

**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES**



**INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**A study on planning and scheduling in federal road projects of Ethiopia:
Causes of non-excusable delay in selected projects.**

A Thesis

By

Nejbel Mohaamed Abdela

Advisor: Professor Abebe Dinku (Dr.Ing)

A thesis submitted to school of graduate studies in partial fulfillment of the requirements for the degree of Master of Science in civil engineering,
(Construction technology and management major)

28th May, 2014

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

A study on planning and scheduling in federal road projects of Ethiopia: Causes of non-excusable delays: (Cause studies in selected projects)

By
Nejbel Mohaamed Abdela

APPROVED BY BOARD OF EXAMINERS:

Professor Abebe Dinku(Dr.Ing)

Advisor

Date

Signature

Engineer Yibeltal Zewdu

Internal Examiner

Date

Signature

Engineer Solomon Yohannes

External Examiner

Date

Signature

Dr. Bikila Teklu

Chair Person

Date

Signature

Dr. Geremew Sahilu

Associate Director for Graduate Program

Date

Signature

Dr. – Ing. Getahun Mekuria

Deputy Scientific Director

Date

Signature

Acknowledgments

First and foremost I would like to thank my God for his grace and favor for the accomplishment of this research. I would like to extend gratefulness to my advisor Professor Abebe Dinku (Dr. Ing) for his support and advise to finish the thesis. I would like to thank persons who responded to the interviews and provided documents from various organizations. At last, but not the least, would like to thank researchers, instructors, writers around the world who generously allowed their studies to be used by others as reference materials.

Abstract

The objective of the project management is to optimize the quality time and resource to the best possible way. In this regard project planning and scheduling has very critical impact on project's performance. Well organized project management team recognizes the importance and applies the basics to achieve the project objectives. The aim and objective of this study is to assess the practice and impacts of the planning and scheduling of road projects and make recommendation based on findings to road projects that are carried out by the Federal Government of Ethiopia.

In order to achieve its objectives, case study of ten projects, desk studies concerning the subject matter on the current trends of Ethiopian roads authority, and 26 interview responses of professionals from Ethiopian Roads Authority, consulting firms and contractors have been analyzed.

Accordingly the findings from the research show that there is a need to improve planning and scheduling trends because risk factors associated with non excusable delays have been triggered due to lack of proper planning and scheduling in execution of works.

Therefore in order to improve the performance of time in project's, in plan and schedule operation, it is fundamental to implement the principles of constructability review and its follow up mechanisms for each project. Constructability review teams should be formed independently from designer, projects managers and other professionals even though the team members should have to be well experience on those projects execution areas

Well planned and scheduled works are not meaning perfect and not amendable after the project is commenced. Rather it always needs to be followed by rigorous review of the plan, reschedule and updates of the project completion.

Key words: Plan, Schedule, Risk assessment, Constructability, Planning appraisals, non excusable delays.

Table of contents

Acknowledgments	i
Abstract	ii
List of Tables	vi
List of Figures	vii
Abbreviations/Acronyms	viii
1 Introduction	1
1.1 Research background.....	1
1.2 The problem statement	2
1.3 The research aim, objective and specific objective:	3
1.4 The Research Questions:	4
1.5 Scope of the study.....	5
2. Literature review: Project planning and scheduling	7
2.1 Project definition	7
2.2 Project planning	8
2.4.1 Planning process	10
2.4.2 Mistakes in planning	11
2.2.2.1 Unilateral Planning	11
2.2.2.2 The Ready- Fire- Aim Mistake	12
2.2.2.3 Planning in Too Little Detail	12
2.2.2.4 Planning in Too Much Detail.....	12
2.2.2.5 Failing to Plan for Risks	13
2.2.3 Developing the work breakdown structure (WBS)	13
2.2.4 Job Activities	14
2.2.5 Estimating Activity Durations	16
2.2.7 Time contingency	23
2.3 Project scheduling.....	24

