JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDENTS

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF CAUSES AND EFFECTS OF VARIATION ORDERS ON OROMIA ROAD CONSTRUCTION ENTERPRISE PROJECTS IN THE CASE OF JIMMA ZONE

A Thesis Submitted to the School of graduate Studies, Jimma University, Jimma Institute of Technology Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirement for the Degree Master of Science in Construction Engineering and Management

By

Abezash Ageru Ademe

February, 2023

Jimma, Ethiopia

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Main Advisor Dr. Engr. Getachew Kebede

Co-Advisor Engr. Mebratu Abera

February, 2023

Jimma, Ethiopia

DECLARATION

I declare that this research entitled "Assessment of Causes and Effects of Variation Orders on Oromia Road Construction Enterprise projects in the case of Jimma Zone" is my own original work, and has not been submitted as a requirement for the award of any degree in Jimma University or elsewhere.

Abezash Ageru Ademe _____ _____

Name Signature Date

As Master research Advisors, we hereby certify that we have read and evaluate this MSc research prepared under our guidance, by Abezash Ageru Ademe entitled "ASSESSMENT OF CAUSES AND EFFECTS OF VARIATION ORDERS ON OROMIA ROADS CONSTRUCTION ENTERPISE PROJECTS In the case of Jimma Zone" and recommend and would be accepted as a fulfilling requirement for the Degree Master of Science in Construction Engineering and Management.

Advisor: Dr. Engr. Getachew Kebede _____ _____

Name Signature Date

Co -Advisor: Engr. Mebratu Abera (MSc.) _____ _____

Name Signature Date

ABSTRACT

One of the most common challenges of road construction projects is low performance in terms of time and cost. One of the contributing factors to this low performance among others is variation; because variation can affect project cost and schedules.

The main objective of the study was to assess the major causes and effects of variation orders on Oromia road construction Enterprise projects in Jimma Zone.

Purposive sampling technique was used to select respondents and collect data. A desk study and questionnaire survey in addition to literature review were carried out to achieve the study objectives. The research work mainly consists of literature review, questionnaires survey, and case study. Based on the literature review a total of 23 potential causes and 11possible effects of variation orders were identified. Questionnaires were distributed to the clients, consultants and contractors who are engaged in Oromia Roads Construction Enterprise projects and 83% of questionnaire were received from respondents. The collected data were analyzed via using RII and Microsoft excels software.

The results of the case study indicated that the varied cost in two projects were above 30% and the total extension of time claimed in Begge-Ketta and Chira-Afalo-Chariko projects were 76% and 81.86% respectively. The causes and effects of variation orders were ranked based on the value of RII. The most significant causes based on the case study and questionnaire surveys in Jimma Zone gravel roads constructed by Oromia Roads Construction Enterprise were identified and ranked: Conflict between contract documents (0.635), poor estimation while design (under estimation) (0.621), change in design including addition and omission (0.596), right of way problems (0.595), lack of materials (0.584) and delay due to adverse weather conditions (0.441). The study also investigated; delay in project completion time (0.819), increase in project cost (0.811), dispute among parties (0.77) and decrease in productivity (0.734) as a major effects.

Owners are recommended to determine the project schedule by experts and not to change the original drawings and choose a consultant that is special to the nature of the project. In addition Contractors are recommended to make a site visit before tender pricing and secure the site and Consultants are recommended to spend adequate time on design detailing and documentation.

Key Words: Cause of Variation, Road Construction, Cost and Time, effects of variation

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ACRONYMS

BOQ	Bill of Quantity
ETB	Ethiopian Birr
EOT	Extension of Time
FIDIC	Federation International Des Ingenieurs Councils
GC	General Contractor
GOE	Government of Ethiopia
MDB	Multilateral Development Banks
ORA	Oromia Road Authority
ORCE	Oromia Road Construction Enterprise
RII	Relative Important Index
Row	Right of Way
VAT	Value Added Tax
VO	Variation Order

CHAPTER ONE

INTRODUCTION

1.1. Background

Construction industry plays a great role on the national prospect. It occupies a fundamental position in the national economy. It is one of the sectors that provide crucial ingredients for development of an economy [1]. Same one cannot think of widespread investment in manufacturing, agriculture or service sectors unless the construction results of infrastructure facilities are in place. There is a wide range of operations and processes, more flexible and exposed for uncertainties than other industries. Thus the field organization must be adaptable to the varied conditions from project to project, and must be flexible enough to control adequately the works being executed under a multiplicity of site conditions.

The construction industry in Ethiopia has been on fast growing mode which plays an instrumental role in the country development [1].

Road net expansion work plays a major role in the socio-economic development of a country. The success of development of this sector depends on the capacity of the country and regional government. (Based on this, although various road construction organizations exist in the country,) Oromia Road Construction Enterprise (ORCE) is the primarily established public Enterprise in Oromia region with the objective of carrying out roads construction, waterworks, buildings, roads maintenance and other construction activities. Oromia Road Construction Enterprise (ORCE) was established public Enterprise as an autonomous body having a legal personality in proclamation No. 116/2000 (2008 G.C) issued by National Regional Government of Oromia since August 2008. It is established to carry out the construction, maintenance and upgrading of roads that contribute to the road network development of the region in particular and the country in general. Apart from the roads construction it participates in buildings, water works and other construction activities. The Enterprise has been certified as General Contractor one (GC-1). At the beginning the road projects were taken from the Oromia Roads Authority (ORA) and contract entered through negotiation.

In Oromia Roads Construction Enterprise (ORCE), each project is designed and executed in a specific work place and under specific circumstances. This makes it hard to tell ahead of time exactly how a project will be completed. In most cases it is difficult to tell exactly ahead of time what the final cost of a project will be. During the execution of the contract many unforeseen circumstances and problems arise that need revision of the work progress and modification usually at a given cost and time. Those modifications are in most cases not part of the original price and duration of projects. So, these variations should be dealt separately.

The greatest problem in construction projects is variation. This variation orders are available in all kind of construction projects and play a significant part in defining the ultimate budget and duration of the projects. It includes a modification of the prior scope of tasks as in the contract. The origins of variation orders are characterized under employer related, consultant related, building executor related and other related causes [2].

Variation order is defined as the additions, omissions, alterations and substitution in terms of quality, quantity and schedule of works [3]. Variation orders ultimately lead to delays in project completion. Delays increase the cost of construction because of price adjustment and causes higher overhead costs because of longer construction period. As well as that, material costs may increase due to inflation. To the client, delay means losing profits that are planned to be earned after starting the project on the scheduled time [4].

Delays can be observed at the time of variation in planned work and actual work done. Variations from planned time are considered as delays, and these variations may be positive or negative. The positive variations means the actual task is completed after planned task and negative variation means the actual task done before the planned task [5].

1.2. Statement of the problem

Projects are needed to be completed within the timeframe, budgeted cost and required quality.

However, unfortunately many projects take longer time to complete, cost more than necessary and some projects are cancelled because of various factors directly and/or indirectly related with it. In developing countries, abundant road construction projects are affected by variation [6]. It is shown from previous studies, As one of civil engineering projects, road construction projects

are highly affected by ground conditions, weather and other uncertainties which eventfully requires variation to be made to the original contract which may affects the project budgeted cost and its planned duration [8].

Poor estimation is the main cause of variation orders in the road construction industry. The consultants do not carry out adequate investigations at the initial investigation and design stage. Therefore, several site conditions rise in the construction stage. Further, clients do not have capable professional staff to carry out investigations and estimates, which are prepared by consultants and are not accurate in most cases [6].

The occurrence of variation orders in construction projects is undesirable due to their negative impacts on project performance. The phenomenon of variation orders is addressed by various studies, however, the studies focused on identifying the causes of variation orders. Less attention has been paid to evaluate the impacts of variation orders on construction projects, especially Roadway construction projects [7]. Variation order is observed as one of the most frequently occurring issues in construction projects in Ethiopia **.**Variation is unavoidable in construction projects due to the complex nature of the construction industry. It is common in all types of construction projects and it determines the time limits and anticipated budget of the projects [1]. Variation can occur due to: Right of way or accesses to site problems change in defined scope, lack of proper planning, and lack of proper evaluations of tender documents by contractors at tendering phase and contractor's financial problems [8].

1.3. Research Questions

1. What are the major causes of variation in Oromia road construction Enterprise projects in the case of Jimma zone?
2. What are the effects of variation orders in Oromia road construction Enterprise projects in the case of Jimma zone?

1.4. Research Objective

1.4.1. General Objective

The general objective of this research is to assess the causes and effects of variation order in Oromia Road Construction Enterprise projects in the case of Jimma zone.

1.4.2. Specific Objectives

- To determine the major causes of variation orders in Oromia road construction Enterprise projects in the case of Jimma zone.
- To determine the effects of variation orders in Oromia road construction Enterprise projects in the case of Jimma zone.

1.5. Significance of the Study

The basic importance of this study is identifying problems caused by variation orders in Oromia road construction projects Jimma zone district. The number of variations and the amount of it may give negative implication on projects quality, time and cost. This research intends to identify the factors which lead to the occurrence and effects of variation orders in Oromia road construction projects and the possible strategies to manage this occurrence. Therefore this study helps owners, contractors and consultants to know about variation orders mainly that occur in road construction projects and to prevent before the occurrence of variation, otherwise to take remedial measures in order to reduce its impacts once the variation occurs. In general this study can help the contractor to be profitable and clients to be satisfied by the works.

1.6. Scope and Limitation of the Study

This paper was limited to assess cause and effect of variation order in Jimma zone constructed by Oromia road construction enterprise. Oromia road construction enterprise is participating in water work, asphalt construction, road maintenance and rural road DS6 gravel road (or unpaved) road construction. But this study addresses only variation orders in rural road DS6 gravel road constructed by Oromia road construction enterprise projects in Jimma zone Cora Boter Woreda,Begge-Keta project and Chira Afallo project.

CHAPTER TWO

LITERATURE REVIEW

2.1. General

Any construction project success can be realized by achieving its objectives within the planned time, budget and level of quality.

During the life cycle of construction projects, most of clients and consultants are striving to obtain the ideal projects with a minimum margin of conflict, minimum cost and time overrun and with maximum profit. One of the real challenges that face clients, contractors and other parties operating in construction projects is how to manage and mitigate the negative impact of the consecutive variation orders that create losses in time, efforts and costs. Variations in construction projects can cause substantial adjustment to the contract duration, total direct and indirect cost, or both. Therefore, project management teams must have the ability to respond to variations effectively in order to minimize their adverse impact to the project. Managing the appearance of (V.O) during construction works (implementation stage) needs special treatment.

Variation is unavoidable situation in construction projects. It is common in all types of construction projects and plays an important role in determining the closing cost and time of the projects [9]. Variations or changes to construction plans have been identified as a major problem in construction projects. Variations have adverse impact on project delivery. Effective management of variations, therefore, is critical to accomplishing project objectives; and this commences with identifying the sources and causes of variations [10]. Variations on construction projects are sometimes unavoidable but most times unnecessary. The resultant effects of allowing too much of variation orders issued on construction projects affect time, cost and quality [11].

The objective of this thesis is to identify the major causes and their consequences on Oromia roads construction enterprise projects in the case Jimma Zone.

2.2. Definition of Variation and Variation Order

There are small difference between the word Variation and change. Different authors use the word interchangeably. In agreement with these authors this thesis also used the words variation and change interchangeably. There is no single definition for variation that is accepted worldwide different researchers define variation indifferent ways:

In construction industry "Change" is defined as: addition or deletion, alteration, transformation or modification, variation or deviation, replacement, substitution of one thing for another [23].

