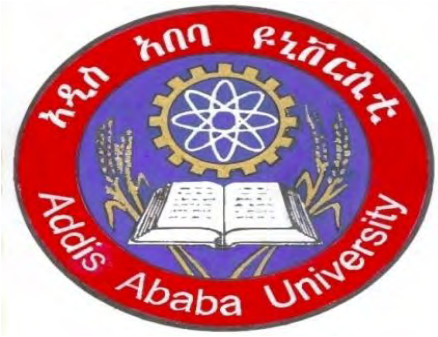

ADDIS ABABA INSTITUTE OF TECHNOLOGY(AAIT)

School of Civil and Environmental Engineering

ANALYZING CHANGE ORDERS IN SELECTED ETHIOPIAN ROAD AUTHORITY ASPHALT CONCRETE ROAD PROJECTS CONSTRUCTED BY FOREIGN CONTRACTORS

BY

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August, 2015

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A thesis submitted to the Graduate School of Addis Ababa Institute of Technology in partial fulfillment of the requirements for the Degree of Master of Science in Civil Engineering(Construction Technology and Management)

BY

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Advised by : Professor Abebe Dinku (Dr.-Ing)

August, 2015

DECLARATION

I declare that this thesis entitled "ANALYZING CHANGE ORDERS IN SELECTED ETHIOPIAN ROAD AUTHORITY ASPHALT CONCRETE ROAD PROJECTS CONSTRUCTED BY FOREIGN CONTRACTORS" is my original work. This thesis has not been presented for any other university and is not concurrently submitted in candidature of any other degree, and that all sources of material used for the thesis have been duly acknowledged.

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ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

ANALYZING CHANGE ORDERS IN SELECTED ETHIOPIAN ROAD AUTHORITY ASPHALT CONCRETE ROAD PROJECTS CONSTRUCTED BY FOREIGN CONTRACTORS

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LIST OF ABBREVIATIONS

CPM	Critical Path Method
DBB	Design Bid Build
DSS	Decision Support System
EI	Effectiveness Index
ERA	Ethiopian Road Authority
EU	European Union
ETB	Ethiopian Birr
IDA	International Development Association
II	Importance Index
PERT	Program Evolution and Review Techniques
PI	Prevalence Index
RSDP	Road Sector Development Programme
UI	Utilization Index
WBS	Work Breakdown Structure

Abstract

The road construction process is a complex one and is associated with various changes. It is virtually certain that changes made during the course of work which affect cost and schedule. Currently ERA is constructing many asphalt concrete road projects which are susceptible to change orders and there is no enough study that addresses the frequent effects of the change orders in overall cost of the asphalt concrete road construction process and time of completion. This study investigated the causes of change orders and their impact on ERA asphalt road project performance. Causes and impacts of change orders are analysed by formulation of questionnaire based on extensively reviewed literature and case study on selected 10 ERA asphalt concrete road projects.

It was concluded that change of plans or scope, change in design, error and omission in design, right of way issue, negligence during design, change in specifications, value engineering and lack of data for design and experience in predicting underground condition were some of the critical factors causing change orders.

In the archival study of 10 selected Ethiopian road authority projects change order contribute 8.74% increase in average cost per project and design consultant initiated 65.38% of change order costs.

The most frequent impacts are project cost increase, completion delay, source of additional payments for contractor, increases in overhead expense, and results in hiring new professionals.

Interims of change order impacts severity rank increases in project cost, completion schedule delay, aadditional payments for contractor, increases in overhead expense, and productivity degradation factors constituted the most visible consequences of variation orders that affect project advisedly.

The findings of the study will increase the awareness on causes of change order and its impact on overall construction project performance which will enable the development of proactive measures to reduce them.

Key words: asphalt concrete ,cause, change order, control, cost, effect

CHAPTER ONE

1. INTRODUCTION

1.1. Background

The involvements of different stockholders in construction industry give rise to undesirable changes on a project, the greater possibility that become time consuming and costly in construction tasks (Mohamed, 2001). It is almost becoming a rare thing for a project not to have variation, thus becoming a normal occurrence in construction tasks and almost unavoidable condition. It is common in all types of construction projects and plays an important role in determining the final cost and time of the projects.

Ethiopia is a country with a population of 85.2 million, eighty-three percent of which live in the rural areas; annual population growth rate is estimated to be 3.2 percent, agriculture sector accounts for more than 85 percent of the population and earns 60 percent of foreign exchange (Alem, 2010). Recognizing the importance of the road transport in supporting social and economic growth, and its role as a catalyst to meet poverty reduction targets, the Government of Ethiopia has placed increased emphasis on improvement of the quality and extent of road infrastructure in the country.

To address the issue of restricted road network coverage and low standards, the Government formulated the Road Sector Development Programme (RSDP) in 1997. In Road Sector Development Program (RSDP), the Government of the Federal Democratic Republic of Ethiopia has introduced a number of policies among which the provision of improved road network is recognized as a major element of road management and which in line with the economic development strategy of the country represented by the Ethiopian Roads Authority.

In1997 the Ethiopian road network length were 26,550 km. The thirteen years of the RSDP has seen significant improvements in the restoration and expansion of Ethiopia‟s road

network. Physical achievements have been matched by significant improvements in the maintenance of the network, strengthening of the management capacity of the road agencies and delivery on policy reform. According to the thirteen years RSDP performance assessment the total length of the network were increased to 49,000km, from which 22,247km, were Federal and the remaining 26,753 km, were regional (FDREMTERA, 2011).

In1997 the Ethiopian paved road network length were 26,550 km. Due to expansion of Federal road network starting from Road Sector Development Program RSDP phase I in 1997 up to 2013 third year of phase IV in sixteen years 11,301km were paved and the remaining 14,455km where unpaved, from which 8467.1km asphalt concrete roads consist of 2683km Federal roads rehabilitation of trunk roads, 2625.3 km upgrading of trunk roads, 2648.8km upgrading of link roads, 510 construction of new link roads and others maintenance works.

In the last two decades ERA spend more funds in the construction of many asphalt concrete road projects in important economic corroders of the country. The majority of this roads are constructed by foreign contractors as the result of financers requirement to international bidding. The contractors are not obliged to administer by local condition of contract, rather contractual liability of both parties based on international condition of contract. This contractors indirectly facilitates bargain more changes in the progress of projects depend project modification and range of errors on the original designs to get benefit from additional work and change order related claims.

The overall disbursement over 13 years of RSDP was ETB 60.4 billion. An assessment of contribution of finance to the implementation of the RSDP shows that 70% raised from internal sources (the Government, the Road Fund and the Community)(ERA, 2014). The remaining 30% has been pooled from the international community. Specifically, the share of the Government of Ethiopia is the highest (53.8%), followed by Road Fund (14.2%), the

IDA (11.8%) and EU (8.6%). As these projects require a great investment, constructing the projects with current trend of changing orders leads to undesired effect, for instance cost and time overrun of the projects.

Finishing projects on time and within budget has been a serious problem for most of ERA asphalt concrete road projects due to changes, which causes cost overruns. According to Anteneh, (2010) construction sector transparency initiative cost-Ethiopia report 40,877,156.66 birr (10.75%) increase in contract amount due change order in Humbo - Arbaminch upgrading road project. These changes come in projects due to design error, poor coordination, inadequate scope, weather damages, and others. "Based on the desk study and questionnaire survey changes are major problems in Ethiopian Federal road construction projects" (Tadesse, 2009).

Most contracts these days must make provisions for possible variations of construction project (Wainwright and Wood, 1983). An unsuccessful aspect of the variation clause is that it tends to encourage clients to change their minds and change order contains a set of instruction which allows changes or modifications to be made to an earlier agreement in terms of volume or nature of task to be carried out (O"Brien,1988). These changes however occur after the award of the initial contract or after work might have commenced at the construction sites.

The changes may be due to various reasons such as the needs of the owner may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer. The engineer"s review of the design may bring about changes to improve or optimize the design and hence the operation of the project. Further, errors and omissions in engineering or construction may force a change. According to Tadesse, (2009) " right of way or access to site problem, change in defined scope, lack of proper planning, lack of contractor evaluation of tender, document at tendering phase and contractor

financial problems are identified as major causes of changes in Ethiopian Federal road projects". All these factors and many others necessitate changes that are costly and generally un-welcomed by all parties.

Consideration must be given to change from the early stages of project until commissioning. A contract change clause is added to define the way that owner, consultant, and contractor will handle changes. A procedure must be set to process a change from its conceptual development until it appears in the work. Given the fact that an adversarial atmosphere usually exists between the parties in the construction industry, a change must be managed well in order to minimize its cost, schedule and consequential effects that can lead to enormous cost and schedule overruns.

Identifying the causes and severity of change orders in ERA asphalt road projects are helpful to avoid potential changes in future projects or minimizes their effects.

1.2. Problem statement

A change order is a written order to the contractor, signed by the owner, and issued after execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time. Changes in drawings and contract documents usually lead to change in contract price or contract schedule. Changes also increase the possibility of contractual disputes.

In general, changes present problems to all parties involved in the construction process. One of the challenges facing ERA asphalt concrete road projects are difficult to manage the risk of cost overruns due to change orders. The assessment of the accomplishment of the 13 years Road Sector Development Program revealed that the execution of most of the Federal asphalt concrete road construction projects resulted in significant cost overruns.

1.3. Significance of study

All construction contracts allocate cost between owners and contractors. Finishing projects on time and within budget has been a serious problem for most of ERA asphalt concrete road projects due to changes that causes cost overruns. It is the responsibility of ERA to finish projects within estimated cost. For this purpose, it is important to identify prevailing causes of change order in ERA asphalt concrete road projects. This can ultimately provide ERA with a better guarantee that the final cost of a delivered road projects. Besides, an understanding of the reasons for such consistent changes should allow ERA to focus on problem areas and implement systems into program budgeting procedures, which may lead to more realistic project cost estimates. The realistic estimates thus made enable the project stakeholders to finish the project within/nearly within estimated budget and time to reduce unnecessary delays and claims relating to financial matters.

This study would also enhance the knowledge in the areas of changes that could materialize during design and construction phases of a project to which corrective measures applied to make better and more prudent design specifications that minimize change orders as possible to finish projects in the final cost, so not to require funds to be diverted from other projects to cover additional project costs for timely finish to make ready for services, due to change orders.

1.4. Objectives and the research question

The main objective of this research is to identify the major causes of change orders leading to cost overrun in selected ERA asphalt concrete road construction projects constructed by foreign contractors with specific objectives to:-

- Investigate the prevalence of change orders on ERA asphalt concrete road construction projects;
- Identify the predominant origin agent as well as the direct causes of change orders;

- Analyze the frequency of impacts to rank their severity;
- Identify which contracting party is responsible for the cost overrun or contribution of each party;
- Forward recommendations which would help to minimize change orders in ERA asphalt road construction projects based on the findings of the study.

To address the above objectives the research will have the following specific question

- Identify stack holder that originate more changes in ERA asphalt concrete road construction projects?

1.5. Methodology

The study start with identification of change orders cost impact on ERA asphalt road projects. As depicted in Figure 1.1, the objectives of this research will be achieved as follows:

- Literature and previous studies related to the area of research will be extensively reviewed, which identify the causes of change order, their originators, impact on construction project and controlling mechanisms. The findings of this will provide the basis for the research design.

- The research design is based on a purposeful sampling selection process in terms of which a representative sample of stakeholders/participants in the construction process will be surveyed. In particular, case studies, examination of project documentation and records of construction projects from which to derive further data on change orders. A list of selected ERA asphalt road projects a representative sample was derived by stratified samples by dividing ERA into contract administrative regions for archival documents data collection, then projects within five ERA contract region randomly selected recent projects.

- Gathered data will be analysed using appropriate statistical analysis tools. Both quantitative and qualitative methods will be used.

Conclusions will be drawn from the analysed data and recommendations for improvement and future study will be formulated.

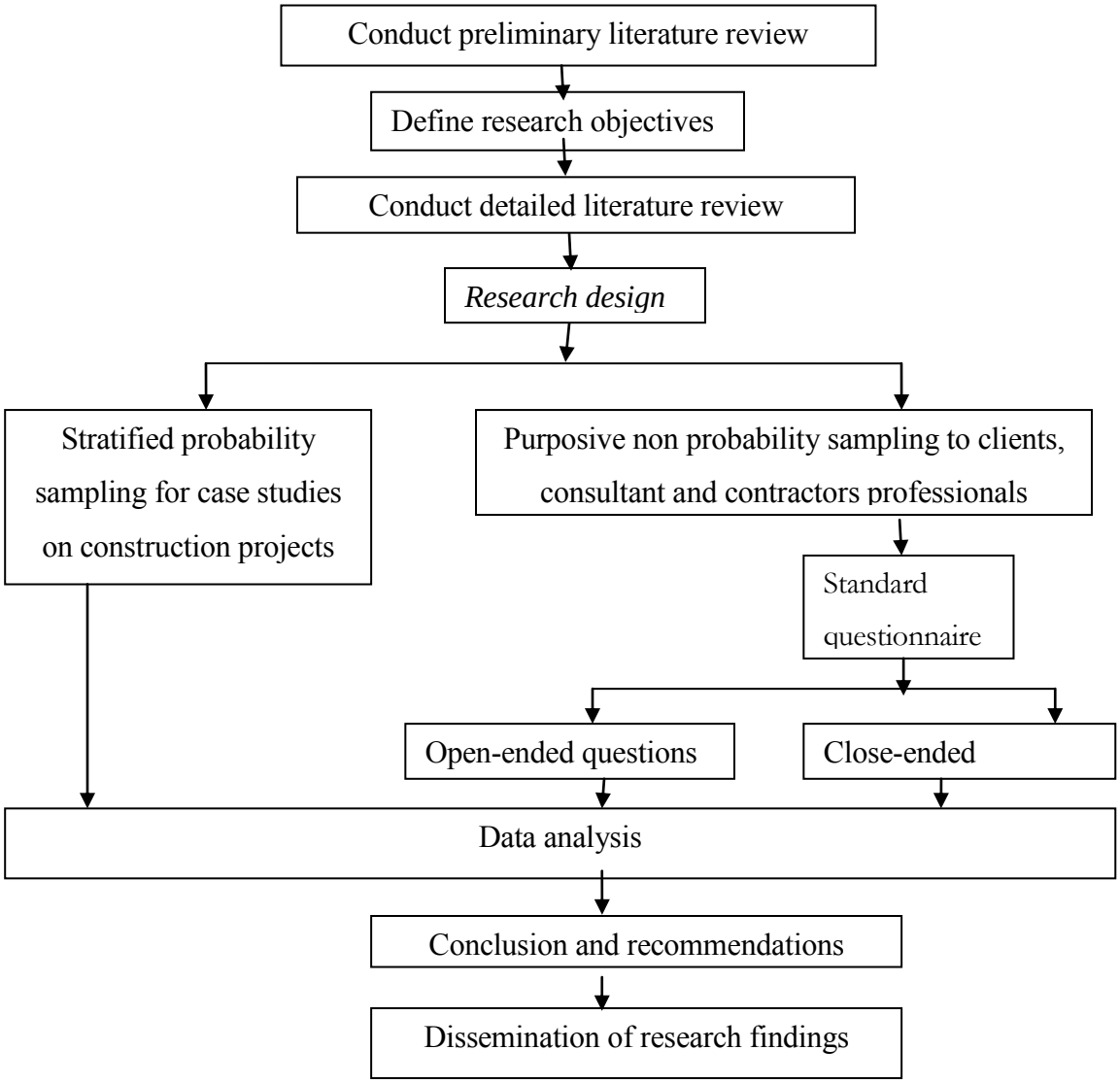

Figure 1.1 Framework of the research study

1.6. Thesis organization

The thesis is organized into five chapters as follows:

Chapter 1−this chapter begins with the discussion on background and general introduction to the research, statement of the problem, objectives, methodology adopted to achieve the objectives of the study and organization of the thesis.

Chapter 2 covers a literature review from professional journals, books, internet searches and interview with road design, construction, and contract administration experts. This chapter essentially provides a review of the current state of change order causes, impacts, control process used and its management in road construction project.

Brief definition of aspects of construction change orders, their root causes and management are also contained within this chapter.

Chapter 3 covers the research methodology. The methodological approach consists of the overall research strategy; the research design, the analysis of the data and writing of the research paper in order to achieve the objectives of the study.

Chapter 4 contains the discussion and analysis part. The results of the data obtained from the desk study on selected ERA asphalt road construction projects and questionnaire surveys were analyzed accordingly. It contains the finding on causes, effect and controls of change order in ERA asphalt concrete road projects.

Finally, in Chapter 5, conclusions and recommendations were forwarded based on the major findings of the study and discussed how the research objectives align with the findings. This will serve as an action guide line to stakeholders in the construction industry.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

In order to develop a better understanding of the research objective, a comprehensive literature review has been conducted focusing on identifying construction change orders causes, effects and controls to manage them.

A construction contract is a professional agreement that is subject to variability. Contractual clauses relating to revision allow parties involved in the contract to freely initiate change orders within the domain of the scope of the works without alteration of the original contract. Change orders involve additions, omissions, alterations and substitutions in terms of quality, quantity and schedule of works.

A change is any modification to the contractual regulation provided to the contractor by the owner or consultant (Fisk, 1988). This includes deviation from an agreed scope, specifications or any other contract document. Changes in construction tasks can cause substantial adjustment to the contract duration and construction cost.

A change order is the formal document that is used to modify the original contract and becomes part of project‟s documents. Once a contract has been concluded, its terms cannot be changed unless the contract itself contains provisions for modification and permitted change are within the contractual standings (Willis & Willis, 1980).

Change clause facilitates more opportunities for modification. Uff, (2005) indicated that a clause permitting change of works is vital article of any construction contract because without it, the contractor is not bound to execute extra work or to make omissions.

To finish projects within contract time and cost it is desirable to manage changes. Unluckily, construction projects involve multipart operations which cannot be accurately

determined in advance, modification occur. Disputably, deviations cannot be avoided completely (Mohamed, 2001). But extent of deviations can be reduced. Ssegawa et al.,(2002) asserted that the presence of change clauses in contracts admit changes in projects. But with proper management changes reduced. Even if carefully planned, it is likely that there will be changes to the scope of the contract as the work progresses (Harbans, 2003).

Changes can be initiated by all parties in the construction process. All modifications must be approved by owner before execution. Initially, the contractor receives the contract package in the form of plans, drawings, equipment lists and other documents. Contractor will calculate labour cost, material cost, and schedule based on this original package. Obviously any modifications to this set of documents will alter his plans and revisions are common in all types of construction projects (Tadesse, 2009).

It is preferable to limit changes to the planning stages. However, late changes regularly occur during construction (Cameron et al., 2004). Progress change minimized by careful planning and monitoring milestone. Identification and management of the reasons for such recurrent construction project changes is a necessary step for the improvement and can be used to pinpoint areas where the greatest improvement can be obtained.

As part of study process, chapter 2 provides a literature review on the aspects of construction project causes of change which often contribute potential for cost overrun and other effects. Effective inquiry of change orders requires a comprehensive understanding of the root causes of deviations and their potential effects (Hester et al., 1991). Hence the structure of literature review consists of cause, effect, controls and management of change orders.

2.2. Nature of change orders

The nature of change orders can be determined by referring to both the reasons for their occurrence and subsequent effects. Arain & Pheng, (2005b) distinguished two types of change orders, namely: constructive and harsh change orders.

2.2.1. Constructive change orders

A valuable change order is one issued to improve the quality standard, reduce cost, schedule, or degree of difficulty in a project (Arain & Pheng, (2005b)). It is a change order initiated for value analysis purposes to realize a balance between the cost, functionality and durability aspects of a project to the satisfaction of clients. Value analysis is an organized approach to the identification and elimination of unnecessary tasks. Therefore, constructive change order is initiated to enhance the client‟s value system elements that include time, capital cost, operating cost, environment, aesthetic and fitness for the purpose (Kelly & Duerk, 2002).

A constructive variation eliminates unnecessary costs from a project. According to Zimmerman & Hart, (1982) even brilliant designer incur unnecessary cost on construction due to design. A constructive change order seeks to improve the owner benefits contrary to the resource contribution by unnecessary costs. A constructive change is initiated in the spirit of adding value to the project. However, it should be noted that regardless of how useful a change order might be non-value-adding costs are likely to grow as a result.

2.2.2. Harsh change orders

A harsh change order is one that negatively impacts the client's value or project performance (Arain & Pheng, 2005b). Disputably, a harsh change order compromises the client's value system. A client who is experiencing financial problems may require the substitution of quality standard expensive materials to substandard cheap materials. While

most construction industry stakeholders are arguably interested in the reduction of overall production costs, they are not always aware of the extent of non-value adding activities on construction projects (Saukkoriipi, L. & Josephson, P.E. 2005). Consequently, there is a lack of knowledge about non value-adding costs associated with variation orders. In common practice, non value-adding costs arising from variation orders that are typically transferred to the client are underestimated. For example, one may be able to calculate the costs of aborted works, but non value-adding costs arising from non-productive time, redesign and overheads are not attributed to such an activity.

2.3. Source of change orders

2.3.1. Introduction

While deviations are common in construction projects, an improved understanding would require their categorization into their root or origin agents and causes. The origin agent consists of the identification of the initiator of the modification orders. A study that focused on the point of view of developers of potential causes of deviation orders suggested four main origin agents (Arain & Pheng, 2006). These included client, consultant, contractors and others. An effective analysis of change orders requires a comprehensive understanding of the root causes (Hester et al., 1991).

Causes of variation orders have been identified by many researchers and the causes of change can be categorized according to the originators (Thomas and Napolitan, 1994). The causes of change can be categorized according to the originators identified in literature review are discussed below.

2.3.2. Consultant related changes

This section discusses the causes of variations that were initiated by the consultant. Consultant directly initiates changes or the changes are required because the consultant fails to fulfil certain requirements for carrying out the project related to change in design by consultant. Members of the consultant team have power to effect change orders upon

delegation by the client or on their behalf. In case errors, omissions or discrepancies are found in the design or a conflict is discovered between the contract documents, it is the duty of the consultant to provide a remedial solution. A contractor who finds a problem to interpret ambiguous design details and inadequate working drawings notifies the concerned consultant as soon as possible. A contractor cannot proceed with work where ambiguous situations arise. A delay by a consultant in issuing a change order may result in losses in terms of idle labour and plant while waiting for the consultant's decision.

Acharya et al., (2006) suggested that consultants should aim at getting an understanding of the overall scope and goals of the project, make sure they understand deliverables and offer specific suggestions when it makes sense. Acharya et al., (2006) accused consultants of protecting their own interest at the expense of the interest of the client and the contractor. The feeling of superiority of the consultant over the contractor may hinder the consultant from giving attention to requests by the contractor. This is different from contractual standing of consultant agreement to perform engineering and construction inspection services for the client on the project. The assignment of consultant is to assist client and contractor in the efficient administration of the agreement and it has strict liability for direct damages resulting from the ordinary negligence or professional incompetence.

Basically, the role of the consultant is to advise the client on technical, legal and financial matters. Consultant issue change order for improvement purposes. During the briefing stage, clients state their requirements and these constitute the basis for formulating contract documents. Unfortunately, a failure by the consultant to interpret the requirements results in the design being different from the perceived one. As a consequence, change orders will be issued to ensure compliance with the requirements for the client.

i. Errors and omissions in design

Design errors and omissions may lead to loss of efficiency and delay in project schedule (Assaf et al., 1995). It common mistakes making in design of project with error and

omission which leads to project delays and cost overrun. Quite often, among the many project documents, one will find a note deleted, a detail miss-referenced or an incomplete specification sheet and important design considerations missing. Hence, errors and omissions in design can affect a project adversely depending on the timing of the occurrence of the errors.

Due to error and omission in design client will pay the extra cost (change order) or accept an inadequate design. These errors, if not rectified during the design phase, would eventually appear in the construction phase where the impact could be more severe than in the design phase. It was revealed through projects were awarded to new consultants who did not have prior experience of error and omission, and the time given for design development was not sufficient, thus leading to numerous errors and omissions in design.

The design effectiveness should be analysed based on the following criteria, accuracy, usability, cost, constructability, economy and schedule (Oberlender, 2000). According to E.C. Ubani et al., (2010) design review process contributes higher in reducing error to project failure. Hence, in order to reduce design errors and omissions, it is vital to concentrate professionals more on allocating sufficient time for design development and improving design detailing.

ii. Change in design

Change in design for improvement by the consultant is a norm in current professional practice (Arain et al., 2004). In the study conducted by Rubin, (2008) on impact of change orders on project performance, the predominant cause of cost change was design Changes. Similarly Turkey, (2011) conducted study on risk factors leading to cost overrun in Ethiopian Federal road construction projects 12.12 % cost overrun due to design problems. The changes in design are frequent in projects where construction starts before the design is finalized (Fisk, 1997). But in ERA asphalt roads the changes in design happen more in projects where construction starts after design is finalized. A new element of design may

not have been considered before or a clear design advantage that is assumed by the change may favour going ahead with implementing this change.

Change in design may also take place when the design is reviewed by the consultant, who has a different opinion than the designer, and he may wish to make changes. Counterpart engineers should be careful of approving changes. Design changes can affect projects adversely depending on the timing of the occurrence of the changes and scope of change.

iii. Conflict between contract documents

Conflict between contract documents can result in misunderstanding of the real obligation of a task. To convey complete project scope for participants, the contract documents must be clear and concise. Insufficient details in contract documents may adversely affect the project, leading to delay in project completion.

Quite often, different documents are drawn by different engineers or design personnel during the design phase of the project. In spite of the close coordination between design personnel or disciplines, discrepancies are sometimes found. Normally contracts include guidelines as to which document governs in case of conflict. Clients must expend sizable efforts to review contract documents for any possible contradictions before award of contract to avoid such changes. Phrases that can be interpreted differently have to be rewritten if confusion is to be avoided. The contractor will normally look for any phrase or note in the contract documents to justifying the inexpensive option.

iv. Inadequate scope of work for contractor

In construction, the scope of work for all the players must be clear and definite for successful project achievement (Arain et al., 2004). Inadequate scope of work for the contractor can cause major deviations that may adversely affect the project, leading to changes in construction planning. Here the change is not forced because of change of a

mind by the client (Fisk, 1997), but rather because of lack of clarity in the documents about the scope of work.

v. Technology changes

Technology change is a potential cause of change in a project. Project planning should be flexible for accommodating new constructive changes (CII, 1994b). Zimmerman and Hart, (1982) indicated that it is impossible to be knowledgeable of all new materials and products that are constantly entering the market. The designer may be unaware of affordable alternative materials for finishes. This can lead to change orders when full information about the materials is available. However, Acharya et al., (2006) insisted that when a new technology is applied, at the same time, it must be seen whether skilled people are available to convert the technology into the real work. For instance, long time gap between design and construction encourage many technological changes, in ERA adoption of technology such as geo-textile and super pave design of 2013 ERA manual. Technology change may influence a consultant to initiate change orders.

Otherwise, improper application of the technology may lead to quality degradation or budgetary losses.

vi. Lack of coordination

A lack of coordination between parties may cause major change that could eventually impact the project adversely (Arain et al., 2004). Harmful changes, which affect the projects adversely, can usually be managed at an early stage with due diligence in coordination. It is quite important in a multi-player environment like a road construction project to keep strong and continuous coordination. ERA should convey new ideas and concerns which form the basis for changes to the consultants in a timely. The consultant has to update the contractor of any concern with the scheduled work. Everything has to be reviewed and approved between each party. Local governments do not always have the

experience needed to review design plans in order to identify conflicts prior to construction. Improve coordination through coordination meetings, progress reports, and conference calls among others.

vii. Value engineering

Value engineering is a systematic method to improve the value of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements. Value engineering should ideally be carried out during the design phase (Dell"Isola, 1982). Value engineering is practiced at any stage of project by assessing value management, but effective in during design phase or at early construction stage.

During the construction phase, value engineering can be a costly exercise, as change in any design element would initiate downstream deviations to other relevant design components (Mokhtar et al., 2000).Value Engineering systematically defines common objectives, functionally prioritizes what needs to be done and then creatively identifies how best to achieve the targeted results. Value engineering uses value management process to enhance cost effective decision making, reducing delay in project and reduce cost without scarifying requirement. Value Management is a structured, systematic and analytical process that seeks to achieve all the necessary functions at the lowest total cost consistent with required levels of quality and performance. Provide engineered values to design by organized effort directed at analyzing the functions of projects, systems, equipment, facilities, services and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with the required performance, reliability, quality and safety. During value adding processes it is preferable to assess directs and indirectly related changes.

viii. Design complexity

Complex designs require unique skills and construction methods (Arainet al., 2004). Complexity affects the flow of construction activities, whereas simple and linear construction works are relatively easy to handle (Fisk, 1997). Hence, complexity may cause major changes in construction projects. Designs need to be simple and inclusive of standard requirements.

ix. Ambiguous design details

A clearer design tends to be comprehended more readily (O'Brien, 1998). Ambiguity in design is a potential cause of variations in a project. This is because ambiguity in design can be misinterpreted by project participants, leading to rework and delay in the project completion. Eventually, this may affect the project adversely.

Inadequate design can be a frequent cause of variations in construction projects (Fisk, 1997). Design discrepancies affect the project functionality and quality. Eventually, this can affect a project adversely depending on the timing of the occurrence of the variations.

x. Inadequate working and shop drawing details

To convey a complete concept of the project design, the working drawings must be clear and concise (Geok, 2002). Insufficient working drawing details can result in misinterpretation of the actual requirement of a project (Arain et al., 2004). Working drawing details submitted to the engineer for approval in sufficient detail to control and complete the work. Working drawings supplement the contract; their approval does not relieve the contractor of responsibility for completion of the work as specified.

