Determinants of Schedule Delay in Road Construction Project (The Case of Jimma-Agaro-Dedessa road project)

A Thesis Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Project Management & Finance (MPMF)

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MPMF PROGRAM

JUNE, 2021

JIMMA, ETHIOPIA

DECLARATION

I hereby declare that this thesis entitled "*Determinants of Schedule Delay in Road Construction Project (The Case of Jimma-Agaro-Dedessa road project)"* has been carried out by me under the guidance and supervision of Mr. *Endalew Gutu (Ass. professor)* and Mr. *Monanol Terfa (Msc.)*.

The thesis is original and has not been submitted for the award of any degree or diploma to any university or institutions.

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CERTIFICATE

This is to certify that the thesis entitles *"Determinants of Schedule Delay in Road Construction Project (The Case of Jimma-Agaro-Dedessa road project)",* submitted to Jimma University for the award of the Degree of Master of Project Management & Finance (MPMF) carried out by Mr. Chernet Seboka Debele under our guidance and supervision.

Therefore, we hereby declare that no part of this thesis has been submitted to any other university or institutions for the award of any degree or diploma.

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Acknowledgements

First of all I would like to gratefully acknowledge the almighty God to get the chance of this program. My deepest gratitude goes to my advisers Mr. Endalew and Mr. Monanol and special thanks to Mr. Abel for all his limitless efforts in guiding me through my work.

I would also like to express my appreciation to all individuals who contributed to this thesis through providing valuable information and by scarifying their precious time in filling the questionnaires.

Finally my deepest appreciation goes to Jimma University, Department of Accounting and Finance.

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ACRONYMS

OCE Omega Consulting Engineers'

CRCC China Railway Construction Corporation

ERA: Ethiopian Road Authority

ETCA: Ethiopian Transport Construction Authority

GTP: Growth and Transformation Plan

IPMA: International Project Management Association

ISO: International Organization for Standardization

PMBOK: Project Management Body of Knowledge

PMI: Project Management Institute

RII: Relative Importance Index

RSDP: Road Sector Development Program

Abstract

Construction delay considered as one of the most recurring problems in the implementation of construction projects. It is widely known to have an adverse impact on project success in terms of time, quality and cost. The causes of construction delay are not only confined to the construction industry, but also its influence on the overall economy of a country. The objective of this paper is to examine the causes of road construction delays in Jimma-Agaro-Dedessa road upgrading project. The research approach is qualitative and quantitative research approach. Questionnaire were constructed and used to collect data from 25 experts and professionals drawn from this specific road project active staffs. The research population was drawn from three parties, which participated in this road construction. The sample size for consultant's were 16 respondents, for contractor 5 respondents and for the Owner, 4 respondents requested which included project managers, engineers, team leaders, director and others technical supporting staffs. To get the required sample size, quantitatively using Statistical Package for Social Science (SPSS) was applied. In this study contractor's slowness in site mobilization, Delay in equipment delivery, and Contractor's poor site management & supervision as the most prominent delay causes of road projects, Unavailability of equipment, Poor managerial skills of contractor, Lack of experience of contractor in decision-making, Contractor's inadequate planning & scheduling, Inadequate handling of project progress by contractor, Shortage of recent technology equipment, and Large or long lead-time equipment not received as requested are also prominent causes of delay road construction projects. Commitment to project can be evident from all stakeholders; similar studies can also be conducted in this area and stakeholders in construction also take in to account such issues and utilize the findings of such studies. I also suggest that future studies can focus on the magnitude of effects of causes on projects (the extent of delay and the contribution of each cause to delay).

Key Words: Construction delay causes, Road construction, Contactor, Consultant, Client

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

In the context of Ethiopia, road is the most important infrastructure that provides access to rural and urban areas in the country. Road plays crucial role to reduce transportation cost and support economic growth in the country. However, in the late 1990‟s; the road network coverage was limited to major urban areas and some rural areas. Most areas in the country were isolated from economic centers, market and basic social services. The existing road network was largely deteriorated and in poor condition.

In Ethiopia road transport is the dominant mode and accounts for 90 to 95 percent of motorized inter-urban freight and passenger movements. However, because of its limited road network, provision of infrastructure has remained one of the formidable challenges for Ethiopia in its endeavor towards socio-economic development and poverty reduction (ERA, 2008a).

It was prior to the second Italian occupation i.e. between the years 1896 and 1936 that a great success was made in road construction. Emperor Menilik was said to be a successful road builder participating himself in the construction. In 1903 the road from Eritrea to Addis Ababa and the road from Addis to Addis Alem were built. In addition it was during this time that the first Asphalt roads appeared in Addis.

During the 5 years of Italian occupation about 6000km road were built by them, approximately 2500 km of them were given a single asphalt surface treatment, drainage structures were usually of stone masonry and at least three tunnels were built. From the time the Italian packed off to home to the eventual creation of the Imperial Highway Authority (1941 to 1951) road construction or maintenance activity was almost subsided for a stagnation period of one decade because of lack of funds, equipment and expertise.

During the establishment of ERA in 1951 the total road network amounted to 6,400 km, which was mainly built during the Italian invasion. In ERA history, major high way construction works

were dominated by international contractors between 1960 and 1970. Between 1972 and 1976, the domestic construction industry had started to develop and became active to same extent in the road construction sector. Unfortunately, their development was impeded by the adverse policy environment created by the Derg regime.

Ethiopia‘s road network has been improving each year. In the past sixteen years, the GOE has been vigorously engaged in new road construction as well as expansion of the existing road network through Ethiopia's Road Sector Development Programs (RSDP). According to 2014 UNDP Human Development report, Ethiopia has invested 142 billion Birr ($7.1 billion) on road construction projects over the past 16 years; out of which $ 5.4 billion (77%) was funded from internal sources. During the GTP II period covering 2015/16 to 2019/20, the GOE anticipates a further expansion of the country‘s road network to 220,000 kilometers (136,701 miles).

The Federal Democratic Republic of Ethiopia, represented by the Ethiopian Roads Authority, has been allocated sufficient budget to finance the construction of road project along Jimma-Agaro-Dedessa in completion time of 42 months. The project was signed a contract between Ethiopian Road Authority and China Railway 21st Bureau Group Co., Ltd. on October 24th 2018. The project is found today 7% of its total work which is by far delayed relative to its progress.

Delays in construction projects have associated negative impacts and effects. The consequence of delays can be late completion, disputes, loss of reputation of the construction organization, loss of opportunity of future projects, loss or reduction of profit margins, insolvency of the organization, termination of the contract etc. Delays in construction projects can lengthen schedule, increase in project costs and jeopardize quality and safety (González etal, 2013). Delays result in huge cost overruns and hinder the economic growth. Although, the causes of delay in construction projects have been explored by many researchers and have been documented in the literature, construction projects across the world continue to suffer delays to varying magnitude. The causes of delays need to be investigated with fresh perspective with steps to mitigate the causes to ensure that projects are delivered on time within budget.

Construction delay can be defined as the time overrun either beyond the contracted date or beyond the date that the parties have agreed upon for the delivery of the project (Marzouk and

El-Rasas, 2014). In the road construction industry, project delays can occur due to the prolongation of the construction time due to disruptive events that hamper the construction workflow (Shebob *et al*., 2012). Moreover, these delays have a negative impact both on the contractors and on the beneficiaries of the completed projects. The objective of this paper is to examine main causes of road construction delays in Jimma-Agaro-Dedessa road upgrading project.

1.2 Statement of the Problem

According to ERA's 2016 report the total road network of federal road reached to 28,032 km of which 14,632 km paved with asphalt and 13,400 km unpaved. Over the past years of RSDP history the performance was improved but still there is a big gap for improvement. Over the past years of RSDP history the performance was improved but still there is a big gap for improvement. The issue of addressing huge network expansion and improvement as well as backlogs of maintenance needs under funding constraints, weak local construction industry, few international contractors, weak capacity of own force with leaner qualified staffing resources is indeed a great challenge for Ethiopian road sector. In addition slow pace of institutional change, weak implementation capacity of the local construction industry, high turnover of professional and managerial staffs, and lengthy contract procurement processes can be cited as major challenges (ERA 2016).

Delays in construction projects are more likely to happen in almost all projects due to the miscommunication between contractors, subcontractors, property owners or any other reasons. Delays are constantly occurring in road construction projects and they could causes great impact on economic growth. It is one of the common problems that upset the construction companies in terms of competitiveness and long term sustainable in the global market Sweis *et al.,* 2008, Construction projects are delayed because of several reasons. The problem of project delay still not solved even today when the technology is advanced and project management practices are more common than before (Yang *et al.,* 2013).

A number of researches also carried out to investigate the causes of delay in construction projects. Al-Momani (2000) surveyed causes of delay in 130 public projects in Jordan. According to his research the important delay causes were related with: (1) design, (2) user

changes, (3) weather, (4) site conditions, (5) late supply, (6) financial conditions and (7) rise quantity of work. On the other hand according to Al-Ghafly (1995), the main causes of delay include finance, delay in agreement and decision-making by owner, variations in the plan and size (project scope), problem in gaining a work permit, and organization and communication problems.

Jimma-Agaro-Dedessa road upgrading project has been considered as the low performing project concerning to its time frame. The Federal Democratic Republic of Ethiopia has allocated sufficient budget to finance the road construction project along Jimma-Agaro-Dedessa in completion time of 42 months. But today staffs and small machineries mobilization and with minor work activities are completed only about 7% of the total work, even though project expected progress should be more than 60%.

Measure work delays assessed are: Failure to mobilize sufficient resources in type and quantity; The Contractor mobilized very limited number of rental equipment on site which are not sufficient to perform the available work load, Quarry Source Development, Mobilization and Installation of Crusher, Preparatory Works Required to Start Permanent Works; Looking into the available volume of works, apart from the earthworks activities, it was time for the Contractor to start production of crushed aggregate for concrete, base course, DBST and asphalt concrete activities, pre-casting of concrete elements for drainage and structural works that include concrete pipes, kerb stones, ditch covers, posts and etc.; however nothing has been done. The site preparation for the establishment of the crushing and asphalt plants, concrete precast yard, aggregate stockpile area, etc. has not been started yet and Provision of Engineer's Facilities; So far the Engineer has not been provided the permanent facilities in line with the provisions of the Contract. Such facilities should have been fully provided before six months. The Engineer's camp facilities including office, laboratory and houses construction have not yet been completed; materials testing laboratory for the Engineer's and the Contractor's use is not yet established; no permanent vehicles has been provided to the Engineer.

With these problems in mind, this research assessed the critical causes of project delay as well as other undesirable causes that delay road construction projects. Hence, the primary output of this investigation is to develop a suitable resolution way to mitigate the occurrence of delay on road

projects and minimize the risks of project failures. Identifying the causes of delay, assessing the severity of the cause and suggest the best practice mitigation of the delay.

1.3 Research Questions

- What are the major causes of project delay in road construction projects?
- How much is the contribution of each of these factors for the project delay?
- How do the responsibilities of delay are apportioned to the stakeholders?

1.4 Objectives of the Study

1.4.1 General Objective

The objective of this paper is to examine causes of construction project schedule delays in Jimma-Agaro-Dedessa road upgrading project.