Variation may mean 'the alteration or modification of the design, quality or quantity of the works, as shown upon the contract drawings and described by or referred to in the contract bills, and includes the addition, omission or substitution of any work, the alteration of the kind or standard of any of the materials as goods executed or brought thereon by the contractor for the purposes of the works other than work or material or goods which are not in accordance with the contract'. This definition is also clearly stated in the Clause 51 sub clause 1 of Ministry of works and urban development standard conditions of contract (1994) [12'] and MDB FIDIC 2006 clause 1.1.6.9 "Variation" means any change to the works, which is instructed or approved as a variation under Clause 13 [Variations and Adjustments] [12].

Variation order is defined as the additions, omissions, alterations and substitution in terms of quality, quantity and schedule of works [3]. Variation order is any modification to the contractual terms of a project by the owner or the owner's representative, it can be a work that is added to or deleted from the original scope of work of a contract, which alters the original contract amount and/or completion date [4].

2.3. Causes of variation Orders

Variation orders arise for a variety of causes, of which some causes are foreseeable and others are not. Various authors had identified different causes of variation orders in construction projects.

As study conducted in Gaza Strip (Palestine) in 2010, there are ten most important factors cause variations. It includes: lack of materials and equipment spare parts due to closure, change in design by consultant, lack of consultant's knowledge of available materials, errors and omission

in design, conflicts between contract documents, owner's financial problems, lack of coordination among project parties, using inadequate specification for local markets by international consultant, internal politics, and change in specification by owners [13]. The research done in Iran in 2012, it was shown that change of plans or scope by employer, errors and omissions in design and owners' financial problems were the critical factors that cause the existence variation orders in roadway construction projects [14]. There are many factors that cause variation order in building projects. They included: Lack of stability of prices and the exchange rate change, new government regulations, Errors and omissions in design, Owner fails to make decisions or review document at the right time, Owner's needs during the design stage are not well-defined or variably , Owner's financial problems , Contractors financial difficulties, The lack of coordination between consultant and contractors and subcontractors and Non-use value engineering in design stage to find the best alternatives and providing cost [15].

Poor estimation is the main cause of variation orders in the road construction industry. The consultants do not carry out adequate investigations at the initial investigation and design stage. Therefore, several site conditions rise in the construction stage. Further, clients do not have capable professional staff to carry out investigations and estimates, which are prepared by consultants and are not accurate in most cases [6]. Delay in acquisition of right of way, differing site conditions, change of plans or scope by client, change of schedule by client, lack of coordination between overseas and local designers were outstanding as the five most important cause of variation orders [9].

According to the study conducted in Malaysia in 2014, there are five most significant causes of variation orders they includes: unavailability of equipment, poor workmanship, design complexity, change of schedule and impediment to prompt decision making process [16**].** Another study in Jordan, 2015, states that the most ten important causes are change of schedule, ambiguous design details, change of plan or scope, conflict between contract documents, lack of coordination, safety considerations, client financial problem, change in design by consultant, socio-cultural factors, and change in government regulations [17].

Design changes, incomplete contract documents, impediment in prompt decision making process, inadequate working drawing details, and change in specifications were the main causes of variation orders on public building projects [1].

As study conducted in Kuwait in 2014, the most five common causes of change orders can be identified as: change of plans by owner, change of project scope by owner (additional-enhancement), problems on site, errors and omission in design (main element), poor design and poor working drawing details (secondary element) [21]. It was concluded that the major causes of change orders in Nigeria and Oman are those related to client and the major reason is that owner request for additional works [24].

The causes or the circumstances under which variations could be initiated were classified as the following categories/types of rework are discussed in detail.

2.3.1 Design Change

Changes in design were frequent in projects where construction starts before the design is finalized. Such changes affect the project in various ways depending on the timing of the change [1].

2.3.2 Change in Scope

Change of plan or scope of the project is one of the most significant causes of variation in construction projects [14]. It is usually the result of inadequate planning at the project definition stage or because of lack of involvement of the owner in the design phase [16].Another study in Jordan, 2015, states that change of plan or scope is one the most significant of causes of variation in construction projects [17].

2.3.3 Design Omission

As study conducted in Gaza Strip (Palestine) in 2010, errors and omission in design is one of the most significant causes of variation orders [13]. Among the many project documents, one may find a not deleted item by mistake; it may consist of incomplete specification or unreferenced details or others. In order to correct these errors and omissions change order will be issued which will ultimately causes cost and schedule adjustment during construction.

2.3.4 Poor workmanship

Defective workmanship of completed work may bring demolition and re-work or it may bring changes in some cases. According to the study conducted in Malaysia in 2014, poor workmanship is one of the most significant causes of variation orders [16**].**

2.3.5 Right of way (or access to site) problems

As part of preconstruction planning, the client should acquire the right of way before the contractor moves in to commence works, a conclusive feasibility study that entails thorough geotechnical investigation that brings to the fore all ground conditions necessary for design, Clients should clarify the scope of works [9].

2.4. Effects/ Impact of variation Orders

In construction, extra work or omission of scope of activities of the project can bring effect on the portions of the project directly or indirectly. It was arguably that the occurrence of variations has an adverse impact on project performance. The optimum project performance would be achieved if the work invariably flows smoothly within time limits and anticipated budget.

Variation orders result in time delay; cost overrun, quality defects, and other associated negative impacts [15]. Delay in completion time, increase in project cost, suspension or disruption of work, decrease in productivity, and dispute between parties respectively are the most significant effects of variations in Ethiopian Federal road construction projects [8]. Time, cost overruns and disputes had great significant effects on project performance [14]. According to the Proceedings of International Conference in Malaysia, 2018, Occurrence of variation orders result with five impacts on roadway construction projects including: disputes between parties; delay in completion schedule; increase in project cost; logistic delay; and poor professional relations [7].

Variation orders cause time delay, cost overrun, quality defects, and other negative impacts. Moreover, variation orders lead to uncertain flow processes and increase of non-value-adding activities which reduce the output value of the projects [18]. The down side of variation order was it brought cost and schedule overrun and causes disagreement and claims among the contract parties [2]. The main effect of the occurrence of variation order is the increase in the project cost [3].

The projects with more VO's have larger cost and schedule overruns than those with less VO's. Additionally it also finds that larger cost and schedule overruns occur when the VO's occur later in the project [19]. The variations in the works, if not handling properly, surely will become the main causal factor of the claims submitted by the contractor [20].

As study conducted in Kuwait in 2014, the most five common effects of change order or variation order are increasing the project's cost, increasing the duration of individual activities, delaying in completion schedule, additional money for contractor, and delaying in payment [21].

Variation that might result in the reduction of the scope of the project input generates claims for loss of profit and overhead cost which may also lead to disagreement and eventually disputes [25]. Cost overrun, Delay in completion schedule, Delays/ obstructs work in other areas or in other projects, Delay in payment to contractor, Public discomfort & Traffic congestion, Increase in contractors overhead, Failure to meet utility, Legal dispute between owner and contractor, Decrease in quality of work, Contract termination and Demolition and rework are the effects of change orders in road construction projects [26].

The effects identified from these literatures will be described below;

2.4.1. Increase in project cost

Many studies on the effects of variations indicated that variations contributed to increase in construction project costs. The more the variation orders, the more they affect the overall construction delivery cost. Increasing project cost is the most common effect of variation in construction projects during construction phase [16]. While due to changes in the work, the project cost has increased. This amount of money affect the initial project cost [30].

2.4.2. Completion schedule delay

Variation may hinder the project progress and leads to delay in achieving the targeted milestones during construction work. According to the Proceedings of International Conference in Malaysia, 2018, Occurrence of variation orders in roadway construction projects affects completion schedule of then projects [7].

2.4.3. Effect on the quality of work

Variation orders cause quality defects. Variation orders were reduce the output value of the projects [18]. A change during the construction work has an impact on the quality of work.

2.4.4. Dispute between contracting parties

Variation is a major cause of claims in construction projects. If this claims are not politely solved they results in dispute that may affect the relation among contracting parties and between professionals of the contracting parties [26].

2.4.5. Decrease Productivity

Decrease in productivity is one the most significant effects of variations in Ethiopian Federal road construction projects [8].The study identified lost in productivity is one of the most effects of road project delays. Occurrence of delay in roadway construction projects affects completion schedule of the projects [29].

Table 2. 1: Summary of effects of variation orders in the construction projects

Cost-related effects	Increase project cost	[2],[3],[7],[8],[15],[18],[19],[21],[26].
Time-related effects	Completion schedule delay	[2],[7],[8],[14],[15],[18],[19],[21],[26], [29].
	Rework and demolition	[26], [30]

2.5. Reduction mechanism

Controls for variations and variation orders have been suggested by many researchers. Controls that have been identified from a literature review are discussed below.

In order to minimize the occurrence of variation order in civil construction projects: As part of preconstruction planning, the client should acquire the right of way before the contractor moves in to commence works, a conclusive feasibility study that entails thorough geotechnical investigation that brings to the fore all ground conditions necessary for design, Clients should clarify the scope of works [9]. Professionals should participate from design phase to assist in clarifying the project objectives and in identifying the noncompliance with their requirements at early stages. Further, consultant must focus on controlling the

recurrent change in design; avoid inadequate working drawing details through systematic detailing of the design [16].

As study conducted in Kuwait in 2014, there are six most common control measures of variation order. Those are : checking and reviewing the contract documents, reviewing design before change approval, the change order must be negotiated by educated persons, the scope of change orders must be precisely done, careful checking in writing must be handed, and the good tools to control the occurrence of change including the areas of concern in monthly reports and meetings [21].Another study conducted in Tanzania in 2017, states that the factors such as effort by client, consultant and contractor to control variation orders; clear design specifications; comprehensive site investigations; use of project scheduling techniques and; use of knowledge base of previous similar projects appear to be the most five important mitigation measures for detrimental variations in construction projects [22].

As the study conducted in the Sri Lanka in 2013, there are several factors to minimize the occurrence of variation orders. The investigation must be carried out properly by qualified professional staff at the initial stage (in the pretender period) and adequate planning in advance is required by all involved parties before work starts at the site. The estimates have to be prepared properly by experienced professionals and clients should provide a clear brief of the scope of work. Further, consultants should ensure that the design/specifications fall within the approved budget and the budget team should be appointed early and they should participate in the designing process. Further, all parties should forecast unforeseen situations. Closer consultant coordination is required at the design stage, and utilization of an experienced consultant to produce a concluding design, working drawings, and contract drawings should be done at the tender stage. Further, maintaining proper communication channels and documentation is very important in terms of variation order management [6].

Implementation/enforcement of National Building Code, Review of contractor's/ consultant's registration should be carried out periodically to ascertain their professional competency and Client should carry out proper feasibility study and survey before the design stage [24]. Land acquisition and related procedures should be completed prior to the commencement of project, Intervention by people other than department should be minimized, and Detailed BOQ

considering practical work has to be made before tendering [26]. The construction parties should have more communication and coordination during all project phases, and the managerial skills of the construction parties should be improved by conducting workshops and training courses [27].

Owners are recommended to request everything they need in the contract from the beginning and avoid any requirements after implementation of works and develop a clear vision for projects. Consultants are recommended to provide more details in drawings. Also, train contractors on certain types of drawings especially that complex ones. Also, consultants should explain on site the complex details to the contractor. Contractors are recommended to take into consideration the days when work stop due to the bad weather and take approval to stop work from consultant on the site. As well, make up for the days when work stop over time or work in holidays to avoid change in schedule especially in road projects.

Table 2. 2: Controlling mechanisms for variation orders adapted from various authors

Stage	Controlling mechanisms	Description
A) Design	➢ Critical review of contract Documents	Contract documents are the main source of information for any project. Critical review of this document at design stage will minimize ambiguity and conflicts between contract documents which ultimately results in misinterpretation of the actual requirement of a project [21], [6].
	➢ Owner involvement at planning and design phases	Involvement of the owner at the design phase would assist in clarifying the project objectives and identifying noncompliance with their requirements at the early stage. Hence, this may help in eliminating variations during the construction stage where the impact of the variations can be severe [16].