2.3.1	Scheduling process.....	25
2.3.2	Resource allocations and management:	31
2.3.3	Planning vs scheduling	32
2.3.4	Constructability	33
2.3.5	Planned Schedules and its Impacts	34
2.4	Risk assessment and classification	38
2.4.1	Portfolio Theory:.....	40
2.4.2	The Delphi technique:.....	41
2.4.3	Risk classification	43
2.5	Applications of constructability.....	45
2.6.1	Constructability review:.....	45
2.6.2	Rescheduling and scheduling updating.....	47
2.6	Ethiopian Context planning and scheduling:.....	49
2.6.1	Ethiopia, general information and brief history of roads.....	49
2.6.2	The road sector development program (RSDP).....	52
2.6.4	The GTP and road constructions	54
2.6.5	Planning and Scheduling in road Construction of federal road projects	57
2.6.6	Time estimation comparisons	58
2.6.7	Major planning and scheduling problems.....	59
3	Research methodology	61
3.1	Research applications	61
3.2	Methodology.....	61
3.2.1	Literature review	62
3.2.2	Interviews.....	63
3.2.3	Case Study:	65
3.2.4	Desk study.....	65
3.2.5	Data Analysis,.....	65
4	Results and discussion.....	66
4.1	Trends and major problems in the current road construction projects	66

4.2	Analyze the impact of schedule in which delay is inherent as an impact.	67
4.3	Case study of selected road construction projects	71
4.3.1	An overview project selection	71
4.3.2	Case study	71
4.3.2.1	Contract 2 :Arerti – Gobensa:	73
4.3.2.2	Lot 1: Shire –Adigoshu	76
4.3.2.3	Shire– Gondar - Debark Project.....	79
4.3.2.4	Lot 2: Adigoshu – Humera Lugdi.....	81
4.3.2.5	Hawusewa – Abala - Irebti Afdera Contract 1	85
4.3.2.6	Contract 3 Adiremet Dejena-Dansha Upgrading Road Project	88
4.3.2.7	Assosa-Kurmuk.....	90
4.3.2.8	Contract 1: Gedo – Bako	93
4.3.2.9	2: Bako-Nekempte	96
4.3.2.10	Contract 1: Wolkite-Arekite	99
4.3.3	Total summary of case study:	101
4.4	Assessment of the appraisal and constructability review methods of the planning and scheduling activities in the federal road construction projects.	105
4.5	Assess the how appraisals and controlling is done in planning and scheduling techniques in federal road constructions.....	106
5.	Conclusions and recommendations	107
5.1	Conclusions.....	107
5.2	Recommendations.....	110
	References.....	112
Appendix	115

List of Tables

	Title	Page
Table 1	List of planning techniques.....	11
Table 2	Top 20 causes of non excusable construction delays.....	35
Table 3	Summary of 16 years performance of RSDP.....	49
Table 4	Road to be constructed in between 2011-2016 according GTP.....	53
Table 5	Time elapsed Vs estimation of time cost model.....	55
Table 6	Informants Profile.....	61
Table 7	Informants' years of experience.....	61
Table 8	Responses from the interview on the causes of non excusable delays in Ethiopian federal road constructions.....	65
Table 9	Selected road construction study projects details.....	70
Table 10	Summary of case study by table.....	102

List of Figures

	Title	Page
Figure 1	Standards of time performance.....	19
Figure 2	Conventional activities in planning and scheduling....	27
Figure 3	Project planning scheduling and control.....	30
Figure 4	Risk assessment matrixes.....	38
Figure 5	Map of Ethiopia.....	46
Figure 6	Research design.....	59

Abbreviations/Acronyms

EFDR	Ethiopian Federal Democratic Republic
ERA	Ethiopian Roads Authority
EOT	Extension of time
WBS	Work breakdown structure
PMI	Project management institute
CPM	Critical path method
PERT	Project evaluation review technique
CII	Construction industry institute
MDA	Multilateral development program
RSDP	Road sector development program
EIA	Environmental impact assessment
GTP	Growth transformation plan
DC	Domestic contractors
IC	International contractors

1 Introduction

1.1 Research background

Construction planning and scheduling tasks are fundamental and challenging activities in the management of executing construction projects. It involves choice of construction technologies, definition of work tasks, estimation of the required resources and durations for individual tasks, and identification of any interactions or constraints among the different tasks. A good construction plan is the basis for developing the project budget and the schedule of work. Poor estimates or schedules can easily result in large construction cost increases or delays [1].