Shop drawings are usually developed for construction work details for site professionals (Cox and Hamilton, 1995). Inadequacy of shop drawing details can be a potential cause of changes in the construction projects. Requires shop drawings to show dimensions, sizes of

materials, and other information and data necessary to the work review. Thorough reviewing of design details would assist in minimizing changes.

xi. Consultant‟s lack of experience and data.

Professional experience and judgment is an important factor for successful completion of construction project (Clough and Sears, 1994). The lack of professional experience increases the risk of errors in design as well as during construction. Eventually, this may affect the project quality and delay the project completion.

A lack of data can result in misinterpretation of the actual requirements of a project (Assaf et al., 1995). Where there is insufficient data, consultants are compelled to develop designs based on their own perceptions, which may not be what the client wants. Eventually, this may cause major variations and affect the project adversely.

Knowledge of available materials and equipment is an important factor for developing a comprehensive design (Geok, 2002). In the construction industry where material standardization is not common, the consultant‟s lack of knowledge of available materials and equipment can cause numerous major changes during various project phases.

xii. Attitude of consultant

In a multi-player environment like construction, the professionals have to work as team at the various interfaces of a project (Wang, 2000). If the consultant is obstinate, he may not accommodate other creative and beneficial ideas. Eventually, this may cause major variations in the later stages and affect the project adversely.

Honest wrong beliefs may cause construction professionals to contribute poor value add in projects (Arain, 2002). Consultants, without having first-hand knowledge, may make decisions based on their wrong beliefs which would adversely affect the pace of the project.

xiii. Noncompliance of design with government regulations

Noncompliance of design with government regulations would render the project difficult to execute (Clough and Sears, 1994). Noncompliance with government regulations may affect the project safety and progress adversely, leading to serious accidents and delays in the project completion.

xiv. Noncompliance of design with owner‟s requirements

A comprehensive design is one that accommodates the owner‟s requirements (Cox and Hamilton, 1995). A noncompliance design with the owner‟s requirements is considered an inadequate design (Fisk, 1997). Eventually, this may cause variations for accommodating the owner‟s requirements. Under contractual provisions, the client has the right to vary the extent and the nature of the performance to be rendered by the contractor (Wainwright & Wood, 1983). Furthermore, the contractor could not refuse to carry out the varied obligation with the only remedy being an adjustment of price to be paid for the performance, and in appropriate circumstances, an extension of time in which to execute such performance (Finsen, 2005). This may affect the project adversely during the construction phase.

xv. Change in specifications by consultant

Changes in specifications are frequent in construction projects with inadequate project objectives (O‟Brien, 1998). Change of Specifications also makes use of the party issuing an instruction and the parties receiving it are already understood. Change in specification is a potential cause of change in a project, leading to reworks and delays in the project completion.

2.3.3. Owner related changes

This section discusses the causes of variations that were initiated by the owner. In some cases, the owner directly initiates variations or the variations are required because the owner fails to fulfil certain requirements for carrying out the project. The client as the project initiator plays a major role in the construction project from the inception to the completion phases. As a result, clients influence the likelihood of the occurrence of variation orders. Clients anticipate the needs and objectives of projects, establish the scope of works and the required quality standards. During the construction stage, clients initiate change due to various reasons.

i. Change of plans/ Project objectives/Scope

Change of plan or scope of project is one of the most significant causes of change in construction projects (CII, 1990b) and is usually the result of insufficient planning at the project definition stage, or because of lack of involvement of the owner in the design phase (Arain et al., 2004).

Change plan affects the project severely during the later phases. Uyun, (2007) remarked that the principal reason for the client to initiate change orders is a change in requirements, rethinking of the needs or change of the use of the anticipated future utilization of finished works; Include addition, omission or modification. Client request is major cause of changes for government contract in Malaysia (Jaspal et al., 2010). Similarly Turkey, (2011) conducted study on risk factors leading to cost overrun in Ethiopian Federal road construction projects and its consequences 9.09 % frequency of observed factor is scope change and Waleed Mostafa EI-Nemr, (2001) in Egyptian industrial construction sector 66.7 % of the projects scope change is dominating cause of change order claims. Tadesse, (2009) conducted desk study in Ethiopian Federal roads upgrading projects scope change is second important cause of change order and reasons for change in scope are: widening of section, construction of extensions, reconstruction of structures.

According to Tadesse, (2009) lack of proper planning cause change due to not clearly define scope of project and its requirements. Lack of proper planning is the third important cause of change in Ethiopian Federal upgrading road projects. Both planning and scope of project are interrelated tasks during project initiation. Clients who have the knowledge and experience of the construction industry are involved during the design stage by providing professional guidance to the design team. This participation may contribute to the avoidance of continuous changes during the construction stage.

The technical input into the design by clients prevents them from fully relying on the designer, minimizing the chance of them changing their mind during the construction stage. Clients without or with little knowledge in construction tend to follow the guidance of the designer without any clear idea that their requirements have been met. Uyun, (2007) remarked that it is sometimes very difficult to determine the exact requirements of the client. If the objectives of the project are inadequately defined, it is common that clients will tend to change their minds along the way.

Early involvement of the owner in the project objective definition and later in the design of the facility normally reduces such changes to a minimum. Inadequate project objectives are important causes of change in construction projects (Ibbs and Allen, 1995). Due to inadequate project objectives, the designer would not be able to develop a comprehensive design which leads to numerous changes during the project construction phase.

The definition of a clear and concise set of project objectives is essential to project success and these objectives must be understood to properly. Begin with a clear understanding of the project objectives by the agency and a clear communication of these objectives to the contracting, consulting, or design community. While this idea seems simple, in practice it is often difficult to identify and prioritize concise objectives because of the complex nature of highway construction projects.

ii. Owner financial difficulties

Owner‟s financial problems affect project progress and quality (O‟Brien, 1998). Owner of the facility may run into difficult financial situations that force him to make changes in an attempt to reduce cost. Dependable financial sources makes clients will tend to change their minds along the way struck with unexpected financial difficulties, during the construction stage initiate changes in order to suite their conditions. Changes may include replacement of materials, change of design, scope and schedule of works. Again proper planning and review of the project cash flow is enough to eliminate this problem.

iii. Owner change of schedule

A change of schedule during the project construction phase may result in main resource rearrangement (O‟Brien, 1998). Changes in the program costly due to time have an equivalent money value. As the contract was signed the contractor has levelled his resources over the time frame agreed upon with the owner. A change in the schedule means the contractor will either provide additional resources in a shorter time or idle some sources that he committed for certain activities which leads to change in strategies. Although there are numerous causes of schedule change such as market conditions, user requirements, or lack of funding, the owner must be certain that the cost of change of schedule is well covered by the anticipated benefits.

iv. Change of materials or procedures

Replacement of materials or procedures may cause major change during the construction phase. The substitution of procedures includes change in application methods (Chappell and Willis, 1996). Therefore, an adjustment to the original contract value is required if there is a change in procedures.

v. Inflexible owner

A construction project is the result of the combined efforts of the professionals. They have to work at the various interfaces of a project (Wang, 2000). If the owner is obstinate, he may not accommodate other creative and beneficial ideas. Eventually, this may cause major change in the later stages and affect the project adversely.

vi. Slow decision making process

Prompt decision making is an important factor for project success (Gray and Hughes, 2001). A delay in decision making may hinder subsequent construction activities that may eventually delay the project progress.

vii. Change in specifications by owner

Changes in specifications are frequent in construction projects with inadequate project objectives (O'Brien, 1998). In construction project, change in specifications by the owner during the construction phase may require major change and adjustments in project planning and procurement activities.

Constructability in the highway industry has also gained considerable attention for adding costs to designed projects. Poor specifications can cause construction rework and delays.

viii. Right of way problems

Tadesse, (2009) conducted study on cause and effect of change in Ethiopian Federal road upgrading projects and "the result of study indicate that right of way is most significant cause interims of frequency of occurrence, impact on cost and time"

Tadesse, (2009) identified right way major problems that leads to change are relocating utility facility and Land acquisition issues. In reallocating utility facility lack of coordination between electricity, water supply, telephone companies with ERA and

information gap in utility own companies to indicate exact location. Land acquisition from land owners due to shortage of land, lack awareness, and compensation process make right of way problems critical in schedule and route changes.

Before starting construction it is preferable to incorporate local government requirements into its design plans to make sure that utility lines have been identified or move the utilities lines timely to facilitate efficient construction as planned. Planning deficiencies included the relocation of utilities not being coordinated, construction being started before an archeological clearance was obtained, materials not being purchased to coincide with construction, and projects scheduled to start late in the construction season.

2.3.4. Contractor related changes

This section discusses the causes of variations that were related to the contractor. In some cases, the contractor may suggest variations to the project, or the variations may be required because the contractor fails to fulfil certain requirements for carrying out the project. Sweeney, (1998) advised that on every project, participants should keep an eye on problems. All parties to the contract have to be aware that the information provided by the consultant is not always accurate.

It is the contractor‟s responsibility to advise the consultant to issue a change order when a technical problem is discovered. Levy, (2002) indicated that general contractors or their subcontractors may discover an obvious discrepancy, omission, error, or conflict in the contract document and request that the consultant to reviews that problem, discuss the additional costs to correct the situation, agree on a price, and authorize the variation order.

A contractor may propose alternative construction methods where his experience shows that the proposed technology will not fulfil the desired fitness and function of a design.

"Ethiopia Federal road projects based survey result contractor more responsible in imitating majority of specified causes and most affected party as the result of the consequential effects"(Tadesse, 2009). The problem would have been avoided if the contractor had been experienced and was aware of possible adverse situations.

Change orders initiated following the default of the contractor are frowned upon by the client. Situations that give rise to default include defective workmanship, unfamiliarity with local conditions, poor management and lack of efficient communication. As a consequence, the contractor may not only suffer monetary loss but also damage to the reputation of the firm.

i. Lack of contractor‟s involvement in design

Involvement of the contractor in the design may assist in developing better designs by accommodating his creative and practical ideas (Arain et al., 2004). Lack of contractor‟s involvement in design may eventually cause changes. Practical ideas which are not accommodated during the design phase will eventually affect the project adversely.

Currently most of ERA roads projects are procured through design bid build contract bidding process. It is difficult to involve contractor during design stage due to during design time the contractor is not selected and it is done after design through bidding process the winner is known.

ii. Contractor financial difficulties

Construction is a labour intensive industry. Whether the contractor has been paid or not, the wages of the worker must still be paid (Thomas and Napolitan, 1994). Contractor‟s financial difficulties may cause major changes during a project, affecting its quality and progress.

Due to the fact that Ethiopia has few new contractors in road construction projects, many of them face financial difficulties in executing large projects. These difficulties affect their ability to execute and deliver. Therefore, delays in the completion schedule may occur due to the financial problems and contractors prefer change for searching works in their financial capacity. But most of foreign contractors are strong enough in their financial capacity to maintain positive cash flow.

According to Tadesse, (2009) Contractor Financial Difficulties is the fifth most important cause of change order in his study in Ethiopian federal upgrading road projects.

iii. Contractor desire to improve his financial conditions

Contractor‟s desired profitability can be a potential cause of variations in construction projects. This is because variations are considered a common source of additional works for the contractor (O‟Brien, 1998). The contractor may eventually strive to convince the project owner to allow certain variations, leading to additional financial benefits for him. The contractor may talk directly to the owner and convince him to do certain changes only to give him the additional benefit of change work. The contractor may take any excuse to claim that certain parts of the work are not in his scope and therefore request compensation for doing it.

iv. Shortage of skilled labour and equipment

Skilled manpower is one of the major resources required for complex technological projects (Arain et al., 2004). Shortage of skilled manpower is more likely to occur in complex technological projects. Certain jobs may require certain expertise that is not available in the local market and for that reason the owner or consultant may agree to modify the method or procedure of construction. This type of change is more likely to happen in construction involving some degree of technological complexity and not in

normal construction. This lack can be a cause for variations that may delay the project completion.

Unavailability of equipment is a procurement problem that can affect the project completion (O'Brien, 1998). Occasionally, the lack of equipment may cause major design variations or adjustments to project scheduling to accommodate their placement.

Lack of a piece of equipment may force a change to the plan. The danger in this comes from the fact that some designs are done outside the country by companies not familiar with the resources available locally. Active participation of the contractor during design will minimize this source of changes.

v. Defective workmanship

Defective workmanship may lead to demolition and rework in construction projects (Fisk, 1997). Defective workmanship results in low quality in construction projects (Arain et al., 2004). Eventually, this cause may affect the project adversely, leading to rework and delay in the project completion. Acceptance of defective workmanship due to schedule may force a change in the facility to correct for it. The professional contractor assesses the level of workmanship, skills of craftsmen and provides solution to technical problems and responsible for the daily production activities on any project site

vi. Differing site and local conditions

Differing site condition can be an important cause of delays in large projects (Assaf et al., 1995). The contractor may face different soil conditions than those indicated in the tender documents. Unforeseen ground conditions are frequently reported to cause construction project cost growth. Ground conditions can be assessed by the use of trial pits and borehole sampling onsite. However, the actual site conditions for full extent of a project, particularly for road projects, are not usually determined until the actual construction is started.

It is sometimes possible that those difficult conditions are overlooked by the initial review or conditions have changed due to adverse weather conditions or changes in sub-grade soil conditions. Unexpected sub surface conditions require fundamental redesign of projects at high expense. The contractor may face rock instead of soft soil as the tender document may have differing conditions can lead to problems of moving machinery and supplies around the site, and in undertaking excavation and replacing the unsuitable material. This can also increase costs and add to the construction time required.

Local conditions are important factor for the successful completion of a construction project (Clough and Sears, 1994). If the contractor is not aware of local conditions, it would be extremely difficult for him to carry out the project. Eventually, project delays may occur that end up with vital change in the design unit.

vii. Value engineering

Cost saving ideas is always welcome. This is a source of changes that cannot be ignored. Value engineering may be practiced formally as an official value engineering study that has all the required elements of this practice or it may be practiced in a simple and unorganized way. In either case the cost saving must be high enough to justify a change because it is not worth going through the problems of changes if the benefit to cost ratio is not attractive.

viii. Lack of a specialized construction manager

The construction manager carries out the construction phase in an organized way to eliminate the risks of delays and other problems. Lack of a specialized construction manager may lead to defective workmanship and delay in the construction project. Good project managers improve the effectiveness of control of their projects. It is a complex task undertaken by project managers in practice, which involves constantly measuring progress; evaluating plans; and taking corrective actions when required (Kerzner, 2003). Having a

design manager with responsibility for the management of the design change process and reviewing related information reduce possible changes.

ix. Fast track construction

Fast track construction requires an organized system to concurrently carry out interdependent project activities (Fisk, 1997). When the public and private sectors have large funds and want to complete projects in a very short time, complete plans and specifications may not be available when the contractor starts work (Arain et al., 2004). Eventually, this procurement mode may cause major variations.

x. Poor procurement process

Procurement delays have various adverse effects on other processes in the construction cycle (Fisk, 1997). Occasionally, the procurement delay may cause an entire change or replacement for originally specified materials or equipment for the project. Delay in long lead procurement is a common cause of delays in construction projects (Assaf et al., 1995). The participants in a construction project constitute client, designers, specialist consultants, project managers and constructors. The path followed to deliver the project differs from one project to another. Typically, this is a procurement method that stipulates the form of contractual arrangement between participants or parties to the contract.

xi. Lack of communication

Harmful changes, which affect the projects adversely, can usually be managed at an early stage with strong and incessant communication. A lack of coordination and communication between parties may cause major variations that could eventually impact the project adversely (Arain et al., 2004). Minimize construction conflict with involved parties by creating better communication and coordination. The continuous coordination and direct communication would not only eliminate design discrepancies and errors as well omissions in the design, but also provide an opportunity for professionals to review the contract

documents thoroughly that would help in eliminating the variation orders arising because of conflicts in contract documents.

xii. Contractor‟s lack of experience

The consultant‟s lack of professional experience increases the risk of errors during construction (O‟Brien, 1998). This lack may cause major construction variations in a project. Eventually, this may affect the project quality and delay the project completion.

Contractors are selected on the basis of price, experience in undertaking particular types of construction project and their reputation or track record in producing high quality work within budget and on time. In some cases there is a trade-off between price, experience and track record but the desire to accept the lowest tender does not always lead to a project that is completed within time and budget. This can lead to significant delays and extra costs arising as the ERA has to re-tender the remaining work to be undertaken by another contractor or change orders.

xiii. Attitude of contractor

Honest wrong beliefs of the contractor can also be a potential cause of change in construction projects. Contractors, without having first-hand knowledge, may make decisions based on their wrong beliefs which would adversely affect the quality and pace of the project.

If the contractor is obstinate, he may not accommodate creative and beneficial ideas suggested by others. Eventually, this may cause major change in the later stages and affect the project adversely.

xiv. Complex design and technology

Complex design and technology require detailed interpretations by the designer to make it comprehensible for the contractor (Arain, 2002). A complex design may be experienced for the first time by the contractor. Eventually, the complexity may affect the flow of construction activities, leading to delays in the project completion. Technological complexity refers to difficulties during the transformation process involving materials, tools, techniques and skills needed to complete a construction project. The greater the project complexity, the greater the likelihood of variation order occurrence. A variation order issued due to the complexity of the design may take time for the design team to understand the required change and redesign while works on site are put on hold.

xv. Lack of strategic planning

Proper strategic planning is an important factor for successful completion of a construction project (Clough and Sears, 1994). The lack of strategic planning is a common cause of variations in projects where construction starts before the design is finalized, for instance, in concurrent design and construction contracts (O"Brien, 1998). In the study of change orders in Ethiopia Federal road projects conducted by (Tadesse, 2009) deficient planning influences logistic supply processes and with sequences of work to proceed with available resources and it is third important causes of change order. Contractor"s lack of required data: A lack of required data may affect the contractor"s strategic planning for successful project completion, leading to frequent disruptions during the construction process. This is because a lack of data can result in misinterpretation of the actual requirements of a project (Arain et al., 2004).

xvi. Lack of proper valuation of tender document

According to Tadesse, (2009) "Lack of proper evaluation of tender document at the tendering phase by contractor forth important cause of change orders and In order to avoid

problem review of document prior to signing contract. In the study 75% of respondent say contractor is responsible for Lack of proper evaluation of tender document at the tendering phase and 56.9% says contractor most affected"

Problem is due to traditional procurement DBB contract type no room for contractor involvement during design. Client procures the services of a design consultant to develop the scope of the project and complete design documents, which are then considered as legal documents for use in selecting a contractor who builds according to the specifications developed by the design players. Errors and omissions in the construction documents are the design-build team"s responsibility and [that] risk is not passed on to the owner.

2.3.5. Other changes/ force majeure

This section discusses the causes of variations that were not directly related to the participants such as Weather conditions; Safety considerations; Change in government regulations; Change in economic conditions; Socio-cultural factors; unforeseen problems (Kumaraswamy, et al., 1998)

i. Weather conditions

Adverse weather conditions can affect outside activities in construction projects (O"Brien, 1998). When weather conditions vary, the contractor needs to adjust the construction schedule accordingly. Occasionally, this may affect the project progress adversely, leading to delays in construction. If the contractor is forced to alter his work schedule due to weather conditions such as high temperature or high winds, he might be entitled for compensation according to contract terms. Also if part of work done is damaged by wind for example, the contractor will be compensated according to contract terms.

ii. Safety considerations

Safety is an important factor for the successful completion of a project (Clough and Sears, 1994). Noncompliance with safety requirements may cause major variations in design. Lack of safety considerations may affect the project progress adversely, leading to serious accidents and delays in the project completion.

If some safety aspects were overlooked during the design phase, the owner or consultant may initiate a change to install additional safety features in the facility. This cannot be different from any other design oversight, except for the fact that safety is usually un-compromised.

iii. New Government regulations

Local authorities may have specific codes and regulations that need to be accommodated in the design (Arain et al., 2004). Change in government regulations during the project construction phase may cause major variations in design and construction. This can affect a project adversely depending on the timing of the occurrence of the changes. Normally the designer insures that his design is in compliance with these codes. However, new regulations may be issued between design and construction and may force some changes to the original plan. Codes such as environmental or labor codes are revised periodically and the contractor or facility owners are requested to comply.

Change orders occur due to a number of reasons ranging from finance, design, aesthetic, geological, weather conditions to feasibility of construction, statutory changes, product improvement, and discrepancies between contract documents (Hanna etal, 2002). The nature and frequency of variation occurrences vary from one project to another depending on various factors (Kaming etal., 1997).

iv. Change in economic conditions

Economic condition is one of the influential factors that may affect a construction project (Fisk, 1997). The economic situation of a country can affect the whole construction industry and its participants. Eventually, this may affect the project adversely, depending on the timing of the occurrence of the changes.

v. Socio-cultural factors

Professionals with different socio-cultural backgrounds may encounter problems due to different perceptions, and this may affect the working environment of the construction project (Arain et al., 2004). Lack of coordination is common between professionals with different socio-cultural backgrounds (O"Brien, 1998). Eventually, project delays may occur that end up with vital changes in the entire project team.

vi. Unforeseen problems

Unforeseen conditions are usually faced by professionals in the construction industry (Clough and Sears, 1994). Turkey, (2011) conducted study on risk factors leading to cost overrun in Ethiopian Federal road construction projects and its consequences 6.06 % frequency of observed factor is unforeseen ground conditions. If these conditions are not solved spontaneously, they may cause major variations in the construction projects. Eventually, this may affect the project adversely, leading to reworks and delays in the project completion.

2.4. Potential effects of change orders

Research on the effects of variation orders were done by many researchers and changes that occur during construction will affect any project (Reichard and Norwood, 2001). Major effects identified in Ethiopia Federal road upgrading projects are "delay in completion time, increases in project cost, suspension of work, decreases in productivity, and dispute

between parties" (Tadesse, 2009). Arain and Low, (2005) identified 16 potential effects of variation orders on construction from the research they did in Singapore. The effects that were determined are discussed further below.

i. Increases in project cost

The most common effect of variations during the construction phase is the increase in project cost (CII, 1990a). Tadesse, 2009 conducted study in Ethiopia Federal roads projects cost increase is the second frequent effect of change order. The increase in the project cost is caused by any major additions or modifications to the design (Clough and Sears, 1994).

When a variation order is issued, numerous non value-adding activities/costs are likely to arise. These include unplanned site meetings, travelling and communication expenses, idle plant and labour during the waiting time, demolitions, time taken by the designer to understand the required change and redesign, cost and time for litigation in case misunderstanding arises between the contractor and the client or his/her consultant. Therefore, contingency sum will usually be allocated in every construction project to cater for any possible variations in the project, while keeping the overall project cost intact.

ii. Increases in overhead expense

Normally change orders require processing procedures, paper work and reviews before they even proceed. They may requires holds on funds that otherwise will be used for other activities. These minor expenses are normally not charged to the change order account as they are difficult to define and separate from the different accounts. The charge normally goes on the contractor"s overhead account.

Variations need to go through a few stages of processing procedures and require to be evaluated before they can even be implemented (O"Brien, 1998). Because of this, the overhead expense for all the parties involved will increase as there is a lot of work and

paperwork need to be done. However, normally these overhead charges are provided for from the contingency fund allocated for the construction projects (Arain and Low, 2005).

iii. Additional payments for contractor

No matter how much was said about the negative effects of change orders, there is often additional money gained by the contractor for executing additional scope. The accuracy of this statement depends on the awareness of contractors and owners of direct and indirect impacts of changes and on the willingness to accept this fact in change order pricing.

Arain and Low, (2005) observed that one of the most common potential effects of variations in construction projects is additional payments for the contractor. This is because variations are normally considered to be a common source of additional works for the contractor (O'Brien, 1998).

Due to additional payments, the contractor looks forward to variations in the construction project. Some contractors even look for ways and excuses to initiate variations during construction just to obtain additional payments and increase their profit.

iv. Poor professional relations and dispute

Construction changes are a major source of construction dispute (Fisk, 1997). Abebe and Girmay, (2003) "indicated that claims, in some projects, in Ethiopian construction sector have been observed reaching up to 200-300% of the project cost". In the research conducted by Deickmann and Nelson in 1985 concluded that 72% of contract claims are due to change orders. High percentage of claims is due to variation order. Ssegawa et al., (2002) reported that more than one-third of disputes pertained to how to determine losses that stem from variation orders.

The excessive occurrence of variation orders due to design errors or omission may undermine the professionalism of the designer. Workers are demoralized when they have to

demolish a portion work that they had already completed. Tadesse,(2009) conducted study in Ethiopia federal road upgrading with questioners survey 26.95% of respondent indicate that variation is primary cause of claim. Similarly in the desk study of two projects most of claims due to change orders. 51.19% survey says contractor more affected by change and dispute among parties is fifth key effect change order.

A construction project creates professional relationships between parties to the contract. Each project successfully completed constitutes an added experience to participants and their reputation builds up. But disputes may arise between parties to the contract due to variation orders. Misunderstandings may arise when contractors are not satisfied with the determination of the valuation of variation orders by the client‟s consultant.

Parties to a contract are left to argue over the cost, time effects and due compensation of a variation order (Bower, 2000). Possibly because contractors are not confident about the outcome of such negotiations, they usually request higher values for variation orders than the actual cost incurred. Bower, (2000) opined that consequently there is tension between parties as the contractor continually pushes the client to settle claims for additional costs while invariably feeling that the reimbursement has been insufficient. This can be very damaging to the relationship between the representatives of all parties (Bower, 2000).

Charoenngam et al. (2003) remarked that disputes between the client and the contractor can occur if variation orders are not managed carefully. Harbans, (2003) warned that unless a mutually acceptable solution is agreed by the parties, valuation of variations in the form of variation orders will continue to remain at the front of disputes and claims making their way ultimately to arbitral tribunals or the corridors of justice. Finsen, (2005) found that a large proportion of current arbitrations were on claims for additional time and additional expenses.

Change orders are among the most common reason leading to claims and disputes. All other work is agreed upon in the contract. However changes must go through evaluation,

estimation and negotiation leading to stress and strains in the relation between parties. If these disputes are not settled peacefully through direct negotiations and arbitration they end up in court and legal procedures may suspend the whole project.

As discussed above, major construction changes usually leads to disputes. Therefore, clear procedures must be presented in the contract and fair allocation of risks among parties involved can help in resolving disputes through negotiation rather than litigation (Arain etal., 2004).

v. Hiring new professionals

Change in complex technological projects may affect the project adversely (CII, 1995). This may be caused by something was ignored by the engineer during the design stage. Complex technologies projects need specialists to get the job done (Fisk, 1997). Depending on the nature, occasionally, new professional need to be hired or the entire project team is replaced to execute the variations (Arain and Low, 2005). Hiring the new professionals takes time and thus affecting the project progress.

vi. Quality degradation

Sometimes changes lead to a lower level of workmanship. As changes alter the original plan in certain items or areas, they might create a mismatch with other items or areas affecting the overall quality of the work. As discussed above, the low morale of the crew after many changes are made is also expected to affect the quality of their performance. Frequent variations may affect the quality of work adversely (Fisk, 1997). This maybe because of frequent variations may cause the contractors to compensate their losses by cutting corners.

If variation orders are frequent, they may potentially affect the quality of works. Quality may be compromised as contractors try to compensate for losses they are not optimistic about recovering.

vii. Productivity degradation

The productivity of workers is negatively impacted by change orders especially repetitive Variation orders often associated with interruption, delays and modification of work do have a negative impact on labor productivity. These in turn can be translated into labour cost or monetary value (Ibbs, 1997b). Hester et al., (1991), feels that the productivity of workers was expected to be seriously affected in cases where they were required to work overtime for prolonged periods to compensate for schedule delays. Thomas and Napolitan, (1995) concluded from their research that variations normally led to disruptions and these disruptions‟ were reasonable for labor productivity degradation and on average, there is a 30 percent loss of efficiency when changes are being performed.

Thomas and Napolitan, (1995), also feel that the most significant types of disruptions were due to the shortage of materials and lack of information as well as the work out of sequence and these disruptions result in daily loss of efficiency in the range of 25 to 50 percent. Reichard and Norwood, (2001), found out from their research that if variations reach 10 to 15 percent of the originally planned labor hours, productivity of the remaining unchanged work will decreased due to the extra labor hours spent on executing the variations. Tadesse, (2009) conducted desk study in Ethiopia federal roads projects and identify change order disruption claim leads to extension of time

viii. Completion schedule delay

Changes often result in time extension. In other instances, the owner may want to compensate the contractor for accelerating the work in order to keep up with the original schedule. In either case, additional time means additional money. Delays in completion can be quite costly. Tadesse,(2009) conducted study in Ethiopia federal road upgrading with questioners survey more than 30% of respondent indicate that variation is primary cause of completion delay and it is first key effect change order.

It is anticipated that projects finished within the shortest possible time achieve some monetary savings. Contractors are heavily penalized when they exceed the original project delivery date. The penalty imposed is meant to compensate damages suffered by the client owing to the prolonged delivery period. Several authors agree that variation orders present as one of the reasons for project time overruns (Mohamed, 2001). It was found that variation orders issued during various phases of construction projects negatively affected both the completion time and costs of projects (Koushki, 2005). Hanna et al., (2002) found that as the number of variation orders increases the more significant productivity losses become.

Productivity is the amount of output over a unit of time. Therefore, loss in productivity implies loss of time and subsequent delays. In the study conducted by Rubin, (2008) construction manager involved into a fast track contract indicated that variation orders affected activities on the critical path and resulted in rescheduling. Respondents to the research instrument suggested that variation orders were the major factor in delays in delivery of construction projects. Yogeswaran et al., (1997) classified delays into 'excusable' and 'non-excusable', where the former category relieves the contractor of liability for liquidated damages and the latter is due to the contractor's culpable delay. Completion schedule delay is a frequent result of deviations in construction projects.