B) At Design-construction interface	➢ Knowledge-base of previous similar projects ➢ Utilize work breakdown Structure	If professionals have a knowledge-base established on past similar projects, it would assist them to plan effectively before starting a project, both during the design phase as well as the construction phase, minimize and control variations and their effects [22].
C) Construction	➢ Owner's involvement during construction phase ➢ Clarity of variation order procedure ➢ Written approvals	Like that of the design stage involvement of the owner during the construction phase would also assist in identifying noncompliance with the requirements and in approving the variations promptly.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study Area

This study was conducted in Jimma zone, Chora Botor and Gera woreda gravel road construction projects. Jimma is one of the ancient and largest towns in the country located in southwestern Oromia region in Ethiopia and which is located around 346 Km from Addis Ababa. Jimma zone is found at an altitude of 1,780 meters (5,840 feet) and the latitude and longitude of $7^{o}40'$ North and 37^{o} East respectively. Jimma zone is bordered on the south by the Southern Nations, Nationalities and Peoples Region, the northwest by Illubabor, on the north by East Wolega and on the northeast by West Shewa; part of the boundary with East Shewa is defined by the Gibe River..

Some of Jimma worad's are;-Chora Botor, Dedo, Gera, Limmu Kosa , Limmu Sakka, Setema, Sigmo, Botor Tolay, Shebe, Nonno Benja, Goma, Guma, Omo Nada, Kersa, Tiro Afeta, Mana etc. Specific area of the study was in Oromia region, Jimma zone, Chora Botor Woreda and Gera woreda.

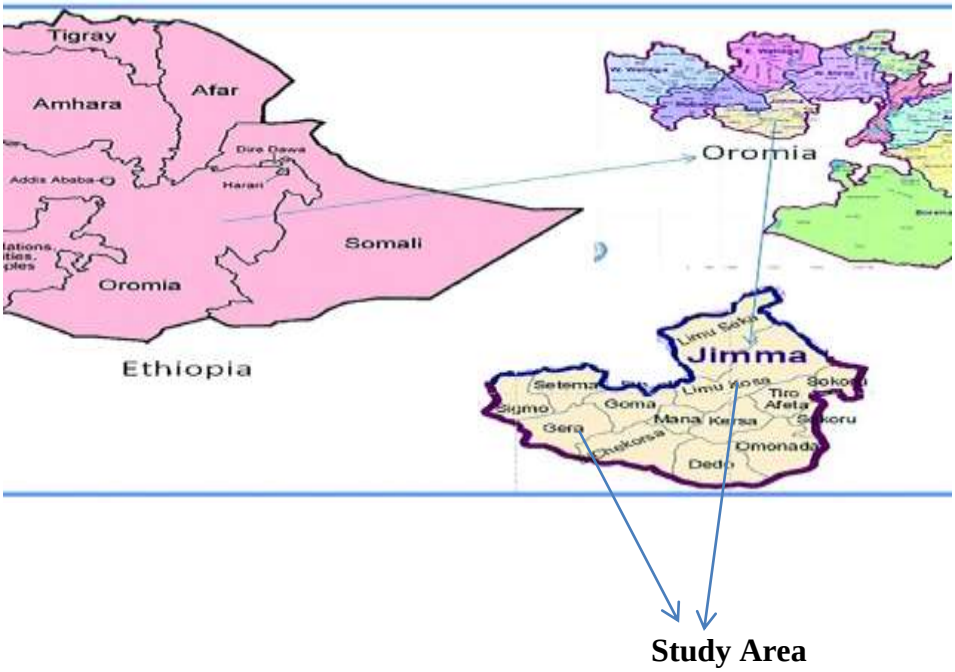


Figure 3.1: Map of Jimma Zone

3.2. Study Period

The study was conducted from the middle of June to end of February, 2023.

3.3. Research Design

The research started with problem identification which has been done through literature review and informal discussion with colleagues and professional in the sector.

Once the research area is identified, literature review have been done to have an in depth understanding on the research topic and its objectives focusing on causes and effects and methods on how to control/minimize variations. The review includes books, journal and articles, internet sources and archival document search such as progress and completion reports, contract documents and claim submittal and written letters within Oromia Road Construction Enterprise Projects. The document search was mainly intended to collect values of variations orders and their causes. After an in depth review of literature and case study, a questionnaire was designed and distributed to contractors, consultants and the employer's staffs to get their professional opinion out of their experience.

Upon obtaining the desired data, checking and sorting of data has been done for the selected method of analysis. The next is performing analysis for questionnaire after inputting the key informant's response through questionnaires ratings. The analysis was done by RII formula by using Microsoft Office Excel and in relation to theoretical proposition.

Finally it enabled to obtain the result followed by comprehensive discussions in order to draw a conclusion and to forward recommendations based on the finding of the research study.

The overall study approach is summarized in Figure 3.2 below.

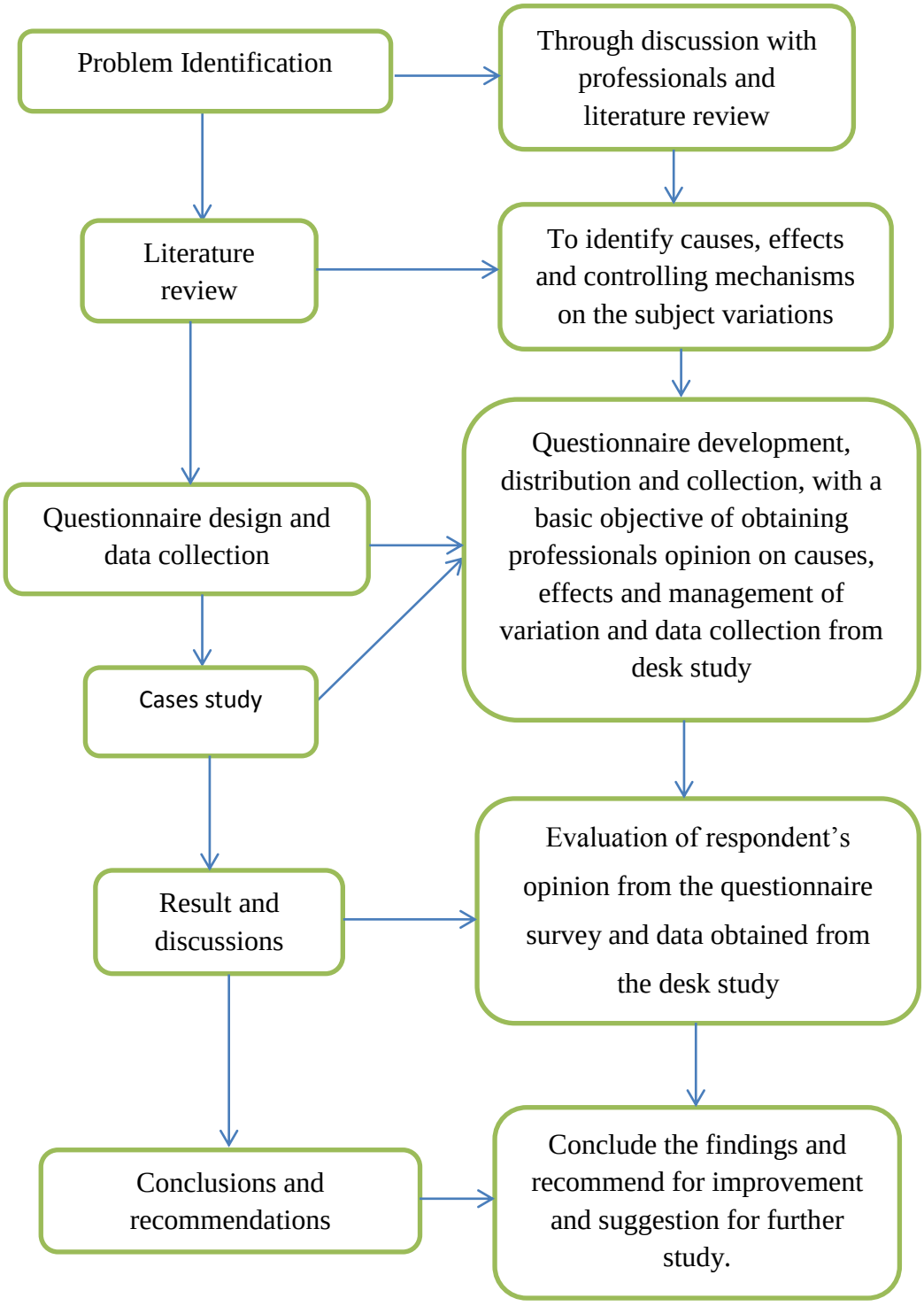


Figure 3.2: Flow chart of study frame work

3.4. Study Variable

3.4.1. Dependent Variable

- Variation order in Oromia road construction enterprise projects.

3.4.2. Independent Variables

- Design change
- Poor estimation of time and cost
- Unforeseen problem
- Right of way (or access to site) problems.

3.5. Population and Sampling Method

3.5.1. Population

The populations under study were road projects constructed by Oromia roads construction enterprise Projects in Jimma zone. These populations were used in the case study to assess the cause and effects of variation orders in Oromia Road Construction Enterprise Projects.

The other populations of the study were respondents of the questionnaires such as contractors, consultants, and clients. They participated in responding the questionnaire that covers the causes, impacts of variation orders.

There are three contracting party are involved for the gravel road construction projects such as clients, contractors, and consultants. The total population used in this research study is 70, comprising of 25 for contractors representative, 22 for clients representative and 23 for consultants representative.

3.5.2. Sampling Method

Due to the nature of data collected through desk study and the expected participants for the survey study, a non-probability sampling was preferred to be used. A purposive sampling method was used to select the target population under study. Therefore, the target group considered to successfully complete the objective of this study were rural road (gravel road DS6) constructed by Oromia road construction enterprise projects in Jimma zone. The primary relevance of this research is to make study on cause and effects of variation orders in Oromia Road Construction in Jimma zone district with projects have variation in terms of cost and time.

3.6. Source of Data

Both primary and secondary data were used for conducting this research. The source of the primary data was in the form of observational checklist and questionnaires designed to gather adequate data. The main role of the primary data is to collect information that can be analyzed, and produce conclusion about the cause and effects of variation orders in Jimma zone. Secondary data used for this study include reviewing related literatures includes books, dissertations, magazines, newspaper, document reviews (contract documents, other letters) and journals of various authors.

3.7. Data Collection Procedure

In order to optimize the significance of the research on the stated problem, useful data was extracted from payment certificate, Progress report (weekly, monthly and annual),different letters, site diary and site book and from contract documents.

To identify the major causes and consequential effects of variation order in Oromia Road Construction Enterprise Projects, a desk study approach and questionnaire survey were carried out in addition with information on archival documents and literature review. The purpose of the desk study was to obtain actual data from the source documents which included the contract documents, variation orders and progress as well as completion report to have contextual bases on variations. Besides this a literature review to develop conceptual basis for the study was also conducted side by side. Through the above literature review, possible causes, effects and methods of controlling of variation orders were identified. The review provided the basis to design the questionnaire which was distributed to professionals.

3.7.1. Case-study

Case study was conducted on two gravel road projects, which were delayed and have variation in Jimma zone road construction projects that was constructed by Oromia Road Construction Enterprise Projects. The documents referred during the case study include progress and completion reports, contract documents and claim submittal, variation orders, correspondences and other important documents of the projects in addition to this direct observation of site condition, correspondences from discussion and interview for criterion based selected projects.. These cases discussed in depth by organizing information and

focusing on causes of variation order and effect of variation order in Jimma Zone constructed by Oromia Road Construction Enterprise.

