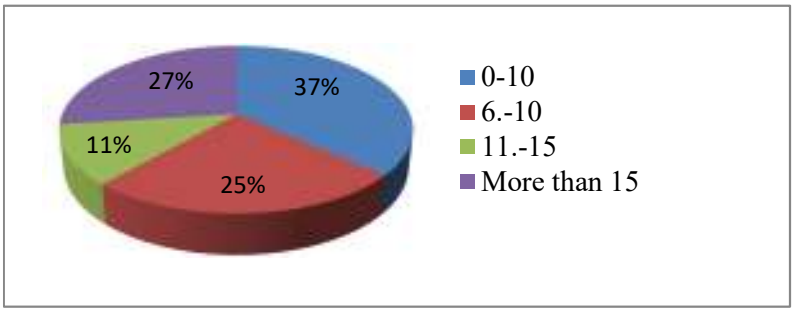
Concerning their positions a majority of the respondents were working as contract administrators (31%), 19% were working as an office engineer, 17%, project manager 17%, Resident engineers, and the rest 16% were site engineers as shown in figure 4.3.1.



Source: Own Survey (2020)

Figure 4.3.1 Professional Background

In terms of the year of experiences of the respondents' majority of the respondents have above 6 years' experience. 37% of the respondents have 0-5 years' experience, 25% has 6-10 years' experience, and 11% has 11-15 years' experience where the rest 27% has more than 15-year experience.



Source: Own Survey (2020)

Figure 4.3.2 Working Experience of Respondents

Based on the professional background and years of experience, it is safe to say that the respondents for this study have a good understanding of the study matter, and could thus provide reliable answers to the questionnaire.

4.4 Descriptive Analysis

4.4.1 Result

This section presents the finding of descriptive analysis of the respondent's opinion towards the causes of variation orders and their effect on project performance. Descriptive statistics were used to evaluate and rank the most important causes and effects of a variation order. The RII method was adopted for this study to determine the relative importance of the various causes and effects of variation orders based on responses of the owner, contractors

and consultants. The relative importance index (RII) ranges from 0-1. The five-point likert scale ranged from 1-5 was transformed to relative importance index using the following equation

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

Where: w is the weighting given to each factor by respondent ranging from 1t o 5

A is the highest weight meaning 5 in this case

N is the total of respondents

The descriptive statistics including the mean and standard deviation along with their ranks are presented in the following tables. The entire frequency and percentage of factors contributing to variation orders and their effects are attached in Appendix C. A mean scores of 0-1.5 means that the respondents strongly disagree with the measurement variable presented in this study, between 1.50 to 2.50 means they are disagreeing, 2.50 to 3.50 means the respondents were neutral or not Sure, for a mean score of 3.50-4.50 respondents have agreed and for a mean over 4.50, respondents have strongly agreed by the statement.

4.4.1.1 Prevalence of Variation/ Variation Order

Table 4.4.1 Descriptive Statistics of Prevalence of Variation/ Variation Order

No	Item	Mean	Std
1.	Variation/change is a problem in Ethiopian construction industry in general and that of road construction projects in particular?	4.385	0.491
2.	Variation orders frequently occur in Ethiopian road construction projects.	4.366	0.525

Source: Own Survey (2020)

Under the prevalence of the problem, there were two statements in a Likert scale which focused mainly on the existence of variation order in Ethiopian road construction projects and how frequent it occurs. Table 4.4.1 shows the means score based on the response of the participants regarding the prevalence of variation/variation order.

As it can be seen in Item 1 (Variation/change is a problem in the Ethiopian construction industry in general and that of road construction projects in particular?), scored a mean value of 4.385 indicating that most of the respondents tend to agree with the existence of variation in the Ethiopian construction industry in general and that of road construction projects in particular. In Item 2 (Variation orders frequently occur in Ethiopian road construction projects), the mean score (4.366) shows that most respondents agreed that variation orders occur frequently in Ethiopian road construction projects.

4.4.1.2 Factors Causing Variation/ Variation Order

Table 4.4.2 Descriptive Statistics of Factors Related to Owners Causing Variation/ Variation Order

No	Item	Mean	Std	RII	Rank
1	Change of project scope by owners	3.558	0.998	0.71154	7
2	Change of implementing schedule by owner	3.404	0.913	0.68077	9
3	Unrealistic contract durations imposed by client	3.692	1.02	0.73846	5
4	Owner's financial problems	3.462	1.02	0.69231	8
5	Weakness in prompt decision making process	3.673	0.879	0.73462	6
6	Inflexible nature of owner	3.096	0.995	0.61923	11
7	Change in specification by owner	3.096	1.11	0.61923	11
8	Inadequate experience of owner's staff	3.135	1.067	0.62692	10
9	Owner instructs additional works	4.135	0.715	0.82692	3
10	Design change originated by owner	3.827	0.964	0.76538	4
11	Right of way (Difficulties faced in land acquisition by the client)	4.54	0.939	0.90769	1
12	Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing.	4.192	1.138	0.83846	2

Source: Own Survey (2020)

Under factors causing variation/ variation order, there are three categories these are owner related factors, contractor related factors, and consultant related factors. Table 4.4.2 shows the means score based on the response of the participants concerning the factors related to owners leading to variation/variation order are presented.

In item 1 (Change of project scope by owners), the mean score is 3.558 which implies most of the respondents lean towards agreeing that change orders are more likely to be caused by the change of project scope initiated by owners.

In item 2 (Change of implementing schedule by owner), the mean score (3.404) indicates that most of the respondents tend to be neutral that change of implementing schedule by owner causes change orders.

In item 3 (Unrealistic contract durations imposed by client), the mean score is 3.692 which implies most of the respondents lean towards agree on that unrealistic contract durations imposed by the client is one of the causes for variation orders.

In item 4 (Owner's financial problems), the mean score is 3.462 which implies most of the respondents tend to stay neutral that the owner's financial problems could be one of the reasons that result in variation order.

In item 5 (Weakness in prompt decision-making process), the mean score (3.673) implies most of the respondents agree that weakness in the prompt decision-making process could be one of the many causes for variation orders in construction projects.

In item 6 (Inflexible nature of owner), the mean score is 3.096 which implies most of the respondents lean towards neutral that the inflexible nature of the owner is a cause for a variation order.

In item 7 (Change in specification by owner), the mean score is 3.096 implying most of the respondents chose to stay neutral that variation orders are caused as a result of a change in specification by the owner.

In item 8 (Inadequate experience of owner's staff), the mean score is 3.135 which implies most of the respondents stayed neutral that variation orders could be caused as a result of the inadequate experience of owner's staff.

In item 9 (Owner instructs additional works), the mean score (4.135) shows that most respondents agree that owner instructing additional works is one of the causes for variation order in construction projects.

In item 10 (Design change originated by owner) the mean score 3.827 which implies most of the respondents lean towards agree on that variation orders may result due to design change originated by owner.

In item 11 (Right of way (Difficulties faced in land acquisition by the client)), the mean score is 4.54 implying that most respondents strongly agree that one of the causes for variation orders is difficulties faced in land acquisition by the client (right of way).

In item 12 (Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing), the mean score (4.192) shows that most respondents agree that variation orders are caused due to delays in obtaining permits from local authorities or insufficient coordination between various departments in utility shifting and placing.

Table 4.4.3 Descriptive Statistics of Factors Related to Contractors Causing Variation/Variation Order

No	Item	Mean	Std	RII	Rank
1	Lack of specialized construction manager	3.615	1.032	0.72308	8
2	Poor procurement process	3.962	0.928	0.79231	3
3	Misunderstanding of tender documents during cost estimate stage	4.096	0.799	0.81923	2
4	Contractor desire to improve his financial conditions based on contract gaps	3.885	0.878	0.77692	4
5	Contractor's financial difficulties	4.12	0.878	0.82308	1
6	Technical incompetency of contractor and unavailability of the required labor skill	3.692	0.919	0.73846	6
7	The required equipment and tools not being available	3.365	1.253	0.67308	12
8	Workmanship or material not meeting the specifications	3.462	1.075	0.69231	11
9	Lack of equipment efficiency	3.577	0.915	0.71538	10
10	Errors during construction	3.462	0.828	0.69231	11
11	Improper construction methods	3.596	0.891	0.71923	9
12	Value engineering (mechanism of saving cost for mutual benefit)	3.62	0.99	0.72308	7
13	Poor performance of subcontractors	3.75	1.03	0.75	5

Source: Own Survey (2020)

Table 4.43 shows the means score based on the response of the participants with respect to the factors related to contractors leading to variation/variation order are presented.