1.4.2 Specific Objectives:

- To study the contribution of each causes for project delay.
- To assess the severity of the causes of delay.
- To suggest the best practice mitigate excessive delays in the construction project

1.5 Significance of the Study

This research will have a significant importance in understanding the extent of delay in road construction projects. It will also help us to know the major causes of this specific road construction project delay and the apportioning of these causes to the major stakeholders in road construction projects. Besides it can also propose way of mitigation in order to control and mitigate project delay causes and provide inputs for the management of ELRC in order to take corrective actions and make informed decisions to promote the successful completion of projects by mitigating the most common causes of delay.

Therefore, this research study will seek to determine and evaluate the causes of delays severe causes which can be under Contractors, Consultants or the Client in the completion of the road project during the construction phase.

In addition it will also be important to the researcher as it add theoretical and practical knowledge on how to conduct research and it may also significantly important to scholars and researchers who require basis for further research in this area.

1.6 Scope and Limitation of the study

This study focused mainly on road construction delay in the case of Jimma-Agaro-Dedessa road upgrading project which is found in Jimma zone south west direction in Ethiopia owned by the Federal Democratic Republic of Ethiopia (FDRE). The project is awarded for foreign company known by China Railway 21st Bureau Group Co., Ltd. under the supervision in charge of Omega Consulting Engineers' for completion within 42 months.

The study area is focusing on this specific road segment hence limited respondents were found especially it was difficult to get the assigned Engineers from the client side. In this connection, making improvement in the road sector of the country will have a significant impact on economic and social sectors as well. The output of this investigation is to develop a suitable resolution way to mitigate the occurrence of delay on road projects and minimize the risks of project failures.

1.7 Organization of the Paper

This study is organized in five consequential chapters. The first chapter deals with the introduction part of the paper comprising back ground of the study, statement of the problem, objectives of the study and scope & limitations of the study. The second chapter focuses on review of literatures related to the topic of this study. The third chapter deals with the research methodology, design, approaches used throughout the data collection and analysis. The fourth chapter presents the overall finding of the study which prevails about the most important and frequently occurring causes of delay from the perspectives of the three main groups (clients/ owner, contractors and consultants). The last chapter, chapter five encompasses the conclusion and recommendation part of the study. Conclusions are be made from the previous chapter so that we can make some recommendations.

CHAPTER TWO

2 REVIEW OF RELATED LITERATURE

2.1 Introduction

The focus area of this chapter is on review of literatures related to the topic under the study. The reviewed literatures are related with the area of project management and most importantly literatures are selected from road and other construction project management areas. Reviewed literatures include books, International journals, articles, thesis papers, reports which are related to the study topic. Most of the literatures' discussed here under are conducted on different countries, environment under different conditions and time to ascertain the fact that causes of delay could be different in different countries and under situations.

2.2 Overview of Project and Project Management

2.2.1 Project

According to the Project Management Body of Knowledge (PMBOK), a project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. Projects can also have social, economic, and environmental impacts that far outlive the projects themselves (PMBOK 5th edition). International Project Management Association (IPMA) defines a project as a time and cost constrained operation to realize a set of defined deliverables up to quality standards and requirements. On the other hand the Association of Project Managers (APM) defines a project as a unique, transient endeavor undertaken to achieve a desired outcome.

According to Robert K. Wysocki (2014) definition Project is a sequence of unique, complex, and connected activities that have one goal or purpose and that must be completed by a specific time, within budget, and according to specification. A Business-focused definition of a Project by the same author Robert K. Wysocki (2014) is a sequence of finite dependent activities whose successful completion results in the delivery of the expected business value that validated doing the project. Gary R. H. (2003) also defines a project as a temporary endeavor undertaken to

achieve a particular aim. A project is actually the response to a need, the solution to a problem. Further, it's a solution that promises a benefit; typically a financial benefit. The fundamental purpose for most projects is to either make money or save money.

By definition, a project is temporary in nature; that means that it has a specific start and finish. A project consists of a well-defined collection of small jobs (tasks) and ordinarily culminates in the creation of an end product or products (deliverables). There will be a preferred sequence of execution for the project's tasks (the schedule). A project is a unique, one-time undertaking; it will never again be done exactly the same way, by the same people, and within the same environment (*Gary R. H., 2003).*

Some of the special features of a project according to (Rory B. and Steve B., 2007) include:

- A project has a clear start and finish.
- A project passes through a number of distinct phases (initiation, design, implementation and handover).
- Projects are often time-limited (they must finish by a certain date).
- Projects have a clear budget which is usually broken down to a budget per work package.
- Activities are essentially unique and non-repetitive - you only get one opportunity to get it right.
- Resources may be sourced from different functional departments and contractors, and need to be coordinated.
- The project manager as project leader is responsible for the successful completion of the whole project.
- Multi-disciplined project teams are formed to manage the project. In large companies the project team would probably work within a matrix organization structure.

2.2.2 Project Management

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements (PMI, 2013). This application of knowledge requires the effective management of the project management processes.

A process is a set of interrelated actions and activities performed to create a pre-specified product, service, or result. Each process is characterized by its inputs, the tools and techniques that can be applied, and the resulting outputs. Project management is accomplished through the appropriate application and integration of the 47 logically grouped project management processes, which are categorized into five Process Groups. These five Process Groups are:

- Initiating,
- Planning,
- Executing,
- Monitoring and Controlling, and
- Closing. (PMBOK 5th edition).

Initiating Process Group: Those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.

Planning Process Group: Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.

Executing Process Group: Those processes performed to complete the work defined in the project management plan to satisfy the project specifications.

Monitoring and controlling Process Group: Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.

Closing Process Group: Those processes performed to finalize all activities across all Process Groups to formally close the project or phase.

The definition of project management that offered by Robert K. Wysocki (2014) is designed to be a working definition that includes the six-question litmus test to check its validity by using it to answer these six questions. Project management is a set of tools, templates, and processes designed to answer the following six questions: What business situation is being addressed by this project? What does the business need to do? What will you do? How will you do it? How will you know you did it? And How well did you do?

According to Kerzner H. (2009) Project management is the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Furthermore, project management utilizes the systems approach to management by having functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy).

As David M. (2009) cited Project management is defined in BS 6079 as _the planning, monitoring and control of all aspects of a project and the motivation of all those involved to achieve the project objectives on time and to cost, quality and performance. The purpose of project management was described by Lock as a system for foreseeing or predicting as many risks and problems as possible in relation to a project and then planning, organizing and controlling the activities required to overcome such risks and problems so that the project is completed successfully.

2.3 Theoretical Review

2.4 Project Schedule

A schedule is the conversion of a project action plan into an operating timetable. As such, it serves as the basis for monitoring and controlling project activity and, taken together with the plan and budget, is probably the major tool for the management of projects.

In a project environment, the scheduling function is more important than it would be in an ongoing operation because projects lack the continuity of day-to-day operations and often present much more complex problems of coordination. Indeed, project scheduling is so important .that a detailed schedule is sometimes a customer- specified requirement. Properly designed, detailed schedule can also serve as a key input in establishing the monitoring and control systems for the project (Jack R. M., Samuel J. M. 2009).

2.5 Project Success

The definition of project success is obviously critical. After all, that‘s how you‘ll be judged as a project manager. Unfortunately, there are almost as many definitions of project success as there are project management professionals. To add to the confusion, every organization has its own view of what matters in project outcomes (Gary R. H. 2014).

Since projects are temporary in nature, the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved between the project managers and senior management (PMBOK 5th edition).

2.6 Project Delay

Several studies have in the recent past attempted to classify road construction project delays and differentiate them based on their context (Rosazuwad, 2010; Chai and Yusof, 2015; Elawi *et al*., 2015). Based on these studies, construction delay causes can be grouped into three main categories; excusable delays with compensation, excusable delays without compensation, and non-excusable delays.

Delay in construction is a global phenomenon (Sambasivan and Soon, 2007) affecting not only the construction industry but the overall economy of countries as well (Faradi and El-Sayegh, (2006).

2.6.1 Excusable delays with compensation

These are delays that are due to an unforeseeable event beyond the contractor's or the subcontractor's control and usually caused by the client's actions or inactions. When contractors encounter this type of delay, they are entitled to time extension as well as monetary compensation due to the delay. An example of an excusable delay with compensation is when an owner denies access to the site after the notice to proceed is issued. This type of delay happens in some unexpected situations, but is not due to the contractor's mistake (Chai and Yusof, 2015; Elawi *et al*., 2015).

2.6.2 Excusable delays without compensation

This type of delays occurs where neither the client nor the contractor is deemed responsible. When this type of delay is encountered, only a time extension will be warranted since there are no grounds for damages. This delay allows for time extension to finish construction without giving any compensation to the contractor. The causes that cause this type of delay include protest from the labor force, unexpected weather conditions preventing or affecting work, unexpected late delivery of equipment, and unexpected late delivery of material (Adam *et al*., 2015).

2.6.3 Non-excusable delays

This happens due to the contractor ignoring agreed terms in the construction contract. Clients can claim their loss if it is spelt out in the contract agreement. These delays have to be identified by client because they rarely check the construction project schedule. Causes that contribute to this type of delay are usually foreseeable weather-related delays, delays caused by the subcontractor, inefficiency of the contractor in managing the construction site, mismanagement of the project finances by contractor, lack of labor, failure to manage work according to contract schedule, and frequent but avoidable mistakes or failure to fulfill owner's specification (Vasilyeva-Lyulina *et al*., 2015).

Although these summarize the major types of road construction projects delays, Shebob *et al*. (2012) identified other causes that include compromised quality, poor site management, government regulations, inadequate planning and resources, and site environmental conditions. However, when compared with the findings of Nyasetia *et al*. (2016), the different delay causes identified in roads construction project can be streamlined into four major categories as follows: Contractor-related causes, Consultant-related causes, Owner-related causes, and Other causes (including materials, labor and equipment, project causes, and delays due to external causes). A summary of all the road construction delay causes identified in literature is presented in Table 1. From Table 1, it is obvious that the delays in road construction projects are influenced by a wide range of causes and related issues. This phenomenon is usually accompanied by cost overruns, which have negative effects on clients, contractors, and consultants. For the owner, delay means loss of income and unavailability of facilities. For the contractor, on the other hand, delay means loss of money for extra spending on equipment and materials and hiring labor and loss of time. All these negative effects can result in litigation, arbitration, cash flow problems, and a general feeling of trepidation about each other. The causes of delay therefore were different for different parties (Motaleb, 2014).

Al-Kharashi and Skitmore (2009) state that causes responsible for road construction project delays vary from country to country. For example, in developing countries where governments are the sole owners of road construction projects, it can be argued that the three major causes that significantly influence the growth of road construction industry include national economic

growth, government spending, and level of demand by the communities (Tang *et al*., 2003). Thus, for African countries like Ethiopia, where government is the sole owner of road construction projects, different causes are bound to influence delays. Okpala and Aniekwu (1988) had earlier posited that governments, especially those of developing countries, were chiefly concerned with road construction. Thus, based on literature findings, it can be said that the chief causes and effects of delays causes in the road construction industry vary from country to country, due to different environments and the techniques applied which affect the construction processes.

2.7 Causes of Delay in Construction Projects

Arditi et al. (1985) surveyed investor public agencies & contractors in Turkey to assess the causes of delay. The study brought out that average delay on 126 public projects contractors' had undertaken was 34.6%, while the average delay was 43.65% in projects contracted out by public agencies. In 1975, only 22% of the public projects in Turkey were completed within their scheduled duration, while 18% were completed with as much as 4 years delay.

Mansfield et al. (1994) investigated the extent of delays in some of the highway projects in Nigeria and the time overrun in 9 highway projects was found to be ranging from 92% to as high as 343%.