3.7.2. Questionnaire approach

For the questionnaire survey the respondent was randomly selected from the employer, contractor and consultant who have been involved in the road sector. After cause and effects of variation orders were identified through unstructured literature review, case study, and informal discussion with colleagues and professionals in the sector; questionnaire was designed and distributed to reputed construction professionals to get their professional opinion based on their experience. The answer for the questionnaire was rated based on Likert's-scale of five ordinal measures of agreement on each contributing factors (from 1-5) to identify potential causes and effects based on their experience.

This questionnaire is used to evaluate the cause of variation orders, effects of variation orders. In addition, the questionnaire form comprises into three parts. The first part is the respondent's profiles (e.g. Name, Experience and occupation). The second part contains the list of causes of variation and the third part contains the list of impacts/effects of variation orders.

3.8. Data Presentation and Analysis

All data used for the study where obtained from the case study and questionnaires survey. Then we would analyze their result and conduct the procedure to achieve settled objective. The result obtained was analyzed using relative important index (RII) technique and Microsoft word excels 2010 used to tabulate and make the analysis easy. Presentation of data would be done using appropriate graphical tools such as: graphs, tables and charts in order to come up with a clear conclusion.

RII =∑W/A*N----------3.1

$(0 \leq RII \leq 1)$

Where:-

W -is the weight given to each factor by the respondents;

A -is the highest weight and;

N -is the total number of respondents

The RII value ranges from 0 to 1 (0 not inclusive), the higher the value of RII, the more that causes is. Both the primary and secondary data collected are entered in to Excel Software. The result is organized and presented in terms of tables.

Spearman's rank correlation coefficient (r) is used to demonstrate whether there is the agreement or disagreement of ranking between any two parties. In this research it is used to show the degree of agreement between the different parties involved in the survey. The correlation coefficient varies between +1 and -1, while -1 results from a perfect negative relationship (disagreement). On the other hand a sample estimate correlation close to unity in magnitude implies good or strong correlations; while value near to zero indicates little or no correlation. This correlation coefficient is used to measure and compare the association between the rankings of two parties for a single cause, while ignoring the ranking of the third one. And it was calculated using the following formula.

$$r_s = 1 - [6 \sum d^2] / n(n2-1) \quad \text{----------} \quad 3.2$$

Where:

r_s = the Spearman's correlation coefficient between two parties

d = the difference between rank assigned variables for each causes

n = the number of parties of rank

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Questionnaire Survey Result

This section deals with the analysis of the information gathered from the questionnaire survey to obtain information on the causes, effect of variation orders from the perspective of owner, contractor and consultant.

4.1.1. Questionnaire survey response rate

As stated in previous section questionnaires were distributed to the major parties that play dominant role in day-to-day construction activities. These are contractors, consultants and clients of the sector

Out of the 70 questionnaires 22 were distributed for Employers staff, 23 for consultants and 25 for contractors which are involved in Oromia Road Construction Enterprise Projects. Out of the distributed 70 questionnaire, 58 professionals responded to the survey which is 21(84 %), 18(82 %), 19(83%) from Contractor, Employer and Consultant respectively.

Before starting the analysis, the returned questionnaire was checked for their reliability and out of the 70 questionnaires 58 were found to be suitable for data analysis. This yields a response rate of 83%. The details of respondent responses and its rate are summarized in Table 4.1.

Table 4. 1: Questionnaire survey response rates

Respondents Category	Questionnaires		Percentage	Valid responses	Percentage
	Distributed	Returned			
Employer	22	18	82%	18	82%
Contractors	25	21	84%	21	84%
Consultants	23	19	83%	19	83%
Total	70	58	83%	58	83%

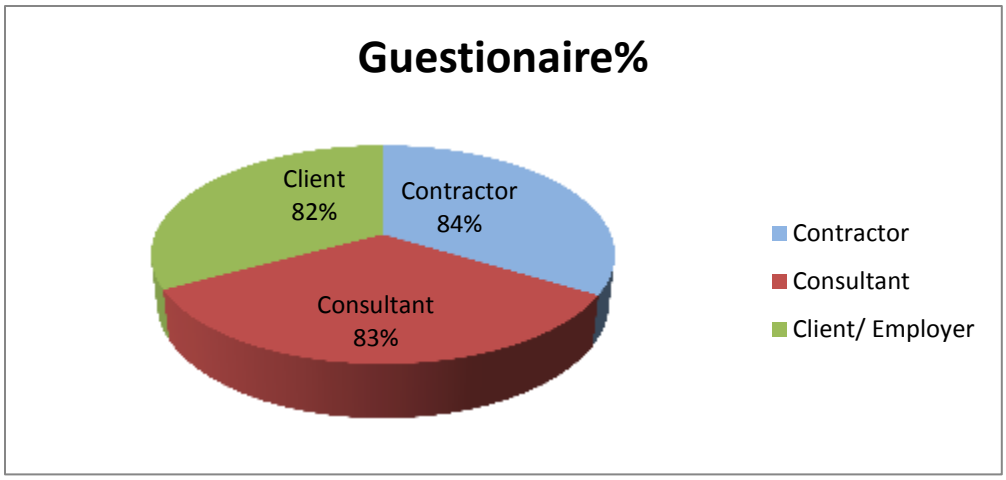


Figure 4. 1 Distribution of Questionnaires and response rate by respondents

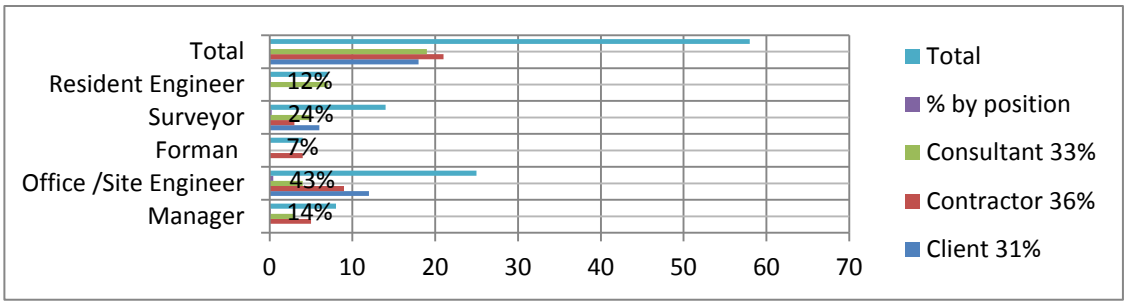
4.1.2. Respondents Profile

This is a part mainly designed to provide general of organization, position and experience in year.

4.1.2.1. Respondents designation by Position

As shown on figure 4.2. 24% (5) of contracting companies respondents were managers, 19% (4) were Forman and, 14% (3) were Surveyor. From the client's respondents 56% (10) were office/site Engineers, 28% (5) were Surveyor and 17% (3) were Resident Engineers. From the consultant respondents 16% (3) were Managers, 21% (4) were office/site Engineers, 26% (5) were Surveyor and 37% (7) were Resident Engineers.

Totally, out of 58 respondents for the three parties, 14% (8) of the respondents were projects managers, 43% (25) were organization site/office Engineers, 7% (4) were Forman,24% (14) were Surveyor and 12% (7) were Resident Engineers.

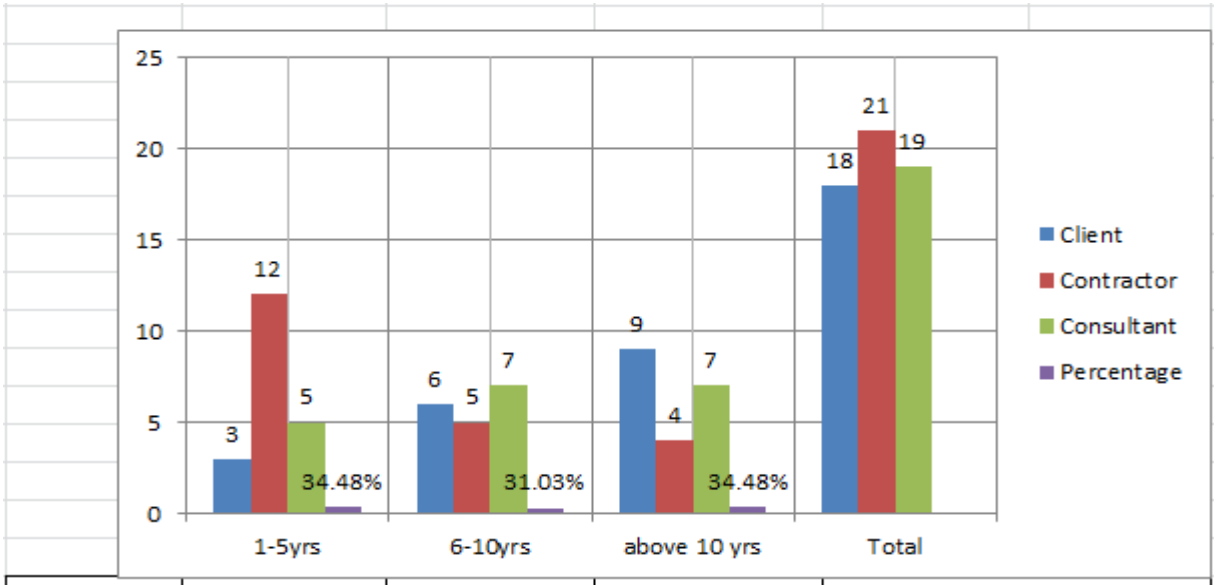


	Client	Contractor	Consultant	% by position	Total
% by parties	31%	36%	33%		
Manager		5	3	14%	8
Office/Site Engineer	12	9	4	43%	25
Forman		4		7%	4
Surveyor	6	3	5	24%	14
Resident Engineer			7	12%	7
Total	18	21	19		58

Figure 4. 2 Respondents' designation by position

4.1.2.2. Experience of respondents by service year

Figure 4.3 shows that 34.48 % (20) of the respondents have experience between 1 to5 years in road project. 31.03% (18) of the respondents have experience in between 5 and 10 years' service in road projects, and 34.48% (20) of the respondents have experience more than 10 years.



Client	3	6	9	18
Contractor	12	5	4	21
Consultant	5	7	7	19
Percentage	34.48%	31.03%	34.48%	

Figure 4. 3 Experience of respondents

4.1.3. Results of variation orders cause

In order to examine the causes of variation orders by each party individually; the owners, contractors and consultants data were divided and analyzed independently. This process helps determining the level of agreement degree between different parties. The following subsections show the causes of variation orders from each party's opinion and the overall results.

4.1.3.1. Owner Results

Table 4.2 Presents the RIIs and ranks of each cause based on owner responses received.

Table 4. 2: Owner Responses Results

No.	Causes of variation order	Client	
		RII	Rank
1	Change in design including addition and omission	0.489	1
2	Conflicts between contract documents	0.456	2
3	Poor estimation	0.412	3
4	Delay in acquisition of right of way	0.395	4
5	Poor workmanship	0.389	5
6	Lack of consultant's knowledge of available materials	0.322	6
7	Non-use value engineering in design stage	0.314	7
8	Change of plans or scope by employer	0.312	8
9	Change in specification by owners	0.311	9
10	Inadequate working drawing details	0.31	10
11	Unavailability of equipment	0.265	11
12	Change of schedule by client	0.25	12
13	Differing site conditions	0.235	13
14	Safety considerations	0.233	14
15	Internal politics	0.23	15
16	Lack of stability of prices and the exchange rate change	0.211	16
17	Owners' financial problems	0.21	17
18	Socio-cultural factors	0.2	18
19	Change in government regulations	0.2	19
20	Lack of coordination	0.2	20
21	lack of materials and equipment spare parts due to closure	0.2	21
22	lack of consultant's knowledge of available materials	0.2	22
23	New government regulations	0.152	23

As shown in Table 4.2, the top five most important causes of variation orders in Oromia Road Construction Enterprise Projects as received by respondent include Change in design including addition and omission , Conflicts between contract documents, Poor estimation, Delay in acquisition of right of way and Poor workmanship. "Change in design including addition and omission" is the most important cause of variation order from the owner perspective as it was

ranked the first with RII = 0.489. “Conflicts between contract documents” is ranked the second important cause with RII= 0.456. “Poor estimation” is ranked the third important cause with RII= 0.412. “Delay in acquisition of right of way” is ranked the fourth important cause with RII= 0.395. The fifth important cause is “Poor workmanship.” With RII=0.389

4.1.3.2. Contractor Results

Table 4.3 Presents the RIIs and ranks of each cause based on Contractor responses received.