In item 1 (Lack of specialized construction manager), the mean score is 3.615 which implies most of the respondents lean towards agreeing that change orders are more likely to be caused by lack of specialized construction manager.

In item 2 (Poor procurement process) the mean score is 3.962 which implies most of the respondents tend to agree that variation orders may result due to poor procurement process.

In item 3 (Misunderstanding of tender documents during the cost estimate stage), the mean score is 4.096 which implies most of the respondents agree that misunderstanding of tender documents during cost estimate stage is one of the causes for variation orders.

In item 4 (Contractor desire to improve his financial conditions based on contract gaps), the mean score is 3.885 which implies most of the respondents agree that variation orders could be caused as a result of contractor desire to improve his financial conditions based on contract gaps.

In item 5 (Contractor's financial difficulties), the mean score is 4.12 implying that most respondents agree that one of the causes for variation orders is the contractor's financial difficulties.

In item 6 (Technical incompetency of contractor and unavailability of the required labor skill), the mean score is 3.692 implying most of the respondents lean towards agreeing that technical incompetency of contractor and unavailability of the required labor skill is one of the causes that result in variation order.

In item 7 (The required equipment and tools not being available), the mean score is 3.365 which implies most of the respondents stayed neutral that the availability of the required equipment and tools could be one of the many causes for variation orders in construction projects.

In item 8 (Workmanship or material not meeting the specifications), the mean score (3.462) indicates that most of the respondents tend to be neutral that workmanship or material not meeting the specifications causes change orders.

In item 9 (Lack of equipment efficiency), the mean score is 3.577 which implies most of the respondents agree that lack of equipment efficiency could be one of the many causes for variation orders in construction projects.

In item 10 (Errors during construction) the mean score is 3.462 which implies most of the respondents chose to stay neutral that variation orders may result due to errors during construction.

In item 11 (Improper construction methods), the mean score is 3.596 which implies most of the respondents agree that variation orders could be caused as a result of improper construction methods.

In item 12 (Value engineering (mechanism of saving cost for mutual benefit)), the mean score is 3.62 implying that most of the respondents tend to agree that mechanism of saving cost for mutual benefit (Value engineering) is one of the many reasons variation orders are created.

In item 13 (Poor performance of subcontractors), the mean score is 3.75 which implies most of the respondents lean towards agree on the performance of subcontractors is one of the causes for variation orders.

Table 4.4.4 Descriptive Statistics of Factors Related to Consultants Causing Variation/Variation Order

No	Item	Mean	Std	RII	Rank
	Consultant Related Factors				
1	Change in design by consultant	3.827	0.944	0.76538	10
2	Errors and omission in design	4.231	0.783	0.84615	3
3	Conflicts between contract documents (insufficient detail)	4	0.741	0.8	6
4	Lack of coordination among project parties	3.865	0.886	0.77308	8
5	Lack of consultant's knowledge of available materials and equipment	3.135	1.138	0.62692	14
6	Failure by the consultant to provide adequate and clear information in the tender documents	3.827	0.901	0.76538	10
7	Failure by the consultant to perform design and supervision effectively	3.827	1.004	0.76538	10
8	Substitution of material or procedures	3.481	0.918	0.69615	13
9	Award project to the lowest bid price	4.308	0.919	0.86154	2
10	Unreasonable project time frame	3.981	0.939	0.79615	7
11	Changes in specifications	3.712	0.825	0.74231	11
12	Changes in grade of work (Deviation from original scope of work)	3.885	1.06	0.77692	9
13	Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study	4.442	0.639	0.88846	1
14	Incomplete bill of quantities (BOQ)	4.077	0.71	0.81538	5
15	Consultant’s lack of judgment and experience	3.519	0.959	0.70385	12
16	Poor estimation	4.096	0.693	0.81923	4

Source: Own Survey (2020)

Table 4.4.4 presents the means score based on the response of the participants concerning the factors related to the consultant that lead to variation/variation order.

In item 1 (Change in design by the consultant), the mean score is 3.827 implying most of the respondents lean towards agreeing that change in design by the consultant is one of the causes initiated by consultants that results in variation order.

In item 2 (Errors and omission in design), the mean score is 4.231 indicating that most respondents agree that errors and omission in design cause variation orders.

In item 3 (Conflicts between contract documents (insufficient detail)), the mean score (4.000) shows that most respondents agree that that variation orders are caused due to insufficient details (conflicts between contract documents).

In item 4 (Lack of coordination among project parties), the mean score (3.865) implies most of the respondents agree that variation orders could be caused as a result of lack of coordination among project parties.

In item 5 (Lack of consultant's knowledge of available materials and equipment), the mean score (3.135) represents most of the respondents stayed neutral that lack of consultant's knowledge of available materials and equipment is a cause for a variation order.

In item 6 (Failure by the consultant to provide adequate and clear information in the tender documents) the mean score is 3.827 which implies most of the respondents lean towards agreeing that variation orders may result due to failure by the consultant to provide adequate and clear information in the tender documents.

In item 7 (Failure by the consultant to perform design and supervision effectively) the mean score (3.962) indicates most of the respondents tend to agree that that variation orders may result due to poor procurement process.

In item 8 (Substitution of material or procedures), the mean score (3.481) indicates that most of the respondents chose to be neutral that the substitution of material or procedures causes change orders.

In item 9 (Award project to the lowest bid price), the mean score is 4.308 which implies most of the respondents agree that awarding the project to the lowest bid price is one of the many causes for variation orders in construction projects.

In item 10 (Unreasonable project time frame), the mean score is 3.981 which indicates most of the respondents lean towards agreeing that an unreasonable project time frame is one of the causes that results in variation order.

In item 11 (Changes in specifications), the mean score is 3.712 which implies most of the respondents lean towards agreeing that change orders are more likely to be caused by changes in specifications.

In item 12 (Changes in the grade of work (Deviation from the original scope of work)) the mean score is 3.885 which imply most of the respondents tend to agree that deviation from the original scope of work or changes in the grade of work is a cause for a variation order.

In item 13 (Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study), the mean score is 4.442 implying that most respondents agree that

one of the causes for variation orders is unforeseen site conditions/ unexpected ground conditions and terrain due to inefficient site study.

In item 14 (Incomplete bill of quantities (BOQ)), the mean score (4.077) shows that most respondents agree that variation orders are caused due to an incomplete bill of quantities.

In item 15 (Consultant's lack of judgment and experience), the mean score is 3.519 which implies most of the respondents lean towards agreeing on that change orders are more likely to be caused by lack of judgment and experience of the consultants.

In item 16 (Poor estimation), the mean score (4.096) shows that most respondents agree that variation orders are caused due to poor estimation.

4.4.1.3 Effect of Variation on Project Performance

Table 4.4.5 Descriptive Statistics of Effect of Variation on Project Performance

No	Item	Mean	Std	RII	Rank
	Effect on Project Management				
1	Time extension (Time overrun)	4.712	0.457	0.94231	1
2	Loss of productivity	3.961	0.839	0.79231	6
3	Increased risk	4.173	0.584	0.83462	5
4	Direct cost /Indirect cost increase (Cost overrun)	4.596	0.495	0.91923	2
5	Claim and dispute	4.423	0.605	0.88462	3
6	Arbitration and litigation	3.712	0.8	0.74231	9
7	Team change	3.538	0.851	0.70769	12
8	Poor co-ordination	3.846	0.894	0.76923	7
9	Revision to work method	4.211	0.572	0.84231	4
10	Site congestion	3.519	0.828	0.70385	13
11	Poor safety conditions	3.403	0.955	0.68077	15
12	Loss of learning curve	3.192	0.908	0.63846	16
13	Lower morale	3.462	1.019	0.69231	14
14	Staff turnover	3.769	8.544	0.75385	8
15	Quality degradation	3.615	1.087	0.72308	11
16	Damage to reputation	3.692	1.076	0.73846	10

Source: Own Survey (2020)

Table 4.4.5 shows the means score based on the response of the participants concerning the effects of variation orders on project performance

In item 1 (Time extension (Time overrun)), the mean score is 4.712 indicating that most respondents strongly agree that one of the major effects of variation order on project performance is time extension (time overrun).