Chan and Kumara Swamy (1995) observed that in 111 building and civil engineering projects completed in Hong Kong between 1990 and 1993, the average time overrun was exceeding 20%, and only 40% government buildings, 25% private sector buildings and 35% of civil engineering works were completed within schedule.

Assaf et al. (2006) conducted study on causes of delays in construction projects in Eastern province of Saudi Arabia through questionnaire survey of contractors & consultants. In their study, 76% of the contractors & 56% of the consultants specified a delay ranging between 10 to 30% and about 25% of the consultants specified a delay of 30% to 50% of original contract duration. Elinwa and Joshua (2001) found that degree of occurrence of time overrun in Nigeria is between 80% and 90%.

According to Sambasivan and Soon (2007), in 2005, about 17.3% of the 417 government projects in Malaysia experienced delays of more than 3 months or were abandoned & were considered sick. Koushki et al. (2005) in the study of 450 private residential housing projects in Kuwait, found that more than 56% of the projects did not complete on scheduled time, about54% of the projects were delayed by four months or more, one-third of the projects were delayed by more than six months.

Largely research has focused on the causes of delays covering all phases of construction projects, barring a very few which have focused on the specifics which are mentioned below.
Marzouk et al. (2008) in their study on engineering related delays in Egypt identified 22 causes among four categories – design development, workshop drawing supervision, workshop drawing approval, & project parties' changes. Their study found that mistakes/changes in the design documents provided by the Employer, delay by Employer in responding to contractor's queries, delay by contractor in preparation of drawings due to lack of resources, experience, management and changes due to mistakes, constructability problems in the design documents generated by employer as some of the most critical causes of delay.

Rahman et al. (2009) from the study of financial related causes contributing to delay of projects in Malaysia found that late payment, poor cash flow management, insufficient financial resources & financial market instability as the most significant causes.

Yang and Wei (2010) brought out that changes in client's requirement, poor scope definition, unreasonable and unpractical initial plan, change orders by client and project complexity as main causes causing delay in planning & design phases of construction projects in Taiwan.
Review of literature has helped us narrow the critical cause causes responsible for construction project delays.

Table 2.1: Causes of delays in road construction projects (Salunkhe & Patil, 2014)

Delay Causes	**Causes of delays**
	1. Contractor's inadequate planning & scheduling.
	2. Lack of experience of contractor in decision-making.
	3. Contractor's slowness in site mobilization.

Contractor-Related Delay Causes	4. Contractor's slowness in preparation of documents
	5. Contractor's poor site management & supervision.
	6. Conflicts with sub-contractor.
	7. Reworking of construction faced by contractor.
	8. Contractor incompatibility with new technology?
	9. Inexperience of contractor with new software.
	10. Poor managerial skills of contractor.
	11. Inadequate handling of project progress by contractor.
	12. Lack of risk analysis & management by contractor.
	13. Communication barriers faced by consultant.
Consultant-Related Delay Causes	1. Slowness in approving drawing by the consultant.
	2. Inadequate authority given to consultant to take decision.
	3. Mistakes in consultant's drawings.
	4. Consultant's inexperience.
	5. Financial difficulties affecting the consultant.
	6. Lack of practical (working) knowledge by the consultant.
	7. Lack of co-ordination of consultant with contractor.
	8. Consultant's ability of leadership.
	9. Conflicts of consultant with design engineer changes in specification during construction by consultant.
	10. Inadequate site information given to consultant.
	11. Delay in handover of site to contractor.
	12. Conflicts between consultant & contractor.
	13. Complexity of project design faced by consultant.
	14. Communication barriers faced by consultant.
Owner/Client-Related Delay Causes	1. Late revising & approving of relevant documents by owner
	2. Contract changes by owner during construction
	3. Delays in payments for completed work by owner.
	4. Lack of communication & co-ordination by owner.
	5. Conflicts between owners in a joint ownership.
	6. Suspension of work due to owner.
	7. Misunderstandings in technical dealing with vendors and contractors.
Material-Related Delay Causes	1. Shortage of material.
	2. Changes in quality of material.
	3. Frequent unexpected modifications in specification of material during construction.
	4. Slow process of material selection.
	5. Poor material management.
	6. Material damage in storage.
	7. Escalation of material prices.
	8. Lateness in finalizing finishing material due to availability of certainties in market.
	9. Insufficient turnover & start-up resources makes project slow.
	10. Materials not in right place when needed.

	11. Untimely delivery of labor
Labor & Equipment-Related Delay Causes	1. Poor labor supply & labor productivity.
	2. Disputes in labor & labor strikes.
	3. Unavailability of equipment.
	4. Delay in equipment delivery.
	5. Shortage of recent technology equipment.
	6. Large or long lead-time equipment not received as requested.
	7. No use of checklist.
	8. Unavailability of equipment lists & related design data.
	9. Shortage of operators.
	10. Space limitations at site for temporary & permanent equipment.
	11. Lack of safety effective inspection & expediting visits project
Project-Related Delay Causes	1. Traffic control at site.
	2. Changes in site conditions.
	3. Unforeseen ground conditions.
	4. Insufficient data collections & survey.
	5. Changes in site topography after design.
	6. Restricted access.
	7. Accidents on site.
	8. Problems due to existing structures.
	9. Unavailability of utilities in site area.
	10. Rework due to error in construction
External-Related Delay Causes	1. Inclement weather effects.
	2. Inaccurate cost estimates.
	3. Restriction due to site location.
	4. Changes in government regulation & laws

Review of literature has helped us narrow the critical cause causes responsible for construction project delays.

Table 2.2: Critical causes of delay

Critical Causes of Delay	
1	Delay in payments by clients
2	Delay in drawings, changes & errors in designs
3	Contractor's financial difficulties
4	Deficiencies in planning & scheduling
5	Delay in delivery of materials
6	Change orders / increase in scope of work
7	Poor site supervision and management
8	Economy, law & order, inflation, political instability

9	Slow decision making by owner
10	Subcontractor & supplier related causes
11	Force majeure / Acts of Gods

Although construction projects share common characteristics across the world, the projects are influenced & governed by some country specific conditions, which needs to be caused and looked into (Olawale and Sun, 2010). The groups and causes causing delays are country, location and project specific and that there are no root causes that can be generalized (Ramanathan et al., 2012). Although there have been many studies to assess the causes of delays in construction projects, this is the first research work carried out on this topic in Jimma-Agaro-Dedessa road project in the recent times. The trend and extent of delays invites for further research on this topic.

2.8 Methods for Minimizing Delays in Road Construction Projects

Different studies have in the past proposed different approaches and techniques in an attempt to address project delays in the road construction sector. Although some variations and differences in degree exist among all these previous techniques and approaches, an understanding of their weakness and strengths will help this study in adopting a better approach in tackling these delay issues, particularly within the context of Ethiopian based on the different influential causes.

The method proposed by Abdul Rahman *et al*. (2013) supposed that financial issues should be given considerable importance by ensuring that there is an effective mechanism for making timely payment from client to contractor, from contractor to sub-contractor, and to suppliers and staff. Based on the significant impact of equipment-related causes on project execution, they also recommended that construction firms should have sufficient materials at hand to ensure a smooth supply throughout the project construction phase, and to invest heavily on the latest machinery, tools and technology, rather than to source them on rental basis.

Memon *et al*. (2014) recommended that proper planning of work, committed leadership and management, and effective communication system can be very helpful in improving time performance. Harisaweni (2007) developed a framework to minimize the effects of delay causes in road construction projects in Padang and Pekanbaru, Indonesia. All these frameworks show that the cycling steps in each framework are almost the same and they also have the same

purpose which is to control the project. However, the framework of Bakhary *et al*. (2016) proposed a more concise description than others because it gave detailed descriptions of the possible actions and endeavors. The key concept of previous frameworks, which can be used as a basis for developing a theoretical framework, is summarized in Table 2.2.

From the above discussions and Table 2, it is clear that the use of a structured framework will help provide a more systematic approach for the road construction process, and a sequence of logical steps for implementation based on predefined activities at each stage of the project. Moreover, having a clear approach for undertaking the project will help in identifying delays at the early stages of the project and hence overcome the consequent effects of such delays. This will help the project manager and the project team to easily monitor and control the progress of their assigned tasks, which helps minimize delays and progresses the project itself.

2.9 Causes of Delay in Construction Projects in Ethiopia

Construction delay is a common problem in construction projects in Ethiopia and occurring in every type and phase of a construction projects. In Ethiopia, the construction industry is blooming and the road networks increasing from time to time all over the country. However the historical data of completed road projects shows that, none of the projects was completed as planned and within the estimated cost (Shambel and D. Patel, 2018). According to Werku and Jha 2016, Construction delays are occurring in every phase of a construction project and are common problems in construction projects in Ethiopia, and this is the major causes of project failure.

Siraw Y. (2014), in his study on analysis of causes contributing to time overruns on road construction projects under Addis Ababa City Administration‘ in Ethiopia, he concluded that slow site clearance, Inflation, progress payments delay by owner, contractors‘ financial problems, inaccurate cost estimation, and delay in commencement were the major causes of time overrun in Addis Ababa road construction. Werku and Jha (2016), in their study _Investigating Causes of Construction Delay in Ethiopian Construction Industries‘ the ranking of groups based on their order of importance as: (1) Contractor‘s related causes, (2) Material related causes, (3) Labor related causes, (4) Designer‘s related causes, (5) Consultants/supervisors related causes, (6) Client related causes, (7) External related causes.

Tsegay and H. Luo (2017) on their study -Analysis of Delay Impact on Construction Project based on RII and Correlation Coefficient:- they summarized their findings on the bases of the average relative important index (RII), the major classification of causes of delay and investigated as external, responsibility, resource, and contract related; for all stages except they influenced by different level and sub groups of cause of delay.

2.10 Conceptual Framework

Delays occur in every construction project and the magnitude of these delays varies considerably from country to country even project to project based on prevailing causes contributing to construction projects.

A number of studies have been conducted in regard to delays in construction projects for decades with scholars advancing various causes and groups of causes that contribute to causing delays.
From the literatures reviewed during this study 70 delay causes were identified. Each delay causes are described on the questionnaire designed for the survey. Literatures reviewed indicate categorization of various causes L. Muhwezi et al (2014) grouped in to four broad categories of causes of schedule delays in construction projects as clients related, consultant related, contractors related and external causes related. However Salunkhe & Patil, 2014 categories of eight (8) causes owner related, consultant related, contractor related, design-related, labor related, material & equipment related, project related, and external cause related. This study therefore, re-clustered these causes into seven (7) categories of client related, consultant related, contractor related, material related, labor and equipment related, project related and external related causes.