Current practices in the road construction industry show that the level of attention to planning and scheduling in road construction is inefficient and projects are often subjected to time and cost overrun (Castro et al, 2005). Project managers use only their experiences gut and feeling to plan and manage the process. In order to have efficiency and deliver projects on time and budget, more innovative tools and techniques are needed to assist managers in planning and scheduling road construction projects. Also, there is a need for tools that will be able to assist project managers to study and compare all possible strategies and methodologies for the execution of the works and without this comparison there will be no evidence that the planner's choice corresponds to the most advantageous possibility[1].

Planning and scheduling highway construction projects are vitally important tasks in highway construction organizations (wang and chou, 2003). A construction planning outlines how resources and cash flows are deployed overtime and any deviation from the stated schedule often should bring a quick response from the stakeholders. When project is delayed due to poor planning and scheduling, the highway construction organizations loss creditability and time. On the other hand, if the highway construction and consulting organizations can produce realistic planning and scheduling especially at the beginning of decision-to-build time stage that it is able to abide by then project delays due to weak planning and scheduling would be avoided[1].

Road construction projects are very expensive and highly influenced by unpredictable factors, like weather, type of soil, environmental issues, and other factors. This has led to difficulties in developing accurate construction plans and modeling the construction operation using a traditional simulation system. In this context, the aim of this research is to create a knowledge driven road construction planning and scheduling to assist project managers in generating accurate and reliable road construction plans to identify the causes of non excusable delays in order to make remedies in avoiding their effects [2].

Road construction operations, rules governing the actions and interactions of the resources should be identified, developed, classified and modeled through a comprehensive analysis of several road construction projects. For every road construction operations (activities), project templates in advance should be defined and developed. Through the templates, which summarize productivity, factors influencing the productivity of resources and the sequence of works, the basics towards complete executions planning and scheduling are achieved [2].

1.2 The problem statement

The proper and acceptable planning and scheduling has to be within the standard and modern procedures in order to be more workable and easy for appraisals. Therefore it is the duty of the planner to check the above criteria on the planning and scheduling issues [1].

Lack of proper planning and scheduling has been one of the greatest setbacks in the road construction sector. According to different project's progress reports the following common problems have been found [1].

- Extremely extended time to the completion of the projects.
- Unwise economical utilization of project resources.
- Grievance of road users due to increased travel time, benefits foregone and health issues.

In addition to the above problems, the followings major points have been raised by stakeholders in project progress documents

- The executors did not submit their revised monthly plans and schedules on due time to the consultants and clients. Due to late schedule updating (rescheduling) the projects follow up and control are affected so that delay was imminent.
- Contractors raise claim that consultants are delayed on making comments and work measurements to the works executed.
- Major tools for planning and scheduling such as construction output and input indexes are not updated as to the current technological and managerial advancements.
- The evaluation of the work progress is not made based on the merits of the physical work progress; rather it is conducted in financial status basis.

Hence in order to solve the above major problems the following research aim and objectives are developed.

1.3 The research aim, objective and specific objective:

The aim of this research is to recommend a knowledge driven road construction planning and scheduling trends which will help to avoid risk factors that are associated with non excusable delays that finally will assist project managers generate accurate and reliable road construction plan and schedule.

Hence the main objective of this research is to assess and make recommendations on the practice and impacts of the planning and scheduling of road projects to Federal road projects.