Table 4.3: Contractor Responses Results

No.	Causes of variation order	Contractor	
		RII	Rank
1	Delay in acquisition of right of way	0.83	1
2	Change in design including addition and omission	0.81	2
3	Conflicts between contract documents	0.79	3
4	Poor estimation	0.762	4
5	Inadequate working drawing details	0.75	5
6	Lack of stability of prices and the exchange rate change	0.53	6
7	Lack of consultant's knowledge of available materials	0.48	7
8	Change of schedule by client	0.46	8
9	Differing site conditions	0.45	9
10	Poor workmanship	0.36	10
11	Change of plans or scope by employer	0.36	11
12	Safety considerations	0.35	12
13	Owners’ financial problems	0.35	13
14	Internal politics	0.35	14
15	New government regulations	0.33	15
16	Non-use value engineering in design stage	0.33	16
17	Unavailability of equipment	0.33	17
18	Change in specification by owners	0.32	18
19	Socio-cultural factors	0.31	19
20	lack of materials and equipment spare parts due to closure	0.31	20
21	Change in government regulations	0.3	21
22	Lack of coordination	0.3	22
23	lack of consultant's knowledge of available materials	0.2	23

As shown in Table 4.3, the top five most important causes of variation orders in Oromia Roads Construction Enterprise Projects as received by respondent include Delay in acquisition of right of way, Change in design including addition and omission, Conflicts between contract documents, Poor estimation and Inadequate working drawing details. "Delay in acquisition of right of way" is the most important cause of variation order from the contractor perspective as it was ranked the first with RII = 0.83. "Change in design including addition and omission" is ranked the second important cause with RII= 0.81. "Conflicts between contract documents" is ranked the third important cause with RII= 0.79. "Poor estimation" is ranked the fourth important cause with RII= 0.762. The fifth important cause is "Inadequate working drawing details." With RII=0.75.

4.1.3.3. Consultant Results

Table 4.4 Presents the RIIs and ranks of each cause based on Consultant responses received.

Table 4.4: Consultant Responses Results

No.	Causes of variation order	Consultant	
		RII	Rank
1	Poor estimation	0.69	1
2	Conflicts between contract documents	0.66	2
3	Change of plans or scope by employer	0.65	3
4	Delay in acquisition of right of way	0.56	4
5	Change in design including addition and omission	0.49	5
6	Lack of consultant's knowledge of available materials	0.47	6
7	Change in specification by owners	0.45	7
8	Differing site conditions	0.42	8
9	Change of schedule by client	0.39	9
10	Internal politics	0.36	10
11	Safety considerations	0.36	11
12	Non-use value engineering in design stage	0.32	12
13	Unavailability of equipment	0.32	13
14	Owners' financial problems	0.31	14
15	Poor workmanship	0.3	15
16	lack of materials and equipment spare parts due to closure	0.3	16
17	Inadequate working drawing details	0.22	17

18	Lack of stability of prices and the exchange rate change	0.21	18
19	New government regulations	0.2	19
20	Socio-cultural factors	0.2	20
21	Change in government regulations	0.2	21
22	Lack of coordination	0.21	22
23	lack of consultant's knowledge of available materials	0.19	23

As shown in Table 4.4, the top five most important causes of variation orders in Oromia Road Construction Enterprise as received by respondent include Poor estimation, Conflicts between contract documents, Change of plans or scope by employer , Delay in acquisition of right of way, Change in design including addition and omission. "Poor estimation" is the most important cause of variation order from the consultant perspective as it was ranked the first with RII = 0.69. "Conflicts between contract documents" is ranked the second important cause with RII= 0.66. "Change of plans or scope by employer" is ranked the third important cause with RII= 0.65. "Delay in acquisition of right of way" is ranked the fourth important cause with RII= 0.56. The fifth important cause is "Change in design including addition and omission." With RII=0.49.

Test for agreement in ranking among respondents

This part of the study checks whether there is an agreement between respondents (client, contractors and consultants) in ranking of cause of variation orders based on Spearman rank correlation coefficients.

$$r_s = 1 - [6 \sum d^2] / n(n2-1)$$

Where:

r_s = the Spearman's correlation coefficient between two parties

d = the difference between rank assigned variables for each causes

n = the number of parties of rank

Based on the above formula degree of agreement between clients vs. consultant, client vs. contractor and consultant vs. contractor were checked and presented below in the tables.

According to spearman rank coefficient formula, value ranges from -1 to +1 and different

rs value have different meanings as it is described below. If spearman rank correlation coefficient value (r)

Is -1 there is a perfect negative correlation

Lying between -1 and -0.5, there is a strong negative correlation

Lying between -0.5 and 0, there is a weak negative correlation

Is 0 there is no correlation

Lying between 0 and 0.5, there is a weak positive correlation

Lying between 0.5 and 1, there is a strong positive correlation

Is 1 there is a perfect correlation

Table 4. 5: Summary of spearman's correlations for causes of variations

Correlation		
Client vs. contractor	Client vs. Consultant	Contractor vs. Consultant
0.764244942	0.741198279	0.589262944

The tables above showed that the calculated spearman rank correlation coefficient values for all pair of parties (client vs. consultant, client vs. contractor and consultant vs. contractor) for relative importance index were between 0.5 and 1, which shows there is a strong positive correlation in ranking the cause of variation orders. This indicates there is a strong agreement between the respondents in ranking the cause of variation orders.

Based on the result of the analysis from respondent's response the most important causes of variation in Oromia Road Construction Enterprise were identified. Table 4.6 below shows the major causes of variation in Oromia Road Construction Enterprise Projects.

Summary of Cause of variation orders

The next step in the research process was to rank the most important causes of variation orders based on the higher relative importance index value. Only the first five causes selected for further analysis.

Table 4. 6 Overall Responses Results

No.	Causes of variation order	Client		Contractor		Consultant		Overall	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Change in design including addition and omission	0.489	1	0.81	2	0.49	5	0.596	3
2	Lack of consultant's knowledge of available materials	0.322	6	0.48	7	0.47	6	0.424	7
3	Internal politics	0.23	15	0.35	14	0.36	10	0.313	15
4	Change in specification by owners	0.311	9	0.32	18	0.45	7	0.360	10
5	Conflicts between contract documents	0.456	2	0.79	3	0.66	2	0.635	1
6	Owners' financial problems	0.21	17	0.35	13	0.31	14	0.290	17
7	Change of plans or scope by employer	0.312	8	0.36	11	0.65	3	0.441	5
8	Lack of stability of prices and the exchange rate change	0.211	16	0.53	6	0.21	18	0.317	13
9	New government regulations	0.152	23	0.33	15	0.2	19	0.227	22
10	Non-use value engineering in design stage	0.314	7	0.33	16	0.32	12	0.321	12
11	Poor estimation	0.412	3	0.762	4	0.69	1	0.621	2
12	Delay in acquisition of right of way	0.395	4	0.83	1	0.56	4	0.595	4
13	Differing site conditions	0.235	13	0.45	9	0.42	8	0.368	8
14	Change of schedule by client	0.25	12	0.46	8	0.39	9	0.367	9
15	Unavailability of equipment	0.265	11	0.33	17	0.32	13	0.305	16
16	Poor workmanship	0.389	5	0.36	10	0.3	15	0.350	11
17	Safety considerations	0.233	14	0.35	12	0.36	11	0.314	14
18	Socio-cultural factors	0.2	18	0.31	19	0.2	20	0.237	19
19	Change in government regulations	0.2	19	0.3	21	0.2	21	0.233	21

20	Inadequate working drawing details	0.31	10	0.75	5	0.22	17	0.427	6
21	Lack of coordination	0.2	20	0.3	22	0.21	22	0.237	20
22	lack of materials and equipment spare parts due to closure	0.2	21	0.31	20	0.3	16	0.270	18
23	lack of consultant's knowledge of available materials	0.2	22	0.2	23	0.19	23	0.197	23

4.1.4. Impact of Variation Orders

This section will examine the impact of variation orders by each party individually. Results obtained from owner, contractor and consultant results will be analyzed independently. Also overall result combining the project parties' results will be shown. This process helps determining the agreement degree between different parties. The following subsections show the impact of variation orders from each party's opinion and the overall results.

4.1.4.1. Owner Results

Table 4.7 Presents the RIIs and ranks of each impact based on owner responses received.

Table 4. 7 Owner Results of Variation Orders Impacts

No.	Impacts/effects of variation orders	Client	
		RII	Rank
1	Time overrun	0.856	1
2	Cost overrun	0.844	2
3	Disputes between parties	0.822	3
4	Decrease quality	0.756	4
5	Suspension or disruption of work	0.6	6
6	Decrease in productivity	0.7	5
7	Poor professional relations	0.489	8
8	Claims among the contract parties	0.522	7
9	Increasing the duration of individual activities	0.478	9
10	delaying in payment	0.433	10
11	additional money for contractor	0.378	11

According to table 4.7, "Time overrun" is the most significant impact of variation orders from the owner point of view with RII = 0.856. The second impact of variation orders from owner point view is "Cost overrun" with RII = 0.844.The third impact is "Disputes between

parties" with RII = 0.822. The fourth impact of variation orders is "Decrease quality" with RII = 0.756. The fifth impact of variation orders is "Decrease Productivity" with RII = 0.7.

4.1.4.2. Contractor Results

Table 4.8 Presents the RIIs and ranks of each impact based on Contractor responses received.

Table 4. 8 Contractor Results of Variation Orders Impacts

No.	Impacts/effects of variation orders	Contractor	
		RII	Rank
1	Time overrun	0.781	2
2	Cost overrun	0.79	1
3	Disputes between parties	0.752	3
4	Decrease quality	0.667	6
5	Suspension or disruption of work	0.676	5
6	Decrease in productivity	0.724	4
7	Poor professional relations	0.59	9
8	Claims among the contract parties	0.648	7
9	increasing the duration of individual activities	0.61	8
10	delaying in payment	0.514	10
11	additional money for contractor	0.504	11

According to table 4.8, "Cost overrun" is the most significant impact of variation orders from the Contractor point of view with RII = 0.79. The second impact of variation orders from Contractor point view is "Time overrun" with RII = 0.781.The third impact is "Disputes between parties" with RII = 0.822. The fourth impact of variation orders is "Decrease Productivity" with RII = 0.724. The fifth impact of variation orders is "Suspension or Disruption of work" with RII = 0.676.

4.1.4.3. Consultant Results

Table 4.9 Presents the RIIs and ranks of each impact based on Consultant responses received.

Table 4. 9 Consultant Results of Variation Orders Impacts

No.	Impacts/effects of variation orders	Consultant	
		RII	Rank
1	Time overrun	0.821	2
2	Cost overrun	0.8	3
3	Disputes between parties	0.737	6
4	Decrease quality	0.744	5

5	Suspension or disruption of work	0.674	8
6	Decrease in productivity	0.779	4
7	Poor professional relations	0.558	9
8	Claims among the contract parties	0.864	1
9	increasing the duration of individual activities	0.695	7
10	delaying in payment	0.495	10
11	additional money for contractor	0.453	11

According to table 4.9, "Claims among the contract parties" is the most significant impact of variation orders from the Consultant point of view with RII = 0.864. The second impact of variation orders from Consultant point view is "Time overrun" with RII = 0.821.The third impact is "Cost overrun" with RII = 0.8. The fourth impact of variation orders is "Decrease Productivity" with RII = 0.779. The fifth impact of variation orders is "Decrease quality" with RII = 0.744.