In item 2 (Loss of productivity) the mean score is 3.961 which implies most of the respondents tend to agree that variation order results in loss of productivity.

In item 3 (Increased risk), the mean score (4.173) shows that most respondents agree that variation orders could result in an increased risk of the project.

In item 4 (Direct cost /Indirect cost increase (Cost overrun)), the mean score (4.596) shows that most respondents strongly agree that one of the major effects of variation order on project performance is an increase in direct/ indirect cost (Cost overrun).

In item 5 (Claim and dispute), the mean score is 4.423 implying that most respondents agree that claim and dispute is one of the effects of variation order on project performance.

In item 6 (Arbitration and litigation) the mean score is 3.712 which implies most of the respondents tend to agree that variation order could result in arbitration and litigation.

In item 7 (Team change) the mean score (3.538) indicates most of the respondents tend to agree that variation orders create changing of teams which in turn affects the performance of the project.

In item 8 (Poor co-ordination), the mean score (3.846) indicates that most of the respondents tend to agree that poor co-ordination in a project could be a result of variation orders.

In item 9 (Revision to work method), the mean score (4.211) shows that most respondents agree that variation orders result in a revision of the work method.

In item 10 (Site Congestion), the mean score is 3.519 which implies most of the respondents lean towards agreeing that project performance could be affected by site congestion resulted from variation orders.

In item 11 (Poor safety conditions), the mean for this item is 3.403 which implies most of the respondents chose to stay neutral that poor safety conditions could be one of the many effects of variation orders in construction project performance.

In item 12 (Loss of learning curve), the mean score is 3.192 which implies most of the respondents stayed neutral that variation order could result in loss of learning curve.

In item 13 (Lower morale), the mean score (3.462) indicates most of the respondents chose to stay neutral that variation orders lower morale which in turn affects the performance of the project.

In item 14 (Staff turnover), the mean score 3.769 which implies most of the respondents tend to agree that variation order could result in staff turnover.

In item 15 (Quality degradation) the mean for this item is 3.615 which implies most of the respondents tend to agree that variation order results in quality degradation.

In item 16 (Damage to reputation), the mean for this item is 3.692 which implies most of the respondents agree that damage to reputation could be one of the effects of variation orders.

4.4.2 Discussion

Since the first objective of this study was to assess the prevalence and check whether variation order exists in road construction projects and it is a problem in Addis Ababa City road construction projects, data was gathered through a desk study from some completed Addis Ababa City Road construction projects as presented in table 15 and 16 below. In the meantime, as presented in the tables above professionals involved in the road sector program were also asked to express their opinion on whether the variation is a problem or not in road construction projects as well as in the Ethiopian road construction industry. The findings obtained from both sources revealed variation as one of the major problems in Ethiopian road construction projects also indicating it is a problem in the Addis Ababa road construction industry.

Similarly, the data from the desk study of completed road construction projects in Addis Ababa under Addis Ababa city road authority showed that variation is one of the major problems in road construction projects. As indicated in the following table (Table 4.4.6) most of the percentage of variations in selected completed road construction projects in Addis Ababa exceeds the contingency amount to the extent one exceeded 100% of the original contract amount. And the average value of variation order was determined to be 30.46%. Like these findings Tadesse (2009) also found that the magnitude of variation based on his desk study at the Ethiopian road authority to be in a range from 0.72 % to 109 %. Tewodros, (2015) also revealed that in average projects faced an increase of 24.11 % of the original project contract amount and time overrun of 126.50% of the original contract period.

Table 4.4.6 Amount and Percentage of Variation in Selected Addis Ababa Road Projects

No	Project	Length (m)	Project Status	Original Contract Amount (Birr)	Revised Contract Amount (Birr)	Amount Due to Variations (Birr)	Variation in %
1	Project A	5877	Completed	388,922,928.30	607,553,972.50	218,631,044.20	56.21%
2	Project B	1990	Completed	106,276,763.04	120,625,177.70	14,348,414.66	13.50%
3	Project C	865	Completed	171,217,780.66	207,443,019.77	36,225,239.11	21.16%
4	Project D	5820	Completed	186,488,010.36	231,067,778.36	44,579,768.00	23.90%
5	Project E	2163	Completed	96,235,273.75	120,096,346.01	23,861,072.26	24.79%
6	Project F	630	Completed	83,460,928.58	91,936,933.53	8,476,004.95	10.16%
7	Project G	1300	Completed	49,587,265.63	145,556,442.04	95,969,176.41	193.54%
8	Project H	980	Completed	43,718,163.46	45,943,383.20	2,225,219.74	5.09%
9	Project I	1491	Completed	131,558,191.34	132,647,148.61	1,088,957.27	0.83%
10	Project J	1315	Completed	74,930,291.79	83,292,113.87	8,361,822.08	11.16%
11	Project K	2058	Completed	189,216,770.04	192,575,162.14	3,358,392.10	1.77%
12	Project L	264.0	Completed	170,718,008.30	176,533,626.90	5,815,618.60	3.41%
						Average in %	30.46%

Source: Desk Study from AACRA (2020)

On the other hand, Table 4.4.7 shows the corresponding granted extension of time (Days) due to variation of the selected road projects with a minimum of 119 days and a maximum of 2498 days of granted extension of time

Table 4.4.7 Granted Extension of Time (Days) Due to Variation

No	Project	Length (m)	Project Status	Contract Commencement Date (GC) dd/mm/yyyy	Original Project Completion Date (GC) dd/mm/yyyy	Revised Project Completion Date (GC) dd/mm/yyyy	Extension Of Time Granted (Days)
1	Project A	5877	Completed	17-Jul-12	17-Jul-14	3-Dec-19	1965
2	Project B	1990	Completed	14-Jul-14	13-Jul-16	28-Sep-17	442
3	Project C	865	Completed	10-Nov-15	10-Nov-16	17-Sep-17	311
4	Project D	5820	Completed	2-Nov-14	2-Nov-15	22-Nov-17	751
5	Project E	2163	Completed	15-Aug-12	5-Feb-14	15-Jan-16	709
6	Project F	630	Completed	17-Apr-16	19-May-16	17-May-17	363
7	Project G	1300	Completed	6-Jul-07	30-Jan-09	3-Dec-15	2498
8	Project H	980	Completed	21-Jan-09	15-Jan-10	10-Feb-14	1487
9	Project I	1491	Completed	24-Mar-15	20-Oct-15	30-Jun-17	602
10	Project J	1315	Completed	1-Oct-15	1-Oct-16	30-Jun-17	119
11	Project K	2058	Completed	1-Nov-14	20-Nov-14	20-Feb-17	531
12	Project L	264.0	Completed	15-Dec-15	14-Dec-16	27-Jun-18	365

Source: Desk Study from AACRA (2020)

The second objective of this study was to identify the causes of variations leading to variation orders in road construction projects in Addis Ababa. Therefore, to achieve this objective, the study organized the most rated factors from the literature and tried to get the opinion of the professionals, and set out to determine the ten most important factors contributing to variation orders based on the respondent's response. Based on the professional's response, it was possible to rank the 10 most important causes of variation order using the Relative Importance Index method (RII).