Kumaraswamy et al., (1998) studied claims for extension of time due to excusable delays in Hong Kong‟s civil engineering projects. Their findings suggested that half of the projects surveyed were delayed because of variations.

ix. Progress is affected but without any delay

Change during the project may affect the project progress and quality (Assaf et al., 1995). Time has an equivalent monetary value even if the professional team tries its best to keep the project completion schedule intact. However, according to Arain and Low, (2005) only major variations during the project may affect the project completion time because the

contractor would usually try to accommodate the variations by utilizing the free floats in the construction schedules. Therefore, variations will affect the project progress but without any delay in the project completion date.

x. Payment delay

If payments due to the contractor are made against a certain milestone then there is a possibility of delay in payment as a result of a change that delays the achievement of that milestone. CII, (1995) variations may hinder the project progress as mentioned before thus leading to delays in the construction works done which will eventually affecting payments to the contractors. Delay in payment occurred regularly due to deviations in construction project.

xi. Procurement delay

Revised procurement request may be required when variations occur during the construction phase of the project (O'Brien, 1998). Arain and Low, (2005), feels that variations that require new materials and specialized equipment are the cause for frequent procurement delays. Procurement delays were common effects of variations related to new resources for construction projects (Hester etal., 1991).

xii. Logistics delays

Logistics delays may occur due to variations requiring new materials and equipment (Fisk, 1997). Change orders bring about problems with materials and tools required to carry out a certain activity.

Most of the researchers (Arain and Low, 2005) believe that variations that require new materials and equipments may result in logistics delay in construction projects. This happen because time is needed for the ordering/booking and transportation of the materials and equipment's on site.

xiii. Rework and demolition

Quite often, changes that occur after construction of the project cause some parts of the work done to be demolished and done again. This is the worst phase to think of changes and the cost of changes is the highest on the project time curve.

Rework and demolition are common and frequent due to variations in construction projects (Clough and Sears, 1994). The main effects when variations occur during the construction phase are rework and delays in project completion. Time and resources are wasted when rework and demolition occurs. However, it do depends on the timing of the variations as if variations occur during the design phase, no rework or demolition is required on construction sites as things are not constructed yet (Arain and Low, 2005)

xiv. Poor safety conditions

The safety conditions in construction projects may be affected by deviations (Arain etal., 2004). Arain and Low, (2005), this may be caused by the additional safety measures that may be required during construction because of variations.

Variation order occurrence can lead to revision of health and safety considerations. Changes necessity, sufficient health and safety information and appropriate resources are to be made available to the contractor to execute the work safely. This is because change in construction methods, materials and equipment may require additional health and safety measures (Arain & Pheng, 2005). Furthermore, the OHS, (2003) clause 5.14 requires the contractor to provide with any information which might lead to health and safety of any person at work carrying out construction work or any person who might be affected by the work of such a person at work or which might justify a review of the health and safety plan.

xv. Work on hold

Change in a certain work package can put the work on other activities on hold. This happens when activities are interdependent. This action may freeze a certain craft crew or shift the schedule of its schedule. Speedy and quick change order procedures are very vital in order to minimize this effect.

Tadesse, (2009) conducted study in Ethiopia Federal road upgrading indicate that work on hold is third key effect of change order.

xvi. Damage to firm‟s reputation

Kumaraswamy et al., (1998) felt deviations are referred to as a major source of construction claims and disputes among the parties involved. The firm‟s reputation may be affected adversely by the claims and disputes which can lead to insolvency if the case is severe. The possibility of professional disputes also increases if variations occur. It is unquestionable that variations present many problems to all the parties which are involved in the construction project (Arain and Low, 2005).

2.5. Administration of change orders

2.5.1. Introduction

According to Ssegawa et al., (2002) contractual clauses state how change orders should be initiated. Change orders are issued by the consultant and must be given in writing or oral instruction should be subsequently confirmed in writing (Wainwright & Wood, 1983). "Writing" includes drawings, faxes, e-mails, telegrams and magnetic tapes and computer disks in which words and drawings may have been electronically recorded and are capable of being converted to text and drawings on paper or other similar media (Finsen, 2005). Since the contractor is not bound to comply with the oral instructions, all oral instructions have to be confirmed in writing by either the consultant or the contractor. Where variation

orders are confirmed in writing by the contractor, the consultant has to confirm by signature.

If the contractor is agreeable with the variation order, the works should precede through variation order process. The contractor and the consultant agree upon which method of valuation of variation orders. The valuation of variation orders, while seen as an administrative step in the remuneration of changes effected to the contract, is in reality a rather complex matter involving a thorough understanding of contractual provisions, costing principles and an exercise of fair judgment on the part of the values (Harbans, 2003).

Krone, (1991) conducted a study on a change order process that promotes efficient administrative performance and addresses the daily demands of changes in the construction process. Change clause is an essential part of any legal construction contract. It defines how the two parties will handle changes and change orders, and form the basis of any legal claims.

Sometimes an owner or an engineer may attempt to avoid responsibility of changes by using a disclaimer clause or risk-shifting clause in the contract (Cox, 1997). Such a clause may state that „subsurface data provided is for information only" and the owner is not responsible for any change.

The owner or the engineer may also place a design responsibility on a contractor, whereas it is the responsibility of the engineer under common law or traditional industry practice. By using such clauses an owner or an engineer is transferring the risk to the contractor.

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals. Project changes are expected at all stages of a task"s. Managing changes effectively is vital to the success of a construction project.

Tiong, (1990) conducted a study on various controls that should be provided for all phases of a major project: cost control, schedule control, quality control, design control, change order control and document control. He concluded that a change order control system should be established for the ultimate benefit of owners.

Dellon, (1986) said: "As construction costs continue to rise, the use of project management techniques is needed to ensure credibility and productivity." Developing an effective construction change management process is a challenging task because it requires an integrated solution for coordinating everything involved for the purpose of the change management. According to Chappell and Willis, (1996) effective construction change management system will have the following requirements:

- Consolidating all aspects of change information, including causes, symptoms, sources, impacts, actions, and processes of changes and their linkages
- Evaluating all elements affected by a change, across all design and construction phases.
- Automating workflow processes for change review, approval and implementation
- Coordinating changes into operational systems of different parties
- Coordinating changes into a shared project management system
- Coordinating people"s activities (including notification, reminding, monitoring, etc.)
- Coordinating the distribution and management of documents and drawings in latest versions
- Day-to-day process and cost recording
- Dispute resolution procedure
- Change traceability and post-change analysis

In its special publication 43-1 (1994), the CII Project Change Management Research Team recognized five principles for effective change management:

- "Promoting a balanced change culture". According to the research team this means allowing „constructive" changes to proceed while preventing damaging changes from occurring the team recommended value engineering, understanding the basis of evaluation, financial justification for elective changes, and maintaining accountability.

- "Recognize change". According to the CII team, there is a common disagreement between parties on what constitutes a change. Consequently, an environment that allows team members to openly communicate is important. The team suggested many ways to enhance change recognition including training team members, flowcharting change management process, devoting specific meetings for change identification, and the regular examination of the total number and value of changes.

- "Evaluate change". This principle requires a change to be classified as required or elective. Required changes are required to meet original objectives of the project while elective changes are additional features that enhance the project. The team warns against quick judgment in favor of implementing elective changes.

- "Implement change". This principle requires the flexibility of team members to implement changes at any point on the schedule. Established procedures must be set for authorization and documentation. "Authorization assures that all parties have been communicated with regarding the change" and that the change can be implemented. The research team stressed that the implementation process should contain a documentation system to follow up on the overall impact of the changes.

- "Continuously improve from the lessons learned". The team emphasized the need to learn from the lessons of past projects executed by an organization. "From the outset, project strategies and philosophies should take advantage of lessons learned from past similar projects".

The team concluded that "significant savings in total installed costs of construction projects are achievable by improving management of changes".

2.5.2. Importance of changes clause in variations

It is difficult for engineer ever produced a perfect set of plans and specifications. Every construction project is different. If there were no changes clause in the contract, the contractor would have a right to construct exactly what was called out in the plans and specifications. The owner could direct no changes without the contractor's consent. If the contractor refused to consent, the change could not be made. That is why every competently drafted construction contract has a changes clause. As (Chan and Yeong, 1995) explains it is always an intelligent provision, in creating contracts amount, to insert provisions to control the case of extra work which may appear to be necessary.

The change clause establishes the right of the owner to make changes within certain limitations and through a defined mechanism. As noted by Cox, (1997) the change clause is "the most frequently relied on by contractors and subcontractors when seeking recovery of extra money".

2.5.3. Controls of change orders

Change controls in construction require an integrated solution to discipline and coordinate the documentation, drawing, process, flow, information, cost, schedule and personnel. The construction industry needs an effective construction change controls mechanisms. From a literature review 18 change order control mechanisms are identified.

i. Review of contract documents

Contract documents are the main source of information for any project. Comprehensive and balanced change clauses would be helpful in improving management and communication excellence (CII, 1994a). Conflicts between contract documents can result

in misinterpretation of the actual requirement of a project. Most of the time during inception report it is common to add conflicting ideas to the original contract document by contractor report carelessly finalized and its leads to skirmish between documents.

ii. Freezing design

Change in design can affect a project adversely depending on the timing of the occurrence of the changes. Therefore, freezing the design is a strong control method. Many owners freeze the design and close the door for variations after the completion of the drawings (CII, 1990a). However, this control requires that the design of the construction project should be comprehensive; otherwise, it may affect the project objectives adversely by hindering constructive changes. For more benefit constructive changes freezing design enemy of improvements.

iii. Value engineering at conceptual phase

During the design phase, value engineering can be a cost saving exercise, as at this stage, change in any design element would not require rework or demolition at the construction site. Change order is valuable if it is initiated to enhance the client's value, the client's value system elements include time, capital cost, operating cost, environment, exchange or resale, aesthetic/esteem and fitness for the purpose (Kelly& Duerk, 2002).

Involvement of professionals in design may assist in developing better designs by accommodating their creative and practical ideas (Arain et al., 2004). This practice would assist in developing a comprehensive design with minimum discrepancies (O"Brien, 1998). Practical ideas that are not accommodated during the design phase may affect the project adversely. During the construction phase is a costly activity as it may initiate numerous changes to construction activities. Value engineering at the conceptual stage can assist in clarifying project objectives and reducing design discrepancies (Dell"Isola, 1982).

iv. Owner‟s involvement at planning and design phase

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 (Fisk, 1997). Hence, this may help in eliminating variations during the construction stage where the impact of the variations can be severe.

v. Contractor involvement at planning and scheduling process

Involvement of the contractor at planning and scheduling may assist in developing better plans and schedules by accommodating practical ideas suggested by the contractor (Arain et al., 2004). The owner should define his needs and project objectives early in the project life. Design scoping paper or the conceptual development should be as clear as possible. If the contractor involvement is started in a fairly late stage of the planning procedure as the sequence of procedures costs much time in defining project objectives, concerned departments in the owner‟s organization should be consulted for their input. Eventually, this may eliminate the major variations in the later stages of the construction project where the impact of the variations can be severe.

vi. Clear detailing of design

A clearer design tends to be comprehended more readily (O‟Brien, 1998). This would also assist in identifying the errors and omissions in design at an early stage. Eventually, thorough detailing of design can eliminate changes arising from ambiguities and errors in design. Eventually, this may reduce the design errors and noncompliance with the owner‟s requirements.

vii. Reducing contingency sum

The provision of a large contingency sum may affect the participants‟ working approaches. This is because the designer may not develop a comprehensive design and would

consequently carry out the rectifications in design as change orders during the later stages of the construction project. Therefore, reducing the contingency sum would be helpful in ensuring that the professionals carry out their jobs with diligence.

viii. Clarity of change order procedures with quick written approvals

Clarity of variation order procedures is an integral part of effective management of change orders (Mokhtar et al., 2000). Early in the project life, the procedures should be identified and made clear to all parties. Clarity of change order procedures would help in reducing the processing time and other mishandling issues (Ibbs et al., 2001).

Any variation in the work that involves a change in the original price must be approved in writing by the owner before a variation order can be executed (Cox, 1997). Any party signing of behalf of the owner must have written authorization from the owner. It is difficult to prove the right for compensation if there is no such authorization from the owner. In the hectic environment of construction, many verbal agreements can be forgotten, leaving the contractor without any legal proof to get compensation for the variations.

The time between recognizing the need to make a change and actually doing the change can be days or months. The longer the period between recognition and implementation, the more costly the change is. Because of the dynamics of construction projects, work impacted by changes increases as the project progresses to a more detailed phase. This control is quite important in large organizations or large projects and a multi-player environment.

ix. Use of change order logic, scope and justification

Perhaps the most important step in the development of a change order is the scope definition step. First, the original scope should be clear and well defined to distinguish between a change of scope and a change due to design development.

The ability to define both original scope and change scope requires very strong technical skills. Any change request must be carefully examined to insure there is enough justification. Knowing the problems associated with construction changes, the authority that approve change must insure a high benefit to cost ratio to precede with the change. An extra effort must be exerted to determine the extent of the effect of a change on scope, cost, material, finance etc. before approval.

Variation logic and justification for implementation was one of the principles of effective change management proposed by Ibbs et al., (2001). This principle required a change to be classified as required or elective. Required changes were required to meet original objectives of the project while elective changes were additional features that enhanced the project. Knowing the logic and justification behind the proposed changes assists the professionals in promoting beneficial variations and eliminating unfavorable changes.

x. Avoid use of open tendering and use restricted pre-qualification system for awarding projects

A restricted pre-qualification system for awarding projects would act as a filter to select only the capable parties for project bids (Fisk, 1997). However, the lack of a restricted pre-qualification system may allow incapable parties to bid. This may eventually lead to numerous problems in the later stages of a construction project.

Competitive open tendering usually encourages the main contractor to price very low to win the contract, especially in bad times when they are in need of jobs. This practice would give rise to the contractor trying to claim more to compensate for the low price (Chan and Yeong, 1995). Avoiding the use of open tender would assist in eliminating the risks of unfair bids. This may eventually help in eliminating variations that may arise due to the contractor‟s bidding strategy.

xi. Use of project scheduling management techniques

To manage change being able to anticipate its effects and to control, or at least monitor, the associated cost and schedule impact (Hester et al., 1991). The most known scheduling techniques in the construction industry are CPM, PERT and Gantt chart (Clough and Sears, 1994). These techniques are helpful in identifying the downstream effects of any change on subsequent construction activities (Mokhtar et al., 2000). Eventually, these may assist in eliminating detrimental variations.

xii. Owner‟s participation and complete documentation of change order

Involvement of the owner during the construction phase would assist in identifying noncompliance with the requirements and in approving the change promptly (Ibbs et al., 2001). Eventually, the involvement of the owner during the construction phase may keep him aware of ongoing activities and assist in prompt decision making.

Through timely notification and documentation of variation orders, participants will have kept their rights and there by their option to pursue a subsequent claim or to defend against a claim (Cox, 1997).

A change order as defined by Fisk, (1988) is “the formal document that alters some conditions of the contract documents”. The word „formal‟ implies legal binding and as such all changes should be in writing and verbal changes should be avoided. Although there is no mandatory form, owners usually have their own forms and procedures that must be followed to process a change.

According to W. Bruce Pruitt, (1999) the approval of a change order is just the beginning, which must be followed by a course of action “to insure that the change is adequately documented”.

One of the most aggravating conditions is the length of time that elapses between the time when a proposed contract modification is first announced and when the matter is finally rejected or approved as a variation order (Fisk, 1997). Cox, (1997) suggested that the documentation of variation orders and claims had assisted in tracking the effects of the variation and claim events on time and cost. A documented source of knowledge about previous change orders would be helpful in making decisions concerning the appropriate handling of variation orders. Involvement of the owner during the construction phase would assist in identifying noncompliance with the requirements and in approving the change promptly (Ibbs et al., 2001). Eventually, the involvement of the owner during the construction phase may keep him aware of ongoing activities and assist in prompt decision making.

xiii. Ability to discuss change with quick approval and decision procedures

Ability to negotiate variation is an important factor for the effective control of variation orders (Clough and Sears, 1994). Effective negotiation can assist the professional team in minimizing the negative impacts of the variation (Cushman and Butler, 1994). There are certain skills required for effective negotiation of variation orders, i.e., the knowledge of contract terms, project details, technology, labour rates, equipment, methods and communication skills. One of the most aggravating conditions is the length of time that elapses between the time when a proposed contract modification is first announced and when the matter is finally rejected or approved as a variation order (Fisk, 1997). However, the longer the period between recognition and implementation, the more costly the change will be. Hence, prompt approval procedures would assist in reducing the adverse effects of changes in the construction project.

Coordination and communication are important in a multi-participant environment as in most construction projects (Assaf et al., 1995). Detrimental variations, which affect the

projects adversely, can usually be managed at the early stage with due diligence in coordination, and frequent communication.

A Decision Support System (DSS) approach for management decisions seems to be the most natural idea to follow (Miresco and Pomerol, 1995). The knowledge-based system would be helpful in presenting a comprehensive scenario of the causes of variations, their relevant effects and potential controls that would assist in decision making at the early stage of the variations occurring.

xiv. Valuation of indirect effects of changes

Consequential effects can occur later in the downstream phases of a project. Therefore, it is essential to acknowledge this possibility and establish the mechanism to evaluate its consequences (Ibbs et al., 2001). Indirect effects of variations can be substantial in the downstream phases of a complex project (Fisk, 1997). Professionals should evaluate overall effects of change on the downstream phases of a project, to manage the change order effectively. Changes should always be in writing to avoid unnecessary disputes among the owners and the contractors

xv. Control the rise of change orders through contractual clauses

Selection of the appropriate contract form with the necessary and unambiguous variation clauses would be helpful in the management of variation orders (Cox, 1997). Clear procedures presented in the contract and fair allocation of risks can help in resolving disputes through negotiation rather than litigation.

xvi. Comprehensive site investigation

Comprehensive site investigations assist in proper planning for construction activities (Fisk, 1997). As mentioned earlier, differing site conditions are an important cause of

delays in projects (Assaf et al., 1995). Therefore, a comprehensive site investigation would help in reducing potential variations in a project.

xvii. Utilize work breakdown structure

A work breakdown structure (WBS) is a management tool for identifying and defining work (Mokhtar et al., 2000). A contractor should consider using the WBS as an evaluation tool, especially on large projects. If a variation involves work not previously included in the WBS, it can be logically added to the WBS and its relationship with the other WBS element can be easily checked.

xviii. Knowledge base of previous similar projects

A knowledge-base would facilitate an effective management process (Ibbs et al., 2001). From the outset, project strategies and philosophies should take advantage of lessons learned from past similar projects (CII, 1994b). If professionals have a knowledge base established on past similar projects, it would assist the professional team to plan effectively before starting a project, both during the design phase as well as during the construction phase, minimize and control variations and their effects.

2.6. Literature Summary

Accordingly, this chapter has presented some of the crucial findings in the existing theoretical and empirical literature on change orders associated with the construction projects, particularly associated with road projects in order to develop conceptual and contextual basis for the research objectives, in depth literature review has been conducted on identification of change orders and their consequential effects.

Literature review introduces some general ideas about change orders in road construction projects, definitions and nature of change orders. After having a clear and general idea of changes, its classifications, management and control has been discussed in detail. Under

contractual conditions, a variation order is only valid if it is confirmed in writing. The valuation of a variation order demands a thorough understanding of contractual provisions, costing principles and fair judgment on the part of the value.

Four origin agents for variation orders were identified. These included the client, the consultant, contractor and other. A comprehensive list of causes stemming from the four origin agents was developed. The literature suggested that 42 causes of change order leading to cost overrun and time extension are identified. change occur due to a number of reasons that include changes in the minds of parties involved into the contract, weather conditions, statutory changes, product improvement, and discrepancies between contract documents were some of factors influencing the occurrence of variation orders on construction projects.

The literature survey has revealed several studies on construction projects which attempt to predict changes initiated during construction projects have a large effect on their financial performance. It was also found that owner scope change and error and omission be major reasons for cost increases. The frequent occurrence of variation orders can affect the overall quality of works. If not carefully administered, a variation order may give rise to disputes between parties to the contract.

It has been reported that, also cost overrun is a global problem but its extent and the importance of variables causing change orders differs based on the project specifics and development status of the construction industry of the concerned country. One of the challenges facing the ERA asphalt road projects is to manage the risk of cost overruns and deliver projects within time due change orders. Predominant origin agents as well as the direct causes of variation orders specific to ERA asphalt road are not well studied. This gives clear justification for the current research on change orders as one possible way to decrease the problem in the Ethiopian construction industry especially in ERA asphalt road

projects, with emphasis on federal road construction projects to identify major causes to fill the gap.

Chapter 3 follows and describes the methodology adopted in the research to assess change orders causes leading to cost overruns and extension of time in ERA asphalt road projects; which are the main objectives of the research.

CHAPTER THREE

3. THE RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter introduces the research tools and procedures used. First, the research objectives are outlined. The following section, the research methodology, is the heart of this chapter, as it describes the five main components leading to the completion of the research objectives. The first of these components is the research procedure outline. Then the sample criteria and the means of calculating the sample size are explained. The third and fourth components describe the data collection methods and the procedure for the formulation of the research questionnaire. The final component is the methodology of the data analysis, which provides the framework for the subsequent chapter

The methodology describes the practical way in which the whole research project has been organized (Oliver, 2004). According to Walliman, (2005) a plan of action must be developed that shows how the problems will be investigated, what information will be collected using which methods, and how this information will be analysed in order to arrive at conclusions and develop recommendations.

Research projects synthesize and analyses existing theory, ideas, and findings of other research, in seeking to answer a particular question or to provide new insights (Fellows & Liu, 1997). Once the problem statement has been formulated, it should become evident what kind of data will be required to study the problem, and also what kind of analysis would be most appropriate to analyze the data (Walliman, 2005). The problem investigated in this study is the potential of causes & impact of change orders on ERA asphalt road construction projects.

3.2. The study approach and source of data

Study explains to some level of understanding the causes of change order in ERA asphalt road construction projects. Inductive survey established on causes and impact of change order through systematic observations on ERA asphalt road construction project with diligent investigation, attempting to collect facts.

For the study both respondents‟ and archival documents are collected.

The respondents‟ document are collected using questionnaires from ERA, contractors and consultants. Study questionnaire survey has both open-ended and closed-ended questionnaires. The study examines the causes, effects and controls of change orders on ERA asphalt road projects. To achieve the study objectives, a critical review of relevant literature will done coupled with questionnaire survey to collect information on potential causes of changes on asphalt road projects carried out by foreign contractors with multi-lateral fund sources. Through the literature review, causes of change orders will identify which provided the basis for the formulation of the questionnaire.

Empirical data of change order were obtained from Ethiopian Road Authority contract administration records. The archival document were mostly from completed projects contract documents, monthly reports, correspondence letters, consultancy completion reports and payment certificates were investigated thoroughly, which were very important in identifying the frequent problems related to cost in ERA asphalt construction sector. Ethiopian Road Authority kept comprehensive records including short descriptions, monetary values, and reasons. The study identified the origin agents and causes of change orders through archival document of asphalt concrete projects.

3.3. Sample process and sample size

The objective of sampling is to provide a practical means of enabling the data collection and processing components of research to be carried out while ensuring that the sample

provides a good representation of the population (Fellows & Liu, 1997). Walliman (2005) indicated that sample should be free from bias. Otherwise, the type of selected sample will greatly affect the reliability of subsequent generalization.

Sampling strategies are categorized into two main groups, namely probability and non-probability sampling (Blaxter, et al, 2001). Both sampling strategies are used in the study. Probability sampling is also known as random sampling. In random sampling, each member of the population has an equal chance of being selected (Fellows & Liu, 1997). The advantage of this method is that it is free from bias. The disadvantage is that the selected sample may not have provided the relevant expected information or may not be willing to provide the required information.

A list of selected ERA asphalt road projects a representative sample was derived by stratified samples by dividing ERA into contract administrative regions for archival documents data collection, then Samples within five ERA contract region recently finished projects must be randomly selected; from each region most recently finished two asphalt concrete projects are chosen. Totally ten asphalt concrete projects document are used in archival document analysis.

For questionnaire distribution both probability and non-probability sampling strategies used. Contractor and consultant companies are randomly selected based on order of initial contract award lump sum amount in decreasing order. ERA questionnaire respondent project are selected with stratified sampling into contract administration regions and Purposeful non-probability sampling consists of hand picking interested and experienced professionals in the randomly selected projects. According to Walliman, (2005), it is a useful sampling method consisting of getting information from a sample of the population that one thinks knows most about the subject matter.

Sample size for questionnaires: - according to Farooq, (1997) “size of the sample required from population was determined on the basis of statistical principles for this type of

investigative study. For such research, sample size was determined as follows" in equation 3.1

$$n_o = (p*q)/ V2 \text{ …….[eq. 3.1]}$$

$$n = n_o / [1+ (n_o / N)] \text{ ……..[eq. 3.2]}$$

Where: $\mathbf{n_0}$= First estimate of sample size

P = The proportion of the characteristic being measured in the target population.

q= Complement of „p" = 1-p

V= The maximum standard error allowed

N= The population size

n= The sample size

Sample size calculation

To maximize n, p is set at 0.5. The target population N is 52 undergoing and completed ERA asphalt concrete road projects during 4th phase of RSDP up to 2014 by foreign contractors. To account for more error in qualitative answers of this questionnaire, maximum standard error V, is set at 10% or 0.1. Substituting in Equations 3.1 and 3.2 above, minimum required sample is calculated to be 16.88 asphalt concrete projects. This means that minimum sample size for each populations is 17.

$$n_o = (p*q)/ V2 \quad =0.5*0.5/0.1*0.1=25$$

$$n = n_o / [1+ (n_o / N)] = 25/ (1+ (25/52)) =16.88=17 \text{ asphalt concrete road projects}$$

Each projects unit represent one client counterpart engineers, one contractor and one consultant professional respondent to the questionnaires. A minimum of 1 respondents were chosen from each project implementation units to have 17 respondents representing the employer, 17 consultants and 17 contractors that are involve in the construction project

were contacted for participation. In general, a total number of 51 questionnaires will prepared and respondent data collected.

The research samples are taken from stakeholders in the construction industry which are clients (project owners), contractors and consultants, that are selected professional purposeful depending on their direct exposure to ERA asphalt concrete construction activities and their willingness.

3.4. Questionnaire design

To examines the causes of change orders on ERA asphalt concrete road projects based on critical review of relevant literature questionnaires prepared to collect information on change order potential causes and its cost impact. ERA administers large number of asphalt concrete projects. Due to this a survey by questionnaire was found to be appropriate in addition to the desk study. According to Walliman, (2005) questionnaire enables a researcher to organize the questions and receive replies without actually having to talk to every respondent. The questionnaire was carefully designed in light of getting high response rate from respondents. Forms were given to project participants to complete. Over a period of two week after distributing the questionnaire and making contact with the contractors and consultants to collect them.

Questionnaires were distributed to collect data on opinions from the project management staff (contract management), consultants and contractors on the nature and causes of change and the contributions of project owners, contractors, and consultants to the occurrence of changes.

Fifty one questionnaires were distributed and forty two of them completed by participants. A final version of the questionnaire was produced (Appendix 1). The questionnaire listed 42 causes, 16 effects and 18 controls for change orders for ERA asphalt concrete projects in Ethiopia. Each respondent was asked to rate each issue based on his/her professional

judgment. The causes of change orders were analyzed and ranked according to their responses.

All of the questionnaires were hand-delivered and responded to in the presence of the researcher. This option might be time consuming but yielded a high response rate. Both Closed-ended and open-ended questions were formulated (See Appendix 1).

Closed-ended questions: - Respondents were restricted in the way they answered the questions as they were required to select one answer from among the given ones. Closed-ended questions, as they provide 'ready-made' categories within which respondents reply to the questions asked by the researcher, help to ensure that the information needed by the researcher is obtained (Kumar, 2005).

Open-ended questions:-These are the questions that seek to get the opinion of respondents. An open ended question is a qualitative enquiry aiming at minimizing the imposition of predetermined responses when gathering data whereby people can respond in their own words (Patton, 2002). Kumar, (2005) indicated that open-ended questions provide a wealth of information provided respondents feel comfortable about expressing their opinions; provide the respondents an opportunity to express themselves freely resulting in a greater variety of information.

The answers for the structured part of the questionnaire are based on Likert‟s-scale of five ordinal measures of agreement towards each statement. Most frequent causes corresponds to „very often‟ whereas the least frequent correspond to „never‟ which denies existence of the condition as a cause. The causes were further grouped as owner originated, designer/consultant originated, contractor originated or others for ease of analysis. Respondents were given a chance to add other causes and rate them.

The main sections of the questionnaire on causes, effects and controls use basically an ordinal scale. This ordinal scale does not offer in its qualitative 5 point scales a direct

quantitative comparison between its intervals. This scale will be transformed into an interval scale by assigning a weight to each interval. So think of intervals from „never" to „very often" and of intervals from „no" to „extreme" as an interval scale from zero to 100, to achieve this transformation which will enable to carry the required parametric statistics in Table 3.1 & Table 3.2 below.

Likert"s-scale is important to know respondents' feelings or attitudes about something. The respondents must indicate how closely their feelings match with the question or statement on a rating scale identified in Table 3.1 below score for frequency of occurrences.

After the variables of cost overgrow in asphalt construction projects are identified; respondents are asked about their agreement on these variables in causing cost overgrow and frequency of occurrences in their projects.