Test for agreement in ranking among respondents

Similar to that of cause, the ranking by all parties for effects were tested to check the agreement between respondents using spearman's rank correlations for the 11 effects listed above. The result of the spearman's correlation coefficient is summarized in Table 4.10.

Table 4. 10 Summary of spearman's correlations for effects of variations

Correlation		
Client vs. Consultant	Client vs. Contractor	Contractor vs. Consultant
0.943	0.721	0.840

The tables above showed that the calculated spearman rank correlation coefficient values for all pair of parties (client vs. consultant, client vs. contractor and consultant vs. contractor) for relative importance index were between 0.5 and 1, which shows there is a strong positive correlation in ranking the cause of variation orders. The result in general indicates that there is a better agreement between all parties. In this result it is indicated that there is a strong correlation between all parties. Generally the correlation test signifies that the degree of agreement between respondents is a very good and the data is highly reliable and valid.

Summary of impact of variation orders

The next step in this research was to rank the most important effects of variation orders based on the higher relative importance index value. Only the first five causes selected for further analysis.

Table 4. 11 Overall Responses Results

No.	Impacts/effects of variation orders	Client		Contractor		Consultant		Overall	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Time overrun	0.856	1	0.781	2	0.821	2	0.819	1
2	Cost overrun	0.844	2	0.79	1	0.8	3	0.811	2
3	Disputes between parties	0.822	3	0.752	3	0.737	6	0.77	3
4	Decrease quality	0.756	4	0.667	6	0.744	5	0.722	5
5	Suspension or disruption of work	0.6	6	0.676	5	0.674	8	0.65	7
6	Decrease in productivity	0.7	5	0.724	4	0.779	4	0.734	4
7	Poor professional relations	0.489	8	0.59	9	0.558	9	0.546	9
8	Claims among the contract parties	0.522	7	0.648	7	0.864	1	0.678	6
9	increasing the duration of individual activities	0.478	9	0.61	8	0.695	7	0.594	8
10	delaying in payment	0.433	10	0.514	10	0.495	10	0.481	10
11	additional money for contractor	0.378	11	0.504	11	0.453	11	0.445	11

4.2. CASE STUDY ANALYSIS

4.2.1 Begge-Ketta road new Project

Project information

Project name : **Begge-Ketta** road new Project.

Project length : 35.20 km

Type of construction : New

Contractor: Oromia Roads Construction Enterprise

Consultant: Oromia Water Works Design and Supervision enterprise

Employer: Oromia Road Authority

Financer: Government of Ethiopia (GOE)

First time commencement date: 9th day of October 2013.

Actual completion date: February 2017

Amendment commencement date: November 30, 2019

Revised completion date for 1st time: February, 2022

Revised completion date for 2nd time: February, 2023

Original Contract Price: ETB **137,448,416.41** with VAT

Revised Contract Price: ETB **347,185,470.71** with VAT

Current status : Ongoing

The evaluations of the above road project have been undertaken here under with in depth information regarding the stated problems and all data are gathered from respective contract documents.

Table 4. 12: Begge-Ketta road new Project Evaluation

No	Project	Original Contract	Revised Contract	Original time	Revised time	% of VO
1	Begge-Ketta	137,448,416.41	347,185,470.71	1095	900+360= 1260	153

Details of Causes and Effect in case of Begge – Ketta

The tender sum of Begge-Ketta project was **137,448,416.4 ETB** and the original planed work duration was 1095 calendar days. According to the document the reasons for present variation were due to discrepancy between the design of the road and the bill of quantity (conflict between contract documents) in the contract agreement, right of way problems and unforeseen conditions (adverse weather conditions). The volume of work on the design is large as compared to that in the bill of quantity. This implies due to under estimation of complexity of projects and discrepancy between design and specification the project cost was under estimated which was resulted in extreme quantity changes to meet this field condition.

The rights of way problems (also called failure to give possession of site) have been the main reason that the contractor claimed for financial compensation as well as time extensions. This right of problems were electricity (electric Poles) and land accusation from a community to road construction.

The project components are earth work including clearing and grabbing, bridge construction, minor drainage (such as: temporary water diversion structure, Pipe works and Culverts).

However, the project encountered quantity variation on clearing, steel reinforcement under drainage (minor structure), earth works, and excavation of soft material under major structure works then the contractor ordered to execute the varied quantity. Hence, the ordered variation of each item is greater than 10%. However the employer and the contractor entered new agreement (supplementary agreement) for the varied quantity of works, which was stipulated in special condition of contract of the main agreement [21']. As mentioned above in Begge- Ketta project the quantity of design and BOQ was shown deference on some items, so regarding the variation happened on the item the contractor requested for variation orders.

In general discrepancies between design and specification (conflict between contract documents), right of way problems and unforeseen conditions (adverse weather conditions) are the main causes for the variation.

In this research variation orders caused time delay, cost overrun and quality defects. The effects of variations indicated that variations contributed to increase in construction project costs. The more the variation orders, the more they affect the overall construction delivery cost. The table below entails the summary of submitted request for Variation order No. 1.

Table 4. 13: Summary of Variation order for Begge-Ketta project

PAY ITEM No.	DESCRIPTION	Unit	Origional Contract Quantity	Varied Quantity	Unit Rate	Origional Contract Amount	variation Amount	Total Amount
2000	**SITE CLEARANCE**							
21.01	Clearing & Grubbing	Hec	72.00	58.52	25,519.79	1,837,424.88	1,493,418.11	3,330,842.99
TOTAL FOR SERIES 2000 CARRIED TO SUMMARY						**1,837,424.88**		**3,330,842.99**
3000	**DRAINAGE**							
32.1	**steel reinforcement**					-		-
32.10(b) (i)	high tensile steel in culverts	ton	5.75	39.02	42,971.31	247,085.03	1,676,560.04	1,923,825.55
4000	**EARTHWORKS**							
42.01	**BORROW TO FILL or CUT TO FILL**							
42.01(a)(ii)	200mm layers to 95% modified AASHTO density (max dry density)	m3	186,452.00	166,271.32	110.71	20,642,100.92	18,407,897.59	39,049,998.76
42.03	**Cut to spoil,material obtained from**					-	-	-
a	common normal excavation	m3	28,965.00	1,025,012.85	67.04	1,941,813.60	68,716,861.40	70,658,675.06
b	Intermediate excavation	m3	8,965.00	502,907.44	116.78	1,046,932.70	58,729,530.35	59,776,463.54
C	rock excavation	m3	6,432.00	158,252.76	206.10	1,325,635.20	32,615,893.84	33,941,529.04
TOTAL FOR SERIES 4000 CARRIED TO SUMMARY						**57,294,602.50**		**235,764,786.48**
8000	**structures**							
81.02	**excavation of materials**							
a(i)	Excavation of soft material at any depth	m3	2,645.00	9,437.32	78.40	207,368.00	739,885.89	947,253.89
TOTAL FOR SERIES 8000 CARRIED TO SUMMARY						**21,392,684.21**		**22,132,570.10**
TOTAL FOR ALL SERIES CARRIED TO SUMMARY						**119,520,362.09**	**182,380,047.22**	**301,900,590.59**
VAT 15%						**17,928,054.31**	**27,357,007.08**	**45,285,088.59**
GRAND TOTAL						**137,448,416.41**	**209,737,054.30**	**347,185,679.18**

In general; the project encountered quantity variation on clearing, steel reinforcement under drainage (minor structure), earth works, and excavation of soft material under major structure works. This variation was about 209,737,054.30 birr. These amounts of birr construct new projects.

The table below entails the summary of submitted extension of time claims, and the engineer recommendation for Begge-Ketta project.

Table 4. 14: Summary of extension of time claims for Begge-Ketta project

No.	Cause of claim	Reasons giving rise to extension of time claim	The Contractor extension time claim	The Engineer's recommendation
EOT-1	Variation	Under estimation	1100 days	800 days
EOT-2	Adverse Weather Condition	Unable to perform as planned	355 days	305 days
EOT-3	Right of way problems	Unable to perform as planned	205days	155 days
Total			**1660 days**	**1260 days**

The contractor submitted over three issues that were directly related to time extension. Among these variation order (change order), Variation, right of way problems and adverse weather conditions are the main causes for the delay.

The total extension of time determined by the engineer and subsequently granted to the contractor in case of Bagge- ketta is 1260 days. This is 76% of the total extension of time claimed by the contractor.

4.2.2 Chira-Afalo Chariko road new Project

Project information

Project name : **Chira- Afalo Chariko** road new Project

Project length : 53.4 km

Type of construction : New

Contractor: Oromia Roads Construction Enterprise

Consultant: Oromia Water Works Design and Supervision enterprise

Employer: Oromia Road Authority

Financer: Government of Ethiopia (GOE)

Commencement date: - 21th day of November 2009.

Scheduled completion date: - June 2014.

Actual completion date: - April 2021.

Original Contract Price: **268,862,927.63** ETB with VAT

Total Revised Contract Price: **368,589,286.42** ETB with VAT

Current status : Completed

Details of Causes and Effect in case of Chira- Afalo Chariko

The tender sum of Chira-Afalo Chariko project was 233,793,850.11 ETB and the original planed work duration was 1444 calendar days. According to the document the reason for present variation were due to Increase in quantities specifically in selected fill, design change including additional works, adverse weather conditions, lack of materials, right of way problems and poor estimation while design. Observing the contract documents it can be noted that about 21 new items have been included in the revised bills of quantities that has now become an official document after the signing of the contract. The original bill of quantity document has changed to an extent that it is largely outdated. These new items were largely variation orders and design changes, reflecting the level of quality and completeness of the pre bid design documents. The rights of way problems (also called failure to give possession of site) have been the main reason that the contractor claimed for financial compensation as well as time extensions. These rights of problems are like coffee trees and underground utility lines (water lines).

In order to minimize the rights of way problems, the Engineer decided to make some design changes that would alter the levels or edge conditions of the roads. The contractor then argued that such design changes would result in the change of the method of work and hence claims for extension of time as well as associated financial compensation. Poor estimation is the main cause of variation orders in this road construction project. The consultants do not carry out adequate investigations at the initial investigation and design stage. Therefore, many quantities are changed in the construction stage.

The road was designed many years before construction start due this the contractor claim unit rate change the Engineer argued such unit rate modification. The contractor submitted a number of claims during the implementation of the works. One of the major factors raised by the contractor as a basis for his claims was the presence of heavy rains, particularly during the period covering, April- June. The contractor claimed that he was unable to carry out his works due to the heavy rains and was entitled to extensions of time. The Client and the consultant agreed that the rains were indeed excessive, and granted the contractor time extensions

The project components are general provision, earth work including clearing and grabbing, minor drainage (such as: temporary water diversion structure, Pipe works and Culverts), finishing (road base sub base, base course and gravel shoulder), major Structure (bridge construction) and ancillary works.

However, the project encountered quantity variation on general provision, clearing, under drainage (minor structure), earth works, major structure (bridge construction), finishing works and ancillary works; then the contractor ordered to execute the varied quantity. As mentioned above the quantity of design and BOQ was shown deference on some items, in other item the consultant change the design. So regarding the variation happened on the item the contractor requested for variation orders. However the employer and the contractor entered new agreement (supplementary agreement) for the remaining amount of work.

In general design change including additional works, adverse weather conditions, Right of way problems, lack of materials and poor estimation while design are the main causes for the variation.

In this research variation orders caused time delay, cost overrun and decrease in productivity. The effects of variations indicated that variations contributed to increase in construction project costs. The more the variation orders, the more they affect the overall construction delivery cost. The table 4.15 below entails the summary of submitted request for Variation order No. 1, 2.