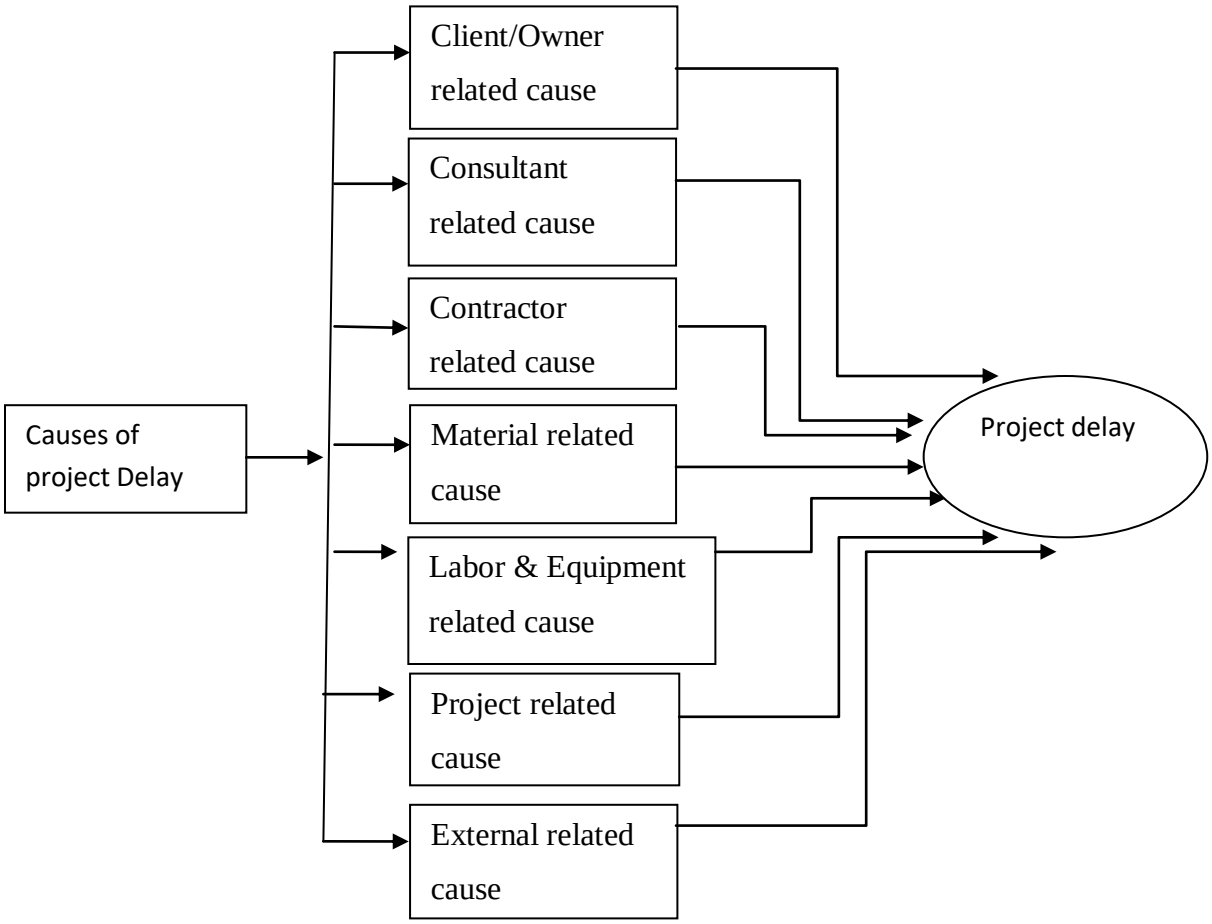

Fig. 2.1 Conceptual framework (Salunkhe & Patil, 2014)

CHAPTER THREE

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Study Design

In order to achieve the objective of the study, this research used qualitative and quantitative or mixed research approach. Particularly this study applied descriptive research design. The survey of the respondents was through questionnaires with the participation of key professionals in the study area.

According to Bhattacherjee (2012) survey is a preferred strategy to be used in exploratory, descriptive, and explanatory study when individual people is a unit of analysis. Survey involves the use of standardized questionnaires or interviews to collect data about people and their preferences, thoughts, and behaviors in a systematic manner. Survey also enables measuring a wide variety of unobservable data about people, such as knowledge, awareness, attitude, behavior, etc… or factual information, such as demographic and socio economic characteristics of a population that are too large to observe directly ((ibid). OECD (2009) also suggested a personal interview survey is preferred approach to collect data on construction delay studies. For this purpose a questionnaire from Salunkhe & Patil, 2014 was developed to assess the perceptions of owners, contractors and consultants on the relative importance of causes and effects of delays in road construction projects. Quantitative data were obtained through questionnaire. The data collected through these methods were analyzed and the results were presented.

3.2 Types and Sources of Data

Both primary and secondary data were used in relation to the topic under discussion. Primary source of data obtained through questionnaire results. Secondary data collected from secondary sources of data such as books, journals, reports, and related articles from the internet. The sources of data were the main parties in the construction namely; owner/ client, contractor and consultant.

3.3 Data collection and Instrument

The data used in this study were gathered from the main parties in the construction (clients, contractor, and consultants) who are participating in this road construction project using questionnaire and document review. Questions used in the questionnaire were close-ended (based on likert scale).

Document review was also employed to collect relevant secondary data from secondary sources (project progress reports, books, journals, reports, contract documents).

The questionnaire used in this study was adopted from the questionnaire used by Salunkhe & Patil, 2014, based on the literature review and some additional suitable questions developed with the expert assistance in the field under study. The questionnaire has 70 well-organized road construction project delay causes and these causes were categorized into the following seven major groups such as Client related, Consultant related, Contractor related, Material related, Labor & Equipment related, Project related and External cause related delay causes. Delay causes related to each groups are described on the questionnaire.

The questionnaire designed to assess the perspective of respondents from each group (clients, consultants and contractors) on the importance/severity and likelihood /frequency of occurrence of delay causes. Then the calculated mean has been taken to compute the Relative Importance Index and to rank each delay attribute based on their order of importance.

3.4 Research Population and Sample Size

Purposive (non probability, deliberate) sampling technique was used to select the respondents under owners, consultants and contractors. This method is used because of the small number of study population. William, (2005) indicates the importance of purposive sampling method in allowing the researcher to get information from a sample of the population that one thinks knows most about the subject matter.

The research population was drawn from three parties, which participated in this road construction. The sample size for consultant's were 16 respondents, for contractor 5 respondents and for the Owner, 4 respondents requested which included project managers, engineers, team

leaders, director and others technical supporting staffs. To get the required sample size, quantitatively using Statistical Package for Social Science (SPSS 16.0) was applied.

3.5 Data Processing and Analysis

The data obtained from the survey used a Likert scale range from 1 (Strongly agree) to 5 (Strongly disagree) and the data analysis is determined to establish the relative importance of various causes that contribute to construction delays.

Primary data were collected and analyzed quantitatively using Statistical Package for Social Science (SPSS 16.0) to determine the causes that contribute to project delays and their corresponding effects based on respondents' opinions. Secondary data collected from secondary sources of data such as books, journals, reports, and related articles from the internet. The sources of data were the main parties in the construction namely; owner/ client, contractor and consultant. The Relative Important Index (RII) technique was used to rank and categorize identifiable causes based on their level of contribution in minimizing delays at Jimma-Agaro-Dedessa road upgrading construction project. Each delay cause was calculated using the equation:

$$RII = \sum \frac{W}{A * N}$$

W ≡ is weight given to each cause by the respondents.

A ≡ is highest weight.

N ≡ is the total number of respondents.

Note: $0 \leq RII \leq 1$.

The RII was used to rank (R) the different causes. These rankings made it possible to cross-compare the relative importance of the causes as perceived by the three groups of respondents (i.e. Clients, consultants, and contractors). Each cause's RII perceived by all respondents were used to assess the general and overall rankings to give an overall picture of the causes of construction delays in the Ethiopian construction industry. The indices (RII) were then used to determine the rank of each item. These rankings made it possible to cross compare the relative importance of the elements as perceived by the three groups of respondents. The weighted

average for each item for the three groups of respondents is to be determined, and ranks (R) are assigned to each item representing the perception of the three groups.

Based on the research methodology, this part of the study targets to show the studies and results to meet the objectives of the study, which will analyzing of the severity and responsibility of the identifiable causes to rank their Relative importance index (RII). To accomplish the objectives, a questionnaire survey will be used. This part includes:

- Questionnaires Response Rate and Respondent Demographics
- To identify the delay causes of failures of an employer, consultant, and contractor during the construction phase.
- Ranking of the cases based on the responsibility of the causes of delay identifies with the contractor, employer, and consultant
- Ranking of the causes of delay, based on the Relative Important Index

A five point Likert scale ranging from "very high" to "very low" effect was used. The same classification is used as Jawal N. A. (2015) used in his study *"Assessment of delay causes of construction projects in Palestine*". If the mean value ranging:

From

1 - 1.8	Considered to be Very high effect
1.81 - 2.6	high effect
2.61 - 3.4	Medium effect
3.41 - 4.2	Low effect
4.21 – 5.0	Very Low effect

3.6 Ethical Considerations

Ethical consideration is part of this study. Documents reviewed from the organization will remain confidential. The findings and results from this study will not used for other purpose. During this study respondents are also free to respond their own opinion from their experience, and their personal information such as name and religion was not mentioned.

CHAPTER FOUR

4 RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with the presentation of the data collected from respondents through questionnaire and document review. An attempt was made to collect relevant data from targeted contractors, Clients/owner, and consultants through designed questionnaire. The questionnaire used in this study has seventy set of questions which are related to clients, contractors, consultants, materials, labor and equipments, project and external causes.

4.2 Questionnaires Response Rate and Respondent Demographics

The sample population composed of professionals from Employer (ERA West region), consulting firm (Omega Consulting Engineers), and contractor (China Railway 21st Bureau Group Co., Ltd),. These included project engineers, office engineers, project team leaders and site project supervisor engineers. Questionnaire survey structure was carried out by distributing a total of 25 sampling sets. It circulated to 4 employee staffs, 5 contractor staffs, and 16 consultant staffs. From these distributed questionnaires, 25 responses received back.

Table 4.1: Distributed Questionnaires, Respondents and Response

Respondent	**Questionnaire Distributed (#)**	**Questionnaire Collected (#)**		**Response from Total (%)**
		Invalid/ Incomplete Questionnaire	**Complete/ Valid response**	
Client	4	0	4	16%
Consultant	16	0	16	64%
Contractor	5	0	5	20%
Total	**31**	**6**	**25**	**100%**

Respondents Experience in Road Construction

Among the respondents 24% or 6 respondents have 1 to 5 years experience, 44% or 11 respondents have 6 to 10 years of experience, and 32% or 8 respondents have 11+ years of experience in road construction. Werku & Jha (2016), Aziz (2013), Owolabi J. D., *et al* (2014),

and N. Jawal (2015) used similar groupings of respondent's years of experience in their study as indicated below.