Table 3.1: Score for frequency of occurrences

	„very often"	„often"	„sometimes"	„rarely"	„never"
probability to happen	100%	51% - 75%	26% - 50%	0% - 25%	0%
Score	1	0.75	0.5	0.25	0

After identifying the chances of occurrence of the cost overgrow variables respondents were asked about the impacts of each causes of cost overgrow based on the following choices in Table 3.2 below.

Table 3.2: Score for significance of cost effects

	'Extreme significance'	'High'	'Average'	'Minor'	'No'
probability to happen	100%	51% - 75%	26% - 50%	0% - 25%	0%
Score 1	1	0.75	0.5	0.25	0

After data is gathered on causes of cost overgrow, the responsible party from stakeholders in the construction industry has to be identified for the cause of cost overgrow; the questionnaires are prepared in such a way that detailed information can be gathered in a systematically prepared matrix table.

3.5. Data analysis

Data analysis encompasses the compilation and interpretation of the data collected. Analysis will depend on the nature and form the data has been recorded. Since the data has been recorded using qualitative and quantitative approaches, the analysis will be done accordingly. Whether it is qualitative or quantitative data, the main rule of any form of analysis is to move from raw data to meaningful understanding (O'Leary, 2004).

The analysis of qualitative data consists of abstracting from the raw data all points that a researcher considers to be relevant to the topic under investigation. Qualitative data is analyzed thematically. Thematic analysis can include analysis of words, concepts, literary devices, and/or non-verbal cues (O'Leary, 2004). Quantitative analysis uses the syntax of mathematical operations to investigate the properties of data (Walliman, 2005).

Descriptive statistics are used to describe and summarizes the basic features of the data in a study, and are used to provide quantitative descriptions in a manageable and intelligible form (O'Leary, 2004). Descriptive statistics measure the central tendency (mode, median, mean); the dispersion (standard variation) will be adopted.

In the analysis the "Mean Score" method is adopted to establish the relative importance of the causes of cost overgrow for ERA asphalt construction projects in Ethiopia. As discussed earlier in Table 3.1 & 3.2 Likert's scale of five ordinal measures of agreement towards each statement is used to calculate the mean score for each factor that is used to determine the relative ranking. Prevalence indices will be calculated in the same way for

impacts, and controls will be ranked on the basis of their indexes with the first rank assigned to the highest index by using input parameters from Table 3.3 below

Sections on causes, effects, and controls respectively will be scored as follows to come up with an index to indicate its importance, or utilization as in the case of controls of each: Arithmetic mean can be used as the measure of central tendency, standard deviation as the measure of dispersion as the statistical procedures. (Cooper & Emory, 1995). Prevalence Index of each cause, effect or control respectively will be calculated as follows in Table 3.3 below.

Table 3.3: Mean score formulas for prevalence index of cause, effect or control

	„very often“	„often“	„sometimes“	„rarely“	„never“
probability to happen	100%	51% - 75%	26% - 50%	0% - 25%	0%
Scores given to each factor(S)	1	0.75	0.5	0.25	0
Frequency of responses for each score(f)	X_1	X_2	X_3	X_4	X_5

Importance index for causes on cost will be calculated as follows by using input parameters from Table 3.4 below:

Table 3.4: Mean score inputs for importance index of cause, effect or control

	'Extreme significance'	'High'	'Average'	'Minor'	'No'
probability to happen	100%	51% - 75%	26% - 50%	0% - 25%	0%
Scores given to each factor(S)	1	0.75	0.5	0.25	0
Frequency of responses for each score(f)	f_1	f_2	f_3	f_4	f_5

Importance or prevalence index for causes, effects or controls will be calculated as follows by using input parameters from Table 3.3 and 3.4 in equation 3.3 below.

$$MS=II_{c1} = \text{sum } (f_i*S_i)/N \text{ ……..[eq. 3.3]}$$

Where: N = Total number of responses concerning each factor

S = Scores given to each factor

f = Frequency of responses for each score

MS = Mean Score = II_{c1} =Importance Index of cause 1

Test of Agreement

Outline test for the degree of agreement or disagreement between the consultants and contractors on the causes, effects, and controls of change orders. To do this we will use the t-test for independent samples as used. The analysis here was done on the mean values for causes, effects, and controls.

Testing comes under the inferential statistics. For the purpose of this study, t-test will be the statistic test of choice. The t-test for small size samples of two independent variables (between contractors‟ point of view and consultants‟ point of view, between contractors‟ point of view and client‟ point of view and between consultants‟ point of view and client‟ point of view) is tested by using equation 3.4 and 3.5 with m+n-2 df.

$$t = [MS_1 - MS_2)- (\mu_1-\mu_2)_0]/ \{SQRT(S_p^2 (1/n_1 + 1/n_2) \}\text{……..[eq. 3.4]}$$

$$S_P^2 = \frac{(m-1)S_1^2 + (n-1)S_2^2}{m+n-2} \text{ ……..[eq. 3.5]}$$

Where: MS_1 and MS_2 : Sample mean values for sample 1 and 2 respectively

μ_1 and μ_2 : Population mean values for population 1 and 2 respectively

S_p : is the pooled variance for the two samples and is equal to

m and n : are sizes of sample 1 and 2 respectively.

S_1 and S_2 : are standard deviation of sample 1 and 2 respectively.

CHAPTER FOUR

4. ANALYSIS AND DISCUSSIONS

4.1. Introduction

The purpose of this chapter is to discuss and analyze the answers made to the research questionnaires and document records in order to fulfill the five research objectives. Each objective shall be addressed separately and the relevant results shall be presented and analyzed thoroughly. The detailed calculations and the data collected shall be presented forthwith in this chapter. It is important to note that the information presented in this chapter lay the foundation for the main conclusions that shall be drawn in the subsequent chapter of this research.

This chapter analyses the data gathered using a questionnaire responses and ERA asphalt concrete roads projects document. It discusses the profile of participants in the study, analysis of questionnaire responses and document records.

4.2. Document analysis

Empirical data of change order were obtained from Ethiopian Road Authority contract administration records. The archival document were mostly from completed projects contract documents, monthly reports, correspondence letters, consultancy completion reports and payment certificates were investigated thoroughly, which were very important in identifying the frequent problems related to cost in ERA asphalt construction sector. Ethiopian Road Authority kept comprehensive records including short descriptions, monetary values, and reasons. The study identified the origin agents and causes of change orders.

The selected ERA asphalt concrete projects are designed by 30% by local consultants, which contribute 8.6% cost , 10% by foreign consultants and 60 % by joint venture agreement between local and foreign consultants, which is shown in Appendix III.

4.2.1. Projects particulars

Archival document were mostly from completed projects contract documents, monthly reports, correspondence letters, consultancy completion reports and payment certificates were investigated thoroughly, which were very important in identifying the frequent problems related to increasing cost, due to change orders in the ERA asphalt road projects carried out by foreign contractors with multi-lateral fund sources.

A list of selected ERA asphalt road projects a representative sample was derived by stratified samples by dividing ERA into contract administrative regions for archival documents data collection, then Samples within five ERA contract region should be randomly selected; from each region two asphalt concrete projects are chosen. Totally ten design bid build asphalt concrete projects document are used. List of brief description for archival documents of selected asphalt concreted projects under study is shown in Table 4.1 below and the detail of the change orders in this projected shown in Appendix II. Cost Change due to different types of change orders in selected Ethiopian Authority projects documents is calculated as shown below in Table 4.1. This archival study of 10 selected Ethiopian road authority projects identified 8.74% increase in average cost per project.

Table 4.1: List of selected asphalt concrete road projects under archival study.

No	Project	Original contract (ETB)	Change order (ETB)	% of Change
1	Gore – Gambella Road Upgrading Project	817570809.8	55965368	6.85
2	Contract 2: Bonga-Mizan Junction	745965117.8	3,586,453.86	0.48
3	Jimma-Bonga Junction	696809155	10,707,118.80	1.54
4	Gedo-Nekempte road rehabilitation project	354350909	21121425.69	5.96
5	Addis Ababa – Dessie – Woldiya Road Rehabilitation Project, Lot 1: Addis Ababa - Tarmaber Tunnel Contract 2: Km 110 + 000 to Km 180 + 000	556610134.9	46393325.9	8.33
6	Nazareth-Assela-Dodola and shashemene-	507784779.1	108921350.6	21.45

	Goba road upgrading project contract 2:Assela-Dodola junction			
7	Nazareth-Assela-Dodola and shashemene-Goba road upgrading project contract 3:Dodola junction Goba	651465740.5	143079483.9	21.96
8	Kombolcha –Gundewein road project contract 2 mekanselam –Gundewein	828084839.2	8483665.8	1.02
9	Irebti-Afedera	727931000	98090000	13.48
10	Gonder-Debarek	743132123.4	83306143.32	11.21
Total		6629704609	579654335.9	8.74

4.2.2. Causes of change order on projects

The causes of change order in ERA asphalt concrete road construction sector were researched to achieve a deeper understanding about the most dominating factor that affects completing projects with allocated fund of projects in the industry. In ten ERA asphalt concrete projects constructed by foreign contractors 85 times change are made. In this section frequency and cost implication of change order causes analyzed based on summary of selected asphalt concrete road projects change order data shown in Table 4.2 below.

Table 4.2: Summary of selected asphalt concrete road projects under change order data

No	change cause	Cost change		Frequency of occurrence	
		Birr	%	Repetition	%
1	Plan change by owner	237000000	32.90	24	28.24
2	Value engineering	-140000000		11(consultant) + 1(contractor)	14.12
3	Error and omission in design	43439121	6.03	15	17.65
4	Lack experience and data for design	214000000	29.76	16	18.82
5	Change in design	36869023	5.12	8	9.41
6	Inadequate scope of work for contractor	138905.70	0.02	1	1.18
7	Lack of contractor‟s involvement	8364907	1.16	2	2.35
8	Contractor unavailability of equipment (Lack of material)	3898342	0.54	1	1.18
9	Negligence during design	92860000	12.89	1	1.18
10	Change in specifications by consultant	83468114	11.59	5	5.88

Causes of change order in terms of prevalence and their originators

A construction contract is a professional agreement that subject to variability. Contractual clauses relating to revision allow parties involved in the contract to freely initiate change orders within the domain of the scope of the works without alteration of the original contract. Causes of change orders have been identified by the study and the causes of change can be categorized according to the originators of change are discussed below.

In ERA asphalt concrete projects constructed by foreign contractors most prevailing change causes interims of originator share are owner 28.24%, consultants 65.88%, and contractors 5.88% contribute to the existence of change. Most prevailing five change order cause in terms of frequency of occurrence are change of plan 28.24% caused by owner of project, lack of data for design and experience in predicting underground condition 18.82% caused by design consultant, error and omission in design 17.65% by design consultant, value engineering 12.94% caused by consultant and 1.18% by contractor and change in design 9.41% initiated by supervision consultant due to design consultant causes need change.

Causes of change order and their cost effect

The study identify the most important causes and their consequence of cost effects. The results of data in Figure 4.1 and 4.2 below shows the characteristics that were directly associated with project cost increases, due to different changes. The parameters in the Figure 4.1 and 4.2 indentified in detail as follows and it is based on summary of selected asphalt concrete road projects data from Table 4.2 above. Figure 4.1 show increase in projects cost for different types of change orders causes and their percentages are identified in Figure 4.2.

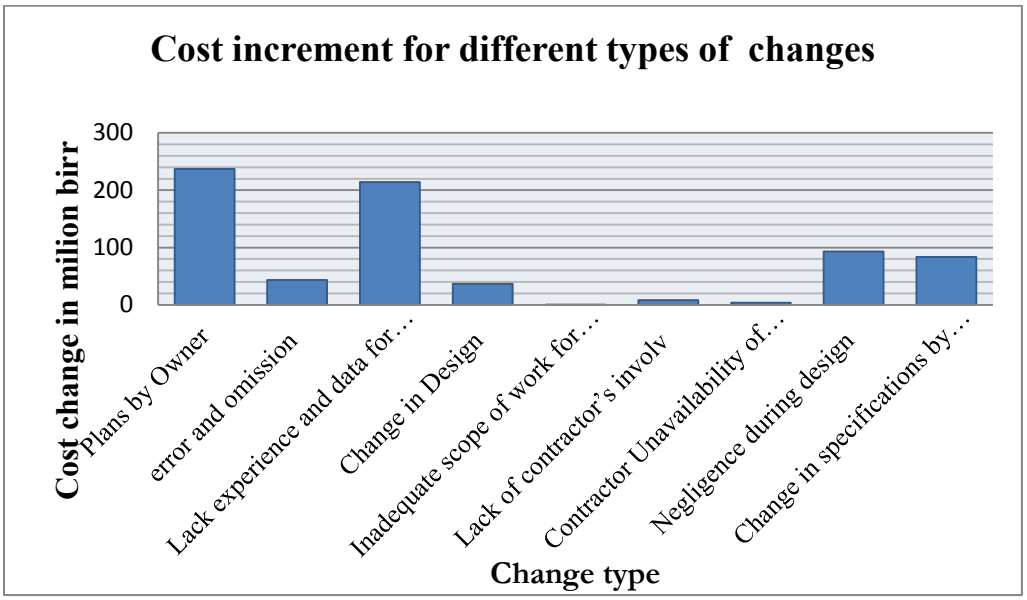

Figure 4.1: Increase in projects cost for different types of change orders causes

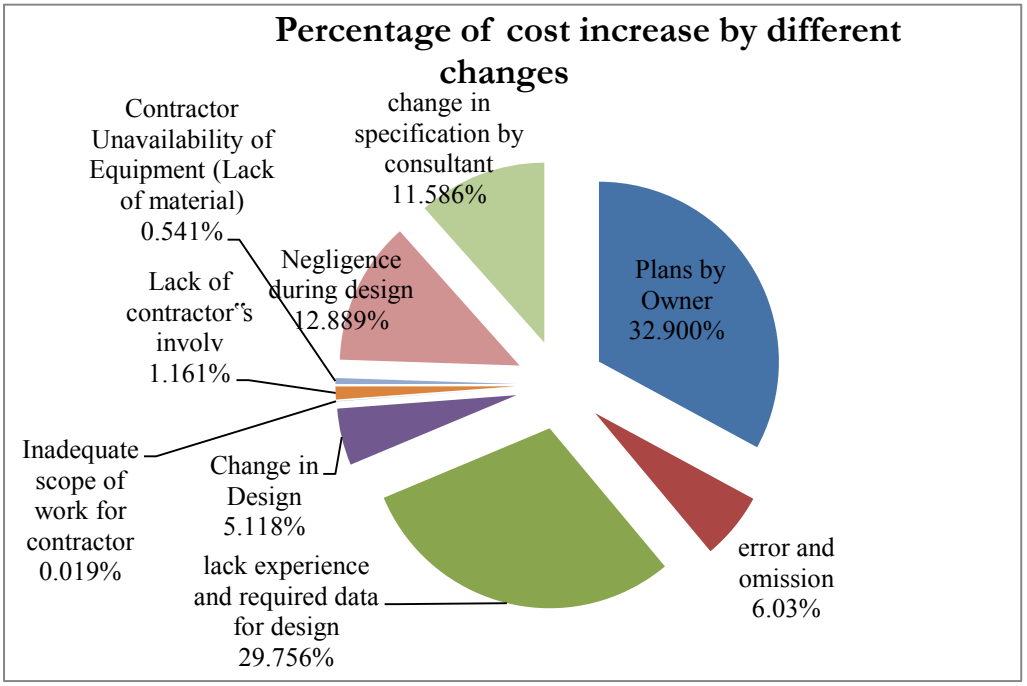

Figure 4.2: Percentage of increase in cost of projects for different types of change orders causes

From Figure 4.1 and Figure 4.2 based on change order document data from Table 4.2 most important change order causes interims of cost effects in document analysis are change of plan 32.90%, lack of data for design and experience in predicting underground condition 29.76%, negligence during design 12.89%, change in specifications by consultant 11.59% and error and omission in design 6.03%.

Changes result either increase or reduction in cost of project activities. The most important thing have to consider is overall cost impact of change increase project cost or decreases. In either case the cost saving must be high enough to justify a change, because it is not worth going through the problems of change, if the benefit to cost ratio is not attractive. Cost saving ideas is always welcome. In Figure 4.3 overall effect of cost change is revealed that 19.5% of change order cost rise from 10 selected project is saved 140,429,595 birr by value engineering. This is a source of changes that cannot be ignored, but overall effect of change order implies increases in cost of 576,654336 birr in ten projects.

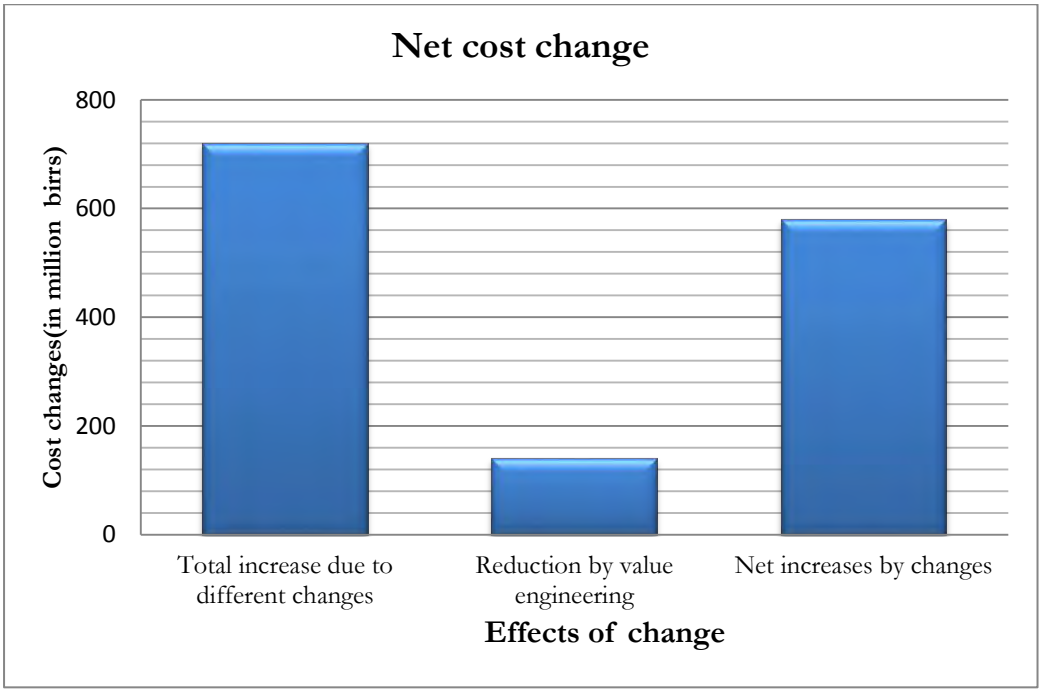

Figure 4.3: Net cost of changes caused by change orders

Cost effects of change order causes and their originators

When a change order is issued, numerous cost are likely to arise. While deviation are common in construction projects, an improved understanding would require their categorization into their root or origin agents and causes. A study that focused on the point of view of developers of potential causes of change orders suggested three main origin agents from document analysis. These included client, consultant, contractors and others.

In ERA asphalt concrete projects constructed by foreign contractors most important change causes in terms of originator share of cost are owner 32.9%, consultants 65.38%, and contractors 1.72 % contribute to the existence of change. The originators cost change implication in shown Figure 4.4 below by histogram and their share of cost interims of percent in Figure 4.5 below by using pie chart.

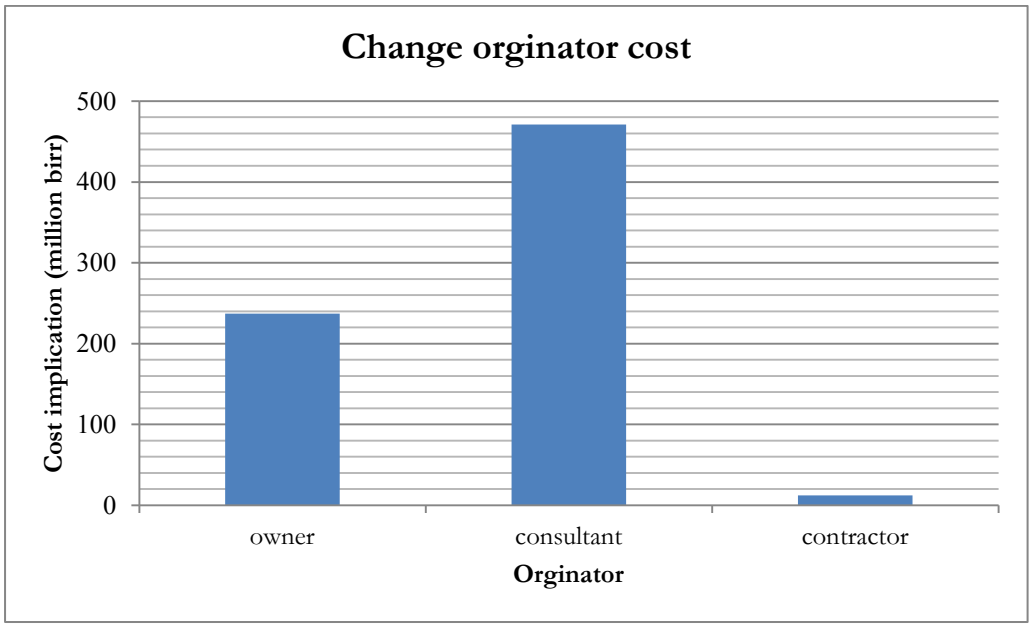

Figure 4.4: Change order originators cost implication

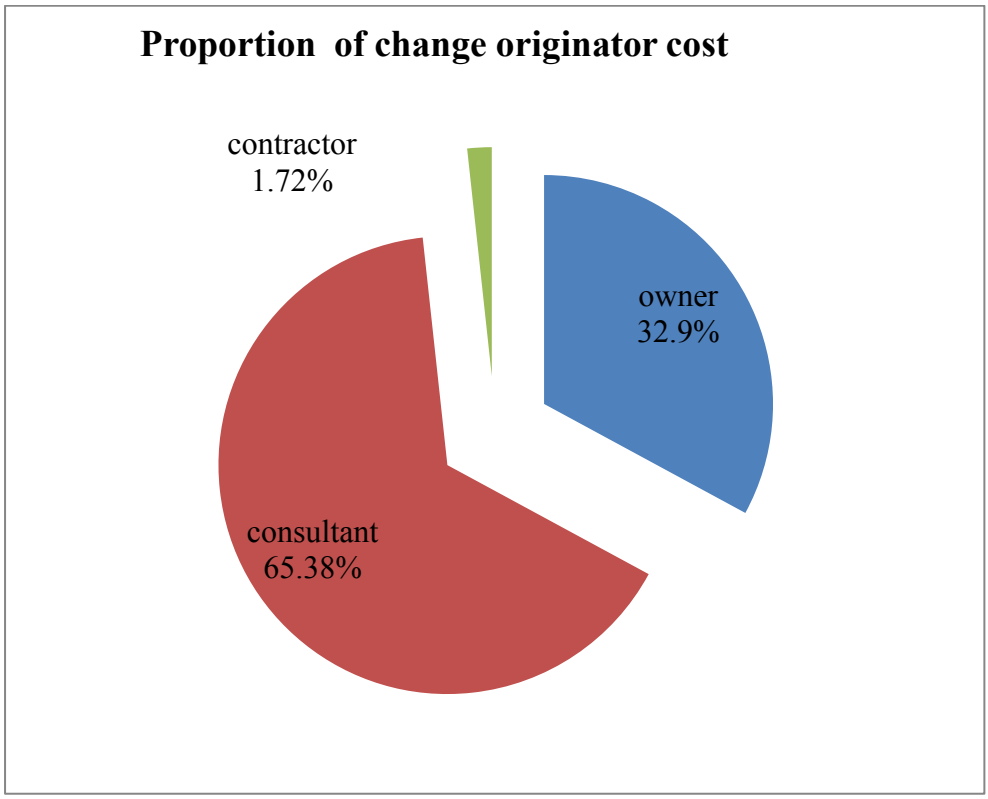

Figure 4.5: Change order originators cost proportions

From the analysis result most troubling area of changes was design, which accounted for a staggering 53.863% of the total number of changes, whereas construction changes accounted for 46.137% of the total number of changes. Design related changes, which accounted for a staggering of 80% of five leading causes of change in archival document analysis of Ethiopian road authority asphalt concrete road projects constructed by foreign contractors. Design related causes contribution consist of lack of data for design and experience in predicting underground condition 29.76%, negligence during design 12.89%, change in specifications by consultant 11.59% and error and omission in design 6.03%. The dominance of the design change factor over the other causes show that changes created during construction stage, due to design stage problems. It is due to additional scope of

work to be given to the contractor concerning the items that were missed by the designer in the tendering stage.

Consultant directly initiates changes or the change are required, because the consultant fails to fulfil certain requirements for carrying out the project related to change in design by consultant. In case errors, omissions or discrepancies are found in the design or a conflict is discovered between the contract documents, it is the duty of the consultant to provide a remedial solution.

4.2. Questionnaire study

Fifty one questionnaires were distributed and forty two of them completed by participants. A final version of the questionnaire was produced (Appendix 1). The questionnaire listed 42 causes, 16 effects and 18 controls for change orders for ERA asphalt concrete projects in Ethiopia. Each respondent was asked to rate each issue based on his/her professional judgment. The causes of change orders were analyzed and ranked according to their responses.

4.3.1. Profile of participants

Detailed questionnaires were designed and distributed for the assessment of change orders on ERA asphalt concrete project stockholders. For this purpose the questionnaires were distributed to major stakeholders in the construction industry; these are contractors, consultants and clients (project owner).

To make the analysis more comprehensive a total of 51 questionnaires were distributed to consultants, contractors and clients (project owner ERA) out of which 42 questionnaires were filled and returned. Table 4.3 below shows the number of questionnaires distributed to clients, consultants and contractors and the number of questionnaires returned from these stakeholders including their percentage response rate.

Table 4.3: Summary of number and percentage of questionnaires distributed, returned; and response rate

No	Respondent	Questionnaire distributed		Questionnaire Returned		Response Rate
		No.	%	No	%	%
1	Client	17	33.33	17	33.33	100
2	Consultant	17	33.33	15	29.37	88.23
3	Contractor	17	33.33	10	19.6	58.82
	Total/Average	51	100	42	82.3	82.3

A final version of the questionnaire was produced (Appendix 1). The questionnaire listed 48 causes, 16 defects and 18 controls for change orders. Each respondent was asked to rate each issue based on his/her professional judgment. The causes of defect were analyzed and ranked according to their responses. Out of 51 targeted stockholders, 42 (82.3%) duly completed and returned the questionnaire. As depicted in Figure 4.6, participant included owner 17 (40.4%), consultants 15 (35.7%), and contractors 10 (23.9%).

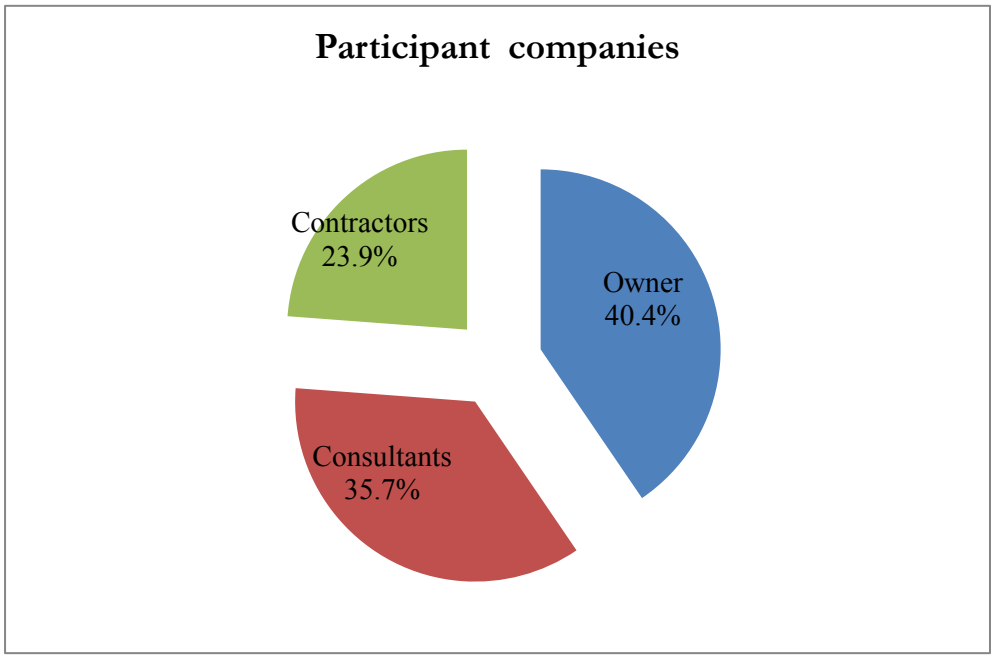

Figure 4.6: Involvements share of participants

From Table 4.4 below it is evident that the experience of respondents in the ERA asphalt project ranged from one year to 22 years. The median length of experience in Asphalt concrete road projects was 9 years. Number of asphalt project carry out while respondents had been working for projects ranging from 2 to15 projects, the median number of asphalt projects during their stay was 4 projects. Their experience in change order administration ranged from zero year to 20 years with the median experience being 6.5 years. 97.6% of respondents had been involved with administration of change orders.

Table 4.4.: Experience of respondents on asphalt concrete road projects

	N	min	max	mean	Std. Dev.	Median
Work experience on asphalt road projects	42.00	1.00	22.00	9.25	5.29	9.00
Number of asphalt project carried out	42.00	2.00	15.00	4.40	2.41	4.00
Change orders administration experience	42.00	0.00	20.00	7.08	4.67	6.50

From figure 4.7 the positions held by respondents in their organizations is evident, these positions include Junior counterpart Engineer/Junior project Engineer, Senior counterpart Engineer/Senior project Engineer, Resident Engineer, Assistant resident Engineer, Project manager, and Contract Engineer. The educational qualifications of respondent are 86% BSC and 14% MSc in civil engineering.