Table 4. 15: Summary of Variation order for Chira- Afalo Chariko project

PAY ITEM No.	DESCRIPTION	Original Amount,Birr	Revised Contract Amount,birr	Total Contract Amount,Birr	Total Contract Amount,Birr up to 130%	Total Contract Amount,Birr Exceeding 130%	Total Revised Amount in Birr
1000	GENERAL PROVISION	359,414.10	3,635,706.89	3,995,120.99	3,995,122.99		3,995,122.99
2000	SITE CLEARANCE	1,414,597.80	1,270,093.50	2,684,691.30	2,684,705.00		2,684,705.00
3000	DRAINAGE	1,381,645.33	6,650,962.06	8,032,607.40	14,971,949.91	406,850.28	15,378,800.19
4000	EARTHWORKS	60,293,118.88	130,600,366.27	190,893,485.15	253,993,195.76	3,869,996.00	257,863,191.76
5000	SUB BASE, BASE-COURSE AND GRAVEL SHOULDER	-	16,959,905.82	16,959,905.82	16,959,905.82	11,067,310.68	28,027,216.50
8000	STRUCTURES	1,217,431.20	7,757,045.52	8,974,476.72	8,952,021.07	1,342,764.07	10,294,785.14
9000	ANCILLARY WORKS	-	2,253,562.74	2,253,562.74	2,253,562.74	15,038.66	2,268,601.40
	Price escalation						-
	TOTAL	64,666,207.31	169,127,642.81	233,793,850.11	303,810,463.29	16,701,959.69	320,512,422.97
	VAT (15%)	9,699,931.10	25,369,146.42	35,069,077.52	45,571,569.49	2,505,293.95	48,076,863.45
	GRAND TOTAL	74,366,138.40	194,496,789.23	268,862,927.63	349,382,032.78	19,207,253.64	368,589,286.42

In general, the project encountered quantity variation on general provision, site clearing, drainage (minor structure), earth works, finishing (sub base, base course and gravel shoulder), major structure works and ancillary works. This variation was about 70,016,613.18 birr without VAT up to 30% and 16,701,959.69 birr without VAT after supplementary agreements.

The table below entails the summary of submitted extension of time claims, and the engineer recommendation for Chira- Afalo- Chariko project.

Table 4. 16: Summary of submitted extension of time claims, and the engineer recommendation for Chira- Afalo- Chariko project.

No.	Cause of claim	Reasons giving rise to extension of time claim	The Contractor extension time claim	The Engineer's recommendation
EOT-1	RoW and Variation	Obstruction and Change in design, Additional work	1200 days	1000 days
EOT-2	Adverse weather condition	Unable to perform as planned	250 days	200 days
EOT-3	Variation	Under estimation	700 days	560 days
Total			**2150 days**	**1760 days**

The contractor submitted over three issues that were directly related to time extension. Among these variation order (change order), Variation, right of way problems and adverse weather conditions are the main causes for the delay.

The total extension of time determined by the engineer and subsequently granted to the contractor in case of Chira- Afalo- Charikoo is 1760 days. This is 81.86% of the total extension of time claimed by the contractor.

Table 4. 17 Summary of cause of variation order for two projects

No.	Causes of variation	Projects
1	Discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents).	Begge-Ketta
2	Right of way or access to site problem	Begge-Ketta and Chira –Afalo- Chariko
3	Design Change	Chira –Afalo- Chariko
4	Poor estimation	Chira –Afalo- Chariko
5	Lack of materials	Chira –Afalo- Chariko
6	Unforeseen conditions (Adverse weather conditions)	Begge-Ketta and Chira –Afalo- Chariko

The table above showed that discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents), right of way problem, design change, poor estimation, lack of materials and unforeseen conditions as most important causes of variation in Oromia roads construction and enterprise.

Table 4. 18 Summary of effects of variation order on two projects

No.	Effects of Variation orders	Projects
1	Delay in project completion time	Begge-Ketta (76%) and Chira –Afalo-Chariko (81.86%)
2	Increase in project cost	Begge-Ketta and Chira –Afalo- Chariko
3	Dispute among parties	Begge-Ketta and Chira –Afalo- Chariko
4	Decrease in productivity	Begge-Ketta and Chira –Afalo- Chariko

The table above showed that delay in project completion time, increase in project cost, dispute among parties and decrease in productivity as the most effect of variation in Oromia roads construction and enterprise.

Comparison of results from Questionnaire Survey and Case Study

As it was described in the previous sections that the assessment of the causes that led to variation orders in Oromia Road Construction Enterprise Projects in Jimma zone were investigated by applying in the two methods such as case study and questionnaire survey. An attempt made to identify the most prevalent causes of variation orders.

After a thorough investigation of the causes, the top six frequently occurring causes were made for case study and the top five frequently occurring causes were made for questionnaire survey. In general, the most dominant causes investigated through case study and questionnaire survey were analyzed and checked for agreement.

As shown in table 4.19, four causes of variation orders were found to be in agreement whereas three causes of variation orders were not.

Table 4. 19 Summary of Cause of variation orders that occurred on both case study and questionnaire survey

No.	Causes of variation order	Causes occurring in Case study (/)	Causes occurring in questionnaire survey (/)	Agreement between the two methods
1	Change in design including addition and omission	/	/	Agreed
2	Conflicts between contract documents	/	/	Agreed
3	Change of plans or scope by employer	Not Occurred	/	Not Agreed
4	Poor estimation	/	/	Agreed
5	Delay in acquisition of right of way	/	/	Agreed
6	Unforeseen conditions (Adverse weather conditions)	/	Not Occurred	Not Agreed
7	Lack of materials	/	Not Occurred	Not Agreed

Comparison of results from Case Study and Questionnaire Survey

The consequential effects of variation orders in Oromia Road Construction Enterprise Projects in Jimma zone were described in the previous sections by applying two methods such as case study and questionnaire survey. After in-depth investigation of the effects, the top four frequently occurring effects were made for case study and the top five frequently occurring effects were made for questionnaire survey. In general, the most significant effects identified in case study and questionnaire survey were analyzed and checked for agreement.

As shown in table 4.20, four significant effects of variation orders were found to be in agreement whereas one effect of variation orders were not.

Table 4. 20 Summary of effects of variation orders that occurred on both case study and questionnaire survey

No.	Impacts/effects of variation orders	Effects occurring in Case study (/)	Effects occurring in questionnaire survey (/)	Agreement between the two methods
1	Time overrun	/	/	Agree
2	Cost overrun	/	/	Agree
3	Disputes between parties	/	/	Agree
4	Decrease quality		/	
5	Decrease in productivity	/	/	Agree

4.3. Discussions

From the result obtained, the six most significant causes and their effects of variation were identified and will be discussed below.

4.3.1. Most significant causes of variation order

In this section, the six most important causes of variations identified based on the case studies of two projects and four most important causes of variations identified in questionnaire surveys are described below.

Based on this discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents), poor estimation while design (under estimation), change in design including addition and omission, right of way problems, lack of

materials and delay due to adverse weather conditions are the top six causes variation orders identified in both case study and questionnaire survey. They cause impact especially on time, and cost.

In case of Bagge- ketta project discrepancy between the design of the road and the bill of quantity in the contract agreement (under estimation) was the most significant cause and more impact on cost and time. The result revealed that right of way problems and unforeseen conditions (adverse weather conditions) were other cause of variation orders but they had low impact on cost and time when I compare with under estimation of quantity or discrepancy between the design of the road and the bill of quantity in the contract agreement.

In case of Chira-Afalo Chariko project design change including additional works and right of way problems were the most significant cause and more impact on cost and time. Adverse weather conditions, lack of materials and poor estimation while designs were other cause of variation orders but they had low impact on cost and time when I compare with design change including additional works and right of problems.

1. Discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents).

The first most significant causes identified as major causes of variation in case of Begge-Ketta project and in questionnaire is discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents).

As study conducted in Gaza Strip (Palestine) in 2010, conflicts between contract documents, is one of the predominant problems in road construction projects [13]. Another study in Jordan, 2015, states that one of the most important causes is conflict between contract documents [17].

In agreement with literature the consequential effects of this problem is delay in completion time, increase in project cost and dispute between parties. It is obvious since the estimation and compensation issue takes much time. In addition to increasing the project cost and time schedule thorough the specified processes the situation will push the work/activity to unfavorable seasons.

Besides this it may also exposes contracting parties' to escalated cost of materials and labor.

2. Poor estimation

The second most important significant causes identified as major causes of variation is poor estimation at initial stage and design stage.

In case of Chira –Afalo- Chariko road construction project poor estimation is the fifth important cause of variation orders.

Poor estimation is the main cause of variation orders in the road construction industry. The consultants do not carry out adequate investigations at the initial investigation and design stage. Therefore, several site conditions rise in the construction stage. Further, clients do not have capable professional staff to carry out investigations and estimates, which are prepared by consultants and are not accurate in most cases [6].

3. Change in Design

The third most significance cause identified in this research is design change which includes addition, omissions or modifications of the original design.

In case of Chira-Afalo Chariko project the first most significance cause identified in this research is design change, which includes addition, omissions or modifications of the original design. As study conducted in Gaza Strip (Palestine) in 2010, the most important factors cause variations are change in design by consultant and errors and omission in design [13]. Other researchers strengthen this finding for the causes of variation orders [14, 24].

Furthermore study in Jordan, 2015, states that change in design by consultant as fifth critical factors that cause variation orders [17]. Similarly study conducted in Kuwait in 2014, the most common causes of change orders identified was errors and omission in design [21]. Changes in design were frequent in projects where construction starts before the design is finalized. Such changes affect the project in various ways depending on the timing of the change [1].

4. Right of way or access to site problem

The fourth most significant causes identified as major causes of variation in this thesis is right of way or accesses to site problem.

As part of preconstruction planning, the client should acquire the right of way before the contractor moves in to commence works, a conclusive feasibility study that entails thorough geotechnical investigation that brings to the fore all ground conditions necessary for design, Clients should clarify the scope of works [9].

In the context of Begge-Ketta project, road construction project the right of way problem is related to land acquisition issue from the community in rural areas for the purpose of infrastructure development and relocating of utility facilities. The land required for these projects includes the land to be used for the construction of the road and local material sources such as quarry site etc. The common problems which are associated with land acquisition issues include; lack of awareness by the community, the fast growth of population which results in critical shortage of land resources and magnify the land issue to be sensitive, estimation for compensation.

Although in the case of Chira- Afalo- Chariko project, road construction project the right of way problem is related to land acquisition issue from the community in rural areas for the purpose of infrastructure development and relocating of utility facilities. The land required for these projects includes the land to be used for the construction of the road and local material sources such as quarry site etc.

On the other hand problems related relocation of utility facilities such as water supply and electricity (electric poles) lines are resulted from lack of proper coordination between utility companies and the road sector implementing agent (ORA) and lack of information on underground utility lines even by the utility companies itself since there is no proper map which indicates the exact location of these lines.

Although right of way or access to site problem is identified as one of the major cause in this research no other researchers on variation orders that I referred identified it as a major cause.

5. Lack of materials

The third important cause in Chira –Afalo- Chariko road construction project which is identified as one of the major cause of variation in this research is lack of materials.

As study conducted in Gaza Strip (Palestine) in 2010, the first most important factors cause variations is lack of materials and equipment spare parts due to closure [13]. According to the study conducted in Malaysia in 2014, lacks of materials are the most significant causes of variation orders [16].

6. Unforeseen conditions (Adverse weather conditions)

The other causes identified as major causes of variation in both projects are unforeseen conditions (adverse weather conditions). In case Chira –Afalo- Chariko road construction project unforeseen conditions (adverse weather conditions) is the second cause of variation orders. But in case of Begge-Ketta project it is the third cause.

Unforeseen conditions (adverse weather conditions) are identified as one of the major causes in this research no other researchers on variation orders that I referred identified it as a cause.