Table 4.2 Respondents Experience in Road Projects

	1-5 Years	**5-10 Years**	**>10 Years**
Client	1	3	0
Consultant	3	5	8
Contractor	2	3	0
Total	6	11	8

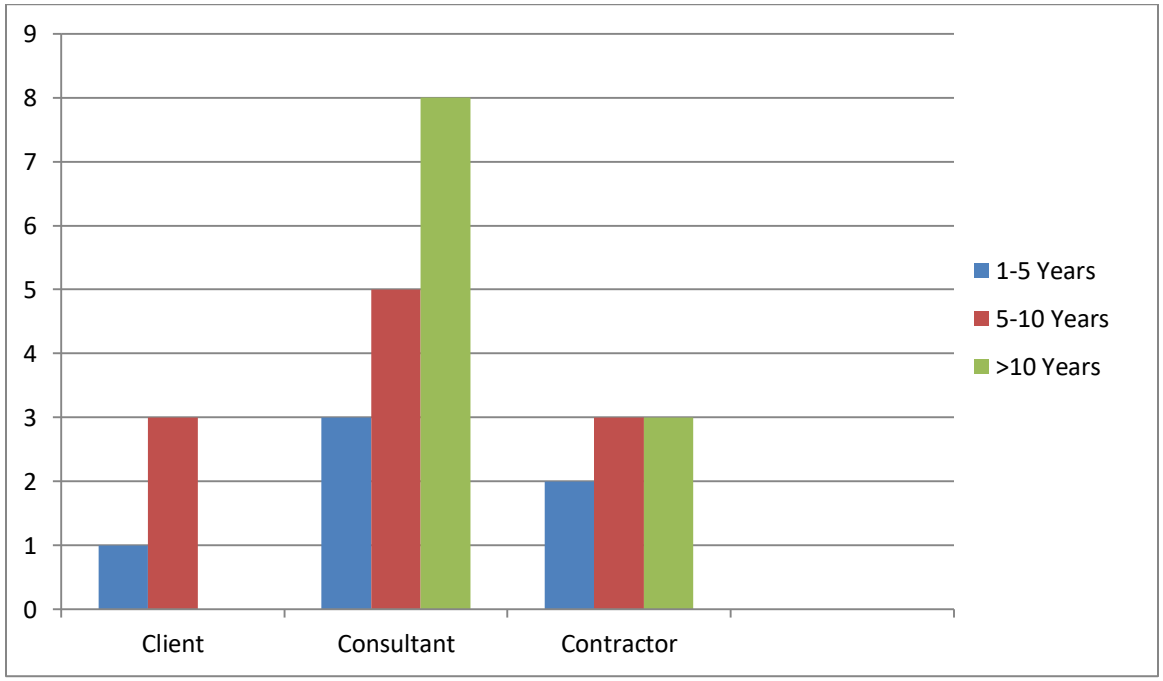

Figure 4.1 Work Experience of Respondents

4.3 Causes of Schedule delay in road construction projects

This part of the paper consists of results and discussion of causes of schedule delay in road construction projects. The causes of delay are discussed under seven groups, Causes related to clients, delay causes related to consultants, causes related to contractors, delay causes related to material, delay causes related to labor and equipments, delay causes related to project and related to external causes. Each delay causes are assessed from the view point of clients, consultants and contractors. Each cause is evaluated and ranked based on their severity/importance and likelihood of occurrence as perceived by respondents and the calculated mean are taken to rank delay causes using Relative Importance Index (RII).

Table 4.3 Causes of contractor related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
3	Contractor's slowness in site mobilization.	1.25	0.25	1	2.0	0.4	2	1.2	0.24	1	1.48	0.296	1
5	Contractor's poor site management & supervision.	1.25	0.25	1	1.94	0.388	1	1.6	0.32	2	1.6	0.32	2
10	Poor managerial skills of contractor.	1.75	0.35	3	2.0	0.4	2	1.8	0.36	3	1.85	0.37	3
2	Lack of experience of contractor in decision-making.	1.75	0.35	3	2.25	0.45	5	1.8	0.36	3	1.93	0.386	4
1	Contractor's inadequate planning & scheduling.	2.0	0.4	4	2.12	.424	3	2.0	0.4	4	2.04	0.408	5
11	Inadequate handling of project progress by contractor.	1.75	0.35	3	2.31	0.462	6	2.2	0.44	5	2.09	0.418	6
12	Lack of risk analysis & management by contractor.	2.0	0.4	4	2.44	0.488	7	2.8	0.56	7	2.41	0.482	7
4	Contractor's slowness in preparation of documents	2.75	0.55	5	2.56	0.512	7	2.4	0.48	6	2.57	0.514	8
13	Communication barriers faced by consultant.	3.25	0.65	6	2.19	0.438	4	3.0	0.6	8	2.81	0.562	9

6	Conflicts with sub-contractor.	2.75	0.55	5	3.19	0.638	10	3.0	0.6	8	2.98	0.596	10
7	Reworking of construction faced by contractor.	3.25	0.65	6	3.13	0.626	9	2.8	0.56	7	3.06	0.612	11
8	Contractor incompatibility with new technology?	3.25	0.65	6	2.94	0.588	8	3.2	0.64	9	3.13	0.626	12
9	Inexperience of contractor with new software.	3.5	0.7	7	3.69	0.738	11	3.6	0.72	10	3.6	0.72	13
	Grand Mean	**2.346**	**0.4692**		**2.52**	**0.504**		**2.415**	**0.4831**		**2.427**	**0.4854**	

According to from all respondents collected from the contractor, "Contractor's slowness in site mobilization" and "Contractor's poor site management & supervision" are the most severe Causes of Delay and as they have RII values of 0.296 and 0.32. "Poor managerial skills of contractor", "Lack of experience of contractor in decision-making", "Contractor's inadequate planning & scheduling", "Inadequate handling of project progress by contractor", "Lack of risk analysis & management by contractor" and "Contractor's slowness in preparation of documents" have been the second higher causes with RII value equal to 0.37, 0.386, 0.408, 0.418, 0.482 and 0.514 respectively. "Communication barriers faced by consultant", "Conflicts with sub-contractor"," Reworking of construction faced by contractor" and "Contractor incompatibility with new technology" have medium causes of effect with RII values of 0.562, 0.596, 0.612 and 0.626 respectively. "Inexperience of contractor with new software" has been considered as low cause of effect with RII value 0.72.

The grand mean values of all causes in this group given by consultants (2.52) are slightly higher than the value given by clients (2.415) and contractors (2.346) and the average mean equals to (2.427).

Table 4.4 Consultant Related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
7	Lack of co-ordination of consultant with contractor.	2.25	0.45	2	2.25	0.45	1	2.6	0.52	2	2.37	0.474	1
8	Consultant's ability of leadership.	3.0	0.6	4	2.69	0.538	3	1.8	0.36	1	2.5	0.5	2
9	Conflicts of consultant with design engineer changes in specification during construction by consultant.	2.25	0.45	2	3.0	0.6	6	2.8	0.56	3	2.68	0.536	3
11	Delay in handover of site to contractor.	1.5	0.3	1	2.63	0.526	2	4.0	0.8	7	2.71	0.542	4
12	Conflicts between consultant & contractor.	2.75	0.55	3	2.75	0.55	4	3.2	0.64	4	2.9	0.58	5
5	Financial difficulties affecting the consultant.	3.25	0.65	5	2.69	0.538	3	2.8	0.56	3	2.91	0.582	6
10	Inadequate site information given to consultant.	3.25	0.65	5	3.0	0.6	6	2.8	0.56	3	3.02	0.604	7
2	Inadequate authority given to consultant to take decision.	3.0	0.6	4	2.81	0.562	5	3.8	0.76	6	3.2	0.64	8

14	Slowness in approving drawing by the consultant.	3.5	0.7	6	3.13	0.626	7	3.2	0.64	4	3.28	0.656	9
6	Lack of practical (working) knowledge by the consultant.	3.0	0.6	4	3.31	0.662	9	4.0	0.8	7	3.44	0.688	10
4	Consultant's inexperience.	3.75	0.75	7	3.19	0.638	8	3.4	0.68	5	3.45	0.69	11
13	Complexity of project design faced by consultant.	3.0	0.6	4	3.81	0.762	11	3.8	0.76	6	3.54	0.708	12
3	Mistakes in consultant's drawings.	4.0	0.8	8	3.56	0.712	10	4.2	0.84	8	3.92	0.784	13
	Grand Mean	**2.962**	**0.5231**		**2.9686**	**0.5972**		**3.262**	**0.6524**		**3.071**	**0.6142**	

The relative importance indices and ranks of the thirteen (13) causes that are classified under the "Consultant related causes category" are shown in Table 4.4. According to from all respondents collected from the Consultant, "Lack of co-ordination of consultant with contractor" and "Consultant's ability of leadership" have high causes of delay causes with RII values of 0.474 and 0.500 respectively.

"Conflicts of consultant with design engineer", "changes in specification during construction by consultant", "Delay in handover of site to contractor", "Conflicts between consultant & contractor", "Financial difficulties affecting the consultant", "Inadequate site information given to consultant", "Inadequate authority given to consultant to take decision" and "Slowness in approving drawing by the consultant" have been considered as medium causes of delay with RII values of 0.536, 0.542, 0.580, 0.582, 0.604, 0.640 and 0.656 respectively. However "Lack of practical (working) knowledge by the consultant", "Consultant's inexperience", "Complexity of

project design faced by consultant" and "Mistakes in consultant's drawings" have been considered as low causes of delay with RII values of 0.688, 0.690, 0.708 and 0.784 respectively. The grand mean values of all causes in this group given by contractors (3.262) are higher than the value given by consultants (2.9686) and clients (2.962) and the average mean equals to (3.071).

Table 4.5 Client Related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
2	Late revising & approving of relevant documents by owner	1.5	0.3	1	2.69	0.538	1	2.4	0.48	1	2.2	0.44	1
4	Delays in payments for completed work by owner.	2.5	0.5	2	2.81	0.562	2	2.4	0.48	1	2.57	0.514	2
5	Lack of communication & co-ordination by owner.	2.25	0.55	2	2.69	0.538	1	2.8	0.56	3	2.58	0.516	3
3	Contract changes by owner during construction	3.25	0.65	4	2.69	0.538	1	3.0	0.6	4	2.98	0.596	4
8	Misunderstandings in technical dealing with vendors and contractors.	3.0	0.6	3	3.13	0.626	4	3.0	0.6	4	3.04	0.608	5
27	Communication barriers faced by consultant.	3.5	0.70	5	2.94	0.588	3	2.8	0.56	3	3.08	0.616	6

7	Suspension of work due to owner.	3.75	0.75	6	3.38	0.676	5	2.6	0.52	2	3.24	0.648	7
6	Conflicts between owners in a joint ownership.	4.25	0.85	7	3.38	0.676	5	3.6	0.72	5	3.74	0.748	8
	Grand Mean	**2.969**	**0.5938**		**2.9638**	**0.5928**		**2.825**	**0.565**		**2.9288**	**0.5858**	

The results presented in Table 4.5 above show that from the 8 delay causes related to the clients/ owner, "Late revising & approving of relevant documents by owner", "Delays in payments for completed work by owner" and "Lack of communication & co-ordination by owner" have been considered as high causes of construction delay with RII values of 0.440, 0.514 and 0.516 respectively. Whereas "Contract changes by owner during construction", "Misunderstandings in technical dealing with vendors and contractors", "Communication barriers faced by consultant" and "Suspension of work due to owner" have been considered as medium causes of delay with RII values of 0.596, 0.608, 0.616 and 0.648 respectively. However "Conflicts between owners in a joint ownership" has low cause of construction delay concerning this project with RII value of 0.748.

The grand mean values of all causes in this group given by client (2.969) are higher than the value given by consultants (2.9638) and contractors (2.825) and the average mean equals to (2.9288).