Table 4.4.8 The Ten Most Important Causes of Variation Orders

No	Item	RII	Rank	Initiators		
				Contractor	Owner	Consultant
1	Right of way (Difficulties faced in land acquisition by the client)	0.908	1		◆	
2	Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study	0.888	2			◆
3	Award project to the lowest bid price	0.862	3			◆
4	Errors and omission in design	0.846	4			◆
5	Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing.	0.838	5		◆	
6	Owner instructs additional works	0.827	6		◆	
7	Contractor's financial difficulties	0.823	7	◆		
8	Misunderstanding of tender documents during cost estimate stage	0.819	8	◆		
9	Poor estimation	0.819	8			◆
10	Incomplete bill of quantities (BOQ)	0.815	9			◆
11	Poor procurement process	0.792	10	◆		

Source: Own Survey (2020)

Based on the above table (Table 4.4.8) the discussion of the ten most important factors causing variation orders are discussed as follows:

Right of way (Difficulties faced in land acquisition by the client) was found to be the most important cause of variation order in road construction projects in Addis Ababa as it was ranked the first with RII of 0.908. The findings show that the client, in this case Addis Ababa city road authority (AACRA) gives a premature notice to proceed with the contract and that the contractor commences work despite the fact that the right of way is not settled due to different issues with the owner of the property, and being resolved alongside the works. Hence, it is a major cause for delays and disruptions of the project leading to

variation in project time and project cost. As Lesser and Wallach (2008) stated the client should avoid liability during the construction of a project as it is the client's responsibility to provide adequate and timely access to the project site. This implies that the client is required to perform the necessary procedures in acquiring the property and provide access to the contractor. Right of way was also found to be the first most significant cause of variation in Ethiopian federal road construction projects in Tadesse (2009) study. Furthermore, Tewodros (2015) also ranked right of way problem the first among all causes. The finding also agrees with the finding of Oloo (2015) who found that the delay in land acquisition/ compensation to be the first most important cause of variation order in Kenya civil engineering construction projects.

Unforeseen site conditions/unexpected ground conditions and terrain due to inefficient site study was found to be the second most important cause of variation order in road construction projects in Addis Ababa with RII of 0.888. The finding implies that in the planning stages the responsible party which is the consultant does not learn as much about the site conditions by conducting adequate site or subsurface investigations through its geotechnical consultant. In some projects contractors often come across subsurface or hidden conditions that were not expected and which may cause variation order and results in a major impact on the time and cost to carry out their work. According to the guidelines developed by Lesser and Wallach, (2008) the duty to provide enough site information is one of the major issues. The obligated party, in this case the consultant should provide the contractor with the necessary information concerning adverse conditions at the site, such as unforeseen soil conditions, water intrusion, underground pipe or cable, and so on. Oloo (2015) also found differing site conditions to be the second most important cause of variation order. Ismail *et al.* (2012) also agree that differing site conditions are one of the most important causes of variation; however, it was ranked third in their research.

Award project to the lowest bid price was found to be the third most important cause of variation order in road construction projects in Addis Ababa with RII of 0.862. According to the finding awarding a project to the lowest bidder is one of the factors that result in variation order. According to Bu-Bshait and Manzanera (1990) contractors sometimes present extremely low bids that lead them in to bringing disputes and claims frequently during the contractual period to recover from their tight situation. Soares (2012) also pointed out that change orders are perceived as one opening of opportunity to increase profit in the contract for the contractors selected based on low bid analysis and for this reason, the contractor will search extensively to find justification to start a change order.

Errors and omission in design were ranked the fourth most important cause of variation order in road construction projects in Addis Ababa with RII of 0.846. As the finding indicates design problems arising from errors and omissions lead to delays, variations, and wastage of public funds because it requires redesign during the implementation stage. Errors and omission in design were also found to be a major cause of variations orders by Enshassi *et al.* (2010) as it may lead to delay and loss of productivity and if not rectified during the design phase would eventually appear in a construction phase and initiate variation order to implement corrective measures. In agreement with this finding Tewodros (2015) found that errors and omission in design is the third most important causes of variation. Ismail *et al.* (2012) also ranked errors and omission in design as the second most important cause of variation order.

Delay in obtaining permits from local authorities or insufficient coordination between various departments in utility shifting and placing was found to be the fifth most important cause of variation order in road construction projects in Addis Ababa with RII of 0.838. As the findings imply there is insufficient coordination between local authorities in charge of utility shifting and placing and project implementing agent (client). As discussed above it is the client's responsibility to obtaining permits from local authorities and shift utility line in order to provide adequate and timely access to the project site. This was also identified by Tadesse (2009) as the researcher ranked delay in obtaining permits from local authorities first most important cause along with right of way (access to site problem). Lack of coordination was also found to be the fourth most important cause of variation in Tewodros (2015) research.

The sixth most important cause of variation order in road construction projects in Addis Ababa was found to be **owner instructs additional works** with RII of 0.827. According to the finding, insufficient plans and lack of scope control lead to frequent change in plans and scope creep further leading to additional work. As Samantha (2002) pointed out having a sufficient plan is an important requirement for construction projects because insufficient plans result in uncertainties and additions in the work which generally lead to an increase in the number of variations in the work. In agreement with this finding Tadesse (2009) included additional work instructions to be the second most important cause enfolded under the change in defined scope. Oloo (2015) research finding also ranked additional work the third most important cause included under change of scope.

Contractor's financial difficulties was found to be the seventh most important cause of variation order in road construction projects in Addis Ababa with RII of 0.823. Contractor's financial problem may cause major variation in construction projects because construction works consist of laborers and subcontractors that depend on the contractor. Contractor's financial difficulties lead to inability to properly execute and deliver large projects according to their schedule. As El-Sadek (2016) noted whether the main contractor was paid for his amount of work or not, the wages for his labor and his subcontractors need to be paid off. If a contractor faces such difficulties during a project, variation orders will result and the quality and progress of the project may be affected as well. In agreement with this finding Ismail *et al.* (2012) ranked contractor's financial difficulties the third most important cause of variation order. Tadesse (2009) also agrees that contractor's financial difficulties is one of the most important causes of variation order in which it was ranked the fifth important cause in his research.

The eighth most important causes of variation order in road construction projects in Addis Ababa was found to be **misunderstanding of tender documents during cost estimate stage and poor estimation** with RII of 0.819. Misunderstanding of tender documents during the estimate stage will cause conflict with the parties once the project has started which will lead to a dispute that could result in the delaying of the project. Poor estimation is a result of inadequate investigations. Estimation at the design stage are prepared by consultants and are not accurate in most cases. Hence, several site conditions rise at the construction stage. It was also found to be the first most important cause of variation order in Halwatura and Ranasinghe (2013) study.

Incomplete bill of quantities (BOQ) was found to be the ninth most important cause of variation order in road construction projects in Addis Ababa with RII of 0.815. According to Lesser and Wallach, (2008), the party responsible, which in this case is the consultant of the project has an implied duty to provide the contractor with accurate plans and specifications, failure to do so will eventually lead to variation order. Oloo (2015) agrees with the finding as an incomplete bill of quantities (BOQ) and other conflicts between contracts documents are among the most important causes of variation order as it was put at the ninth position in the research.

Poor procurement process was found to be the tenth most important cause of variation order in road construction projects in Addis Ababa with RII of 0. 792. The findings show

that a poor procurement process causes variation which in turn leads to variation order. Unavailability of materials and resources at the construction site followed by procurement delay or logistics delay eventually affects the project. Arain and Pheng (2006) also agreed poor procurement process as the result of lack of strategic planning may initiate delays in procurement which has an adverse effect on project performance.

According to the documents and reports of projects at the desk study, the main reasons for the occurrence of variations/ variation orders that lead to cost revision and extension of time are **design change due to right of way, errors, unfinished/ changed utility line design**, **delay in utility shifting**, **additions, and omissions** which complement the findings found from the response of professionals using the questionnaire.

The third objective of the study was to identify the effects of variation order on project performance to achieve this objective, the study organized the most rated effects from the literature and tried to get the opinion of the professionals, and set out to determine the five most important effects of variation orders based on the respondent's response. Based on the professional's response it was possible to rank the 5 most important effects of variation order using the relative importance index method as shown in the table below.

Table 4.4.9 The Five Most Important Effects of Variation Orders on Project Performance

No	Item	RII	Rank
1	Time extension (Time overrun)	0.94231	1
2	Direct cost /Indirect cost increase (Cost overrun)	0.91923	2
3	Claim and dispute	0.88462	3
4	Revision to work method	0.84231	4
5	Increased risk	0.83462	5

Source: Own Survey (2020)

This finding shows that **time extension (time overrun)** is the first most important effect of variation orders on road construction project performance in Addis Ababa with RII of 0.942. According to Arain and Pheng (2006b), minor variations may not cause a delay in the overall project completion but it will affect the progress, but frequent minor and major variations affect the project adversely, leading to delays in the project completion. Even though contractors usually accommodate the implementation time for variations by utilizing the free floats in the construction schedules, sometimes they became continual and large in magnitude to the extent that they cannot be accommodated within the floats in the construction schedules. Time overrun or delay in completion schedule was also ranked as the first most important effect of variation order by Ismail *et al.* (2012), Tadesse (2009), and

Ndihokubwayo and Haupt (2008b). However, in Tewodros (2015) research it was ranked the second most important effect of variation order and third in Oloo (2015) research.