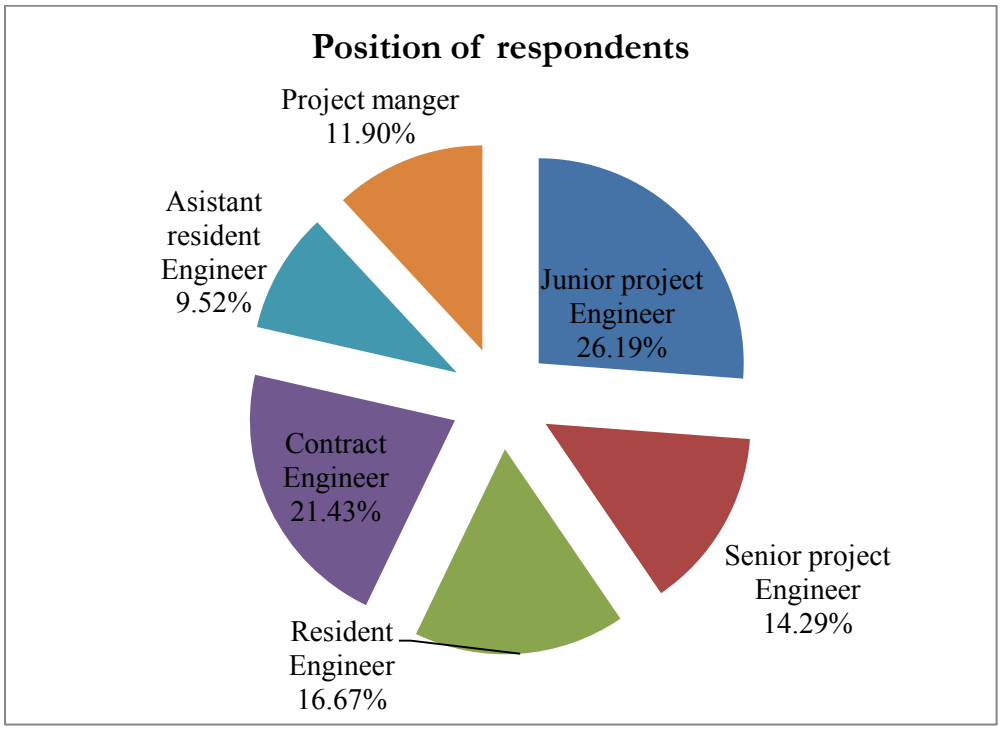

Figure 4.7:Positions of respondents

Respondents reported that the consequence of change orders that occurred to a lesser extent were damaging works while extra works was reported to be the most frequent with a prevalence index of 0.77 and prevalence index of different change order activities mentioned in Table 4.5 below.

Table 4.5: Prevalence index of different change order activities

Activity"s	Extra works	Omissions from works	Replacement of works	Constructive changes	Damaging changes
Prevalence Index	0.77	0.44	0.30	0.61	0.14

Change order causes was analysed in terms of originator and its rank in Table 4.6 below. This was made possible by designing an origin-rank matrix as illustrated(See Appendix 1). Row contain rank of change orders as per originator and column contain change orders as per origin agent.

Table 4.6: Originator ranks of change order

Originator	Client	Contractor	Design Consultant	Supervision consultant	others
Rank	2nd	3rd	1st	3rd	5th

From the questioners‟ study 81% of respondents say variation clause isn‟t cause of changes

4.3.2. Causes of change orders

The responses on the causes of change orders will be looked from three different perspectives. In this section we will examine the responses from client, contractors, consultants, and the overall responses on the causes of change order in ERA asphalt concrete road projects.

The index will be calculated as outlined in chapter three above. Study will also look at the categories of change orders originators; such as owner generated, contractor generated, design or supervision consultants generated, and other causes. Causes will be ranked and categorized based on the prevalence and importance index in clients, consultants and contractor‟s point of view. Finally, overall data will be analyzed calculating prevalence and importance indexes for the overall data.

The prevalence indexes indicate frequency of occurrence of the change order causes and its adverse effects. Similarly importance index identify significance of change order causes and its adverse effects contribution in terms of cost inquired in the project.

The analysis will be carried out on data from consultants, contractors and client. Finally, overall data will be analyzed calculating importance indexes for the overall. Table 4.7 below lists the results of responses of clients, consultants and contractor‟s on the causes of change order.

Table 4.7.: Prevalence index of causes in clients, consultants and contractor‟s view

Source or Cause of change order	Owner		Consultant		Contractor		Overall	
	PI	SD	PI	SD	PI	SD	PI	SD
1. Change in design	0.82	0.23	0.60	0.21	0.70	0.20	0.71	0.23
2. Errors and omissions in design	0.60	0.27	0.75	0.00	0.78	0.14	0.70	0.20
3. Design complexity	0.26	0.22	0.18	0.18	0.13	0.13	0.20	0.19
4. Inadequate working &shop drawing details for contractor	0.25	0.22	0.35	0.13	0.40	0.13	0.32	0.18
5. Lack experience and data for design	0.59	0.20	0.62	0.16	0.70	0.39	0.63	0.24
6. Attitude of consultant	0.32	0.12	0.30	0.24	0.30	0.23	0.31	0.19
7. Ambiguous design details	0.31	0.19	0.47	0.21	0.43	0.21	0.39	0.21
8. Noncompliance of design with government regulations	0.28	0.23	0.15	0.13	0.20	0.11	0.21	0.18
9. Noncompliance of design with owner‟s requirements	0.26	0.22	0.13	0.13	0.35	0.21	0.24	0.21
10.Consultant‟s lack of judgment and experience	0.37	0.18	0.40	0.31	0.60	0.13	0.43	0.24
11.Change in specifications	0.28	0.25	0.32	0.11	0.33	0.12	0.30	0.18
12.Conflict between Contract documents	0.37	0.13	0.32	0.11	0.40	0.13	0.36	0.13
13.Inadequate scope of work for contractor	0.24	0.19	0.20	0.17	0.28	0.22	0.23	0.19
14.Technology changes	0.16	0.18	0.05	0.10	0.18	0.24	0.13	0.18
15.Lack of coordination	0.25	0.18	0.58	0.12	0.50	0.17	0.43	0.22
16.Supervision consultant value engineering	0.38	0.18	0.43	0.22	0.40	0.21	0.40	0.20
17.Contractor financial difficulties	0.43	0.29	0.50	0.09	0.10	0.21	0.38	0.27
18.Contractor desire to improve his Finance	0.19	0.12	0.40	0.13	0.18	0.24	0.26	0.19
19.Lack of contractor involvement in design	0.18	0.17	0.52	0.15	0.65	0.13	0.41	0.25
20.Shortage of skilled labour	0.46	0.25	0.47	0.13	0.38	0.18	0.44	0.20
21.Unavailability of equipment	0.28	0.23	0.43	0.32	0.28	0.25	0.33	0.27
22.Defective workmanship	0.44	0.26	0.40	0.39	0.10	0.13	0.35	0.32
23.Differing site and local conditions	0.46	0.24	0.52	0.20	0.73	0.34	0.54	0.27
24.Value engineering by contractor	0.34	0.12	0.45	0.10	0.55	0.16	0.43	0.15
25.Lack of a specialized construction	0.47	0.28	0.45	0.10	0.18	0.12	0.39	0.23

Source or Cause of change order	Owner		Consultant		Contractor		Overall	
	PI	SD	PI	SD	PI	SD	PI	SD
manager								
26.Fast track construction	0.12	0.18	0.12	0.13	0.15	0.13	0.13	0.15
27.Poor procurement process	0.44	0.14	0.33	0.20	0.33	0.13	0.38	0.17
28.Lack of communication	0.43	0.15	0.38	0.13	0.40	0.13	0.40	0.13
29.Contractor‟s lack of experience	0.56	0.21	0.27	0.11	0.13	0.13	0.35	0.24
30.Long lead procurement	0.37	0.20	0.12	0.19	0.03	0.08	0.20	0.22
31.Attitude of contractor	0.31	0.21	0.08	0.12	0.05	0.11	0.17	0.20
32.Complex design and technology	0.10	0.15	0.27	0.15	0.20	0.11	0.18	0.16
33.Lack of strategic planning:	0.51	0.30	0.35	0.16	0.60	0.21	0.48	0.25
34.Lack of proper tender evaluation	0.24	0.19	0.33	0.12	0.50	0.24	0.33	0.20
35.Change of plans/Scope by Owner	0.66	0.31	0.70	0.32	0.85	0.24	0.72	0.36
36.Owner financial difficulties	0.37	0.20	0.25	0.00	0.25	0.00	0.30	0.14
37.Owner change of schedule	0.29	0.27	0.40	0.18	0.25	0.17	0.32	0.22
38.Inadequate project objectives	0.35	0.22	0.50	0.00	0.63	0.13	0.47	0.18
39.Change of materials or procedures	0.40	0.22	0.37	0.21	0.25	0.20	0.35	0.21
40.Slow decision making process	0.32	0.23	0.42	0.32	0.28	0.30	0.35	0.28
41.Change in specifications by owner	0.34	0.22	0.55	0.14	0.53	0.20	0.46	0.21
42.Weather conditions	0.51	0.16	0.68	0.11	0.70	0.11	0.62	0.16
43.Right of way issue	0.56	0.21	0.75	0.00	0.83	0.12	0.69	0.18
44.Safety considerations	0.31	0.21	0.38	0.28	0.30	0.31	0.33	0.26
45.New government regulations	0.31	0.21	0.22	0.25	0.13	0.17	0.23	0.22
46.Change in economic conditions	0.28	0.17	0.22	0.25	0.10	0.13	0.21	0.20
47.Socio-cultural factors	0.19	0.24	0.45	0.10	0.20	0.12	0.29	0.21
48.Unforeseen problems	0.40	0.23	0.47	0.09	0.60	0.17	0.47	0.19

The results in Table 4.7 are depicted graphically on Figure 4.8. It is apparent that overall rank cause no.1 “change of plans and scope by owner” as the prime cause of change orders in ERA asphalt concrete projects constructed by foreign contractors.

It is worth noting that the data from 17 ERA contract administration professionals, 15 consultant professionals and 10 contractors‟ professionals is widely dispersed and reflects differing opinions about the importance of each cause. This wide dispersion is clearly reflected by the high standard deviation values calculated in Table 4.7 above. From Table 4.4 above we can observe prevalence index given to many causes are less than 0.5, which

indicates a frequency of less than „sometimes" or actually happens only rarely or never at all. As evident from Table 4.7 above and Figure 4.8 below, 100% causes scored below 0.75 prevalence index, which indicates a frequency of less than often, sometimes or actually happens only rarely or never at all. 12.5% of causes have prevalence indexes between 0.5 and 0.75, this interval indicate often occurrence of causes. The majority of causes have prevalence indexes between 0.25 and 0.5. It accounts 43.75% of 48 causes of change order and fall in the category of 25-49. The first six important causes scored in the second category.

Figure 4.8 below is a histogram of the overall importance index of causes of change orders as summarized in Table 4.7.

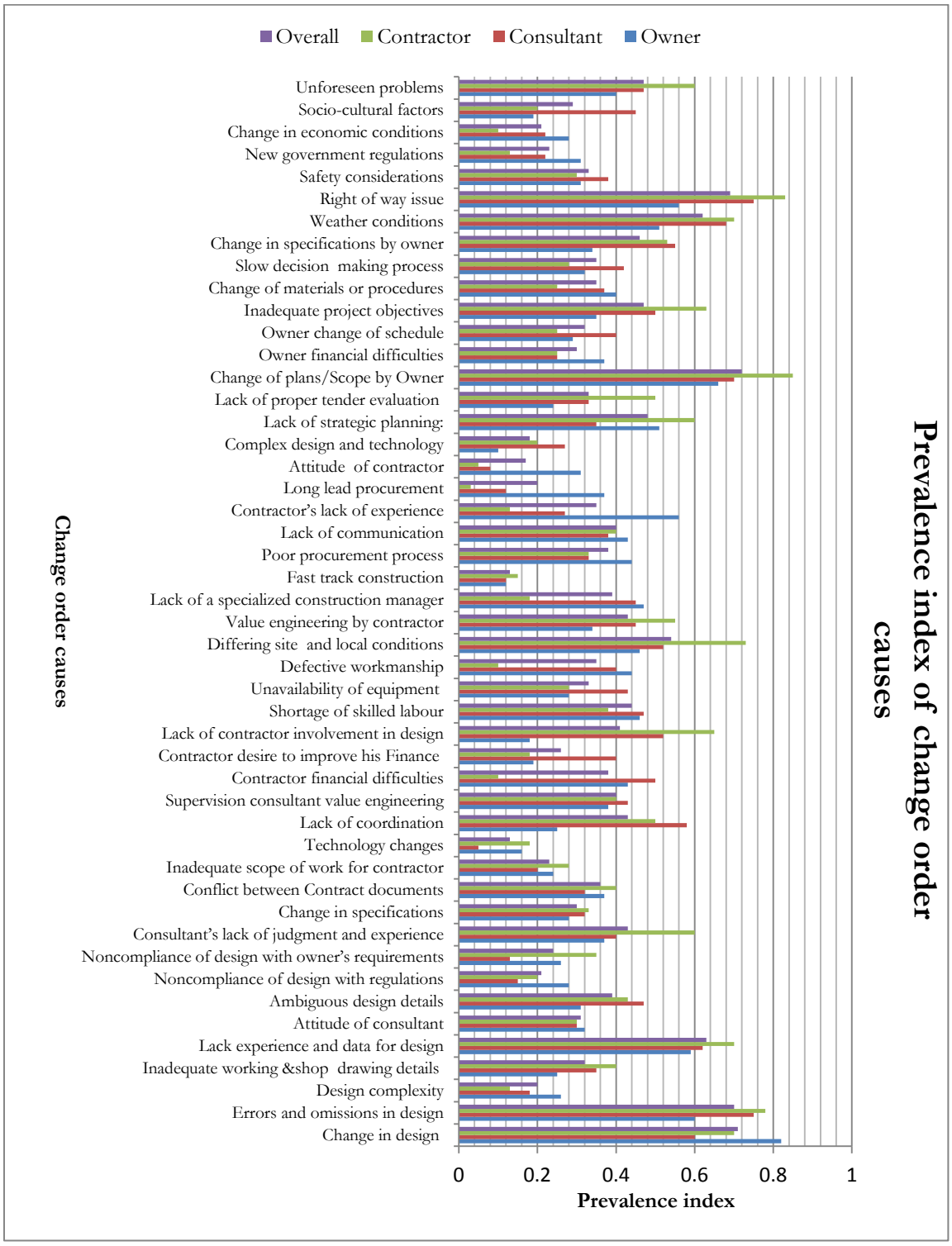

Figure 4.8: Prevalence index of change order causes

The ranking of the different causes or sources of change orders prevalence based on importance indexes is presented in Table 4.8 below for contractors, consultants, client as well as the overall ranking.

Table 4.8: Ranking of causes of change order prevalence

Source or Cause of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Change in design	6	5	1	2
2. Errors and omissions in design	1	3	3	3
3. Design complexity	42	41	37	43
4. Inadequate working &shop drawing details for contractor	29	18	39	31
5. Lack experience and data for design	5	5	4	5
6. Attitude of consultant	35	26	26	33
7. Ambiguous design details	13	17	28	19
8. Noncompliance of design with government regulations	43	34	33	41
9. Noncompliance of design with owner‟s requirements	44	23	37	38
10. Consultant‟s lack of judgment and experience	22	10	19	13
11. Change in specifications	33	24	33	34
12. Conflict between contract documents	33	18	19	23
13. Inadequate scope of work for contractor	41	28	41	39
14. Technology changes	48	37	46	47
15. Lack of coordination	7	15	39	14
16. Supervision consultant value engineering	19	18	18	17
17. Contractor financial difficulties	11	44	14	21
18. Contractor desire to improve his finance	22	37	43	37
19. Lack of contractor involvement in design	9	8	45	16

Source or Cause of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
20. Shortage of skilled labour (experienced)	13	22	10	12
21. Unavailability of equipment	19	28	33	28
22. Defective workmanship	22	44	12	26
23. Differing site and local conditions	9	4	10	7
24. Value engineering by contractor	16	13	24	14
25. Lack of a specialized construction manager	16	37	9	19
26. Fast track construction	45	40	47	47
27. Poor procurement process	31	24	12	21
28. Lack of communication	26	18	14	17
29. Contractor‟s lack of experience	36	41	5	24
30. Long lead procurement	45	48	19	44
31. Attitude of contractor	47	47	28	46
32. Complex design and technology	36	34	48	45
33. Lack of strategic planning:	29	10	7	8
34. Lack of proper tender evaluation	31	15	41	28
35. Change of plans/Scope by owner	3	1	2	1
36. Owner financial difficulties	38	31	19	35
37. Owner change of schedule	22	31	32	31
38. Inadequate project objectives	11	9	23	9
39. Change of materials or procedures	28	31	16	24
40. Slow decision making process	21	28	26	26
41. Change in specifications by owner	8	14	24	11
42. Weather conditions	4	5	7	6
43. Right of way issue	1	2	5	4
44. Safety considerations	26	26	28	28
45. New government regulations	39	41	28	39
46. Change in economic conditions	39	44	33	41
47. Socio-cultural factors	16	34	43	36
48. Unforeseen problems	13	10	16	9

Study list the five most common causes of change order from the overall point of view. The overall ranking of the top five causes of change are as follows:

1. Change of plans by owner.
2. Change in design.
3. Errors and omissions in design.
4. Right of way issue
5. Lack of data for design and experience in predicting underground condition.

Table 4.9 below lists the result of the survey response from clients, consultants and contractor‟s firms in the field of asphalt concrete construction projects. The analysis will be carried out on data from consultants, contractors and client. Finally, overall data will be analyzed calculating on the causes of change orders cost effect implication index.

Table 4.9: Importance of cost effect (implication index) of causes in clients, consultants and contractor‟s view.

Source or Cause of change order	Owner		Consultant		Contractor		Overall	
	II	SD	II	SD	II	SD	II	SD
1. Change in design	0.76	0.21	0.67	0.15	0.78	0.22	0.73	0.19
2. Errors and omissions in design	0.59	0.32	0.62	0.13	0.65	0.17	0.61	0.23
3. Design complexity	0.34	0.32	0.60	0.34	0.50	0.42	0.47	0.36
4. Inadequate working &shop drawing details for contractor	0.35	0.29	0.42	0.12	0.43	0.24	0.39	0.23
5. Lack experience and data for design	0.54	0.30	0.63	0.13	0.60	0.13	0.59	0.21
6. Attitude of consultant	0.25	0.27	0.58	0.12	0.38	0.21	0.40	0.25
7. Ambiguous design details	0.40	0.25	0.58	0.24	0.48	0.17	0.48	0.24
8. Noncompliance of design with government regulations	0.38	0.33	0.33	0.28	0.23	0.22	0.33	0.29
9. Noncompliance of design with owner‟s requirements	0.49	0.39	0.37	0.30	0.25	0.31	0.39	0.35
10. Consultant‟s lack of judgment and experience	0.57	0.26	0.50	0.31	0.50	0.24	0.53	0.27

Source or Cause of change order	Owner		Consultant		Contractor		Overall	
	II	SD	II	SD	II	SD	II	SD
11. Change in specifications	0.31	0.30	0.42	0.23	0.35	0.24	0.36	0.26
12. Conflict between Contract documents	0.59	0.28	0.50	0.00	0.50	0.18	0.54	0.20
13. Inadequate scope of work for contractor	0.44	0.26	0.48	0.27	0.35	0.27	0.43	0.27
14. Technology changes	0.26	0.26	0.40	0.30	0.23	0.22	0.30	0.27
15. Lack of coordination	0.41	0.32	0.50	0.00	0.40	0.24	0.44	0.23
16. Supervision consultant value engineering	0.54	0.18	0.17	0.24	0.38	0.27	0.37	0.28
17. Contractor financial difficulties	0.53	0.36	0.50	0.00	0.35	0.21	0.48	0.26
18. Contractor desire to improve his finance	0.37	0.28	0.25	0.00	0.18	0.12	0.28	0.20
19. Lack of contractor involvement in design	0.18	0.19	0.25	0.00	0.18	0.12	0.20	0.14
20. Shortage of skilled labour (experienced)	0.44	0.27	0.55	0.19	0.45	0.28	0.48	0.25
21. Unavailability of equipment	0.43	0.30	0.37	0.23	0.43	0.24	0.40	0.26
22. Defective workmanship	0.43	0.40	0.37	0.23	0.23	0.25	0.36	0.32
23. Differing site and local conditions	0.43	0.28	0.42	0.12	0.33	0.17	0.40	0.21
24. Value engineering by contractor	0.07	0.12	0.25	0.00	0.08	0.00	0.14	0.12
25. Lack of a specialized construction manager	0.60	0.28	0.50	0.00	0.45	0.11	0.53	0.19
26. Fast track construction	0.19	0.21	0.15	0.13	0.15	0.17	0.17	0.17
27. Poor procurement process	0.51	0.36	0.40	0.21	0.45	0.16	0.46	0.27
28. Lack of communication	0.25	0.15	0.25	0.00	0.23	0.14	0.24	0.12
29. Contractor‟s lack of experience	0.54	0.30	0.25	0.00	0.30	0.11	0.38	0.24
30. Long lead procurement	0.26	0.34	0.18	0.00	0.23	0.20	0.23	0.23
31. Attitude of contractor	0.22	0.30	0.18	0.11	0.23	0.14	0.21	0.21
32. Complex design and technology	0.32	0.29	0.25	0.00	0.23	0.22	0.27	0.21
33. Lack of strategic planning:	0.63	0.29	0.25	0.00	0.43	0.24	0.45	0.27
34. Lack of proper tender evaluation	0.57	0.35	0.25	0.00	0.23	0.08	0.38	0.28
35. Change of plans/Scope by owner	0.68	0.26	0.73	0.22	0.85	0.24	0.74	0.25
36. Owner financial difficulties	0.43	0.26	0.25	0.00	0.30	0.20	0.33	0.20
37. Owner change of schedule	0.57	0.33	0.25	0.00	0.35	0.29	0.40	0.29
38. Inadequate project objectives	0.57	0.35	0.25	0.00	0.43	0.31	0.42	0.30

Source or Cause of change order	Owner		Consultant		Contractor		Overall	
	II	SD	II	SD	II	SD	II	SD
39. Change of materials or procedures	0.34	0.23	0.40	0.21	0.33	0.24	0.36	0.22
40. Slow decision making process	0.32	0.21	0.40	0.21	0.40	0.21	0.37	0.21
41. Change in specifications by owner	0.54	0.32	0.25	0.00	0.43	0.31	0.41	0.28
42. Weather conditions	0.57	0.19	0.50	0.00	0.50	0.12	0.53	0.14
43. Right of way issue	0.60	0.29	0.72	0.09	0.68	0.17	0.66	0.21
44. Safety considerations	0.40	0.32	0.15	0.13	0.25	0.20	0.27	0.26
45. New government regulations	0.26	0.27	0.30	0.25	0.28	0.18	0.28	0.24
46. Change in economic conditions	0.29	0.28	0.40	0.21	0.25	0.18	0.32	0.24
47. Socio-cultural factors	0.35	0.35	0.50	0.00	0.38	0.18	0.41	0.25
48. Unforeseen problems	0.46	0.33	0.50	0.00	0.40	0.17	0.46	0.23

Study carry out the same exercise did for prevalence of causes, the results in Table 4.9 are depicted graphically on Figure 4.9. It is apparent that overall rank cost effect implication index of causes no.1 “change of plans and scope by owner” as the prime cause of change orders in ERA asphalt concrete construction project constructed by foreign contractors.

In Table 4.9 above the significance index given to many cause are less than 50%, which indicates a significance of less than „average“ or actually minor or no significance at all. As evident from Table 4.9 and Figure 4.9, no causes scored higher than 0.75, which indicate no evident cause which is extremely significant in terms of cost effect. 16.67% of causes have importance indexes between 0.5 and 0.75, this range indicates higher significance of causes. Majority of causes have importance indexes between 0.25 and 0.5 that accounts 70.83% of 48 causes of change orders are in this interval and it has minor cost effects. The first eight important causes scored in the second category.

Figure 4.9 below is a histogram of the overall cost effect implication index of causes of change orders as summarized in Table 4.9.

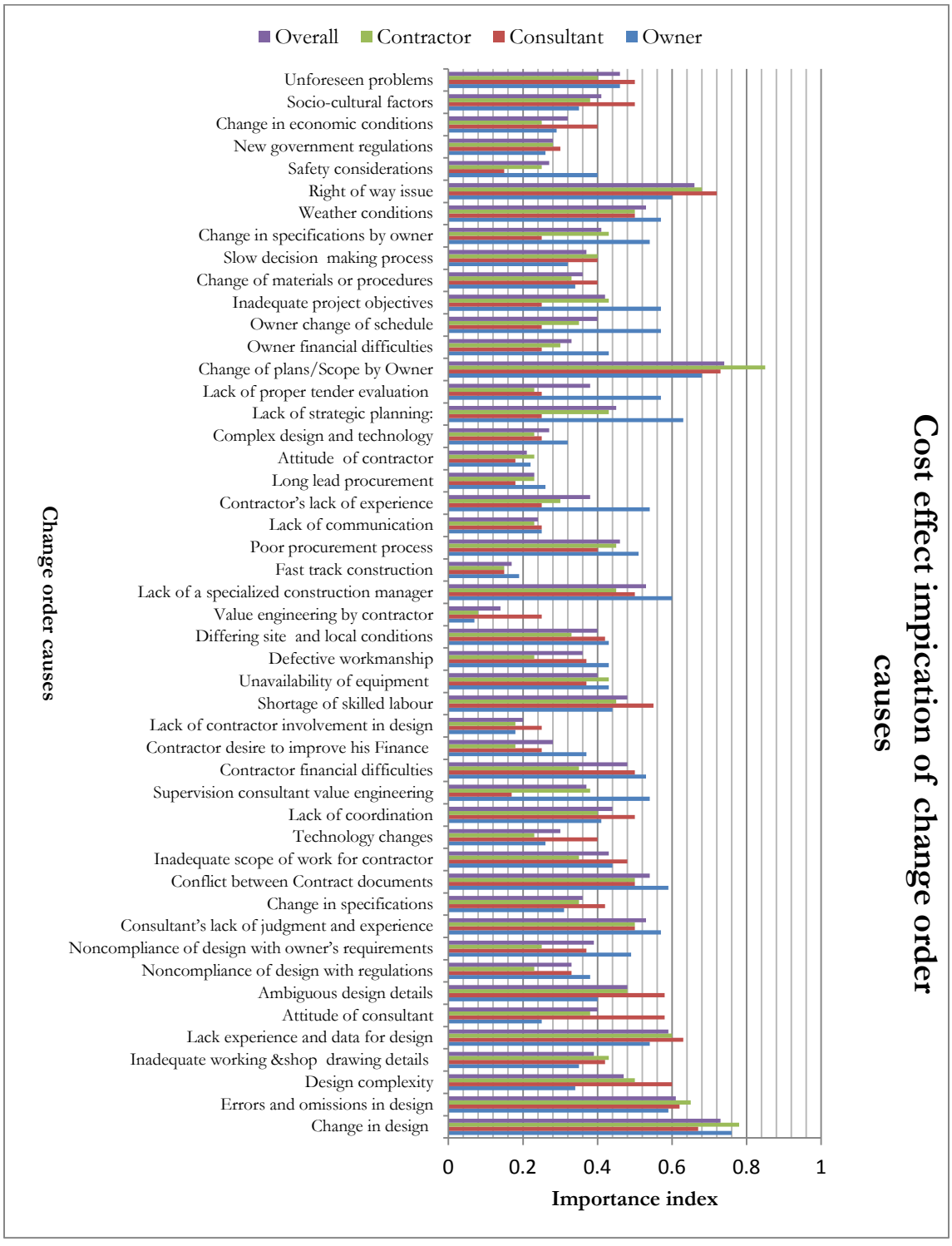

Figure 4.9: Cost effect implication index of causes.

The ranking of the different causes or sources of change order based on importance indexes of cost effect is presented in Table 4.10 below for contractors, consultants, client as well as the overall ranking.