Table 4.6 Material Related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	**Causes of Delay**	**Client**			**Consultant**			**Contractor**			**Average**		
		Mean	**RII**	**Rank**	**Mean**	**RII**	**Rank**	**Mean**	**RII**	**Rank**	**Mean**	**RII**	**Rank**

1	Shortage of material.	2.0	0.4	1	2.63	0.526	2	2.8	0.56	3	2.48	0.496	1
9	Insufficient turnover & start-up resources makes project slow.	2.5	0.5	2	2.88	0.576	5	2.4	0.48	1	2.59	0.518	2
4	Slow process of material selection.	2.75	0.55	3	2.81	0.562	4	2.4	0.48	1	2.65	0.53	3
5	Poor material management.	3.25	0.65	5	2.63	0.526	2	2.4	0.48	1	2.76	0.552	4
11	Untimely delivery of labor	2.5	0.5	2	3.0	0.6	7	2.8	0.56	3	2.77	0.554	5
8	Lateness in finalizing finishing material due to availability of certainties in market.	2.5	0.5	2	2.69	0.538	3	3.2	0.64	5	2.8	0.56	6
7	Escalation of material prices.	3.0	0.6	4	2.5	0.5	1	3.0	0.6	4	2.83	0.566	7
10	Materials not in right place when needed.	3.0	0.6	4	2.94	0.588	6	2.8	0.56	3	2.91	0.582	8
3	Frequent unexpected modifications in specification of material during construction.	2.75	0.55	3	2.94	0.588	6	3.2	0.64	5	2.96	0.592	9
6	Material damage in storage.	3.75	0.75	6	3.06	0.612	8	3.0	0.6	4	3.27	0.654	10
2	Space limitations at site for temporary & permanent equipment.	3.0	0.6	5	3.25	0.65	10	3.0	0.6	6	3.08	0.616	11

Grand Mean	**2.8409**	**0.5682**		**2.5809**	**0.5162**		**2.7818**	**0.5564**		**2.8155**	**0.5631**	

The results presented in Table 4.6 above show that from the 11 delay causes related to the Material, "Shortage of material" and "Insufficient turnover & start-up resources makes project slow" have shown high causes of delay with RII values of 0.496 and 0.518. However the remaining 9 causes reflecting the medium effects of causes of delay; "Slow process of material selection", "Poor material management", "Untimely delivery of labor", "Lateness in finalizing finishing material due to availability of certainties in market", "Escalation of material prices", "Materials not in right place when needed", "Frequent unexpected modifications in specification of material during construction", "Material damage in storage and Space limitations at site for temporary & permanent equipment" have been considered causes of delay respectively.

The grand mean values of all causes in this group given by client (2.8409) are higher than the value given by contractors (2.7818) and consultants (2.5809) and the average mean equals to (2.8155).

Table 4.7 Labor and Equipment Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	**Causes of Delay**	**Client**			**Consultant**			**Contractor**			**Average**		
		Mean	**RII**	**Rank**	**Mean**	**RII**	**Rank**	**Mean**	**RII**	**Rank**	**Mean**	**RII**	**Rank**
4	Delay in equipment delivery.	1.5	0.3	1	1.17	0.234	1	2.0	0.4	2	1.56	0.312	1
3	Unavailability of equipment.	1.5	0.3	1	2.19	0.438	4	1.8	0.36	1	1.83	0.366	2
5	Shortage of recent technology equipment.	2.25	0.45	3	2.06	0.412	2	2.0	0.4	2	2.1	0.42	3

6	Large or long lead-time equipment not received as requested.	2.0	0.4	2	2.13	0.426	3	2.2	0.44	3	2.11	0.422	4
46	Poor labor supply & labor productivity.	2.25	0.45	3	2.25	0.45	5	2.4	0.48	4	2.3	0.46	5
1	Lack of safety effective inspection & expediting visits project	2.25	0.45	3	2.75	0.55	8	2.2	0.44	3	2.4	0.48	6
2	Disputes in labor & labor strikes.	2.75	0.55	4	2.56	0.512	7	2.4	0.48	4	2.57	0.514	7
8	Unavailability of equipment lists & related design data.	3.0	0.6	5	2.25	0.45	5	2.8	0.56	5	2.68	0.536	8
7	No use of checklist.	3.0	0.6	5	2.31	0.462	6	3.2	0.64	7	2.84	0.568	9
9	Shortage of operators.	4.0	0.8	6	3.0	0.6	9	1.8	0.36	1	2.93	0.586	10
10	Space limitations at site for temporary & permanent equipment.	3.0	0.6	5	3.25	0.65	10	3.0	0.6	6	3.08	0.616	11
Grand Mean		**2.5227**	**0.5045**		**2.3564**	**0.4713**		**2.3455**	**0.4691**		**2.400**	**0.4800**	

The results presented in Table 4.7 above show that from the 11 delay causes related to the Labor and Equipment, "Delay in equipment delivery" has the highest effect of the causes of delay in this road project by the respondents' judgment in all categories with the average mean value of

1.56 and RII value of 0.312. Whereas the causes of delays from 2nd to 7th are considered as higher causes of effect which are: "Unavailability of equipment", "Shortage of recent technology equipment", "Large or long lead-time equipment not received as requested", "Poor labor supply & labor productivity", "Lack of safety effective inspection & expediting visits project" and "Disputes in labor & labor strikes" with mean values of 1.83, 2.1, 2.11, 2.3, 2.4 and 2.57 respectively which all are between 1.8 and 2.6 as a five point Likert scale used.

The grand mean values of all causes in this group given by client (2.5227) are higher than the value given by consultants (2.3564) and contractors (2.3455) and the average mean equals to (2.400).

Table 4.8 Project Related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
2	Changes in site conditions.	2.75	0.55	2	2.63	0.526	2	2.2	0.44	1	2.53	0.506	1
10	Rework due to error in construction	3.5	0.7	3	2.69	0.538	3	2.2	0.44	1	2.8	0.56	2
3	Unforeseen ground conditions.	2.5	0.5	1	2.88	0.576	5	3.2	0.64	5	2.86	0.572	3
9	Unavailability of utilities in site area.	3.5	0.7	3	2.69	0.538	3	2.6	0.52	2	2.93	0.586	4
1	Traffic control at site.	3.75	0.75	5	2.81	0.562	4	2.6	0.52	2	3.05	0.61	5

6	Restricted access.	3.5	0.7	3	2.94	0.588	6	2.8	0.56	3	3.08	0.616	6
4	Insufficient data collections & survey.	3.5	0.7	3	2.5	0.5	1	3.6	0.72	7	3.2	0.64	7
8	Problems due to existing structures.	3.75	0.75	4	3.0	0.6	7	3.0	0.6	4	3.25	0.65	8
7	Accidents on site.	3.5	0.7	3	3.0	0.6	7	3.8	0.76	8	3.43	0.686	9
5	Changes in site topography after design.	4.0	0.8	6	2.88	0.576	5	3.4	0.68	6	3.43	0.686	10
	Grand Mean	**3.425**	**0.685**		**2.802**	**0.5604**		**2.9400**	**0.588**		**3.056**	**0.6112**	

The results presented in Table 4.8 above show that from the 10 delay causes related to the Project, "Changes in site conditions" has higher causes of delay taken from all respondents' information with mean value of 2.53 and RII value of 0.506. However, starting from 2nd to the 8th causes of delay, considered as medium causes of delay: "Rework due to error in construction", "Unforeseen ground conditions", "Unavailability of utilities in site area", "Traffic control at site", "Restricted access", "Insufficient data collections & survey" and "Problems due to existing structures". Whereas "Accidents on site" and "Changes in site topography after design" considered as low causes of effect for the project.

The grand mean values of all causes in this group given by client (3.425) are higher than the value given by contractors (2.9400) and consultants (2.802) and the average mean equals to (3.056).

Table 4.9 External Related Delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
1	Inclement weather effects.	2.75	0.55	2	2.19	0.438	1	1.8	0.36	1	2.25	0.45	1
2	Inaccurate cost estimates.	1.75	0.35	1	2.81	0.562	3	2.8	0.56	2	2.45	0.49	2
3	Restriction due to site location.	3.25	0.65	3	2.75	0.55	2	3.2	0.64	3	3.07	0.614	3
4	Changes in government regulation & laws	4.0	0.8	4	3.06	0.612	4	4.0	0.8	4	3.69	0.738	4
	Grand Mean	**2.9375**	**0.5875**		**2.7025**	**0.5405**		**2.9500**	**0.5900**		**2.8650**	**0.5730**	

The results presented in Table 4.9 above show that from the 4 delay causes related to the External," Inclement weather effects" and "Inaccurate cost estimates" have higher causes of delay with mean value of 2.25 and 2.45 respectively, and RII value of 0.45 and 0.49 respectively. Whereas the cause of delay "Restriction due to site location" has medium delay of construction with RII value of 0.614. However "Changes in government regulation & laws" has low causes of effect with RII value 0.738.

The grand mean values of all causes in this group given by contractors (2.9500) are higher than the value given by client (2.9375) and consultants (2.7025) and the average mean equals to (2.8650)

Table 4.10 Ranking of group causes (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Group	Client		Consultant		Contractor		Average	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Labor & Equipment-Related Delay Causes	0.5045	2	0.4713	1	0.4691	1	0.4800	1
2	Contractor-Related Delay Cause	0.4692	1	0.504	2	0.4831	2	0.4854	2
3	Material-Related Delay Cause	0.5682	4	0.5162	3	0.5564	3	0.5631	3
4	External-Related Delay Causes	0.5875	5	0.5405	4	0.5900	6	0.5730	4
5	Owner/Client-Related Delay Causes	0.5938	6	0.5928	6	0.565	4	0.5858	5
6	Project-Related Delay Cause	0.685	7	0.5604	5	0.588	5	0.6112	6
7	Consultant-Related Delay Causes	0.5231	3	0.5972	7	0.6524	7	0.6142	7

The relative importance index rank presented in Table 4.10 above shows that Labor & Equipment-Related Delay group of causes are the most contributing causes to project delay with the relative importance index value equals to 0.4800. Hence the labor & equipment related delay is majorly due to the contractor incapacity of deploying equipments recruiting of labors. The contractor related delay causes (RII=0.4854) ranked the second. Material-Related Delay cause ranked 3rd with (RII=0.5631) followed by External-Related and Owner/Client Related Delay cause groups with (RII=0.5730) and (RII=0.5858) respectively. The Project-Related Delay and the Consultant related delay causes category demonstrated the least aggregated relative importance index of (RII=0.6112) and (RII=0.6142) respectively.

Table 4.11 Overall ranking of delay causes top ten causes of delay (The mean is evaluated using SPSS 16.0 and RII values are evaluated manually)

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
1	Contractor's slowness in site mobilization.	1.25	0.25	1	2.0	0.4	3	1.2	0.24	1	1.48	0.296	1
2	Delay in equipment delivery.	1.5	0.3	2	1.17	0.234	1	2.0	0.4	4	1.56	0.312	2
3	Contractor's poor site management & supervision.	1.25	0.25	1	1.94	0.388	2	1.6	0.32	2	1.6	0.32	3
4	Unavailability of equipment.	1.5	0.3	2	2.19	0.438	7	1.8	0.36	3	1.83	0.366	4
5	Poor managerial skills of contractor.	1.75	0.35	3	2.0	0.4	3	1.8	0.36	3	1.85	0.37	5
6	Lack of experience of contractor in decision-making.	1.75	0.35	3	2.25	0.45	8	1.8	0.36	3	1.93	0.386	6
7	Contractor's inadequate planning & scheduling.	2.0	0.4	4	2.12	.424	5	2.0	0.4	4	2.04	0.408	7
8	Inadequate handling of project progress by contractor.	1.75	0.35	3	2.31	0.462	9	2.2	0.44	5	2.09	0.418	8
9	Shortage of recent technology equipment.	2.25	0.45	5	2.06	0.412	4	2.0	0.4	4	2.1	0.42	9

10	Large or long lead-time equipment not received as requested.	2.0	0.4	4	2.13	0.426	6	2.2	0.44	5	2.11	0.422	10

The survey results presented previous Tables 4.3, 4.4, 4.5, 4.6, 4.7, 4.8 and 4.9 show that, when the causes were ranked overall, the top ten most influential causes of delay are identified as: Contractor's slowness in site mobilization with mean value equals to 1.48 or (RII=0.296), Contractor's poor site management & supervision with mean value of 1.56 or (RII=0.312), Delay of financing and payments by owners with mean value of 1.6 or (RII=0.32), Unavailability of equipment with mean value of 1.83 or (RII=0.366), Poor managerial skills of contractor (RII=0.37), Lack of experience of contractor in decision-making (RII=0.386), Contractor's inadequate planning & scheduling (RII=0.408), Inadequate handling of project progress by contractor (RII=0.418), Shortage of recent technology equipment (RII=0.42), and Large or long lead-time equipment not received as requested (RII=0.422).