Cost overrun (direct cost/indirect cost increase) was found to be the second most important effect of variation order on road construction project performance in Addis Ababa with RII of 0.919. It is expected for the project cost to increase due to some variations in the project that is why every project allocates a contingency sum to provide for possible variations in the project while keeping the overall project cost. However, frequent and major variations lead to cost overrun in the contingency sum. In agreement with this finding Ismail *et al.* (2012), Tadesse (2009), and Ndihokubwayo and Haupt (2008b) ranked cost overrun (increase in project cost) the second most important effect of a variation order. Although Tewodros (2015) and Oloo (2015) found that cost overrun (increase in project cost) is the first most important effect of a variation order.

Claim and dispute were found to be the third most important effect of variation order on road construction project performance in Addis Ababa with RII of 0.885. The findings show that even though there are variation clauses in a project contract, the dispute and claim over variation orders don't seem to be avoided. According to Yogeswaran *et al.* (1998), variation order was found to be a major reason for a claim for extension of time. If these claims are not solved they result in a dispute that may affect the relation among contracting parties and between professionals of the contracting parties. Ndihokubwayo and Haupt (2008b) and Ismail *et al.* (2012) research findings agree with this finding as claim and dispute among parties were ranked to be the third most important effect of variation. Oloo (2015) ranked claim and dispute among parties as second most important effect of variation order. In Tadesse (2009) research, it was ranked to be fifth, and in Tewodros (2015) it was found to be the fourth most important effect of a variation order.

Revision to work method was ranked to be the fourth most important effect of variation order on road construction project performance in Addis Ababa with RII of 0.84231. As a result of frequent variations/variation orders working conditions and methods are forced to be revised which will take some amount of time leading to delay and extra cost on the project.

Increased risk was ranked to be the fifth most important effect of variation order on road construction project performance in Addis Ababa with RII of 0.83462. In addition to the immediate consequences, variation order can also increase the risk of further disruptions. According to Sun and Meng (2009), to catch up with the delays caused by change, some

tasks have to be accelerated and some floats of the original schedule are lost and workflow is interrupted which will also cause increased sensitivity to further delays.

4.5 Regression Analysis and Interpretation

To examine the effect of variation order on project performance linear regression was conducted. However, before preceding the regression analysis all the relevant assumptions must be tested. Therefore, the researcher has examined the following assumptions before heading to the regression.

Assumption Test 1: Linearity Test

The linearity test aims to determine the relationship between independent variables and the dependent variable is linear or not for the regression model to be good there should be a linear relationship between independent variables and the dependent variable. If the value of sig. for deviation from linearity >0.05, then the relationship between the independent variables are linearly dependent. Whereas if the value of sig. for deviation from linearity <0.05, then the relationship between the independent variables are not linearly dependent.

Table 4.5.1 Linearity Test

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
prj_perf * Vari_ord	Between Groups	(Combined)	8.471	31	.273	1.581	.143
		Linearity	2.134	1	2.134	12.351	.002
		Deviation from Linearity	6.337	30	.211	1.222	.324
	Within Groups		3.456	20	.173		
	Total		11.928	51			

Source: Own Survey (2020)

Based on the above ANOVA output table, value sig. deviation from linearity of 0.324 > 0.05, it can be concluded that there is a linear relationship between variation orders and its effect on project performance.

The linearity assumption can also be tested by inspecting the Normal Probability Plot (PP) of the Regression Standardized Residual Scatter plot. As shown in figure 4.5.1 the scatter plot of residuals showed that the points laid in a reasonably straight line from bottom left to top right. Therefore, we can say that the assumption of linearity was not violated.

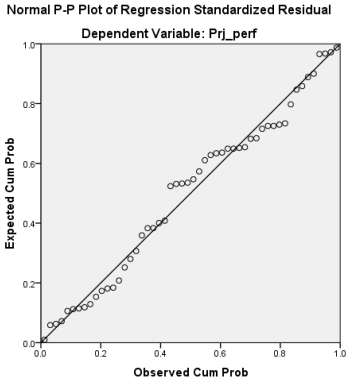


Figure 4.5.1 Normal P-P Plot of Standardized Residual

Assumption Test 2: Normality Test

Normality test was used to determine whether the error term is normally distributed. The frequency distribution of the standardized residuals was also compared to a normal distribution. As can be seen from figure 4.5.2, although some residuals are relatively far away from the curve, many of the residuals are fairly close. Moreover, the histograms are bell-shaped which leads to infer that the residual (disturbance or errors) are normally distributed for all the models. Thus, it can be said that the assumption of normally distributed error term is not violated.

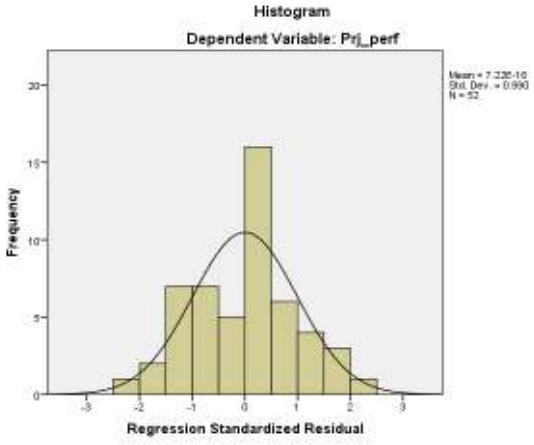


Figure 4.5.2 Frequency Distribution of Standardized Residual

Assumption Test 3: Hetroscedasticity Chart Scatterplot Test

Hetroscedasticity chart scatterplot test is one of the important assumption tests in the regression model which can be done by simply looking at the scatterplot graph of the SPSS output. If there is a particular pattern in the scatter plot graph or points that form a regular pattern it can be said that there has been a problem of hetroscedasticity on the contrary if there is no clear pattern and the spreading dots then it indicates there is no hetroscedasticity problem.

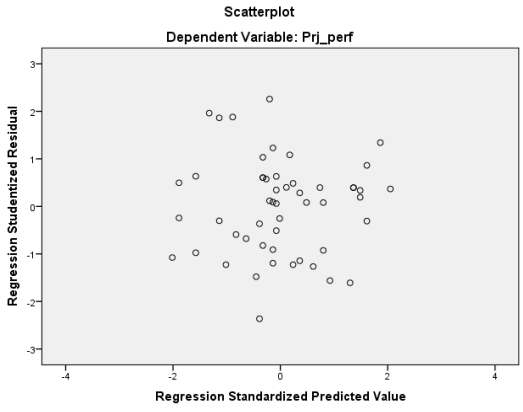


Figure 4.5.3 Scatter plot Output

Based on the scatterplot output in figure 4.5.3, it appears that the dots are spread and do not form a clear specific pattern. So it can be concluded that the regression model does not have hetroscedasticity problem.

Simple Regression Analysis

After testing the classic assumptions of linear regression for the data used, the researcher conducted a linear regression to examine the cause and effect relationship between variation order and project performance. The output obtained from the analysis are presented and interpreted as follows.

Table 4.5.2 Model Summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.423[a]	.179	.163	.44257
a. Predictors: (Constant), Vari_ord				
b. Dependent Variable: prj_perf				

Source: Own Survey (2020)

The above table shows a model summary with R= 0.423 indicating that the independent variable (variation order) predicts the dependent variable (effect on project performance) and the R square (coefficient of determination) indicates the proportion of variance that can be explained in the dependent variable by the linear combination of the independent variables. In the model summary R^2 amounted to 0.179; this indicates that variation order can be accounted for 17.9% of the variation in project performance where the rest 82% of variation may be explained by either by variations that occur beyond the control of the contractual parties or other factors like economical inflation, seasonal change, national health concerns, natural disaster, war and so on.