Therefore in order to reach the main objective of the research the following specific objectives are set out:

- i. To identify the trends in the current practice and major problems in planning and scheduling of road construction projects.
- ii. To analyze the impact of scheduling which delay is inherent as an impact.
- iii. To assess the impacts of scheduling and constructability review methods of the planning and scheduling activities in the Federal road construction projects.
- iv. To assess how controlling is done in planning and scheduling of Federal road constructions.
- v. To make recommendations based on the above findings.

1.4 The Research Questions:

From the above objectives the following research questions are raised to answer the objective of the research

- Do the Federal road construction projects have standard procedures to plan and schedule? What are the common mandatory procedures in plan and schedule preparations? What are the major problems in estimating the durations of activities?
- What are the major reasons in planning and scheduling caused delays in Federal road projects activities? What are the factors that affect schedule effectiveness of the road construction projects?
- What are the common impacts in planning and scheduling of Federal Road projects? Is there risk management strategy in road construction project? What is your opinion in risks associated with non excusable delays? What are associated to the risks from the perspective of project stakeholders and life cycle of the projects? Is there a process of study on team of expertise other than participants of design concerning constructability of projects?
- How are the plans and schedules evaluated and reviewed in road projects? Based on the types of the schedule impacts happened in the projects you have been working? what was/were the major reason/s to make schedule updates/rescheduling to happen?

1.5 Scope of the study

The primary objectives of construction projects management are to optimize quality, cost and time. In order to secure the optimality of the project objectives planning and scheduling is very critical activity. This research work therefore, studies on the planning and scheduling of Federal roads construction projects, considerations in planning and scheduling in relations to the risk factors of non-excusable delays. Hence, the scope of the study is restricted to the major consideration in road construction planning and scheduling and causes of non excusable delays in relation to their impacts on scheduling.

In this research the major focus concerning procedures of resource assignment and time estimating in road projects at different level with the help of constructability review concepts had been studied. Ethiopian government through its agencies: Ethiopian Roads Authority (ERA), Addis Ababa City Roads Authority (AACRA), and Regional Rural Roads Authorities have started a major road sector development program to increase the road network in the country which includes new, upgrading and rehabilitation projects, this study has focused on Federal road upgrading and rehabilitation projects implemented by ERA during the RSDP I and II as well as part of RSDP III, and IV (1997-2010).

The scope of the study is, therefore, limited to study of planning and scheduling trends, impacts of scheduling and risk factors of non excusable delays in Ethiopian Federal road projects. All projects selected for the desk study were from projects in progress of more than half of the contracts and the data used came from published/ unpublished sources within Ethiopian Roads Authority (ERA).

Besides the identification of risk factors leading to non-excusable delays, this thesis work has attempted to assess the current project time estimating practices in Ethiopian Federal road construction projects, and to examine methods that could improve the overall time estimating accuracy and management of risk factors to non excusable delays in Federal road construction industry. Every effort has been made to seek information from relevant stakeholders, and to review different standard literatures.

However, the thesis work is limited by several factors: due shortage of allocated budget for the research work, it has not been possible to get detail data for the projects undertaken by road contractors as most of the relevant documents for these projects are found at Districts and project offices requiring visiting the actual site of the project. Hence, some of the findings of the study are based on ten sample projects.

2. Literature review: Project planning and scheduling

2.1 *Project definition*

According to the Project Management Institute (PMI®) is professional association for project managers (more about them later). In the latest edition of the Project Management Body of Knowledge, or PMBOK® GUIDE (2008), the PMI defines a project as “a temporary endeavor undertaken to produce a unique product, service, or result.” Temporary means that every project has a definite beginning and end. Unique means that this product, service, or result is different from others that may have preceded it [3].

Abraham Assefa also describes projects as a means of organizing activities that cannot be addressed within the organization's normal operational limits. Projects are, therefore, often utilized as a means of achieving an organization's strategic plan, whether the project team is employed by the organization or is a contracted service provider [3].