The survey result also revealed that out of the total 70 delay attributes which are categorized under the seven major groups (clients, consultants, contractor, material, labor & equipment, project and external related cause) with the most least causes of delay are: Changes in site topography after design with (RII=0.738), Complexity of project design faced by consultant with (RII=0.708) and Misunderstandings in technical dealing with vendors and contractors with (RII=0.608).

4.4 Discussions

The relative importance index rank presented in Table 4.11 above shows that labor & equipment group of causes are the most contributing causes to project delay. This result is consistent with the findings of Werku (2016) and Aziz (2013) even though Werku grouped delay causes in to four, and Aziz (2013), grouped delay causes in to nine major groups since the equipment group categorized under contractor group in their cases. The material related causes contribute ranked second.

The result of ranking order of group causes in this study is not consistent with the ranking of Werku and Jha (2016). They ranked groups based on their order of importance as: (1)

Contractor‘s related, (2) Material related, (3) Labor related, (4) Designer‘s related, (5) Consultants/supervisors related, (6) Client related, (7) External related causes. In this study delay attributes re-categorized under seven major groups (clients, consultants, contractor, material, labor & equipment, project and external) related causes. Most of material and labor related causes are categorized under contractor related causes; and designer related causes under consultant related causes. Therefore according to this categorization, labor & equipment related causes placed on the first place, followed by contractor related, material related, external related, client related and then project related, finally consultant related causes.

Hence, the overall ranking of group causes may not consistent with other studies as Sambasivan and Soon (2007) stated that, "The effects of delays in construction projects can be country specific" none of the studies is comparable to any other and each study has different rankings for the causes of delay and the groups as project characteristics are unique and may even be region specific. As project is unique endeavor, delay attributes to projects and their ranking may differ from country to country, region to region, even project to project. Therefore the ranking of the causes and groups in this study also does not compare with other studies. Ahmed *et al.,* (1999), reinforced this issue by making statement like this; Construction projects vary in terms of complexity in nature, location, type of contract, communication between parties.

CHAPTER FIVE

5 CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary of Major Findings

According to from all respondents, Contractor's slowness in site mobilization, Delay in equipment delivery, and Contractor's poor site management & supervision as the most prominent delay causes of road projects, Unavailability of equipment, Poor managerial skills of contractor, Lack of experience of contractor in decision-making, Contractor's inadequate planning & scheduling, Inadequate handling of project progress by contractor, Shortage of recent technology equipment, and Large or long lead-time equipment not received as requested are also prominent causes of delay road construction projects.

The relative importance index rank presented in previous Table 4.10 above shows that labor & equipment group of causes are the most contributing factors to project delay with the relative importance index value (RII= 0.4800) or grand mean value equals to 2.400. The contractor related causes ranked second with the grand mean values of 2.427 or (RII=0.4854), followed by material related causes with the grand mean values equals to 2.8155 or (RII=0.5631). The consultant factor related delay causes category demonstrated the highest aggregated relative importance index of (RII=0.6142) or grand mean values equals to 3.071.

5.2 Conclusion

The outcome of the analysis from this study can be said to be of high relevance to the construction industry. The majority of the respondents are fully involved in the construction industry with at least 3 years of construction experience, meaning that the respondents have a wealth of knowledge and could supply the necessary information on the question sent out in the questionnaires according to this research study.

Project delay is still happening and will continue to happen in the construction for various reasons. Delays are inevitable; however, they can be avoided or minimized when their causes are effectively identified and analyzed. The objective of this research was to identify the main causes

of delay that affect road construction projects. A literature review and questionnaire for experts were conducted to identify the causes of delay. A compiled list of 70 delay attributes were identified and categorized into seven groups of consultant related delay factors, contractor related delay factors, client related delay factors material related delay factor, labor & equipment related delay factor, project related delay factor and external related delay factors and listed on the questionnaire for further quantitative evaluation in a questionnaire survey to confirm the causes and to identify the most important causes of road construction project delay. The most important causes of delay identified by the survey through questionnaire and the results were analyzed for the overall view and for each of the three major parties in construction who participated in the questionnaire (clients/owner, consultants, and contractors) separately to make an overall view of the causes of delay in road projects.

The above mentioned seventy (70) delay attributes were categorized into seven major groups (clients, consultants, contractors, material, labor & equipment, project and external factors) and were ranked using relative importance indices (RII). The results show that the average results of respondents from the three major groups indicated that the labor & equipment group of delay factors was the most prominent delay factor. Contractor related factors were considered the second most influential causes of delay in road construction projects followed by material related causes of delay, external related causes of delay, client's related causes of delay, project related causes of delay and then consultant factors related causes of project delay placed in the last stage.

The top ten most important causes of delay in this specific Jimma-Agaro-Dedessa Road Project ranked so that the party involved would have to examine their weaknesses to adjust in project implementation.

5.3 Recommendations

Based on the results of the study, the following recommendations are forwarded to minimize the problem associated with Delay.

- The contractor should hire well experienced project management staffs and re-organize its structure.

- Contractors shall mobilize resources without delay.
- Contractors must also allocate adequate construction equipments and ensure to avoid frequent equipment breakdown.
- Establishing centralized project information database that helps all stakeholders by giving all relevant information about the project status is required and the contractor work repetition.
- Improving performance of professionals and firms through capacity building program in the construction industry like ERA Master Program for professionals in road sectors.
- It is better to establish a system to share experience and knowledge between consulting firms and firms as well as between contractors and contractors.
- Capacity building of construction managers by Short term and long term training program on the spot of the project shall be practiced.

Finally, Commitment to project can be evident from all stakeholders; similar studies can also be conducted in this area and stakeholders in construction also take in to account such issues and utilize the findings of such studies. I also suggest that future studies can focus on the magnitude of effects of causes on projects (the extent of delay and the contribution of each cause to delay).

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Annex 1. Questionnaire

JIMMA UNIVERSITY

COLLEGE OF BUSINESS & ECONOMICS

DEPARTMENT OF ACCOUNTING & FINANCE

Causes of Delay in Road Construction Projects (Questionnaire)

Dear Sir/ Madam,

My name is Chernet Seboka, a graduate student of Jimma University. I am conducting a research about "*Determinants of Schedule Delay in Road Construction Project (The Case of Jimma-Agaro-Dedessa road project)",* which I had chosen as a topic to conduct research on it for my master's project.

The aim of the research is to study the various delay factors with regards to the Construction environment. I kindly invite you to be a part of this research and request you to assist me in completing the brief questionnaire. I would kindly request your participation, and cooperation of your construction personnel and project managers in providing the required information in the questionnaire, as well as to thank you for your valuable time and efforts.

The information provided will only be used for research on an academic platform. Your kind assistance in this regard is highly appreciated. Thank You for your time and attention. I look forward to hearing from you,

Yours Sincerely,

Chernet Seboka

Graduate Student,

Jimma University

E-mail: *senaolch@gmail.com*

1. General Information

Please check which most accurately describes:

All information, including all results and personal information from participating individuals will be kept strictly confidential and be used only for research purposes.

1.1. Organization type

- Client/Owner
- Consultant
- Contractor

1.2. Experience in Road construction (in years)

- 1-5 Years
- 5-10 Years
- >10 Years

1.3. Job Designation

- Project Manager
- Resident Engineer
- Project Office Engineer
- Surveyor

Other, Specify_____

2. Ranking Causes of Delay

Please evaluate the following attributes based on:

Importance (the delay impact on construction project) (How often the attribute is implemented or considered) on a rating scale of 1 - 5 as shown below:

Rating Scale	Strongly agree	Agree	Fairly agree	Disagree	Strongly disagree
	1	2	3	4	5

		Strongly agree	Agree	Fairly agree	Disagree	Strongly disagree
	1. Contractor's inadequate planning & scheduling.					
	2. Lack of experience of contractor in decision-making.					
	3. Contractor's slowness in site mobilization.					
Contractor-	4. Contractor's slowness in					

Related Delay Factors	preparation of documents					
	5. Contractor's poor site management & supervision.					
	6. Conflicts with sub-contractor.					
	7. Reworking of construction faced by contractor.					
	8. Contractor incompatibility with new technology?					
	9. Inexperience of contractor with new software.					
	10. Poor managerial skills of contractor.					
	11. Inadequate handling of project progress by contractor.					
	12. Lack of risk analysis & management by contractor.					
	13. Communication barriers faced by consultant.					
Consultant-Related Delay Factors	1. Slowness in approving drawing by the consultant.					
	2. Inadequate authority given to consultant to take decision.					
	3. Mistakes in consultant's drawings.					
	4. Consultant's inexperience.					
	5. Financial difficulties affecting the consultant.					
	6. Lack of practical (working) knowledge by the consultant.					
	7. Lack of co-ordination of consultant with contractor.					
	8. Consultant's ability of leadership.					
	9. Conflicts of consultant with design engineer changes in specification during construction by consultant.					
	10. Inadequate site information given to consultant.					
	11. Delay in handover of site to contractor.					
	12. Conflicts between consultant & contractor.					
	13. Complexity of project design faced by consultant.					
	14. Communication barriers					

	faced by consultant.					
Owner/Client-Related Delay Factors	1. Late revising & approving of relevant documents by owner					
	2. Contract changes by owner during construction					
	3. Delays in payments for completed work by owner.					
	4. Lack of communication & co-ordination by owner.					
	5. Conflicts between owners in a joint ownership.					
	6. Suspension of work due to owner.					
	7. Misunderstandings in technical dealing with vendors and contractors.					
Material-Related Delay Factors	1. Shortage of material.					
	2. Changes in quality of material.					
	3. Frequent unexpected modifications in specification of material during construction.					
	4. Slow process of material selection.					
	5. Poor material management.					
	6. Material damage in storage.					
	7. Escalation of material prices.					
	8. Lateness in finalizing finishing material due to availability of certainties in market.					
	9. Insufficient turnover & start-up resources makes project slow.					
	10. Materials not in right place when needed.					
	11. Untimely delivery of labor					
Labor & Equipment-Related Delay Factors	1. Poor labor supply & labor productivity.					
	2. Disputes in labor & labor strikes.					
	3. Unavailability of equipment.					
	4. Delay in equipment delivery.					
	5. Shortage of recent technology equipment.					
	6. Large or long lead-time					

	equipment not received as requested.					
	7. No use of checklist.					
	8. Unavailability of equipment lists & related design data.					
	9. Shortage of operators.					
	10. Space limitations at site for temporary & permanent equipment.					
	11. Lack of safety effective inspection & expediting visits project					
Project-Related Delay Factors	1. Traffic control at site.					
	2. Changes in site conditions.					
	3. Unforeseen ground conditions.					
	4. Insufficient data collections & survey.					
	5. Changes in site topography after design.					
	6. Restricted access.					
	7. Accidents on site.					
	8. Problems due to existing structures.					
	9. Unavailability of utilities in site area.					
	10. Rework due to error in construction					
External-Related Delay Factors	1. Inclement weather effects.					
	2. Inaccurate cost estimates.					
	3. Restriction due to site location.					
	4. Changes in government regulation & laws					