Table 4.5.3 Analysis of Variance (ANOVA)

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.134	1	2.134	10.897	.002[b]
	Residual	9.793	50	.196		
	Total	11.928	51			
a. Dependent Variable: prj_perf						
b. Predictors: (Constant), Vari_ord						

Source: Own Survey (2020)

In the above table, it is revealed that F is 10.897 with a p-value of 0.002 which is statically significant at α=0.01 which tells us that there is less than 1% that an F-ratio of this amount

would happen if the null hypothesis is true. Therefore, it can be said that the regression model overall predicts effect on project performance significantly well.

Table 4.5.4 Summary of Coefficient

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.892	.601		3.150	.003		
	Vari_ord	.524	.159	.423	3.301	.002	1.000	1.000
a. Dependent Variable: prj_perf								

Source: Own Survey (2020)

The above table displayed a significance of 0.002 < 0.05, therefore, it can be concluded that the variation order has a significant effect on project performance. The statistical results is given as; variation order; β=0.524, t=3.301, p<0.01. The statistical result implies that variation order is a statistically significant predictor of the effect on project performance. And the value of β (slope of regression line) = 0.524 represents the value change in project performance is associated with a unit change in variation order. Therefore, if our predictor variable (Variation order) is increased by one percent, then our model predicts a 52.4 percent increase in its effect on project performance. Furthermore, the regression equation that predicts the overall project performance using the linear regression model is presented as follows:

$$Y = a + \beta X + e$$

$$Y = 1.892 + 0.524\ X + e$$

Where Y = Project performance
α = 1.892 = Constant
β = 0.524= Coefficient of X
X= Variation order
e= sampling error

4.6 Hypothesis Testing

➢ **H_1: Variation order has effect on road construction project performance - Accepted**

As obtained from the result of the regression analysis, the relationship between Variation order and its effect on project performance is significant (β =.524, p<0.05). Thus, based on the result, the ρ-value is less than 0.05; therefore we accept the alternative hypothesis and reject the null hypothesis. That is, variation order has an effect on project performance.

In conclusion the findings of the research as compared to findings of previous researches are presented hereafter. In agreement with the finding of this research which shows that there is a significant relationship between variation order and project performance and that variation order has an effect on project performance, in which increased variation order results in an increased effect on project performance (increased time extension, cost and claim and dispute and etc…). Arain and Pheng (2005) also indicated that variation will affect not only the effectiveness of the project but it will affect the performance of the project team which is mainly indicated in terms of completion time and additional direct and indirect project costs as well as healthy professional and contracting parties relationships. Ibbs (1997) stated that variations in construction projects can cause substantial adjustments to the contract duration, total direct and indirect costs, or both, i.e. cost and time overrun. In support of this Oladapo (2007) also revealed that variation orders often cause significant disruptions to a construction project performance. Ndihokubwayo (2008a) also argue that the one of the reason for low project performance is the occurrence of variation orders. In supports of this findings Hanif *et al.* (2014) also stated variation order has considerable negative impacts on the performance of the project concerning cost, time and quality resulting in cost & time overruns, quality degradation, and loss in productivity on construction projects.

4.7 Chapter Summary

In this chapter, the study results are presented, interpreted and discussed. The data collected from 52 professional respondents from the client (ACCRA), contractor and, consultant working under ACCRA was analyzed using the Statistical Package for Social Science (SPSS version 20). The respondent's opinion towards the existence, the causes of variation orders and their effect on project performance was presented using descriptive statistics and ranked using the relative importance index (RII). These outputs were also supported by the data obtained from the desk study. To further strengthen the findings and to examine the effect of variation order on project performance simple regression analysis was carried out after testing all the assumptions. Finally, based on the results the alternative hypothesis was accepted and the null hypothesis was rejected.

CHAPER FIVE
SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter is the final chapter which is divided into three sections. The first section contains a summary of the major findings of the study, the next section presents conclusions from the findings and in the last section, and recommendations are forwarded based on the established finding and conclusions that could be useful and viable for the construction industry.

5.2 Summary of Findings

The objective of this study was to study variation order and its effects on the overall project performance in the road construction projects in Addis Ababa with a specific objective to

- Assess the prevalence and the nature of variation order in road construction projects;
- Identify the causes of variation leading to variation order in road construction projects;
- Identify the potential effects of a variation order in road construction project performance;
- Forward possible solution and recommendation to reduce the adverse effects of a variation order in road construction project performance

Based on the objective of the study, research questions and hypotheses, questionnaires (survey instruments) for measuring the research variables were prepared and organized.
Out of 60 distributed questionnaires, 52 (86.7%) valid questionnaires were collected and used for the analysis. The participants of this study were professionals from contractors, consultants and the client. Project Manager, site engineer, office engineer, contract administrator and resident engineer from their respective organizations with experience ranging from 0 to more than 15 years were the professionals who participated in filling the questionnaires. The collected data were analyzed using a statistical package for social science software (SPSS). Simple regression analyses were employed for testing the hypotheses.

Descriptive analysis was computed and presented in tables. Prior to applying regression analysis, reliability tests, correlation analysis, and assumption tests such as linearity, normality, and heteroscedasticity tests were performed. With regard to reliability, the results

showed that all measures used in this study had an acceptable level of reliability. Descriptive statistics like frequency, percentage mean and standard deviation were employed to analyze the opinion of the respondents towards the prevalence, cause and effect and ranked using relative important index (RII).

Based on the descriptive statistical analysis most of the respondents tend to agree with the existence of the problem and its frequent occurrence in Ethiopian road construction projects. Similarly, the data from the desk study also showed that variation is one of the major problems in road construction projects in which the amount of variation exceeds the contingency amount with an average value of 30.46% and a minimum of 119 days and a maximum of 2498 days of granted extension of time. Based on the data obtained from the descriptive analysis the most important causes and effects of variation order were ranked using relative important index (RII) in which the most rated cause of variation order was found to be right of way and the most rated effect was found to be time extension (time overrun).

To examine the effect of variation order on project performance regression analysis was carried out after testing all the assumptions and found that variation order has a significant effect on project performance with $R^2 = 0.179$, F–ratio = 10.897 & sig= 0.002 < 0.05, β=0.524, t=3.301 and p-value < 0.01. Finally, based on the results of the ANOVA table the alternative hypothesis was accepted and the null hypothesis was rejected.

5.3 Conclusion

The first objective of the research was to identify whether variation is a problem or not in Ethiopia specifically Addis Ababa road construction projects. According to the result obtained from the questionnaire survey, 100 % of the respondent agreed on variations as one of the major problems. The result of the desk study also strengthens this finding indicating that the magnitude of variations in these projects ranges between 0.83% and 193% of the variation in total amount with 119 - 2498 days of granted extension of time.

- Therefore, based on the data obtained from both the questionnaire survey and the desk study, the study concluded that variation/variation order is one of the major problems in road construction projects.

The second objective of this research was the identification of causes of variations leading to variation orders. To achieve this, 41 potential causes were identified from literature and respondent were requested to rate these factors based on their experience and the most important causes were ranked using the relative important index (RII).

- Based on the survey result the research concluded that the top five major causes of variation order in Addis Ababa road construction projects are right of way (difficulties faced in land acquisition by the client), unforeseen site conditions/ unexpected ground conditions and terrain due to inefficient site study, award project to the lowest bid price, errors and omission in design, delay in obtaining permits from local authorities or insufficient coordination between various departments in utility shifting and placing.

The third specific objective of this research was aimed to identify the major effects of variation order in Ethiopian road construction project performance. For this purpose, 16 potential effects were identified from literature and respondent were requested to rate these effects based on their experience and the most important effects were ranked using the relative important index (RII).

- Based on the survey result the research concluded that the top five major effects of variation order on road construction project performance are time extension (time overrun), direct cost/ indirect cost increase (cost overrun), claim and dispute, revision to work method and increased risk.

To strengthen these results and understand the relationship as well as the effect of variation orders on project performance the study carried out regression analysis respectively.

- Based on the results the research concluded that the effect of variation order on project performance regression analysis result the research concluded that variation order can be accounted for 17.9% of the variation in project performance and that the regression model overall predicts the effect on project performance significantly well. Furthermore, variation order is a statistically significant predictor of project performance and represents the value change in project performance is associated with a unit change in variation order. Therefore, one percent increased variation order results in 52.4% increased effect on project performance (increased time extension, cost and claim and dispute and so on).