Table 4.10: Ranking of causes of change order interims of cost effects

Source or Cause of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Change in design	3	2	1	2
2. Errors and omissions in design	5	4	6	4
3. Design complexity	6	6	34	13
4. Inadequate working &shop drawing details for contractor	19	14	32	26
5. Lack experience and data for design	4	5	13	5
6. Attitude of consultant	7	22	43	24
7. Ambiguous design details	7	10	28	10
8. Noncompliance of design with government regulations	30	37	30	36
9. Noncompliance of design with owner‟s requirements	27	34	19	27
10. Consultant‟s lack of judgment and experience	10	6	8	7
11. Change in specifications	19	25	38	32
12. Conflict between contract documents	10	6	6	6
13. Inadequate scope of work for contractor	18	25	21	18
14. Technology changes	22	37	40	38
15. Lack of coordination	10	19	27	17
16. Supervision consultant value engineering	46	22	13	30
17. Contractor financial difficulties	10	25	17	12
18. Contractor desire to improve his finance	32	45	31	39
19. Lack of contractor involvement in design	32	45	47	46
20. Shortage of skilled labour	9	11	21	10

Source or Cause of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
21. Unavailability of equipment	27	14	23	22
22. Defective workmanship	27	37	23	32
23. Differing site and local conditions	19	29	23	24
24. Value engineering by contractor	32	48	48	48
25. Lack of a specialized construction manager	10	11	4	7
26. Fast track construction	47	47	46	47
27. Poor procurement process	22	11	18	14
28. Lack of communication	32	37	43	43
29. Contractor"s lack of experience	32	31	13	28
30. Long lead procurement	44	37	40	44
31. Attitude of contractor	44	37	45	45
32. Complex design and technology	32	37	36	41
33. Lack of strategic planning:	32	14	3	16
34. Lack of proper tender evaluation	32	37	8	29
35. Change of plans/Scope by Owner	1	1	2	1
36. Owner financial difficulties	32	31	23	35
37. Owner change of schedule	32	25	8	22
38. Inadequate project objectives	32	14	8	19
39. Change of materials or procedures	22	29	34	32
40. Slow decision making process	22	19	36	30
41. Change in specifications by owner	32	14	13	20
42. Weather conditions	10	6	8	7
43. Right of way issue	2	3	4	3
44. Safety considerations	47	34	28	41
45. New government regulations	31	33	40	39
46. Change in economic conditions	22	34	39	37
47. Socio-cultural factors	10	22	32	20
48. Unforeseen problems	10	19	20	14

Study list the five most common causes of change order from the overall point of view in Table 4.10 above. It has the following list start with the most important causes interims cost effect are:- change of plans or scope by owner, change in design, right of way issue, errors and omissions in design and lack of data for design and experience in predicting underground condition.

It might be noted that all causes are originated by the owner, designer/consultant, contractor and others. This is expected since each party is trying to blame the other for causing changes in construction. The study want to compare the strength or the importance of each category, the study by finding the mean value of the causes that compose this category. The results of this calculation are tabulated in table 4.11 below.

Table 4.11: Originators‟ of change orders causes from overall point of view

Source or cause of change order	Overall originator index				
	Design consultant	Supervision consultant	Client	Contractors	Others
1. Change in design	0.76	0.24	0.00	0.00	0.00
2. Errors and omissions in design	1.00	0.00	0.00	0.00	0.00
3. Design complexity	0.56	0.27	0.17	0.00	0.00
4. Inadequate working &shop drawing details for contractor	0.64	0.32	0.04	0.00	0.00
5. Lack experience and data for design	0.91	0.09	0.00	0.00	0.00
6. Attitude of consultant	0.47	0.53	0.00	0.00	0.00
7. Ambiguous design details	0.93	0.02	0.05	0.00	0.00
8. Noncompliance of design with government regulations	0.56	0.06	0.36	0.00	0.02
9. Noncompliance of design with owner‟s requirements	0.76	0.04	0.20	0.00	0.00
10. Consultant‟s lack of judgment and experience	0.56	0.24	0.20	0.00	0.00
11. Change in specifications	0.54	0.25	0.21	0.00	0.00
12. Conflict between contract documents	0.52	0.27	0.21	0.00	0.00
13. Inadequate scope of work for contractor	0.40	0.38	0.22	0.00	0.00
14. Technology changes	0.41	0.09	0.05	0.44	0.01
15. Lack of coordination	0.14	0.42	0.07	0.36	0.00

Source or cause of change order	Overall originator index				
	Design consultant	Supervision consultant	Client	Contractors	Others
16. Supervision consultant value engineering	0.02	0.62	0.37	0.00	0.00
17. Contractor financial difficulties	0.02	0.02	0.05	0.90	0.00
18. Contractor desire to improve his finance	0.02	0.02	0.05	0.90	0.00
19. Lack of contractor involvement in design	0.00	0.02	0.07	0.88	0.02
20. Shortage of skilled labour (experienced)	0.30	0.30	0.04	0.35	0.00
21. Unavailability of equipment	0.00	0.07	0.02	0.88	0.02
22. Defective workmanship	0.09	0.39	0.04	0.48	0.00
23. Differing site and local conditions	0.42	0.09	0.26	0.22	0.01
24. Value engineering by contractor	0.02	0.07	0.00	0.90	0.00
25. Lack of a specialized construction manager	0.01	0.12	0.38	0.49	0.00
26. Fast track construction	0.02	0.06	0.11	0.79	0.02
27. Poor procurement process	0.02	0.05	0.07	0.86	0.00
28. Lack of communication	0.08	0.40	0.15	0.36	0.00
29. Contractor‟s lack of experience	0.02	0.05	0.00	0.93	0.00
30. Long lead procurement	0.27	0.02	0.06	0.65	0.00
31. Attitude of contractor	0.22	0.06	0.00	0.71	0.00
32. Complex design and technology	0.81	0.02	0.00	0.15	0.02
33. Lack of strategic planning:	0.24	0.35	0.25	0.16	0.00
34. Lack of proper tender evaluation	0.11	0.02	0.82	0.00	0.05
35. Change of plans/Scope by Owner	0.16	0.00	0.81	0.00	0.02
36. Owner financial difficulties	0.05	0.02	0.91	0.00	0.02
37. Owner change of schedule	0.00	0.00	0.95	0.02	0.02
38. Inadequate project objectives	0.00	0.00	0.98	0.00	0.02
39. Change of materials or procedures	0.01	0.48	0.43	0.06	0.03
40. Slow decision making process	0.01	0.48	0.49	0.01	0.01
41. Change in specifications by owner	0.00	0.00	0.93	0.02	0.05

Source or cause of change order	Overall originator index				
	Design consultant	Supervision consultant	Client	Contractors	Others
42. Weather conditions	0.00	0.00	0.00	0.08	0.92
43. Right of way issue	0.14	0.09	0.20	0.27	0.29
44. Safety considerations	0.19	0.17	0.00	0.17	0.47
45. New government regulations	0.00	0.00	0.00	0.00	1.00
46. Change in economic conditions	0.00	0.00	0.00	0.00	1.00
47. Socio-cultural factors	0.00	0.00	0.00	0.00	1.00
48. Unforeseen problems	0.00	0.00	0.00	0.00	1.00

The analysis of the response of the questionnaire found that rank of predominant origin agent are design consultant as 1st rank, client as 2nd rank, supervision consultant and contractor as 3rd rank, and others conditions as 5th rank generally in ERA asphalt concrete construction project from respondent point of view.

Most prevailing five change order causes are:- change of plans or scope by owner caused by owner of project, change in design caused by consultant 76% by design consultant and 24% by supervision consultant, error and omission in design caused by design consultant, right of way issue as caused by all originators and lack of data for design and experience in predicting underground condition caused by design consultant.

4.3.3. Effects of change orders

A section of the questionnaire listed 16 effects of changes orders for ERA asphalt concrete projects in Ethiopia. Each respondent was asked to rate each issue based on his/her professional judgment. The list of effects of change orders were analyzed and ranked according to their responses. The data is still widely dispersed reflecting the wide variation of opinion from different owner representatives, consultants and contractors.

The 16 effects of variation orders were tabulated according to their means and standard deviations as shown in Table 4.12 below, which summarizes overall survey responses of clients, consultants and contractors participant on prevalence of change order effects in ERA asphalt concrete projects.

Table 4.12: Prevalence indexes of effect in clients, consultants and contractor‟s view

Impacts of change order	Owner		Consultant		Contractor		Overall	
	PI	SD	PI	SD	PI	SD	PI	SD
1. Increases in project cost	0.88	0.13	0.92	0.12	0.88	0.13	0.89	0.13
2. Increases in overhead expense	0.74	0.19	0.50	0.00	0.68	0.17	0.64	0.18
3. Additional payments for contractor	0.76	0.22	0.73	0.06	0.83	0.12	0.77	0.16
4. Poor professional relations and dispute	0.54	0.28	0.47	0.09	0.45	0.26	0.49	0.22
5. Hiring new professionals	0.50	0.28	0.73	0.13	0.48	0.32	0.58	0.27
6. Quality degradation	0.34	0.22	0.43	0.11	0.35	0.24	0.38	0.19
7. Productivity degradation	0.51	0.24	0.50	0.00	0.43	0.24	0.49	0.19
8. Completion schedule delay	0.84	0.22	0.83	0.12	0.85	0.31	0.84	0.21
9. Progress is affected but without any delay	0.57	0.26	0.33	0.12	0.53	0.30	0.48	0.25
10. Delays in payment	0.50	0.32	0.42	0.12	0.43	0.33	0.45	0.27
11. Procurement delay	0.56	0.31	0.33	0.18	0.48	0.32	0.46	0.29
12. Logistics delays	0.59	0.28	0.38	0.19	0.55	0.37	0.51	0.28
13. Rework and demolition	0.47	0.28	0.40	0.16	0.48	0.34	0.45	0.26
14. Poor safety conditions	0.51	0.27	0.55	0.34	0.48	0.34	0.52	0.31
15. Damage to firm‟s reputation	0.47	0.20	0.52	0.06	0.65	0.21	0.53	0.17
16. Work on hold	0.51	0.29	0.43	0.11	0.50	0.31	0.48	0.24

As evident from Table 4.12 and Figure 4.11, 18.75% prevalence of effects scored higher than 0.75 index. 31.25% of effect have importance indexes between 0.5 and 0.75. The majority of effects have importance indexes from 0.25 to 0.5 and it accounts 50% of 16 effects of change order. The first three important effects scored in the first category. Figure 4.10 below is a histogram of the overall prevalence index of effects of change orders as summarized in Table 4.12.

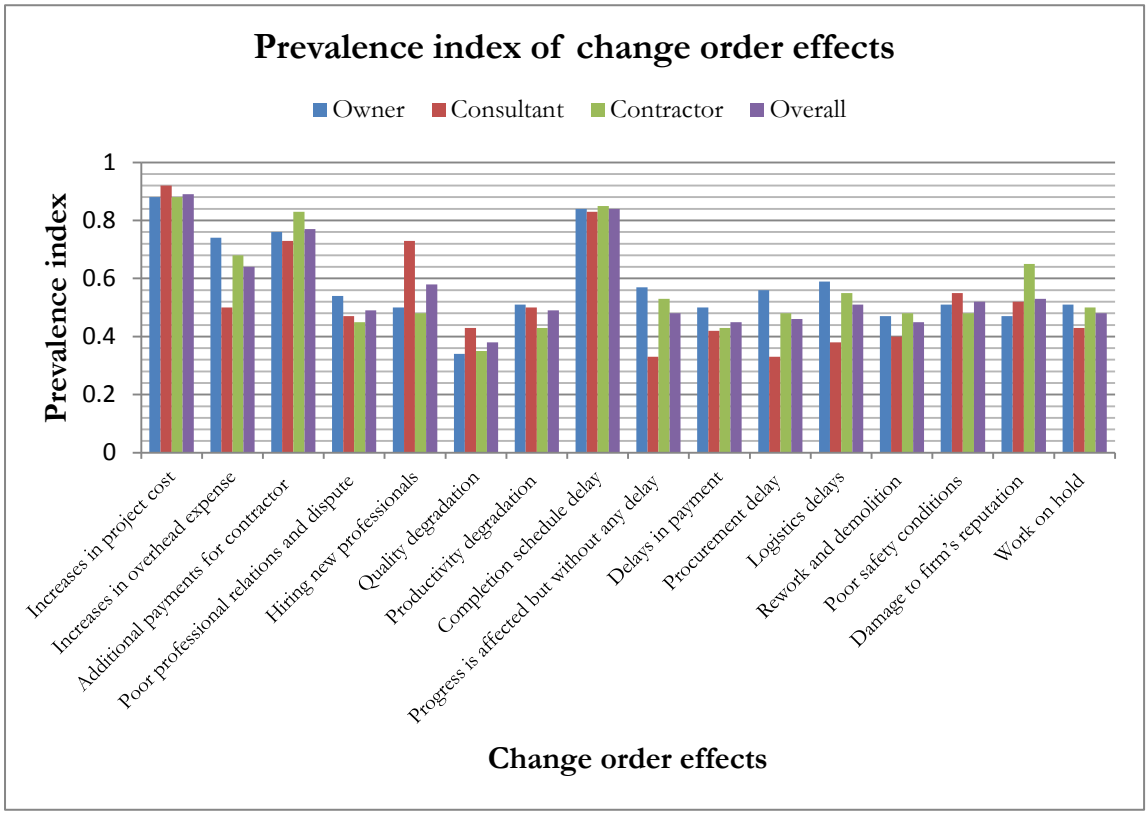

Figure 4.10: prevalence index of effects

The ranking of the different effects of change orders based on prevalence indexes is presented in Table 4.13 below for contractors, consultants, client as well as the overall ranking.

Table 4.13: prevalence rank of effects in clients, consultants and contractor‟s view

Impacts of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Increases in project cost	1	1	1	1
2. Increases in overhead expense	7	4	4	4
3. Additional payments for contractor	3	3	3	3
4. Poor professional relations and dispute	9	13	8	9
5. Hiring new professionals	3	9	12	5
6. Quality degradation	10	16	16	16
7. Productivity degradation	7	14	9	10
8. Completion schedule delay	2	2	2	2
9. Progress is affected but without any delay	15	7	6	12
10. Delays in payment	12	14	12	14
11. Procurement delay	15	9	7	13
12. Logistics delays	14	6	5	8
13. Rework and demolition	13	9	14	15
14. Poor safety conditions	5	9	9	7
15. Damage to firm‟s reputation	6	5	14	6
16. Work on hold	10	8	9	11

It is apparent that overall rank of prevalent effects no.1 “Increases in project cost” as the prime effect of change orders in ERA asphalt concrete project constructed by foreign contractors.

Study list the five prevalent effects of change orders from the overall point of view. The overall ranking of the top five effects of changes are as follows:

1. Increases in project cost.
2. Completion schedule delay.
3. Additional payments for contractor.
4. Increases in overhead expense.
5. Hiring new professionals.

Table 4.14 below summarizes the overall results of the survey of responses of client, contractors and consultants on effects of change orders in ERA asphalt concrete projects. Importance indexes of effects in clients, consultants and contractor‟s view widely dispersed and reflects differing opinions about the importance of each effect. This wide dispersion is clearly reflected by the standard deviation values calculated in table 4.14 below.

Table 4.14: Importance indexes of effects in clients, consultants and contractor‟s view

Impacts of change order	Owner		consultant		contractor		Overall	
	II	SD	II	SD	II	SD	II	SD
1. Increases in project cost	0.76	0.19	0.77	0.06	0.83	0.17	0.78	0.15
2. Increases in overhead expense	0.56	0.31	0.50	0.00	0.58	0.37	0.54	0.26
3. Additional payments for contractor	0.63	0.20	0.75	0.00	0.75	0.17	0.70	0.16
4. Poor professional relations and dispute	0.38	0.18	0.50	0.00	0.43	0.21	0.43	0.16
5. Hiring new professionals	0.34	0.22	0.58	0.12	0.40	0.21	0.44	0.21
6. Quality degradation	0.40	0.28	0.58	0.12	0.45	0.26	0.48	0.24
7. Productivity degradation	0.51	0.30	0.58	0.12	0.50	0.26	0.54	0.24
8. Completion schedule delay	0.81	0.17	0.72	0.21	0.78	0.18	0.77	0.19
9. Progress is affected but without any delay	0.50	0.25	0.58	0.12	0.50	0.22	0.53	0.20
10. Delays in payment	0.38	0.18	0.50	0.00	0.43	0.21	0.43	0.16
11. Procurement delay	0.49	0.24	0.33	0.12	0.50	0.31	0.43	0.23
12. Logistics delays	0.41	0.25	0.25	0.00	0.45	0.28	0.36	0.22
13. Rework and demolition	0.41	0.28	0.23	0.06	0.40	0.32	0.35	0.25
14. Poor safety conditions	0.40	0.31	0.25	0.00	0.40	0.29	0.35	0.25
15. Damage to firm‟s reputation	0.46	0.33	0.25	0.00	0.45	0.33	0.38	0.28
16. Work on hold	0.44	0.30	0.25	0.00	0.45	0.33	0.38	0.26

As evident from Table 4.14 and Figure 4.11, 12.5% importance index of effects scored higher than 0.75 importance indexes , 25% of effect have importance indexes between 0.5 and 0.75. The majority of effects have importance indexes from 0.25 to 0.5 and it accounts 50% of total effects of change order. The first two important effects scored in the first

category. Figure 4.11 below is a histogram of the importance indexes of change order effects as summarized in Table 4.14

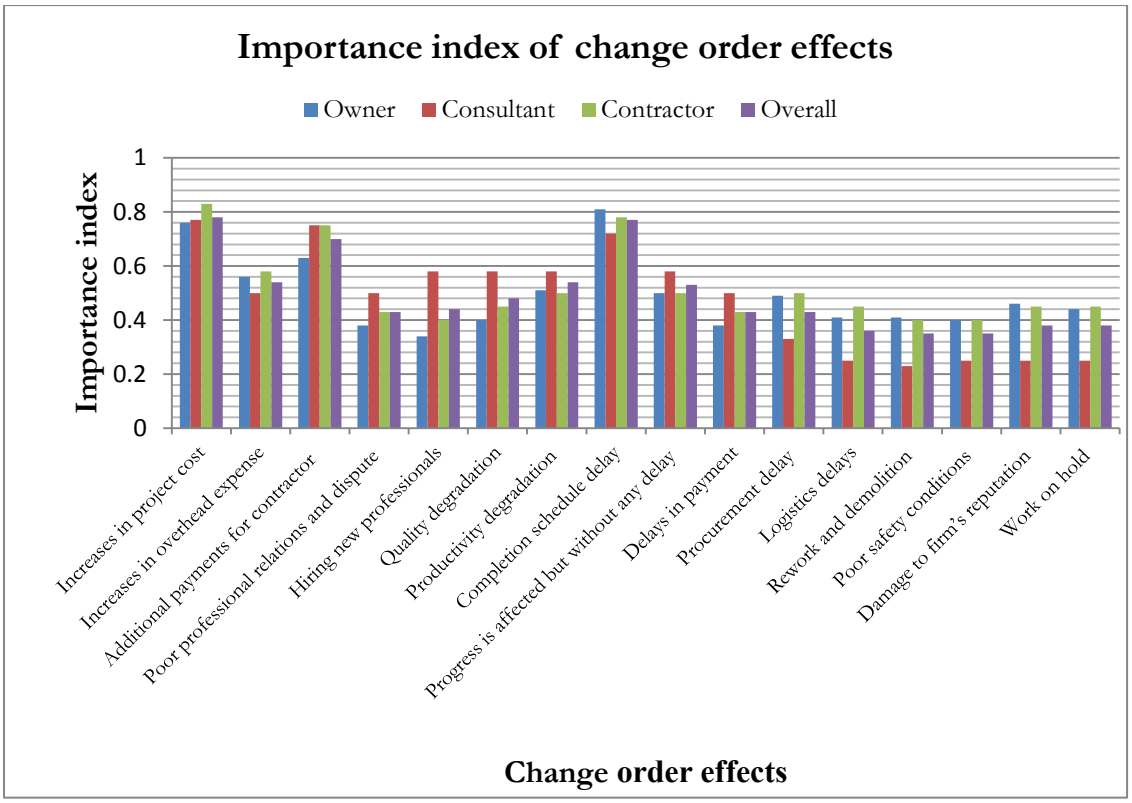

Figure 4.11: Importance indexes of effects

The ranking of the different effects of change orders based on importance indexes is presented in Table 4.15 below for contractors, consultants, client as well as the overall ranking.

Table 4.15: Importance rank of effects in clients, consultants and contractor‟s point of view

Impacts of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Increases in project cost	1	1	2	1
2. Increases in overhead expense	8	4	4	4
3. Additional payments for contractor	2	3	3	3
4. Poor professional relations and dispute	8	12	14	9
5. Hiring new professionals	4	14	16	8
6. Quality degradation	4	8	12	7
7. Productivity degradation	4	5	5	5
8. Completion schedule delay	3	2	1	2
9. Progress is affected but without any delay	4	5	6	6
10. Delays in payment	8	12	14	9
11. Procurement delay	11	5	7	9
12. Logistics delays	12	8	10	14
13. Rework and demolition	16	14	10	15
14. Poor safety conditions	12	14	12	15
15. Damage to firm‟s reputation	12	8	8	12
16. Work on hold	12	8	9	13

It is apparent that overall rank of important effects no.1 “Increases in project cost” as the prime effect of change orders in ERA asphalt concrete construction project constructed by foreign contractors. Study list the five important effects of change orders from the overall point of view. Most important impacts which affect project advisedly is shown Table 4.14 above, according the rank in Table 4.15, study find the following:

1. Increases in project cost.
2. Completion schedule delay.
3. Additional payments for contractor.
4. Increases in overhead expense.
5. Productivity degradation.

4.3.4. Controls of change orders

In this section we will examine the responses from Client, contractors, consultants, and the overall response on the controls of change order in ERA asphalt concrete road projects.

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals. Project changes are expected at all stages of a task‟s. Managing changes effectively is vital to the success of a construction project. The study analyzes responses of questioners in summarized form in Table 4.16 and 4.17 as follows.

Controls of change order will be ranked and categorized based on the utilization index(UI) and effectiveness index(EI) reported. The analysis will be carried out on data from consultants, contractors and client. Finally, overall data will be analyzed calculating utilization index in Table 4.16 and effectiveness indexes in Table 4.18 below. The utilization indexes indicate controlling mechanism that are under use in order to prevent or minimize change order and its adverse effects. Similarly effectiveness index identify effectiveness of change order controlling mechanisms in preventing change or minimizing their adverse effects. The respondents rated the 18 controls for change orders based on his/her professional judgment and these are tabulated according to their means and standard deviation(SD).

Table 4.16: Utilization index of change order controls in clients, consultants and contractor‟s point of view

Controls of change order	Owner		Consultant		Contractor		Overall	
	UI	SD	UI	SD	UI	SD	UI	SD
1. Review of contract documents	0.78	0.28	0.65	0.13	0.70	0.33	0.71	0.25
2. Freezing design	0.18	0.30	0.00	0.00	0.35	0.34	0.15	0.28
3. Value engineering at conceptual phase	0.47	0.29	0.72	0.23	0.50	0.31	0.57	0.29

Controls of change order	Owner		Consultant		Contractor		Overall	
	UI	SD	UI	SD	UI	SD	UI	SD
4. Owner‟s involvement at planning and design phase	0.65	0.34	0.62	0.19	0.55	0.35	0.61	0.29
5. contractor Involvement at planning and scheduling process	0.15	0.28	0.33	0.13	0.30	0.33	0.25	0.33
6. Clear and brief detailing of design	0.82	0.19	0.68	0.09	0.80	0.16	0.77	0.16
7. Reducing contingency sum	0.25	0.27	0.00	0.00	0.08	0.17	0.12	0.22
8. Clarity of change order procedures for decision and approval	0.66	0.29	0.80	0.17	0.78	0.18	0.74	0.23
9. Use of change order logic, scope and justifications	0.62	0.22	0.75	0.00	0.68	0.24	0.68	0.19
10. Avoid use of open tendering and use restricted pre-qualification system for awarding projects	0.50	0.29	0.30	0.14	0.45	0.35	0.42	0.27
11. during construction phase owner‟s involvement and complete documentation of change order	0.69	0.34	0.43	0.24	0.60	0.36	0.58	0.32
12. Use of project scheduling techniques	0.57	0.26	0.15	0.26	0.43	0.39	0.39	0.35
13. Ability to discuss change with decision and approval	0.69	0.19	0.57	0.24	0.55	0.26	0.61	0.23
14. Valuation of indirect effects of change	0.65	0.20	0.48	0.20	0.63	0.29	0.58	0.23
15. Utilize work breakdown structure	0.54	0.24	0.57	0.24	0.40	0.21	0.52	0.24
16. Control the potential for change orders to arise through contractual clauses:	0.78	0.15	0.68	0.15	0.78	0.28	0.74	0.19
17. Comprehensive site investigation	0.76	0.21	0.83	0.18	0.80	0.29	0.80	0.22
18. Knowledge-base of previous similar projects	0.79	0.22	0.83	0.15	0.78	0.33	0.80	0.23

Figure 4.12 below is a histogram of the overall utilization index of change order controls as summarized in Table 4.16.

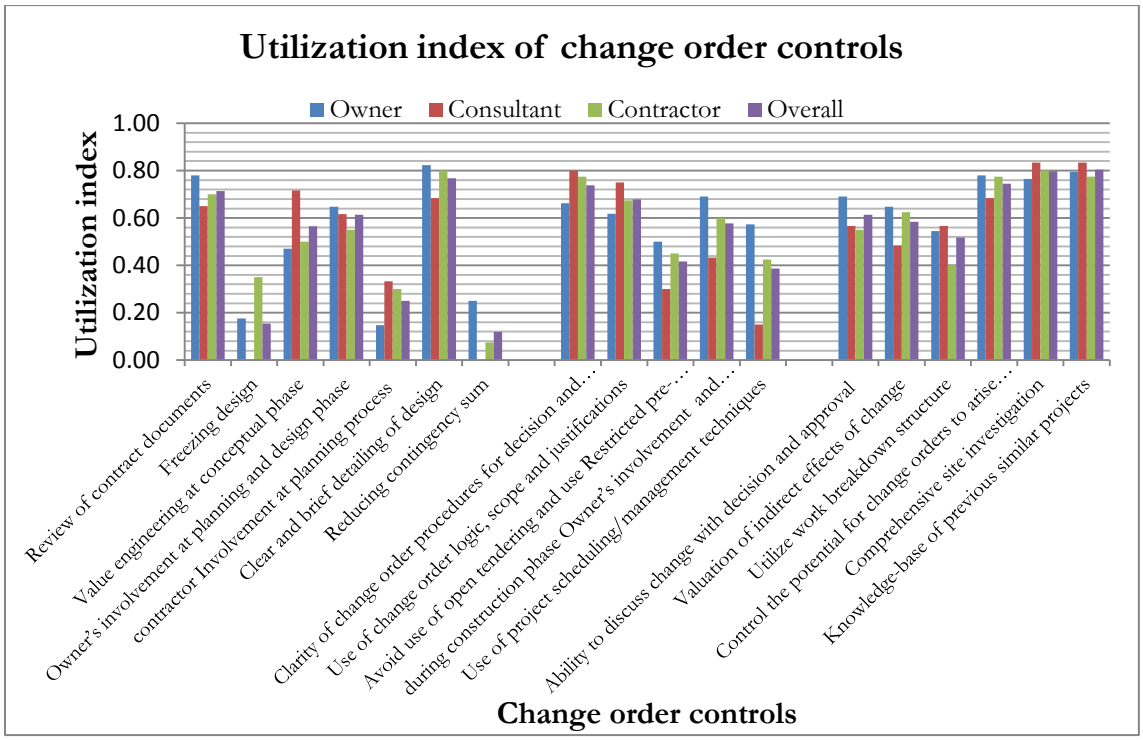

Figure 4.12: Utilization index of change order controls.

The results in Table 4.16 are depicted graphically on Figure 4.12 above. It is apparent that overall rank control no.1 "Knowledge-base of previous similar projects" as the prime control of change orders in ERA asphalt concrete construction project constructed by foreign contractors.

As evident from Table 4.16 and Figure 4.12, 11.1% utilized controls scored higher than 0.75 utilization index. 61.11% of controls have importance indexes between 0.5 and 0.75. 16.67% of utilized controls have importance indexes between 0.25 and 0.5. It accounts 11.1% of total utilized controls of change order is between 0 and 0.25 range. The first two important controls scored in the first category. The majority of the utilized controls fall in the category 50-74. Table 1.17 ranking of different control of change orders data based on

utilization indexes is presented in Table 4.16 above for contractors, consultants, client as well as the overall point of views.

Table 4.17: Rank utilization index of change order controls in clients, consultants and contractor‟s point of view.

Controls of change orders	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Review of contract documents	8	6	3	6
2. Freezing design	17	16	17	17
3. Value engineering at conceptual phase	5	12	15	12
4. Owner‟s involvement at planning and design phase	9	10	9	8
5. contractor Involvement at planning and scheduling process	14	17	18	16
6. Clear and brief detailing of design	6	1	1	3
7. Reducing contingency sum	17	18	16	18
8. Clarity of change order procedures for decision and approval	3	3	8	5
9. Use of change order logic, scope and justifications	4	7	11	7
10. Avoid use of open tendering and use restricted pre-qualification system for awarding projects	15	13	14	14
11. during construction phase owner‟s involvement and complete documentation of change order	13	9	6	11
12. Use of project scheduling/management techniques	16	14	12	15
13. Ability to discuss change with decision and approval	10	10	6	8
14. Valuation of indirect effects of change	12	8	9	10
15. Utilize work breakdown structure	10	15	13	13
16. Control the potential for change orders to arise through contractual clauses:	6	3	3	4
17. Comprehensive site investigation	1	1	5	2
18. Knowledge-base of previous similar projects	1	3	2	1

In Table 4.17 the study rank utilization index of change order controls in clients, consultants and contractor‟s point of view and list the five most utilized change order controls from the overall point of view, to safeguard against occurrence of change orders or to minimize their impacts if they occur are:

1. Knowledge-base of previous similar projects.
2. Comprehensive site investigation
3. Clear and brief detailing of design
4. Control the potential for change orders to arise through contractual clauses:
5. Clarity of change order procedures for decision and approval

Table 4.18: Effectiveness index of change order controls in clients, consultants and contractor‟s point of view

Controls of change order	Owner		Consultant		Contractor		Overall	
	EI	SD	EI	SD	EI	SD	EI	SD
1. Review of contract documents	0.60	0.32	0.72	0.23	0.58	0.37	0.64	0.30
2. Freezing design	0.41	0.37	0.12	0.13	0.30	0.39	0.28	0.33
3. Value engineering at conceptual phase	0.56	0.36	0.63	0.30	0.63	0.34	0.60	0.33
4. Owner‟s involvement at planning and design phase	0.44	0.31	0.70	0.24	0.58	0.31	0.57	0.30
5. contractor Involvement at planning and scheduling process	0.29	0.33	0.27	0.06	0.23	0.25	0.27	0.24
6. Clear and brief detailing of design	0.87	0.13	0.48	0.26	0.70	0.23	0.69	0.35
7. Reducing contingency sum	0.29	0.32	0.02	0.06	0.30	0.35	0.20	0.29
8. Clarity of change order procedures for decision and approval	0.56	0.30	0.33	0.24	0.43	0.29	0.45	0.29
9. Use of change order logic, scope and justifications	0.69	0.23	0.48	0.36	0.60	0.27	0.60	0.30
10. Avoid use of open tendering and use Restricted pre-qualification system for awarding projects	0.50	0.32	0.27	0.15	0.38	0.24	0.39	0.27
11. during construction phase owner‟s involvement and complete	0.68	0.34	0.40	0.13	0.55	0.31	0.55	0.29

Controls of change order	Owner		Consultant		Contractor		Overall	
	EI	SD	EI	SD	EI	SD	EI	SD
documentation of change order								
12. Use of project scheduling techniques	0.68	0.29	0.43	0.15	0.60	0.24	0.57	0.25
13. Ability to discuss change with decision and approval	0.60	0.25	0.78	0.19	0.65	0.27	0.68	0.24
14. Valuation of indirect effects of change	0.56	0.24	0.68	0.24	0.53	0.25	0.60	0.25
15. Utilize work breakdown structure	0.56	0.30	0.82	0.15	0.65	0.24	0.67	0.26
16. Control the potential for change orders to arise through contractual clauses:	0.78	0.17	0.58	0.24	0.78	0.22	0.71	0.23
17. Comprehensive site investigation	0.78	0.23	0.85	0.13	0.75	0.24	0.80	0.20
18. Knowledge-base of previous similar projects	0.81	0.19	0.65	0.26	0.85	0.17	0.76	0.23

As shown in Table 4.18, the results indicated that the design stage was considered as the most important time-line for implementing the most effective controls for variations. A majority of controls that were ranked as very effective were from the design stage and design and construction interface stage categories.