Annex 2. Overall ranking of delay causes using RII

S. No.	Causes of Delay	Client			Consultant			Contractor			Average		
		Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank	Mean	RII	Rank
1	Contractor's inadequate planning & scheduling.	2.0	0.4	4	2.12	.424	3	2.0	0.4	4	2.04	0.408	5
2	Lack of experience of contractor in decision-making.	1.75	0.35	3	2.25	0.45	5	1.8	0.36	3	1.93	0.386	4
3	Contractor's slowness in site mobilization.	1.25	0.25	1	2.0	0.4	2	1.2	0.24	1	1.48	0.296	1
4	Contractor's slowness in preparation of documents	2.75	0.55	5	2.56	0.512	7	2.4	0.48	6	2.57	0.514	8
5	Contractor's poor site management & supervision.	1.25	0.25	1	1.94	0.388	1	1.6	0.32	2	1.6	0.32	2
6	Conflicts with sub-contractor.	2.75	0.55	5	3.19	0.638	10	3.0	0.6	8	2.98	0.596	10
7	Reworking of construction faced by contractor.	3.25	0.65	6	3.13	0.626	9	2.8	0.56	7	3.06	0.612	11
8	Contractor incompatibility with new technology?	3.25	0.65	6	2.94	0.588	8	3.2	0.64	9	3.13	0.626	12
9	Inexperience of contractor with new software.	3.5	0.7	7	3.69	0.738	11	3.6	0.72	10	3.6	0.72	13

10	Poor managerial skills of contractor.	1.75	0.35	3	2.0	0.4	2	1.8	0.36	3	1.85	0.37	3
11	Inadequate handling of project progress by contractor.	1.75	0.35	3	2.31	0.462	6	2.2	0.44	5	2.09	0.418	6
12	Lack of risk analysis & management by contractor.	2.0	0.4	4	2.44	0.488	7	2.8	0.56	7	2.41	0.482	7
13	Communication barriers faced by consultant.	3.25	0.65	6	2.19	0.438	4	3.0	0.6	8	2.81	0.562	9
Contractor-Related Delay Factor Grand Mean		**2.346**	**0.4692**		**32.76**	**0.504**		**2.415**	**0.4831**		**2.427**	**0.4854**	
14	Slowness in approving drawing by the consultant.	3.5	0.7	6	3.13	0.626	7	3.2	0.64	4	3.28	0.656	9
15	Inadequate authority given to consultant to take decision.	3.0	0.6	4	2.81	0.562	5	3.8	0.76	6	3.2	0.64	8
16	Mistakes in consultant's drawings.	4.0	0.8	8	3.56	0.712	10	4.2	0.84	8	3.92	0.784	13
17	Consultant's inexperience.	3.75	0.75	7	3.19	0.638	8	3.4	0.68	5	3.45	0.69	11
18	Financial difficulties affecting the consultant.	3.25	0.65	5	2.69	0.538	3	2.8	0.56	3	2.91	0.582	6
19	Lack of practical (working) knowledge by the consultant.	3.0	0.6	4	3.31	0.662	9	4.0	0.8	7	3.44	0.688	10

20	Lack of co-ordination of consultant with contractor.	2.25	0.45	2	2.25	0.45	1	2.6	0.52	2	2.37	0.474	1
21	Consultant's ability of leadership.	3.0	0.6	4	2.69	0.538	3	1.8	0.36	1	2.5	0.5	2
22	Conflicts of consultant with design engineer changes in specification during construction by consultant.	2.25	0.45	2	3.0	0.6	6	2.8	0.56	3	2.68	0.536	3
23	Inadequate site information given to consultant.	3.25	0.65	5	3.0	0.6	6	2.8	0.56	3	3.02	0.604	7
24	Delay in handover of site to contractor.	1.5	0.3	1	2.63	0.526	2	4.0	0.8	7	2.71	0.542	4
25	Conflicts between consultant & contractor.	2.75	0.55	3	2.75	0.55	4	3.2	0.64	4	2.9	0.58	5
26	Complexity of project design faced by consultant.	3.0	0.6	4	3.81	0.762	11	3.8	0.76	6	3.54	0.708	12
Consultant-Related Delay Factors Grand Mean		**2.962**	**0.5231**		**2.9686**	**0.5972**		**3.262**	**0.6524**		**3.071**	**0.6142**	
27	Communication barriers faced by consultant.	3.5	0.70	5	2.94	0.588	3	2.8	0.56	3	3.08	0.616	6
28	Late revising & approving of relevant documents by owner	1.5	0.3	1	2.69	0.538	1	2.4	0.48	1	2.2	0.44	1

29	Contract changes by owner during construction	3.25	0.65	4	2.69	0.538	1	3.0	0.6	4	2.98	0.596	4
30	Delays in payments for completed work by owner.	2.5	0.5	2	2.81	0.562	2	2.4	0.48	1	2.57	0.514	2
31	Lack of communication & co-ordination by owner.	2.25	0.55	2	2.69	0.538	1	2.8	0.56	3	2.58	0.516	3
32	Conflicts between owners in a joint ownership.	4.25	0.85	7	3.38	0.676	5	3.6	0.72	5	3.74	0.748	8
33	Suspension of work due to owner.	3.75	0.75	6	3.38	0.676	5	2.6	0.52	2	3.24	0.648	7
34	Misunderstandings in technical dealing with vendors and contractors.	3.0	0.6	3	3.13	0.626	4	3.0	0.6	4	3.04	0.608	5
Owner/Client-Related Delay Factors Grand Mean		**2.969**	**0.5938**		**2.9638**	**0.5928**		**2.825**	**0.565**		**2.9288**	**0.5858**	
35	Shortage of material.	2.0	0.4	1	2.63	0.526	2	2.8	0.56	3	2.48	0.496	1
36	Changes in quality of material.	3.25	0.65	5	3.0	0.6	7	2.6	0.52	2	2.95	0.59	8
37	Frequent unexpected modifications in specification of material during construction.	2.75	0.55	3	2.94	0.588	6	3.2	0.64	5	2.96	0.592	9
38	Slow process of material selection.	2.75	0.55	3	2.81	0.562	4	2.4	0.48	1	2.65	0.53	3

39	Poor material management.	3.25	0.65	5	2.63	0.526	2	2.4	0.48	1	2.76	0.552	4
40	Material damage in storage.	3.75	0.75	6	3.06	0.612	8	3.0	0.6	4	3.27	0.654	10
41	Escalation of material prices.	3.0	0.6	4	2.5	0.5	1	3.0	0.6	4	2.83	0.566	6
42	Lateness in finalizing finishing material due to availability of certainties in market.	2.5	0.5	2	2.69	0.538	3	3.2	0.64	5	2.8	0.56	6
43	Insufficient turnover & start-up resources makes project slow.	2.5	0.5	2	2.88	0.576	5	2.4	0.48	1	2.59	0.518	2
44	Materials not in right place when needed.	3.0	0.6	4	2.94	0.588	6	2.8	0.56	3	2.91	0.582	7
45	Untimely delivery of labor	2.5	0.5	2	3.0	0.6	7	2.8	0.56	3	2.77	0.554	5
Material-Related Delay Factor Grand Mean		**2.8409**	**0.5682**		**2.5809**	**0.5162**		**2.7818**	**0.5564**		**2.8155**	**0.5631**	
46	Poor labor supply & labor productivity.	2.25	0.45	3	2.25	0.45	5	2.4	0.48	4	2.3	0.46	5
47	Disputes in labor & labor strikes.	2.75	0.55	4	2.56	0.512	7	2.4	0.48	4	2.57	0.514	7
48	Unavailability of equipment.	1.5	0.3	1	2.19	0.438	4	1.8	0.36	1	1.83	0.366	2

49	Delay in equipment delivery.	1.5	0.3	1	1.17	0.234	1	2.0	0.4	2	1.56	0.312	1
50	Shortage of recent technology equipment.	2.25	0.45	3	2.06	0.412	2	2.0	0.4	2	2.1	0.42	3
51	Large or long lead-time equipment not received as requested.	2.0	0.4	2	2.13	0.426	3	2.2	0.44	3	2.11	0.422	4
52	No use of checklist.	3.0	0.6	5	2.31	0.462	6	3.2	0.64	7	2.84	0.568	9
53	Unavailability of equipment lists & related design data.	3.0	0.6	5	2.25	0.45	5	2.8	0.56	5	2.68	0.536	8
54	Shortage of operators.	4.0	0.8	6	3.0	0.6	9	1.8	0.36	1	2.93	0.586	10
55	Space limitations at site for temporary & permanent equipment.	3.0	0.6	5	3.25	0.65	10	3.0	0.6	6	3.08	0.616	11
56	Lack of safety effective inspection & expediting visits project	2.25	0.45	3	2.75	0.55	8	2.2	0.44	3	2.4	0.48	6
Labor & Equipment-Related Delay Factors Grand Mean		**2.5227**	**0.5045**		**2.3564**	**0.4713**		**2.3455**	**0.4691**		**2.400**	**0.4800**	
57	Traffic control at site.	3.75	0.75	5	2.81	0.562	4	2.6	0.52	2	3.05	0.61	5

58	Changes in site conditions.	2.75	0.55	2	2.63	0.526	2	2.2	0.44	1	2.53	0.506	1
59	Unforeseen ground conditions.	2.5	0.5	1	2.88	0.576	5	3.2	0.64	5	2.86	0.572	3
60	Insufficient data collections & survey.	3.5	0.7	3	2.5	0.5	1	3.6	0.72	7	3.2	0.64	7
61	Changes in site topography after design.	4.0	0.8	6	2.88	0.576	5	3.4	0.68	6	3.43	0.686	9
62	Restricted access.	3.5	0.7	3	2.94	0.588	6	2.8	0.56	3	3.08	0.616	6
63	Accidents on site.	3.5	0.7	3	3.0	0.6	7	3.8	0.76	8	3.43	0.686	9
64	Problems due to existing structures.	3.75	0.75	4	3.0	0.6	7	3.0	0.6	4	3.25	0.65	8
65	Unavailability of utilities in site area.	3.5	0.7	3	2.69	0.538	3	2.6	0.52	2	2.93	0.586	4
66	Rework due to error in construction	3.5	0.7	3	2.69	0.538	3	2.2	0.44	1	2.8	0.56	2
Project-Related Delay Factor Grand Mean		**3.425**	**0.685**		**2.802**	**0.5604**		**2.9400**	**0.588**		**3.056**	**0.6112**	
67	Inclement weather effects.	2.75	0.55	2	2.19	0.438	1	1.8	0.36	1	2.25	0.45	1

68	Inaccurate cost estimates.	1.75	0.35	1	2.81	0.562	3	2.8	0.56	2	2.45	0.49	2
69	Restriction due to site location.	3.25	0.65	3	2.75	0.55	2	3.2	0.64	3	3.07	0.614	3
70	Changes in government regulation & laws	4.0	0.8	4	3.06	0.612	4	4.0	0.8	4	3.69	0.738	4
External-Related Delay Factors		**2.9375**	**0.5875**		**2.7025**	**0.5405**		**2.9500**	**0.5900**		**2.8650**	**0.5730**	
Grand Mean													