5.4 Recommendation

The researcher recommended the following list of action items based upon the findings of the study discussed in the previous chapter. These recommendations are a set of remedies to minimize variation orders in construction projects and minimize their effect on road construction project performance in Addis Ababa.

The findings of the study revealed that variation orders are one of the major problems in Ethiopian road construction projects and have a significant effect on project performance. In order to minimize variation orders and their effects, establishing effective management of construction change is the first thing that needs to be given the attention which requires both engineering and project management knowledge. Proactive change management is recommended in order to identify and forecast potential changes and develops solutions before the change occurs. The identified potential causes of variation order in this study range from the conceptual/ design stage to the construction stage. Therefore, the researcher recommends all the parties involved (the client, the consultant and the contractor)

At the design stage to

- Have a better initial planning and thorough detailing of design,
- Allocate sufficient time for design development,
- Involve all the relevant professionals at the initial stages of the project,
- Implement comprehensive site investigation and obtain all the necessary permits,
- Award the tender to the right contractor,
- Standardize the procedure for projects from the start of the project until completion and closeout,
- Apply value engineering at the conceptual phase, and
- Reduce contingency sum and award contract on a fixed sum basis,

In the construction stage to have

- Team effort by all parties to control variation orders,
- Comprehensive documentation of variations orders,
- Continuous coordination and direct communication,
- Clear change order procedure,
- Prompt approval procedure,
- To appoint an independent professional to manage the project, and
- To utilize work breakdown structure(WBS)

Based on Ibbs et al. (2001) suggestion of having a systematic approach to manage project change, it is advised to have a balanced change culture, to recognize the change before the occurrence, evaluate the change and implement approved change with continuous improvements.

As observed from the literature supporting change management system with technology have an advantage in order to deliver information in a timely, remote and accurate manner for projects. Therefore, the researcher advises all the parties involved to adopt different technological tools in order to have facilitated change order management process through a common centralized database.

Implication for Further Research

The results of this study can be further utilized to suggest a direction for future research. Therefore, the researcher recommends for future studies to focus on the technological development for effective variation order management.

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APPENDIX A

ST. MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES
GRADUATE PROGRAM

QUESTIONNAIRE SURVEY FOR A MASTERS THESIS

ON

VARIATION ORDER AND ITS EFFECT ON CONSTRUCTION PROJECT PERFORMANCE: IN THE CASE OF ROAD CONSTRUCTION PROJECTS

BY

HAIMANOT CHALCHISSA

ADVISOR: MULUADAM ALEMU (PHD)

FOR THE PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF ARTS IN PROJECT MANAGEMENT

MARCH, 2020

GENERAL INFORMATION

I am currently conducting a research for partial fulfillment of Master of Arts in Project Management under the supervision of Dr. Muluadam Alemu (PHD) at St.Mary's University, School of graduate studies. This questionnaire is designed to study about variation order and its effect on construction project performance: in the case of road construction projects in Ethiopia.

I kindly request your participation and support in my research by responding to this questionnaire. Please answer all questions. Any information you provide will be greatly appreciated. All the information gathered through this questionnaire will be kept strictly confidential and will be used only for academic matter.

Thank you in advance for your time and kind cooperation.

If you have any questions, please contact me through the following addresses

Tel: 0913705966,
Email: haimihero@gmail.com

Part I. Respondent and company information

1. Type of your organization

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

2. Your position in the organization

1.Site Engineer ☐ **3.Contract administrator** ☐
2.Office Engineer ☐ **4.Project Manager** ☐
5.Resident Engineer ☐ If other please specify_____

3. Your professional experience in road construction projects

1. 0-5 years ☐ **3. 10-15 years** ☐
2. 6-10 years ☐ **4. More than 15** ☐

Part II. Prevalence of variation

No	Prevalence of variation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1.	Variation/change is a problem in Ethiopian construction industry in general and that of road construction projects in particular?					
2.	Variation orders frequently occur in Ethiopian road construction projects					

Part III. Causes and Effects of Change/Variation Orders

Based on your experience indicate the significance of the following variation order causing factors in Ethiopian road construction projects on scale of 1-5 by marking (X) under each preferences: -
Where 1=Strongly Disagree 2= Disagree 3= Neutral 4= Agree 5=Strongly Agree

No	Parameters of independent Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Owner related factors	1	2	3	4	5
1	Change of project scope by owners					
2	Change of implementing schedule by owner					
3	Unrealistic contract durations imposed by client					
4	Owner's financial problems					
5	Weakness in prompt decision making process					
6	Inflexible nature of owner					
7	Change in specification by owner					
8	Inadequate experience of owner's staff					
9	Owner instructs additional works					
10	Design change originated by owner					
11	Right of way (Difficulties faced in land acquisition by the client)					
12	Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing.					

No	Parameters of independent Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Contractor related factors	1	2	3	4	5
1	Lack of specialized construction manager					
2	Poor procurement process					
3	Misunderstanding of tender documents during cost estimate stage					
4	Contractor desire to improve his financial conditions based on contract gaps					
5	Contractor's financial difficulties					
6	Technical incompetency of contractor and unavailability of the required labor skill					
7	The required equipment and tools not being available					
8	Workmanship or material not meeting the specifications					
9	Lack of equipment efficiency					
10	Errors during construction					
11	Improper construction methods					
12	Value engineering (mechanism of saving cost for mutual benefit)					
13	Poor performance of subcontractors					
	Consultant related factors					
1	Change in design by consultant					
2	Errors and omission in design					
3	Conflicts between contract documents (insufficient detail)					
4	Lack of coordination among project parties					
5	Lack of consultant's knowledge of available materials and equipment					
6	Failure by the consultant to provide adequate and clear information in the tender documents					
7	Failure by the consultant to perform design and supervision effectively					
8	Substitution of material or procedures					
9	Award project to the lowest bid price					
10	Unreasonable project time frame					
11	Changes in specifications					
12	Changes in grade of work (Deviation from original scope of work)					
13	Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study					
14	Incomplete bill of quantities (BOQ)					
15	Consultant's lack of judgment and experience					
16	Poor estimation					

If other please specify_____

_____

Based on your experience Please rate the effects of variations/change orders in Ethiopian road construction project performance? Please rate their effects on scale of 1-5 by marking (X) under each preference
Where 1= Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

Parameters of dependent Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Effect of variation orders	1	2	3	4	5
Time extension (Time overrun)					
Loss of productivity					
Increased risk					
Direct cost /Indirect cost increase (Cost overrun)					
Claim and dispute					
Arbitration and litigation					
Team change					
Poor co-ordination					
Revision to work method					
Site congestion					
Poor safety conditions					
Loss of learning curve					
Lower morale					
Staff turnover					
Quality degradation					
Damage to reputation					
If other please specify_____ _____					

APPENDIX B

Reliability output

Prevalence Questions

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.737	.738	2

Owner Related Questions

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.730	12

Contractor Related Questions

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.809	.818	13

Consultant Related Questions

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.835	.835	16

Effects on project performance Questions

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.873	.862	16

Overall Reliability

Case Processing Summary

		N	%
Cases	Valid	52	100.0
	Excluded[a]	0	.0
	Total	52	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.906	.908	59

APPENDIX C

Descriptive Statistics of Respondents Perspective on Factor Causing Variation Order