Figure 4.13 below is a histogram of the overall utilization effectiveness index of change order controls as summarized in Table 4.18.

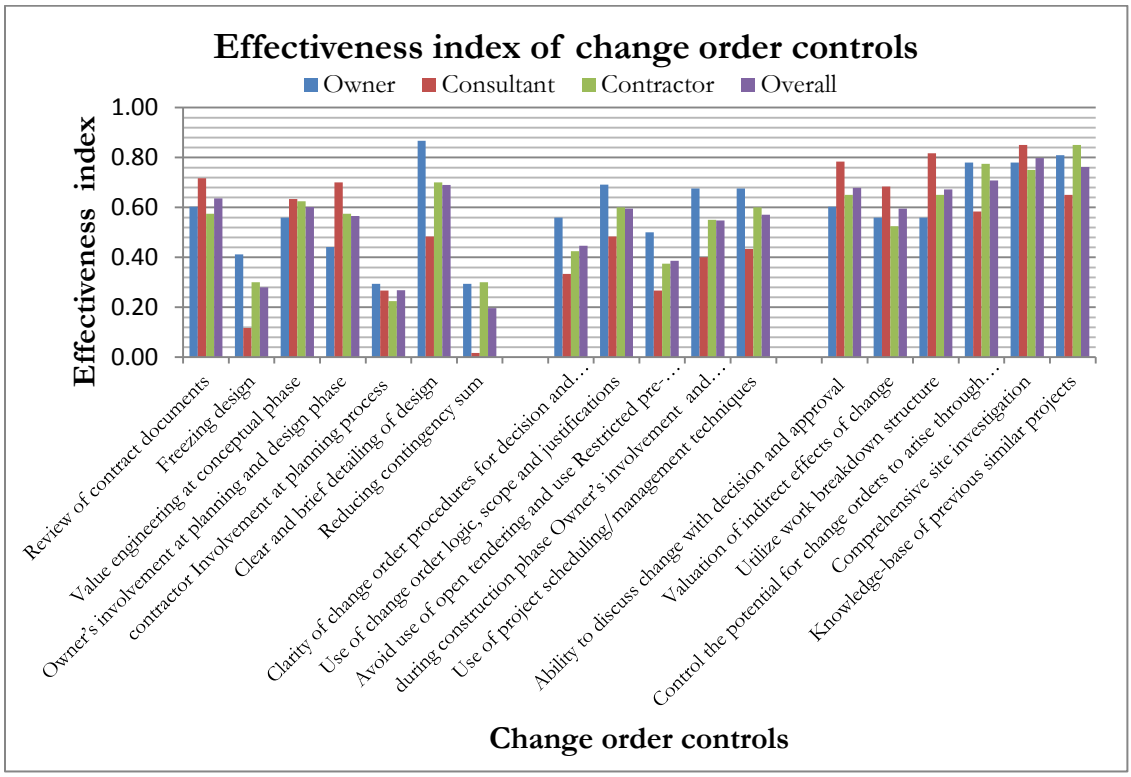

Figure 4.13: Effectiveness index of change order controls

The results in Table 4.18 are depicted graphically on Figure 4.13 above. It is apparent that overall effective control no.1 "Comprehensive site investigation" as the effective control of change orders in ERA asphalt concrete construction project constructed by foreign contractors.

As evident from Table 4.18 and Figure 4.13, 11.1% effective controls scored higher than 0.75 effectiveness index. 61.11% of controls have importance indexes between 0.5 and 0.75. 22.2% of utilized controls have importance indexes between 0.25 and 0.5. 5.5% of total utilized controls of change order is between 0 and 0.25 index range. The first two important causes scored in the first category. The majority of the utilized controls fall in the category 50-74.

Table 1.19 ranking of effective controlling mechanisms of change orders data based on effectiveness indexes is presented in Table 4.18 above for contractors, consultants, client as well as the overall point of views.

Table 4.19: Rank effectiveness of change order controls in clients, consultants and contractor‟s point of view

Controls of change order	Ranking by consultants	Ranking by contractors	Ranking by client	Overall ranking
1. Review of contract documents	4	10	8	7
2. Freezing design	17	16	16	16
3. Value engineering at conceptual phase	8	7	10	8
4. Owner‟s involvement at planning and design phase	5	10	15	12
5. contractor Involvement at planning and scheduling process	15	18	17	17
6. Clear and brief detailing of design	10	4	1	4
7. Reducing contingency sum	18	16	17	18
8. Clarity of change order procedures for decision and approval	14	14	10	14
9. Use of change order logic, scope and justifications	10	8	5	9
10. Avoid use of open tendering and use restricted pre-qualification system for awarding projects	15	15	14	15
11. during construction phase owner‟s involvement and complete documentation of change order	13	12	6	13
12. Use of project management techniques	12	8	6	11
13. Ability to discuss change with decision and approval	3	5	8	5
14. Valuation of indirect effects of change	6	13	10	9
15. Utilize work breakdown structure	2	5	10	6
16. Control the potential for change orders to arise through contractual clauses:	9	2	3	3
17. Comprehensive site investigation	1	3	3	1
18. Knowledge-base of previous similar projects	7	1	2	2

From Table 4.19 the five most effective controls to safeguard against occurrence of change orders or to minimize their impacts if they occur are:

1. Comprehensive site investigation.
2. Knowledge-base of previous similar projects.
3. Control the potential for change orders to arise through contractual clauses.
4. Clear and brief detailing of design.
5. Ability to discuss change with decision and approval.

Specific findings to change order causes that originated by foreign contractors

Study list specific findings to the foreign contractors on the causes of change orders from the overall response of client, consultants and contractors professionals.

Prevalence (frequency of occurrence) of change orders caused by foreign contractors identified in Table 4.8 above from the overall client, consultants and contractors point of view. It has the following list start with the most prevalent causes interims cost effect are:- differing site and local conditions, lack of strategic planning, value engineering by contractor, lack of contractor involvement in design and lack of communication.

Importance (cost implication) of change orders caused by foreign contractors identified in Table 4.10 above from the overall client, consultants and contractors point of view. It has the following list start with the most important causes interims cost effect are:- lack of a specialized construction manager, shortage of skilled labour, contractor financial difficulties, poor procurement process and lack of strategic planning.

4.3.5. Comments from respondents

The following comments are made by client, consultants and contractors on the questionnaire forms and are documented here for reference. The comments will give a further understanding of the nature and problems of the construction in ERA asphalt concrete road projects in Ethiopia. The comments are documented here as written below.

Clients

1. Accuracy of documents, drawings, specifications and bill of quantities (BOQ) is required to minimize changes.
2. Change orders occur due to improper studies of the site conditions and design packages.

Consultants

1. Coordination helps improve change order problems
2. Improvement of project management in ERA projects is required to solve the problems of change orders
3. Sometimes problems arise between the owner and consultant because owners do not appreciate that change orders are required sometimes to account for new site conditions or improvement during construction.
4. Try to influence the owner not to change too much during construction. Stick to the original scope of work.

Contractors

1. Changes happen because the owner does not have full understanding of the project and I think that it is the obligation of the consultant or the design engineer to explain clearly the design and its benefits to the owner to minimize changes.
2. Contractor shall not interfere between the owner and the consultant so that ideas of change orders takes time to develop and then the owner issue it to contractor through his consultant.
3. Change orders come from owner during construction or ambiguity in the contract.
4. Change orders should not be meant to increase project cost.
5. Client should consider the bad and negative effect of change orders and try to avoid as much as possible, by doing a good design job before calling for bidders to price.

4.3.6. The level agreement among owner, consultant and contractor

Test of Agreement

In this section, outline test for the degree of agreement or disagreement between the client, consultants and contractors on the causes, effects, and controls of change orders. To do this we will use the t-test for independent samples as used. The analysis here was done on the mean values for causes, effects, and controls.

Agreement in change order causes

I. The null hypothesis and the alternative hypothesis can be formulated as follows in prevalence of causes of change order:

H_0 : Client and consultants agree on the prevalence of causes of change orders.

H_A : Client and consultants disagree on the prevalence of causes of change orders.

The t value calculated is -5.05 (parameters: m=48, n =48, s1 =0.14, s2 =0.17). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and consultants do not agree on the prevalence of causes of change orders.

H0 : Client and contractors agree on the causes of change orders prevalence.
HA : Client and contractors disagree on the causes of change orders prevalence.

The t value calculated is -2.06 (parameters: m=48, n =48, s1 =0.14, s2 =0.23). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and contractors do not agree on the prevalence of causes of change orders.

H0 : Contractors and consultants agree on the causes of change orders prevalence.
HA : Contractors and consultants disagree on the causes of change orders prevalence.

The t value calculated is 1.22 (parameters: m=48, n =48, s1=0.17, s2 =0.23). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is not to reject the null hypothesis. Contractors and consultants do agree on the causes of change orders.

Outline for the degree of agreement or disagreement between the client, consultants and contractors in prevalence of causes of change orders are indicated in Figure 4.14. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned prevalence index of change order causes.

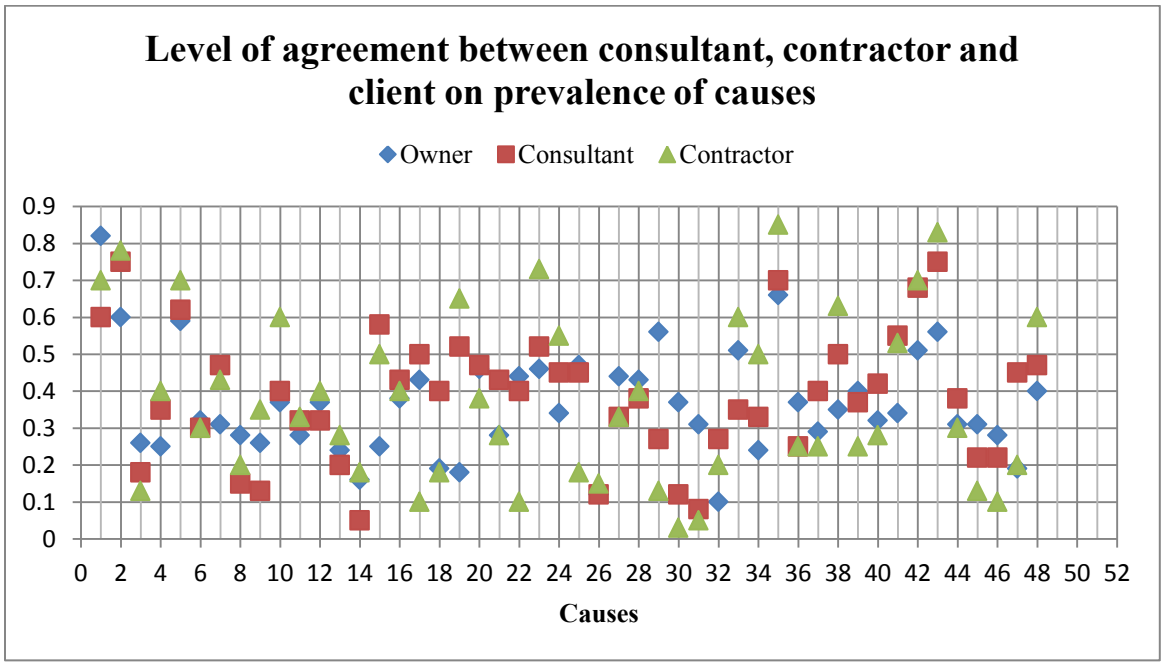

Figure 4.14: A scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned prevalence index of change order causes.

II. The null hypothesis and the alternative hypothesis can be formulated as follows in prevalence of causes of change order:

H_0 : Client and consultants agree on the importance of causes of change orders.

H_A : Client and consultants disagree on the importance of causes of change orders.

The t value calculated is 6.92 (parameters: m=48, n =48, s1 =0.15, s2 =0.16). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and consultants do agree on the importance of causes of change orders.

H0 : Client and contractors agree on the causes of change orders importance.
HA : Client and contractors disagree on the causes of change orders importance.

The t value calculated is 11.2 (parameters: m=48, n =48, s1 =0.15, s2 =0.16). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and client do not agree on the importance of causes of change orders.

H0 : Contractors and consultants agree on the causes of change orders importance.
HA : Contractors and consultants disagree on the causes of change orders importance.
The t value calculated is 4.07 (parameters: m=48, n =48, s1 =0.16, s2 =0.16). The critical value of t is 1.99 (df = 94, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and consultants do not agree on the importance of causes of change orders.

Outline for the degree of agreement or disagreement between the client, consultants and contractors on importance of change order causes are indicated in Figure 4.15. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned importance index of change order causes.

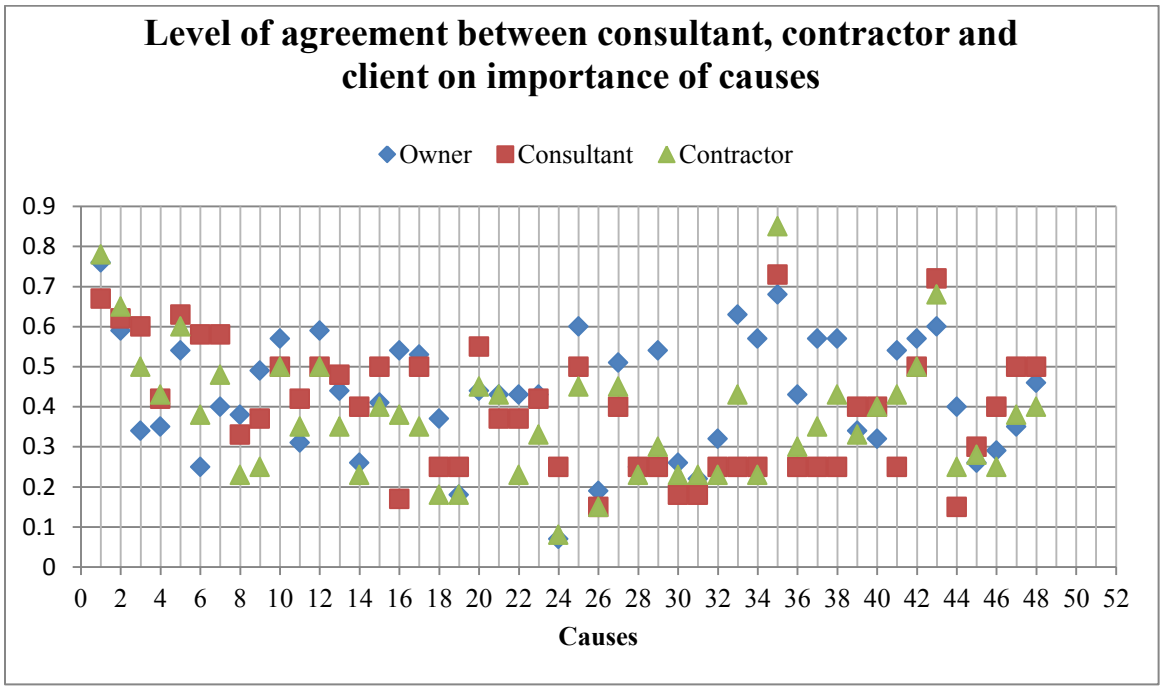

Figure 4.15: A scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned importance index of change order causes.

Agreement in change order impacts

I. Likewise for the prevalence of effects of change orders, the null hypothesis and the alternative hypothesis can be formulated as follows:

H0 : Client and consultants agree on the effects of change orders prevalence.
HA : Client and consultants disagree on the effects of change orders prevalence.

The t value calculated is 5.39 (parameters: m=16, n =16, s1 =0.15, s2 =0.18). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and consultants do not agree on the prevalence index of change order effects.

H0 : Client and contractors agree on the prevalence of effects of change orders.
HA : Client and contractors disagree on the prevalence of effects of change orders.

The t value calculated is 1.75 (parameters: m=16, n =16, s1 =0.15, s2 =0.16). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is not to reject the null hypothesis. Client and contractors do agree on the prevalence index of change order effects.

H_0 : Contractor and consultants agree on the prevalence of effects of change orders.
HA : Contractor and consultants disagree on the prevalence of effects of change orders.

The t value calculated is -3.49 (parameters: m=16, n =16, s1 =0.18, s2 =0.16). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and consultants do not agree on the prevalence index of change order effects.

Outline for the degree of agreement or disagreement between the client, consultants and contractors on prevalence of change order effects are indicated in Figure 4.16. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned prevalence index of change order effects.

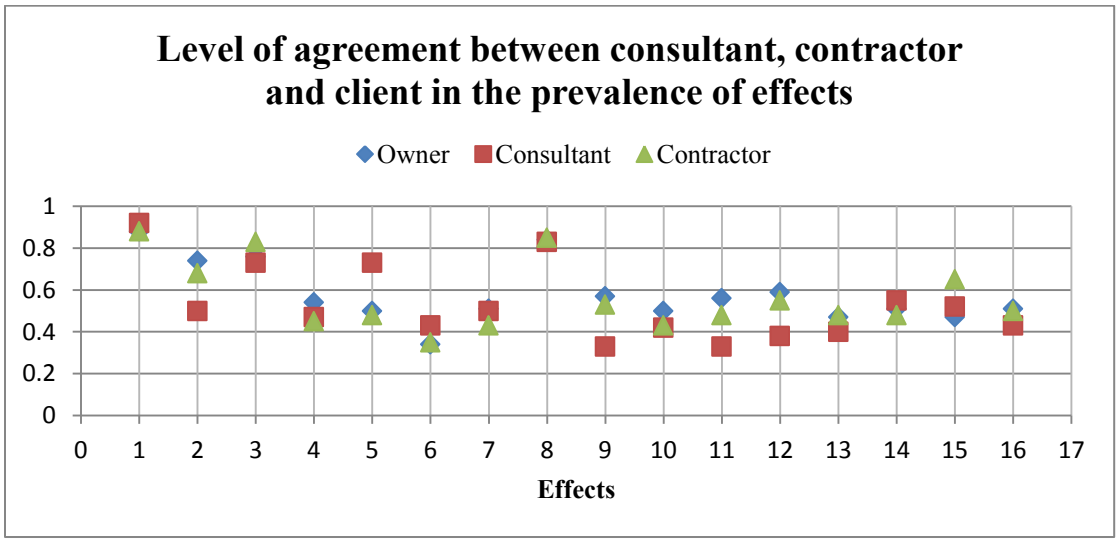

Figure 4.16: A scatter plot of the mean values of for client, consultants and contractors to show the level of agreement on the assigned prevalence index of change order effects.

II. Likewise for the importance of effects of change orders, the null hypothesis and the alternative hypothesis can be formulated as follows:

H_0 : Client and consultants agree on the effects of change orders importance.
HA : Client and consultants disagree on the effects of change orders importance.

The t value calculated is 1.66 (parameters: m=16, n =16, s1 =0.14, s2 =0.19). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is not to reject the null hypothesis. Client and consultants do agree on the importance index of change order effects.

H_0 : Client and contractors agree on the importance of effects of change orders.
H_A : Client and contractors disagree on the importance of effects of change orders.

The t value calculated is -3.84 (parameters: m=16, n =16, s1 =0.14, s2 =0.14). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and contractors do not agree on the importance index of f change order effects.

H0 : Contractor and consultants agree on the importance of effects of change orders.
HA : Contractor and consultants disagree on the importance of effects of change orders.

The t value calculated is –4.23 (parameters: m=16, n =16, s1 =0.19, s2 =0.14). The critical value of t is 2.04 (df = 30, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and consultants do not agree on the importance index of change order effects.
Outline for the degree of agreement or disagreement between the client, consultants and contractors on importance of change order effects are indicated in Figure 4.17. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned importance index of change order effects.

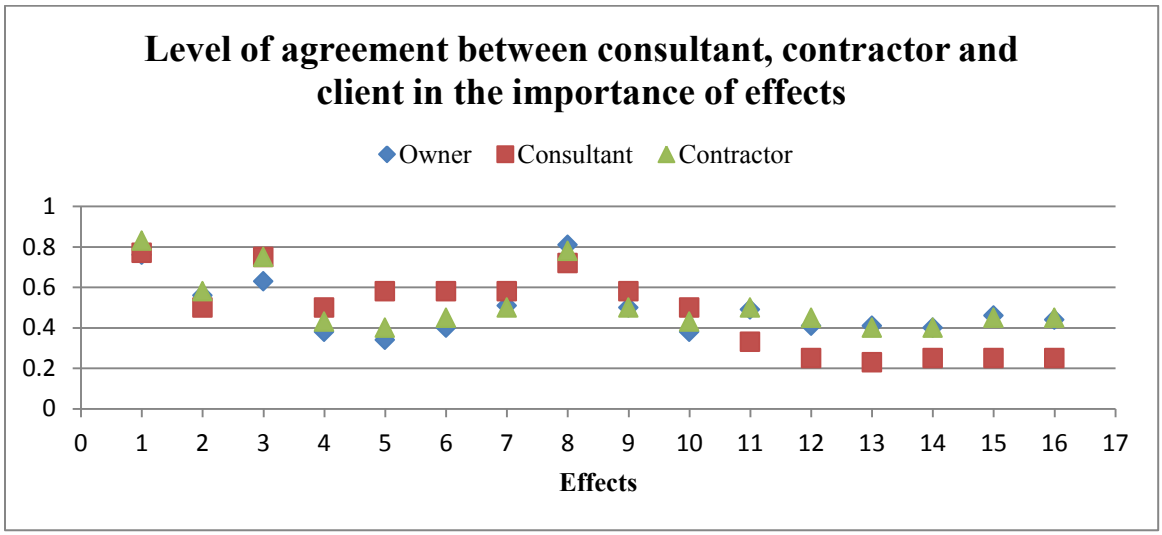

Figure 4.17: A scatter plot of the mean values of for client, consultant and contractors to shows the level of agreement on the assigned importance index of change order effects.

Agreement in change order controls

I. Likewise for the utilization of controls of change orders, the null hypothesis and the alternative hypothesis can be formulated as follows:

H_0 : Client and consultants agree on the utilization of controls of change orders.

HA : Client and consultants disagree on the utilization of controls of change orders.

The t value calculated is 3.37 (parameters: m=18, n =18, s1 =0.21, s2 =0.27). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and consultants do not agree on the utilization index of change order controls.

H0 : Client and contractors agree on the utilization of controls of change orders.

HA : Client and contractors disagree on the utilization of controls of change orders.

The t value calculated is 1.54 (parameters: m=18, n =18, s1 =0.21, s2 =0.2). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is not to reject the null hypothesis. Client and contractors do agree on the utilization of change order controls.

H0 : Contractors and consultants agree on the utilization of controls of change orders.
HA : Contractors and consultants disagree on the utilization of controls of change orders.

The t value calculated is -2.27 (parameters: m=18, n =18, s1 =0.27, s2 =0.2). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and consultants do not agree on the utilization of change order controls.

Outline for the degree of agreement or disagreement between the client, consultants and contractors on utilization of change order controls are indicated in Figure 4.18. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned utilization of index of change order controls.

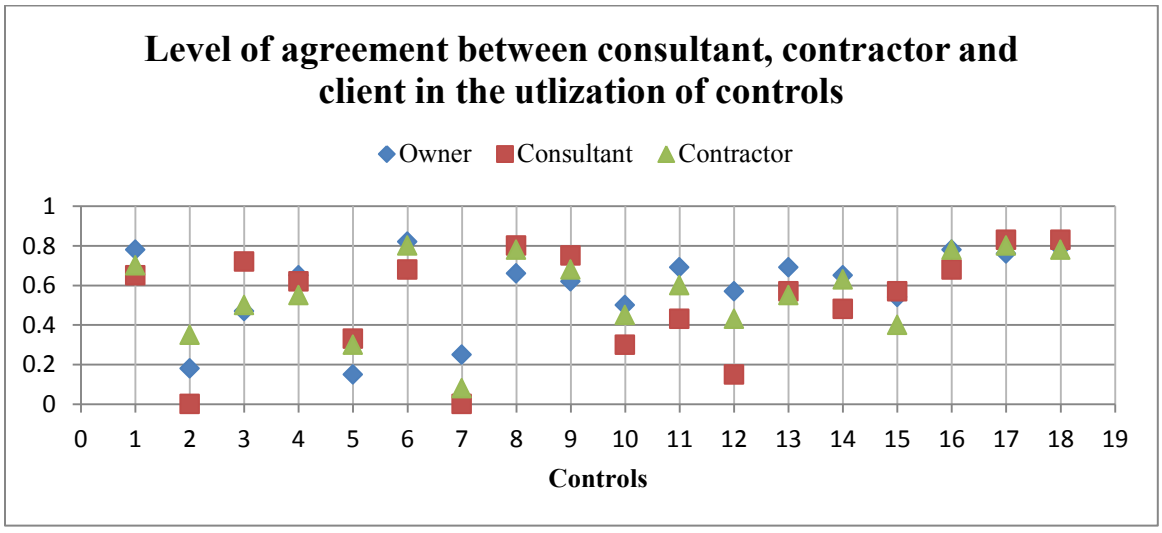

Figure 4.18 A scatter plot of the mean values of client, consultants and contractors to shows the level of agreement on the assigned utilization index of change order controls.

II. Likewise for the effectiveness of controls of change orders, the null hypothesis and the alternative hypothesis can be formulated as follows:

H_0 : Client and consultants agree on the effectiveness of controls of change orders.
HA : Client and consultants disagree on the effectiveness of controls of change orders.

The t value calculated is 5.61 (parameters: m=18, n =18, s1 =0.17, s2 =0.24). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and consultants do not agree on the effectiveness index of change order controls.

H0 : Client and contractors agree on the effectiveness of controls of change orders.
HA : Client and contractors disagree on the effectiveness of controls of change orders.

The t value calculated is 3.3 (parameters: m=18, n =18, s1 =0.17, s2 =0.17). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Client and contractors do not agree on the effectiveness index of change orders controls.

H0 : Contractors and consultants agree on the effectiveness of controls of change orders.
HA :Contractors and consultants disagree on the effectiveness of controls of change orders.

The t value calculated is -3.32 (parameters: m=18, n =18, s1 =0.24, s2 =0.17). The critical value of t is 2.03 (df = 34, $\propto$ = 0.05). The statistical decision therefore is to reject the null hypothesis. Contractors and consultants do not agree on the effectiveness index of change order controls.
Outline for the degree of agreement or disagreement between the client, consultants and contractors on effectiveness of change order controls are indicated in Figure 4.19. It is a scatter plot of the mean values of for client, consultants and contractors to shows the level of agreement on the assigned effectiveness of index of change order controls.

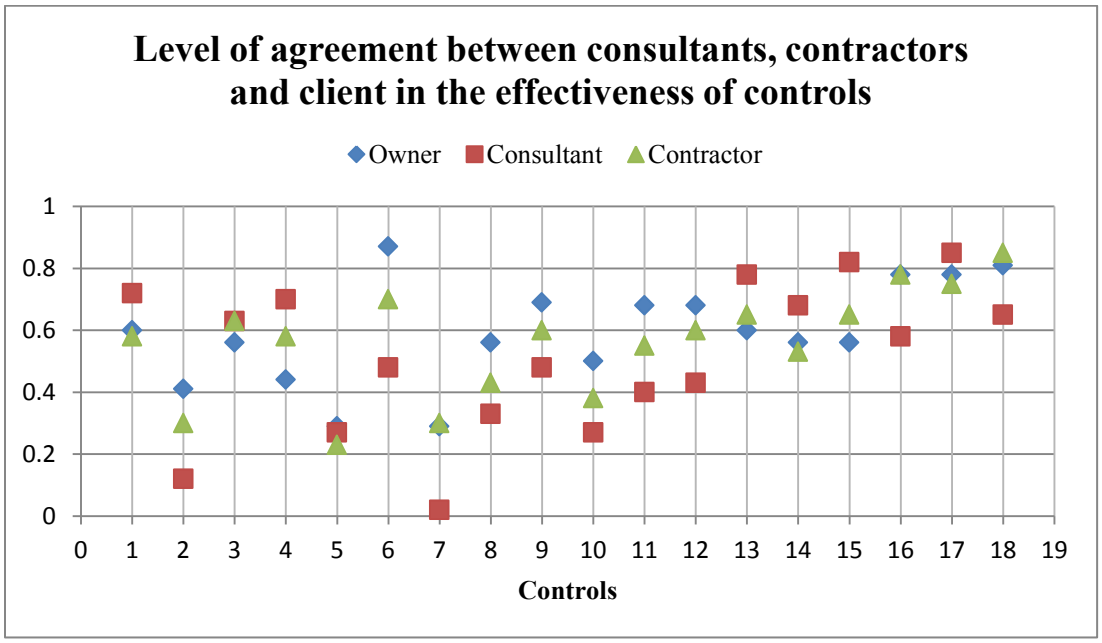

Figure 4.19 A scatter plot of the mean values for client, consultants and contractors to show the level of agreement on the assigned effectiveness index of change order controls.