Also projects are basically operations of some verified tasks there are different views from the whole process of continual tasks. PMI (2000) Organizations perform work to achieve a set of objectives. Generally, work can be categorized as either projects or operations, although the two sometimes overlap. The common characteristics shared include, performed by people, constrained by limited resources, and they are planned, executed, and controlled. Projects and operations differ primarily in that operations are ongoing and repetitive, while projects are temporary and unique [4].

When projects are said temporary endeavor, temporary means that every project has a definite beginning and a definite end. It does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite. Projects are not ongoing efforts. Also when it is said unique products, services or results, it is referring to a project creates unique deliverables, which are products, services, or results. Uniqueness is an important characteristic of project deliverables [3].

For example, many thousands of office buildings have been constructed, but each individual facility is unique, different owner, different design, different location, different contractors, and so on. The presence of repetitive elements does not change the fundamental uniqueness of the project work [3].

Hassanein and Moselhi (2004) stated that road projects can be classified as a linear repetitive project. Though the projects might have the presence of repetitive elements, it does not change the fundamental uniqueness of the project work (PMI, 2004). Repetitive projects can be classified into two broad categories: linear (such as highways and pipelines) and nonlinear (such as high rise and multiple housing constructions) (Vorster et al. 1992 cited by Hassanein and Moselhi (2004)). While the former are repetitive due to their geometric layout, the latter are repetitive as crews repeat the same task in all units. For linear projects, assigning crews to nonadjacent units prolongs the construction schedule and increases total cost [3].

Thus a road project is a linear repetitive engineered construction project requiring an external organization for its implementation and is a temporary endeavor undertaken to produce a unique product, the road infrastructure [4].

2.2 Project planning

Prior to discussing construction project planning it is essential to make a glance at planning as whole function of management. According to koontz and O'donnell, Planning as general management function is deciding in advance what to do, how to do it, when to do it, and who is to do it." The following are some basic characteristics that differ planning from other management functions [4]

1. Planning focuses on achieving the objectives: Management begins with planning and planning begins with the determining of objectives. In the absence of objectives no organization can ever be thought about.
2. Planning is the primary function of Management: Planning is the first important function of management. The other functions –organizing, staffing, directing and controlling come later. In the absence of planning no other function of management can be performed.
3. Planning is continuous: Planning is the process which begins with the beginning of business itself and ends with the ending of the business. It means that as long a business exists, the planning process is continuous.

Planning is the first and most important function of the management. It is needed at every level of the management. In the absence of planning all the business activities of the organization will become meaningless. The importance of planning has increased all the more in view of the increasing size of organizations in the absence of planning; it may not be impossible but certainly difficult to guess the uncertain events of future [4].

Concerning construction project management, it is stimulated through a study of project documents. These documents include but are not limited to the available technical and commercial studies and investigations, designs and drawings, estimation of quantities, construction method statements, project planning data, contract documents, site conditions, market survey, local resources, project environment and the client's organization. The planning process takes in to account, the strengths and weakness of the organizations [4].

Construction planning bases time performance with cost, quality and safety as one of the four main critical success factors in any construction project. The initial planning framework of a project, including contractor commitment to the overall construction timescale, is set during the preconstruction 'first planning' period. Adequate preconstruction planning is therefore recognized as essential to limit potential for later construction delays and cost overruns [4].

However, many recent industry initiatives while recognizing the need for accurate planning at the strategic level have resulted in much focus upon improving site-based construction planning. This, of course is after the contractor has irretrievably committed to a contractually binding construction project timescale. The production of feasible preconstruction and project master plans is essential to achieve later success during the construction phase and any failure in producing this can affect both the client's and contractor's success and negate or neutralize any successful onsite planning [4].

Logistics involves how prefab parts are going to be delivered to the site, how tools and other equipments are supplied to the workers, how they are feed, and so on. Also it is mandatory to have project and technical strategies. Project strategy worries how tasks are done where technical strategy is about whom will make tasks done [5].

Construction project planning is the necessary forerunner to scheduling and includes defining work tasks, determining general sequence, construction methods and assigning responsibilities [5].