No	Factors Related to Owners		Frequency							
	Item		SD	D	N	A	SA	Total	Mean	Std
1	Change of project scope by owners	No	1	10	6	29	6	52	3.558	0.998
		%	1.9	19.2	11.5	55.8	11.5	100		
2	Change of implementing schedule by owner	No	0	11	13	24	4	52	3.404	0.913
		%	0	21.2	25	46.2	7.7	100		
3	Unrealistic contract durations imposed by client	No	1	8	7	26	10	52	3.692	1.02
		%	1.9	15.4	13.5	50	19.2	100		
4	Owner's financial problems	No	1	11	9	25	6	52	3.462	1.02
		%	1.9	21.2	17.3	48.1	11.5	100		
5	Weakness in prompt decision making process	No	1	6	7	33	5	52	3.673	0.879
		%	1.9	11.5	13.5	63.5	9.6	100		
6	Inflexible nature of owner	No	1	18	10	21	2	52	3.096	0.995
		%	1.9	34.6	19.2	40.4	3.8	100		
7	Change in specification by owner	No	4	13	13	18	4	52	3.096	1.11
		%	7.7	25	25	34.6	7.7	100		
8	Inadequate experience of owner's staff	No	3	12	17	15	5	52	3.135	1.067
		%	5.8	23.1	32.7	28.8	9.6	100		
9	Owner instructs additional works	No	1	0	4	33	14	52	4.135	0.715
		%	1.9	0	7.7	63.5	26.9	100		
10	Design change originated by owner	No	1	5	8	26	12	52	3.827	0.964
		%	1.9	9.6	15.4	50	23.1	100		
11	Right of way (Difficulties faced in land acquisition by the client)	No	2	1	1	11	37	52	4.54	0.939
		%	3.8	1.9	1.9	21.2	71.2	100		
12	Delay in obtaining permits from local authorities or Insufficient coordination between various departments in utility shifting and placing.	No	4	0	5	16	27	52	4.192	1.138
		%	7.7	0	9.6	30.8	51.9	100		

No	Factors Related to Contractors		Frequency							
	Item		SD	D	N	A	SA	Total	Mean	Std
1	Lack of specialized construction manager	No	1	7	14	19	11	52	3.615	1.032
		%	1.9	13.5	26.9	36.5	21.2	100		
2	Poor procurement process	No	0	6	5	26	15	52	3.962	0.928
		%	0	11.5	9.6	50	28.8	100		
3	Misunderstanding of tender documents during cost estimate stage	No	0	2	8	25	17	52	4.096	0.799
		%	0	3.8	15.4	48.1	32.7	100		
4	Contractor desire to improve his financial conditions based on contract gaps	No	0	3	13	23	13	52	3.885	0.878
		%	0	5.8	25	44.2	25	100		
5	Contractor's financial difficulties	No	0	4	5	24	19	52	4.12	0.878
		%	0	7.7	9.6	46.2	36.5	100		
6	Technical incompetency of contractor and unavailability of the required labor skill	No	1	5	11	27	8	52	3.692	0.919
		%	1.9	9.6	21.2	51.9	15.4	100		
7	The required equipment and tools not being available	No	6	7	10	20	9	52	3.365	1.253
		%	11.5	13.5	19.2	38.5	17.3	100		
8	Workmanship or material not meeting the specifications	No	3	8	9	26	6	52	3.462	1.075
		%	5.8	15.4	17.3	50	11.5	100		
9	Lack of equipment efficiency	No	1	6	13	26	6	52	3.577	0.915
		%	1.9	11.5	25	50	11.5	100		
10	Errors during construction	No	0	8	15	26	3	52	3.462	0.828
		%	0	15.4	28.8	50	5.8	100		
11	Improper construction methods	No	0	8	11	27	6	52	3.596	0.891
		%	0	15.4	21.2	51.9	11.5	100		
12	Value engineering (mechanism of saving cost for mutual benefit)	No	1	6	15	20	10	52	3.62	0.99
		%	1.9	11.5	28.8	38.5	19.2	100		
13	Poor performance of subcontractors	No	2	5	8	26	11	52	3.75	1.03
		%	3.8	9.6	15.4	50	21.2	100		

No	Factors Related to Consultants		Frequency							
	Item		SD	D	N	A	SA	Total	Mean	Std
1	Change in design by consultant	No	0	7	7	26	12	52	3.827	0.944
		%	0	13.5	13.5	50	23.1	100		
2	Errors and omission in design	No	0	2	5	24	21	52	4.231	0.783
		%	0	3.8	9.6	46.2	40.4	100		
3	Conflicts between contract documents (insufficient detail)	No	0	3	5	33	11	52	4.000	0.741
		%	0	5.8	9.6	63.5	21.2	100		
4	Lack of coordination among project parties	No	0	6	6	29	11	52	3.865	0.886
		%	0	11.5	11.5	55.8	21.2	100		
5	Lack of consultant's knowledge of available materials and equipment	No	5	11	12	20	4	52	3.135	1.138
		%	9.6	21.2	23.1	38.5	7.7	100		
6	Failure by the consultant to provide adequate and clear information in the tender documents	No	1	4	8	29	10	52	3.827	0.901
		%	1.9	7.7	15.4	55.8	19.2	100		
7	Failure by the consultant to perform design and supervision effectively	No	1	7	4	28	12	52	3.827	1.004
		%	1.9	13.5	7.7	53.8	23.1	100		
8	Substitution of material or procedures	No	0	8	18	19	7	52	3.481	0.918
		%	0	15.4	34.6	36.5	13.5	100		
9	Award project to the lowest bid price	No	1	1	7	15	28	52	4.308	0.919
		%	1.9	1.9	13.5	28.8	53.8	100		
10	Unreasonable project time frame	No	1	2	11	21	17	52	3.981	0.939
		%	1.9	3.8	21.2	40.4	32.7	100		
11	Changes in specifications	No	0	4	15	25	8	52	3.712	0.825
		%	0	7.7	28.8	48.1	15.4	100		
12	Changes in grade of work (Deviation from original scope of work)	No	3	2	8	24	15	52	3.885	1.060
		%	5.8	3.8	15.4	46.2	28.8	100		
13	Unforeseen site conditions/ Unexpected ground conditions and terrain due to inefficient site study	No	0	0	4	21	27	52	4.442	0.639
		%	0	0	7.7	40.4	51.9	100		
14	Incomplete bill of quantities (BOQ)	No	0	1	8	29	14	52	4.077	0.71
		%	0	1.9	15.4	55.8	26.9	100		
15	Consultant’s lack of judgment and experience	No	2	5	15	24	6	52	3.519	0.959
		%	3.8	9.6	28.8	46.2	11.5	100		
16	Poor estimation	No	0	2	4	33	13	52	4.096	0.693
		%	0	3.8	7.7	63.5	25	100		

Descriptive Statistics of Respondents Perspective on the Effect of Variation on Project Performance

No	Effect of Variation on Project Performance		Frequency							
	Item		SD	D	N	A	SA	Total	Mean	Std
1	Time extension (Time overrun)	No	0	0	0	15	37	52	4.712	0.457
		%	0	0	0	28.8	71.2	100		
2	Loss of productivity	No	1	1	10	27	13	52	3.961	0.839
		%	1.91	1.91	19.2	51.9	25	100		
3	Increased risk	No	0	0	5	33	14	52	4.173	0.584
		%	0	0	9.6	63.5	26.9	100		
4	Direct cost /Indirect cost increase (Cost overrun)	No	0	0	0	21	31	52	4.596	0.495
		%	0	0	0	40.4	59.6	100		
5	Claim and dispute	No	0	0	3	24	25	52	4.423	0.605
		%	0	0	5.8	46.2	48.1	100		
6	Arbitration and litigation	No	0	5	11	30	6	52	3.712	0.80
		%	0	9.6	21.2	57.7	11.5	100		
7	Team change	No	0	5	21	19	7	52	3.538	0.851
		%	0	9.6	40.4	36.5	13.5	100		
8	Poor co-ordination	No	0	5	10	25	12	52	3.846	0.894
		%	0	9.6	19.2	48.1	23.1	100		
9	Revision to work method	No	0	0	4	33	15	52	4.211	0.572
		%	0	0	7.7	63.5	28.8	100		
10	Site congestion	No	0	6	18	23	5	52	3.519	0.828
		%	0	11.5	34.6	44.2	9.6	100		
11	Poor safety conditions	No	1	8	18	19	6	52	3.403	0.955
		%	1.9	15.4	34.6	36.5	11.5	100		
12	Loss of learning curve	No	1	11	20	17	3	52	3.192	0.908
		%	1.9	21.2	38.5	32.7	5.8	100		
13	Lower morale	No	2	8	12	24	6	52	3.462	1.019
		%	3.8	15.4	23.1	46.2	11.5	100		
14	Staff turnover	No	0	4	14	24	10	52	3.769	8.544
		%	0	7.7	26.9	46.2	19.2	100		
15	Quality degradation	No	2	7	11	21	11	52	3.615	1.087
		%	3.8	13.5	21.2	40.4	21.2	100		
16	Damage to reputation	No	2	5	13	19	13	52	3.692	1.076
		%	3.8	9.6	25	36.5	25	100		