4.4. Comparison between archival and respondents findings

The study identified most important change order causes in its archival and respondent document analysis. Both archival document and questionnaire analysis in common identify change of plans or scope by owner, lack of data for design and experience in predicting underground condition, error and omission in design as most important change order causes interims of cost implication. Respondents document analysis reveals most dominating factor that cause change order in ERA asphalt concrete road projects as change in design and right of way issue, but it is different from archival document reveal factors such as negligence during design and change in specifications as dominant causes interims cost implication in ERA asphalt concrete projects. This implies between archival and respondent document analysis agree on the 60 percent of most important causes and they have difference in 40 percent of the top five causes of change order.

4.5. Chapter Summary

This chapter analyses the data gathered using a questionnaire responses and ERA asphalt concrete roads projects document. It discusses the profile of participants in the study, analysis of questionnaire responses and document records.

Data was analysed from the research instrument on causes of change orders, effects of change orders, controls of change orders. Results on all these parameters from client, consultants and contractors are presented. Importance Index (II) of causes and effects, Prevalence Index (PI) of causes and effects, effectiveness index(EI) and Utilization Index (UI) of controls are tabulated. Each cause, effect, and control is ranked in client, consultants and contractor point of view. At the end of this chapter was dedicated for the comments made by respondents on the questionnaire forms. Closed-ended questions were interpreted by means of frequencies and descriptive statistics. Open-ended questions were summarized. The assessment of change orders was done on ten projects.

The archival document were mostly from completed projects contract documents, monthly reports, correspondence letters, consultancy completion reports and payment certificates were investigated thoroughly, which were very important in identifying the frequent problems related to cost in ERA asphalt construction sector. The findings were discussed of both the research instrument and the archival documents linking them to the literature review.

The research reveals prevalence of change orders on ERA asphalt road projects. The most prevalent change order causes in its archival document analysis are:- change of plan 28.24%, lack of data for design and experience in predicting underground condition 18.82%, error and omission in design 17.65%, value engineering 14.12% and change in design 9.41%. Similarly, most prevailing change order causes from respondents document analysis are:- change of plans or scope, change in design, error and omission in design,

right of way issue, and lack of data for design and experience in predicting underground condition.

Most prevailing change order causes interims cost effects are:- change of plan 32.90%, lack of data for design and experience in predicting underground condition 29.76%, negligence during design 12.89%, change in specifications by consultant 11.59% and error and omission in design 6.03% in archival document analysis. Respondents document analysis results shows change of plans or scope by owner, change in design, right of way issue, errors and omissions in design and lack of data for design and experience in predicting underground condition are important causes interims cost effects in ERA asphalt concrete projects.

The design consultant was the most predominant origin agent of this changes. Originators prevalence share of change order causes in the study are:- 28.24% owner, 65.88% consultants, and 5.88% contractors. Most prevailing change order causes in the study are change of plan 28.24% caused by owner of project, lack of data for design and experience in predicting underground condition 18.82% caused by design consultant, error and omission in design 17.65% by design consultant, value engineering 12.94% caused by consultant and 1.18% by contractor and change in design 9.41% initiated by supervision consultant due to design consultant causes need change.

In this study analysis of the respondent document found that rank of predominant origin agent are design consultant as 1st rank, client as 2nd rank, supervision consultant and contractor as 3rd rank, and others conditions as 5th rank generally in ERA asphalt concrete construction project from respondent point of view. It consists of major change order causes such as:- change of plans or scope caused by owner of project, change in design caused by consultant 76% by design consultant and 24% by supervision consultant, error and omission in design caused by design consultant, right of way issue as caused by all

originators and lack of data for design and experience in predicting underground condition caused by design consultant.

The study identified cost change contribution of change originating stack holders as follows:- 32.90% by owner, 65.38% by consultants, and 1.72% by contractors interims prevalence of change order.

The major effects that identified in this research interims of rate of occurrence are increases in project cost, completion schedule delay, additional payments for contractor, increase in overhead expense, and Hiring new professionals. Time and cost overruns and productivity degradation had major impacts on project performance. Respondents suggested that change orders should be kept to minimum, they acknowledged that clients had the right to initiate changes provided they were contractually permissible and were prepared to pay the associated costs. The study found that change orders had an impact on overall cost of projects. Most cost inquiring effects of change order in ERA asphalt concrete projects in decreasing order of their severity are:- increases in project cost, completion schedule delay, additional payments for contractor, increase in overhead expense, and Productivity degradation.

The most effective controls to safeguard against occurrence of change orders or to minimize their impacts if they occur are: comprehensive site investigation, knowledge-base of previous similar projects, control the potential for change orders to arise through contractual clauses, Clear and brief detailing of design, ability to discuss change with decision and approval.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Identification of causes of change order is a prerequisite to minimize or to avoid changes in construction projects. The main objective of this research is investigate the critical causes and effects of change orders on ERA asphalt concrete road construction projects in Ethiopia. Desk study was used to identify the existence and extent of change order on ERA asphalt concrete road construction projects in Ethiopia. Questionnaire survey was also used to identify the causes and effects of change orders. Clients, consultants and contractors were asked to identify the cause, effect and controls of change order in the asphalt concrete construction. Frequency of occurrence of the variables of change order, and their impacts on the final cost of the project were also asked.

Based on questioner‟s survey and documented analysis results, the following conclusions are drawn.

1. The findings of the research reveal prevalence of change orders on ERA asphalt concrete road projects.
2. The study identified most prevalent change order causes in its archival and respondent document analysis such as:- change of plan 28.24%, lack of data for design and experience in predicting underground condition 18.82%, error and omission in design 17.65%. Study identified most prevalent change order causes in its archival document analysis value engineering 14.12% and change in design 9.41% in addition to commonly identified study results. Similarly, respondents document analysis results are:- change in design and right of way issue. In conclusion, the occurrence of change orders was prevalent on ERA asphalt construction projects and their principal causes are change of plan, lack of data for design and experience in

predicting underground condition, error and omission in design, value engineering, change in design, right of way issue and change in design.

3. Both archival document and questionnaire analysis in common identify change of plans or scope by owner, lack of data for design and experience in predicting underground condition, error and omission in design as most important change order causes interims of cost implication. Respondents document analysis reveals most dominating factor that cause change order in ERA asphalt concrete road projects as change in design and right of way issue, but it is different from archival document reveal factors such as negligence during design and change in specifications as dominant causes interims cost implication in ERA asphalt concrete projects.
4. Originators prevalence share of change order causes in the study are:- 28.24% owner, 65.88% consultants, and 5.88% contractors. Originators of most prevailing change order causes in the study are change of plans or scope 28.24% caused by owner of project, lack of data for design and experience in predicting underground condition 18.82% caused by design consultant, error and omission in design 17.65% by design consultant, value engineering 12.94% caused by consultant and 1.18% by contractor and change in design 9.41% initiated by supervision consultant due to design consultant causes need change. From overall design change in ERA asphalt concrete road projects 76% by design consultant and 24% by supervision consultant share, right of way issue as caused by all originators.
5. The study identify cost change contribution of change originating stack holders as follows:- 32.90% by owner, 65.38% by consultants, and 1.72% by contractors interims prevalence of change order.
6. The major effects that identified in this research interims of rate of occurrence are increases in project cost, completion schedule delay, additional payments for contractor, increase in overhead expense, and hiring new professionals.

7. The study found that change orders had an impact on overall cost of projects. Most cost inquiring effects of change order in ERA asphalt concrete project in decreasing order of their severity are:- increases in project cost, completion schedule delay, additional payments for contractor, increase in overhead expense, and Productivity degradation.
8. It was found that design consultants to be predominant originator of change orders in ERA asphalt concrete construction projects constructed by foreign contractors.

5.2. Recommendations

Based on the findings of the research following improvements were recommended to control of change order and handling of project adverse effects leading to productivity loss, to alleviate the problem by parties in ERA asphalt concrete road construction projects:

1. Adequate planning in advance is required by owner before works start on site and owner should provide a clear brief of the scope of works. A clear and thorough project brief would assist in eliminating changes that may arise due to unclear project objectives. Eventually, this may assist in developing a clear scope of work for the professionals.
2. The identification and analysis of potential changes possible in a project as early as possible can enhance the management of changes in the projects. Learning from these variations is imperative because the professionals can improve and apply their experience in the future. It would assist the professional team to plan effectively during the design phase as well as construction phase to minimize and control changes and their adverse effects.
3. The involvement of the owner in the design phase would assist in clarifying the project objectives and in identifying the noncompliance with their requirements at an early stage. Eventually, this may help in eliminating the occurrence of variations arising from errors and design discrepancies during the construction stage where the impact of the variations can be severe.
4. The controls for the errors and omissions in design, design discrepancies and frequent change in design, would be through thorough detailing of design, value engineering at conceptual phase and allocating sufficient time for design development. This will provide an opportunity for the consultant to review and finalize the design during the design phase. It would assist in reducing the variation occurrences during the construction phase where the impact of changes can be severe.

5. Reviews project plans, designs, and specifications to ensure that all information is accurate and complete. Accuracy of documents, drawings and specifications are required to minimize change. Detailed check of harmonization of design and construction documents that are complete, correct, consistencies of dimensions and reliability to construct a road without design changes.
6. Changes can be reduced with due diligence in investigation of available material information accurately through experienced professionals during the design stage.
7. Consultants are responsible to administration the contract in full and in complete accordance with contract agreement, applicable laws and regulations. Interpret the requirements of the contract and make all decisions regarding work of the contractor. It is the responsibility of consultant to inform and advise the client in a timely manner regarding all claims of the contractor relating to the execution, progress, and completeness of the work. Unethically superiority feeling of consultant acting as a boss over contractor affect project achievement in its obstinate nature.
8. Coordinates the relocation of utilities to avoid construction delays, alignment change due to right of way problems. Planning in advance to relocation of utilities being coordinated, start construction after right of way clearance was completed.
9. Further study on construction ethics of professionals corruption and design defect liability of consulting companies in Ethiopian Road Authority asphalt concrete project.

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Appendix I

Questionnaire

Questionnaire

On

Analyzing change orders in selected Ethiopian Road Authority asphalt concrete road projects constructed by foreign contractors

BY

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Dear sir/madam

I, Graduate Research Inc. undertaking research to determine the preferences and reasons why change orders occur and its corresponding impacts with controlling mechanisms for asphalt concrete roads in your experience of ERA asphalt concrete road projects constructed by international contractors. To this end we kindly request that you complete the following short questionnaire regarding your preferences and attitudes towards change orders. It should take no longer than 30 minutes of your time. Although your response is of the utmost importance to me, your participation in this survey is entirely voluntary.

Please do not enter your name or contact details on the questionnaire. It remains anonymous. Information provided by you remains confidential and will be reported in summary format only. Kindly return the completed questionnaire to me before October 2014. Should you have any queries or comments regarding this survey, you are welcome to contact me with telephone at +251-912674085 or e-mail fikreyesusd@yahoo.com.

Fikreyesus Demeke

Yours sincerely

Graduate student

AAIT

Section I:-Background information

This section of the questionnaire refers to background or biographical information.

Although we are aware of the sensitivity of the questions in this section, the information will allow us to compare groups of respondents. Once again, we assure you that your response will remain anonymous. Your co-operation is appreciated.

- Your highest educational qualification…… Company……
- Work experience on asphalt road projects……Position……..
- Number of asphalt project carry out ……..
- Change orders administration experience ……

Section II Instruction:-please answer the following questions by crossing (x) the relevant block or writing down your answer in the space provided.

Section III: - Generals of change orders

Choice	yes	No
Is variation clause is cause of variation order		

If yes why……

Otherwise why No …….

Any other comment……

Activity"s rank	Very often	Often	Sometimes	Rarely	Never
Extra works					
Omissions from works					
Replacement of works					
Constructive changes					
Damaging changes					

Please enter your perception regarding any other constructive or harmful effects of change order in the space provided.....

Origin agent/ rank	**1st**	**2nd**	**3rd**	**4th**	**5th**
Client					
Contractor					
Design consultant					
Supervision consultant					
Others					

Any Comment …….....

Section IV causes of change orders**: -** This section of the questionnaire explores preferences, if any, with regard to the frequency of change orders causes with the following occasions and cost implication

causes	Frequency of occurrence					Significance of cost change						Origin of change				
	Very often	Often	Sometimes	Rarely	Never	Extreme increase	High increase	Average increase	Minor increase	No change	Cost reduction	Design consultant	Supervision consultant	Client	Contractors	Others
Change in design																
Errors and omissions in design																
Design complexity																
Inadequate working &shop drawing details for contractor																
Lack experience and data for design																
Attitude of consultant																
Ambiguous design details																
Noncompliance of design with government regulations																
Noncompliance of design with owner‟s requirements																
Consultant‟s lack of judgment and experience																
Change in specifications																
Conflict between contract documents																
Inadequate scope of work for contractor																
Technology changes																
Lack of coordination																
Supervision consultant value engineering																
Contractor Financial Difficulties																
Contractor desire to improve his finance																
Lack of contractor involvement in design																
Shortage of skilled labour (experienced)																
Unavailability of equipment																
Defective workmanship																
Differing site and local Conditions																

Value engineering by contractor																
Lack of a specialized construction manager																
Fast track construction																
Poor procurement process																
Lack of communication																
Contractor‟s lack of experience																
Long lead procurement																
Attitude of contractor																
Complex design and technology																
Lack of strategic planning:																
Lack of proper tender evaluation																
Change of plans/Scope by owner																
Owner financial difficulties																
Owner change of schedule																
Inadequate project objectives																
Change of materials or procedures																
Slow decision making process																
Change in specifications by owner																
Weather conditions																
Right of way issue																
Safety considerations																
New government regulations																
Change in economic conditions																
Socio-cultural factors																
Unforeseen problems																

If any other causes exist write and identifies the scale

……

……

……..

Section V Potential effects of change orders

This section explores your experience and perceptions regarding effect of change Order.

Impacts	frequency of Occurrence					Effect on construction project				
	very often	often	some times	rarely	never	Extreme	High	Average	Minor	No effect
Increases in project cost										
Increases in overhead expense										
Additional payments for contractor										
Poor professional relations and dispute										
Hiring new professionals										
Quality degradation										
Productivity degradation										
Completion schedule delay										
Progress is affected but without any delay										
Delays in payment										
Procurement delay										
Logistics delays										
Rework and demolition										
Poor safety conditions										
Damage to firm‟s reputation										
Work on hold										

If any other impact exists write and identifies the scale

……

……

……

…….

Section VI controls for variation orders

This section explores your experience and perceptions regarding controls of change order how often do you are familiar with controls of change order on each of the following mechanisms?

Controls mechanisms	frequency of utilization on projects					Effectiveness of measure				
	„very often"	„often "	„some times"	„rarely"	„never"	Very high	high	medium	low	not at all
Review of contract documents										
Freezing design										
Value engineering at conceptual phase										
Owner"s involvement at planning and design phase										
Contractor Involvement at planning and scheduling process										
Clear and brief detailing of design										
Reducing contingency sum										
Clarity of change order procedures for decision and approval										
Use of change order logic, scope and justifications										
Avoid use of open tendering and use restricted pre-qualification system for awarding projects										
During construction phase owner"s involvement and complete documentation of change order										
Use of project scheduling techniques										
Ability to discuss change										

with decision and approval										
Valuation of indirect effects of change										
Utilize work breakdown structure										
Control the potential for change orders to arise through contractual clauses:										
Comprehensive site investigation										
Knowledge-base of previous similar projects										

If any other control mechanism exists write and identifies the scale

……

……

Thank you for your collaboration in carrying out this questionnaire.

Appendix II

Change order and other data for asphalt concrete projects surveyed

	Task	Cause	ETB (change)	originator
Gore – Gambella Road Upgrading Project				
1	Change of the pavement 4 type for the section km 95 -104	Change of plan	45809368	Owner
	HAL shift at km70-71	Value engineering	-3000000	Contractor
	replacement of existing box culvert C-120 at km76+906 with new one)	Error and omission	553000	Designer
	Revision of Guidepost Schedule	Consultant‟s lack of required data	12300000	consultant
	Revision of Road marking	Change in design	303000	Consultant
Contract 2: Bonga-Mizan Junction				
2	Minor Traffic Crossing at Km. 158+940 RHS	Inadequate scope of work for contractor	138,905.70	Consultant
	New alignment from 168+780 to 171+740	Change in design	3,341,822.41	consultant
	Bonga Realignment	Change in design	-1,236,979.10	Consultant
	Culvert and Structures	Errors and omissions in Design	575,369.56	Consultant
	Design Modification from Km 110+680-116+220	Design consultant value engineering	-3,866,587.50	Consultant
	Asphalt concrete in lieu of DBST in shoulder	Consultant change in design	821,358.31	Consultant
	Extension of Bonga and Chena Town length	Change of plans by owner	4,968,006.00	Consultant
	Design modification from Km 168+020 to Km 173+300 and from Km 209+340 to Km 220+660 and extension of existing Box culverts as replacement of pipe culvert at Km 169+440 and replacement of existing Arch culvert by slab culvert at Km 111+491.	Value engineering	- 6,280,278.52	Consultant
	Extension of Mizan Town Section	Owner change in plan	5,124,837.00	owner

Jimma-Bonga Junction				
3	Using non-granular material instead of rock fill in swampy areas of Airport bypass	Value engineering	(-) 1,063,590.84	Consultant
	Five additional Pipe culverts to be constructed within the Airport By pass and the omission of two pipe culverts at Km 5+081 and Km 5+400	Errors and omissions in design	(+) 230,537.81	Consultant
	Jimma Town connectivity of 2.3 km length	Change of plan	(+)17,188,704.9	Owner
	Omission of 2.7 Km along the old alignment	Change of plan	(-) 15,671,646.88	Owner
	Design review of Minor structures from Km 30+000 to Km 60+000	Design consultant lack of required data	(+) 3,866,244.40	Consultant
	Design review of Bridges	Design consultant lack of required data	(-) 2,483,453.56	Consultant
	Design review of Culverts from Km 60+0000 to 90+000	Design consultant lack of required data	(+) 7,547,583.78	Consultant
	Design review of highways for the whole project length including KM 83+800 to Km 84+800 and Km 92+400 to Km 94+500	Design consultant lack of required data	(-)9,644,301.75	Consultant
	Revision of Minor Cross Drainage Structure between Km 2+700 to Km 30+000	Design consultant lack of required data	1,888,663.41	Consultant
	Realignment of Seka Town from Km 16+020 to Km 18+940	Change of plans	(-)138,029.05	Owner
	Proposal for changing of DBST by AC surfacing at internal curves of shoulders and parking lane and parking bays	Change of plans	(+)8,986,406.57	Owner
Gedo-Nekempte road rehabilitation project				
4	Realignment of centerline from5km to 11km	Value engineering	-6352839.49	Consultant
	Contract modification change of design minor structure.	Change design	15806257	Consultant

	Contract modification change of design major structure.	Change design by consultant	-2426860.8	Consultant
	Design change town section	Change in plan	6848781.98	Owner
	Cyclopean concrete major structure	Lack of contractor‟s involvement in design	3143555	Contractor
	Lean concrete	Change of plans	809109	Owner
	Gabion walls	Change of plans	235043	Owner
	Installation of guard nails	Change of plans	3058380	Owner
Addis Ababa – Dessie – Woldiya Road Rehabilitation Project, Lot 1: Addis Ababa - Tarmaber Tunnel,: Contract 2: Km 110 + 000 to Km 180 + 000				
5	Supply of additional two Type 'B' vehicles to the Engineers	Lack of consultant‟s knowledge of available materials and equipment	(+) 1,031,073.44	Consultant
	Change of Design of Road in Debere-Birhan town.	change in plan	(+) 8,032,763.18	Owner
	Revised Design of Tebase Town	Change of plans	(+) 3,898,342.19	Owner
	Change of Design of RCC wing wall of Box Culvert to Masonry wing wall	Contractor Unavailability of Equipment (Lack of material)	(-) 1,095,961.12	Contractor
	Change type of Culvert from RC Box Culvert to SC widening	Contractor value engineering	(-) 328,165.96	Contractor
	Provision of Additional Items in Tarmaber Tunnel Design (Provisional)	Lack of contractor‟s involvement in design	(+) 5,221,351.50	Contractor
	Provision of Additional Items in Tarmaber Tunnel Design	Lack of contractor‟s involvement in design:	(+) 874,533.99	Contractor
	2nd Revised Design of road length within limits of Debre-Birhan Town	Change of plans	(+) 19,684,110.73	Owner
	Widening of Beressa River Bridge to match with revised design of Debre Birhan town	Change of plans	(+) 4,723,011.42	Owner
	Provision of access to road side compounds with pipe or masonry and concrete slab over type C drain in semi-urban sections	Change of plans	(+) 4,401,547.86	Owner

	Change in position of Concrete Post for Road Sign Boards	Contractor request value Engineering	(-) 49,281.33	Contractor
Nazareth-Assela-Dodola and shashemene-Goba road upgrading project contract 2:Assela-Dodola junction				
6	Widening of Bekoji urban section	Change of plans	2888957.72	Owner
	Provision of walkway in urban sections	Change of plans	5711383.08	Owner
	Change of wearing course from DBST to AC	Lack of required data during design	66019090	Consultant
	Provision of additional slab culvert	Errors and omissions in Design	1737552.2	Consultant
	Design modification of Assasa town	Change of plans	1452000.66	Owner
	Construction of safe structure in flood porn areas of kubsa and Assasa town	Errors and omissions in Design	5426806.64	Consultant
	Removing and relaying of existing pipe	Change in design	742.153.5	Consultant
	Provision of vehicular access	Errors and omissions in design	14635196.3	Consultant
	Change of SST to AC at towns for parking lanes	Change in design	11050364	Consultant
Nazareth-Assela-Dodola and shashemene-Goba road upgrading project contract 3:Dodola junction Goba				
7	Extension of route by 2.8km at the end project	Change of plans	11371843.7	Consultant
	Vehicular access over RPWW	Design consultant‟s lack of required data	14821567.69	Consultant
	Provision of concrete kerbing	Design consultant‟s lack of required data	2549658.66	Consultant
	Change of DBST to AC	Design consultant‟s lack of required data	95335071.53	Consultant
	Backfill at the back of RPWW	Design consultant‟s lack of required data	4306032.3	Consultant
	Additional slab culvert and channelization	Design consultant‟s lack of required data	2561357	Consultant
	Change of SSST to AC on parking lanes	Design consultant‟s lack of required data	12133953	Consultant
Kombolcha –Gundewein road project contract 2 mekanselam –Gundewein				
8	Additional engineer facility	Error and omission	3720384.74	Consultant

	Realignment from km 193+500-202+400	Consultant value engineering	-39297632.93	Consultant
	Alignment improvement 202+400-208+000km	Consultant value engineering	-39297632.93	Consultant
	Alignment improvement 212-217km	Consultant value engineering	-27745773.56	Consultant
	Alignment improvement 217-222+500km	Consultant value engineering	-10283407.95	Consultant
	Four additional vehicle type B(double cabin pickup)	Error and omission	3200000	Consultant
	Additional facilities in the site for the construction of blue Nile and Diferesa river bridges	Error and omission	1457801.39	Consultant
	Purchasing of additional surveying equipment	Error and omission	63504	Consultant
	Change in specification from crushed stone sub base to gravel sub base	Change in specifications by consultant	-696200	Consultant
	Provision of 2ADF scanners	Error and omission	40000	Consultant
	Revision of rate for C20/C30 and C40 concrete for the pile cap and piers of blue Nile and Difarsa river bridges	Change in specifications by consultant	-736931	Consultant
	Revision of rate for precast concrete pipe culvert arising from AASHTO class III to ERA standard details	Change in specifications by consultant	-11794898.9	Consultant
	Revision of rates for cement mortared masonry wall as a result of changes in specification of cement and ratio to 1:3 from 1:6	Change in specifications by consultant	26696143.4	Consultant
	Supply of internet connection to engineers office and purchase of computer for material engineer	Error and omission	128095.36	Consultant
	Approval of realignment from km 244+200-245+500	consultant value engineering	-5000000	Consultant
	Installation of approach slab at bridges and viaducts	Error and omission	2001311.31	Consultant
	Changing bitumen grade from 80/100 to MC300 for plateau section	Change in specifications by	70000000	Consultant

		consultant		
	Remedies measure to prevent the slide in the gorge section	Error and omission	5503153	Consultant
	Widening of mertole Mariam town section from 10 to 17	Change of plan	20512643.77	Owner
	Construction and remedies measure to protect the slopes in the gorge section from further sliding and related cracks on road pavement as per the recommendation of geotechnical engineer	Lack of required data during design	10013106.1	Consultant
Irebti-Afedera				
9	Additional structures	Negligence during design	92860000	Consultant
	Omission of Engineers Type A houses	Error and omission	5230000	Consultant
Ambagerigies, Dabat, Debarek				
10	Design modification of town section Ambagerigies, Dabat, Debarek	Change of plan	50,658,919.37	Owner
	Realignment	Lack experience and data for design	3,173,128.95	Consultant
	Provision of median at town section	Change of plan	1,358,250	Owner
	Design modification of town section	Change of plan	28,115,845	Owner

Appendix III

List of contractors, design and supervision consultants of archival projects

No	project	Contractor	Supervision consultant	Design consultants
1	Gore – Gambella Road Upgrading Project	Consolidated Contractors Company/CCC/ of (Kuwait) W.L.L	Pan Arab Consulting Engineers /PACE/ with Omega Consulting Engineers /OCE/	Associated Engineering Consultant
2	Contract 2: Bonga-Mizan Junction	Keangnham Enterprise, Ltd	Intercontinental Consultants and Technocrats in association with Transom Technologies Ethiopia Ltd.(TCTE) and Intercontinental Consultants and Technocrats Ethiopia Private Limited	Intercontinental Consultants and Technocrats in association with Transom Technologies Ethiopia Ltd.(TCTE) and Intercontinental Consultants and Technocrats Ethiopia Private Limited
3	Jimma-Bonga Junction	Keangnham Enterprise, Ltd	LEA International Ltd in JV with Core Consulting plc.	
4	Gedo-Nekempte road rehabilitation project	China highway Construction Company	EHB consultant in association with TWC consultant	Metaferia Consulting Engineers
5	Addis Ababa – Dessie – Woldiya Road Rehabilitation Project, Lot 1: Addis Ababa - Tarmaber Tunnel Contract 2: Km 110 + 000 to Km 180 + 000	Sinohydro cooperation of china	LEA International Ltd. Canada in joint venture with LEA Associates South Asia Pvt. Ltd. India	G.MESKE TEARE Architects, Engineers, Planners in association with COWI consulting
6	Nazareth-Assela-Dodola and shashemene-Goba road upgrading	Sinohydro cooperation of china	FINNROAD of Finland in association with SABA engineering Ethiopia	UNICONE in JV with Rites

	project contract 2:Assela-Dodola junction			
7	Nazareth-Assela-Dodola and shashemene-Goba road upgrading project contract 3:Dodola junction Goba	CGCOC overseas construction Co. LTD	Transport construction design share company	UNICONE in JV with Rites
8	Kombolcha–Gundewein road project contract 2 mekanselam–Gundewein	CGCOC overseas construction Co. LTD	Transport construction design share company	ICS consulting
9	Irebti-Afedera	China Railway Seventh group	Gauff Ingenieur GMBH & Co KG-JBG Consulting Engineers	HEC, HAMDA and UNICONE
10	Gonder-Debarek	Sinohydro cooperation of china	J.burrow JV with omega consultant	Metaferia Consulting Engineers

Appendix IV

List of some of the respondents companies

Client

Ethiopian road authority contract regions and departments:-

- Central region,
- Eastern region,
- Northern region,
- Southern region,
- Western region and
- Planning department

Consulting Firms

Associated Engineering Consultant

Transport construction design share Company

Best consulting engineer‟s plc

Beza consulting engineer‟s plc

Construction design Share Company

Core consulting engineer‟s plc

Classic consulting engineer‟s plc

FINN ROAD of Finland in Association

Gulf Ingénue GMBH & CoKG-JBG Consulting

LEA International Ltd

LED International Ltd. Canada

Metaferia Consulting Engineers (MCE)

Net consulting engineer‟s plc

Saba Engineering plc

United Consulting Engineers Plc.(UNICONE)

Contractors

Arab contractors

China communication Construction Company

China highway Construction Company

China Tiesiju Civil Engineering Group

CGCOC overseas construction co.ltd

China railway Seventh Group

Consolidated Contractors Company/CCC/ of (Kuwait) W.L.L

Kajima construction Co.ltd

Keangnham enterprise, ltd

Sino Hydro Corporation