4.3.2. Most significant effects of variation order

In this research there are four most important identified effects of variation orders in two projects. This includes delay in completion time, increase in project cost and dispute among contracting parties and decrease in productivity. These effects will be briefly discussed in the following paragraphs.

1. Delay in project completion time (Time overrun).

In agreement with literature the consequential effects of variation order is delay in completion time. Variation orders result in time delay [15]. Delay in completion time is the most significant effects of variations in Ethiopian Federal road construction projects [8]. One of the most significant effects which ranked first is delay in project completion time [14]. According to the Proceedings of International Conference in Malaysia, 2018, Occurrence of variation orders result with delay in completion schedule [7].

Variation orders cause time delay of the projects [18]. The down side of variation order was it schedule overrun [2].

The projects with more VO's have schedule overruns than those with less VO's. Additionally it also finds that schedule overruns occur when the VO's occur later in the project [19].

As study conducted in Kuwait in 2014, the effects of change order or variation order is increasing the duration of individual activities, delaying in completion schedule [21]. Delay

in completion schedule is the first effects of change orders in road construction projects [26]. The result from case study of both projects reveals delay in completion time is more than 30%.

2. Increase in project cost

The second most frequent effect of variation orders identified in this research is increase in project cost. This finding agrees with the findings of many other researchers such as:

According to the Proceedings of International Conference in Malaysia, 2018, Occurrence of variation orders increase in project cost [7]. The one of effects of variations orders is increase in project cost in Ethiopian Federal road construction projects [8]. Variation orders result cost overrun [15]. Variation orders cause cost overrun [18]. The down side of variation order was it brought cost overrun [2]. The main effect of the occurrence of variation order is the increase in the project cost [3].

As study conducted in Kuwait in 2014, the first common effect of change order or variation order is increasing the project's cost as well as additional money for contractor [21]. Cost overrun is the first effects of change orders in road construction projects [26].

Many studies on the effects of variations indicated that variations contributed to increase in construction project costs. The more the variation orders, the more they affect the overall construction delivery cost. Increasing project cost is the most common effect of variation in construction projects during construction phase [16]. While due to changes in the work, the project cost has increased. This amount of money affect the initial project cost [30]. In both projects the amount of variation order occurred is equivalent to amount of new projects (construct new projects).

3. Dispute among parties

The third significant effect of variation in Oromia road construction enterprise projects is dispute among contracting parties. The finding agrees with the findings of many other researchers such as:-Dispute between parties is the most significant effects of variations in Ethiopian Federal road construction projects [8]. Disputes had great significant effects on project performance [14]. According to the Proceedings of International Conference in Malaysia, 2018, Occurrence of variation orders result disputes between parties in roadway construction projects [7]. The down side of variation order was it brought causes disagreement and claims among the contract parties

[2]. The variations in the works, if not handling properly, surely will become the main causal factor of the claims submitted by the contractor [20].

Variation that might result in the reduction of the scope of the project input generates claims for loss of profit and overhead cost which may also lead to disagreement and eventually disputes [25]. Variation is a major cause of claims in construction projects. If this claims are not politely solved they results in dispute that may affect the relation among contracting parties and between professionals of the contracting parties [26]

During the case study this was observed in project A and project B. Majority of the claims issues in these projects were variation related. Beyond being a claim issue they were also results dispute among the contractor and employer.

4. Decrease in productivity

The fourth major effect identified in this research is decrease in productivity. Delay in completion time, increase in project cost, suspension or disruption of work, decrease in productivity, and dispute between parties respectively are the most significant effects of variations in Ethiopian Federal road construction projects [8].

The study identified lost in productivity is one of the most effects of road project delays. Occurrence of delay in roadway construction projects affects completion schedule of the projects [29].

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This part of the thesis provides conclusions based on the findings form the case study and questionnaire survey. It also contains recommendations of methods and techniques that help in mitigating those variations that are taken as the major sources of variation.

5.1. Conclusion

As it is clearly stated in the first chapter one of the main objectives of this research were to identify the cause of variation order in Oromia roads construction enterprise projects as well as to identify the consequences /effects. To achieve these objectives, the study use case study, questionnaire survey as a research instrument and Relative Importance Index method is used to find out the result through the analysis. The result obtained in this processes has been presented and discussed in the previous chapter. In this chapter the major finding of the research which has been discussed before will be briefly summarized in accordance with the objectives of the research.

To achieve these objectives, 23 variables (potential causes) had identified from literature and respondent were then requested to rate these factors based on their experience in terms their frequency of occurrences. discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents) (0.635), poor estimation (0.621), change in design (0.596), Right of way or access to site problem (0.595), lack of material (0.584) and unforeseen condition /adverse weather conditions (0.441) are the six top most significant causes of variations orders.

Based on the data from both the desk study and questionnaire survey the research concluded that, discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents), poor estimation, change in design, Right of way or access to site problem, lack of material and unforeseen condition /adverse weather conditions are the six top most significant causes of variations orders in both case study and questionnaire in Oromia Road Construction Enterprise.

For impact of variation orders 11variables (potential effect) were identify from literature and respondent were then requested to rate these effects based on their experience in terms their level of impact. Time overrun (0.819), cost overrun (0.811), dispute between parties (0.77) and decreases in productivity (0.734) are the top four most important impacts of variation orders.

The major effects identified in this research are time overrun, cost overrun, dispute between parties and decreases in productivity in both cases on Oromia Road Construction Enterprise.

5.2. Recommendations

In addition to, identifying the major causes, effects of variation orders was identified. One of the specific objectives of this research was to forward recommendations based on the finding of the study in order to minimize variation order so as to minimize their effects. Based on this the recommendation will focus in addressing the major causes identified through the research processes.

A. Recommendation on how to minimize variation as a result of discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents).

The first significant cause identified in this research is discrepancy between the design of the road and the bill of quantity in the contract agreement (conflict between contract documents).

- Before the works are started all parties must check the specifications. They must avoid conflict between bill of quantity and design.
- A more detailed pre contract planning and detailing of contract documents, site investigation reports and preparation of detailed drawings and documents.
- Contractors should identify and inform the varied item of work to the client before the activity starts to reduce variations. Because the client will have sufficient time to check the varied item in different perspectives to give work order at minimum variations.

B. Recommendation on how to minimize variation as a result of right of way or accesses to site problem

The second significant cause identified in this research is right of way or accesses to site problems. As it is clearly described in the previous section (i.e. review of literature and discussion part), the major sources of this problems are utility relocation and land acquisition

from the public in rural areas. With this understanding the following measures can be considered during pre-feasibility, feasibility, planning and design stages;

a. Regarding land acquisition problem;

- Proper consultation with the public/stakeholder's to accommodate the variation issue at earliest stage (i.e. during feasibility study, planning and design).
- Improving the responsiveness of local peoples on how important is the project to the community and the capital resources spend to these projects

b. Regarding utility issues

- Most of the problems with utility lines are due to lack of information about their exact location even by the utility companies themselves. In order to minimize this problem utility company should develop a map that clearly indicates the location of utility lines especially the underground ones so that planners and designers can easily refer the map to consider the issues as early as possible.

C. Recommendation on how to minimize variation as a result of design change

Design errors, change and omissions cannot be completely avoided but can be reduced and decrease its negative impact. Recommendations to reduce the occurrence of variation orders are stated as follows:

- Consultants should spend adequate time on design detailing and documentation, including critical revisions, before site construction operations in order to reduce errors and omissions in design.
- Highly coordination by consultant is required at the design stage
- A detailed design would be able to exert control to unnecessary interference from consultants or other external influences
- Variations can be minimized if consultants produce a complete design.
- Direct communication among the project team is a key to minimize variations occur due to communication gap during design and execution phase

D. Recommendation on how to minimize variation as a result of poor estimation

- The consultants must carry out adequate investigations at the initial investigation and design stage.

- Clients must have capable professional staffs to carry out investigations and estimates, which are prepared by consultants.

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JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDENTS

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

QUESTIONNAIRE SURVEY

ON

ASSESSMENT ON CAUSE AND EFFECT OF VARIATION ORDERS ON OROMIA ROAD CONSTRUCTION ENTERPISE In case of Jimma Zone (Chora Botor Woreda and Gera Woreda)

By

Abezash Ageru Ademe

Main Advisor Dr.-Engr. Getachew Kebede

Co-Advisor Engr. Mebratu Abera

FOR THE PARTIAL FULFILLMENT OF MSc. DEGREE IN CIVIL ENGINEERING (MAJOR CONSTRUCTION ENGINEERING AND MANAGEMENT)

February, 2023

Jimma, Ethiopia

QUESTIONNAIRE

Dear Sir

The researcher is a graduate student of MSC in civil engineering, in CEM at JIT. JU, the requirement of the program is to come up with a research related the field of study.

The aim of this questioner is to study the causes and effects of variation orders in Oromia Road Construction Enterprise in Jimma Zone (Chora Botor Woreda and Gera Woreda) and recommends possible remedial measures that minimized the cause of variation orders. This questionnaire is required to be filled with exact relevant facts as much as possible. All data included in this questionnaire will be used only for academic research. Your response, in this regard, is highly valuable and contributory to the outcome of the research.

Regards,

Abezash Ageru

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Section One: Respondent Profile

1.1.Name (optional) _____

1.2.Which organization are you working currently?

□ Client □ Contractor □ Consultant □ others (specify):

_____

_____

_____

1.3.What is your job position in your organization (optional)?

_____

_____

1.4. Work experience in the construction industry:

a.1 up to 5 years□ b. 6 up to 10 years□ c. above 10 years□

Section Two: Causes of variation orders in construction

1. The following are lists of causes of variation orders in road construction industry; please indicate the degree of occurrences for each cause according to the scale of 1 to 5 from your experience.

[Note: If causes were left mention under the provided space (i.e. others) and rank them; uses 'X' to rank:

Important (Scale 1 to 5)

1 = No occurrence

2 = Low occurrence

3 = Medium occurrence

4 = High occurrence

5 = Very high occurrence

Table 1: Causes of variation orders

No.	Causes of variation order	Important Scale 1 to 5				
		1	2	3	4	5
1	Change in design including addition and omission					
2	Lack of consultant's knowledge of available materials					
3	Internal politics					
4	Change in specification by owners					
5	Conflicts between contract documents					
6	Owners' financial problems					
7	Change of plans or scope by employer					
8	Lack of stability of prices and the exchange rate change					
9	New government regulations					
10	Non-use value engineering in design stage					
11	Poor estimation					
12	Delay in acquisition of right of way					
13	Differing site conditions					
14	Change of schedule by client					
15	Unavailability of equipment					
16	Poor workmanship					
17	Safety considerations					
18	Socio-cultural factors					
19	Change in government regulations					
20	Inadequate working drawing details					
21	Lack of coordination					
22	lack of materials and equipment spare parts due to closure					
23	lack of consultant's knowledge of available materials					
	Others…..					

Section Three: Impacts/effects of variation orders

1. The followings are lists of expected impacts/effects of variation order in road construction projects. From your experience, please tick the appropriate cell by indicating how much you agree to listed impacts/effects in road construction projects.

1. Never
2. Seldom
3. Sometimes
4. Often
5. Always

[Note: If effects were left mention under the provided space (i.e. others)]

Table 2 Impacts/effects variation orders.

Impacts/effects of variation orders	Level of Impact				
	1	2	3	4	5
Time overrun					
Cost overrun					
Disputes between parties					
Decrease quality					
Suspension or disruption of work					
Decrease in productivity					
Poor professional relations					
Claims among the contract parties					
increasing the duration of individual activities					
delaying in payment					
additional money for contractor					
Others…..					

2. Please list possible controlling mechanisms for variation orders in Oromia road construction Enterprise projects._____
_____
_____
_____

Thank you very much for successfully completing the questionnaire