2.4.1 Planning process

It is fundamental to analyze the planning process in order to identify what is done during each planning procedures. According to Ibrahim most design and construction projects pass through the following phases: programming/Planning (Pre-Design), design, bidding/contract negotiations, construction and post-Construction/commisioning [4].

He also discussed that for competitive bid construction projects, prudent general contractors typically begin the development of a work plan during the bid preparation phase. Price quotations and performance durations are obtained from preferred subcontractors for various major or specialty elements of the project. Cost and time estimates, for the remaining elements of the project are estimated by the general contractor and merged into the bid price and bid schedule. At this stage, the schedule is almost exclusively a planning tool to help determine if the project can be completed within the required time specified in the construction contract with the resources available [4].

According to Jeyakumar planning aims to utilize time, resources and finally methodologies to implementation will be formulated. Hence the process and techniques has been drafted based on project objectives. At the beginning of the project planning time planning is very critical. Breaking down project works is mandatory process and techniques. Then resource planning will be followed by forecasting resource requirements, material supply and selections of equipments. Finally implementation of plan with different techniques of controlling and monitoring is performed [4].

Table 1 List of the project planning techniques [4].

Stages	Planning process	Techniques/methods
Planning time	Breaking down project work	Work break down,
Planning resources	Forecasting resource requirements, planning manpower requirements, planning material requirements, budgeting costs, designing organizational structure	Man power , material ,resource allocation Cost planning & budgeting Equipment selection
Planning implementation	Formulating monitoring methodology	Resource productivity control, time control, contribution control, budgetary control

2.4.2 Mistakes in planning

During planning process mistakes might be done if they are not identified. It is helpful to sort out common mistakes done during planning. Ibrahim believed there are five common mistakes that people made in planning [4].

2.2.2.1 Unilateral Planning

This mistake is made when the project manager plans a project for the group and turns it over to the group members to execute. The major reason that this is a mistake is no one individual can possibly think of everything in a project. Even a one person project can benefit from the thinking of other individuals [4].

Furthermore, when a project is planned, and task's duration is estimated, then estimates are likely to be wrong. Specifically, unilateral estimates are very likely to be optimistic because it is forgotten about all of the details that consume most of the time. For this reason, the person who eventually does the work is not likely to be very committed to the time it is specified by single person. If the person misses the mark, it is likely to be said, "It was your number, not mine. I knew it couldn't be done that fast" [4].

No project can succeed when the team members are not committed to the plan, so the first rule of project planning is that the people who must do the work should help plan that part of the project. Not only will it is gained their commitment to the plan, but they will most likely cover all of the important issues that single person may have forgotten [4].

2.2.2.2 The Ready- Fire- Aim Mistake

When project is to be executed with need of urgency and funds are available, most of the executors are eagerly anticipated to get the job done. The reason that project plan is not done by the executor is that they are convinced project is completed by the time they could do the plan. The complaint is, "We don't have time to plan; we need to get the job done." However, this is a counterintuitive situation. Proper planning helps to deliver the project with the best possible duration [4].

2.2.2.3 Planning in Too Little Detail

One major cause of project failures is that approximate estimates become targets. If the ball is hit over the wall, it is out of the approximate. If it does not go over the wall, then it is in the approximate. So we use the term *approximate estimate* to mean one that is nearly correct. (It is within acceptable boundaries or limits.)[4].

2.2.2.4 Planning in Too Much Detail

Unfortunately, the reverse of too little detail also causes problems. Some people get carried away and micro plan. I know. I did it myself once, and lived to regret it. The basic principle is that you should never plan in more detail than you can actually control [4].

2.2.2.5 Failing to Plan for Risks

Risk planning is one of the fundamental considerations in planning and scheduling stages due to reasons that life is full of surprises so we surely got what we did not expect and life is again full of surprises which engage us with unforeseen events again and again. Risks and opportunities are common in construction sector that needs to be considering [4].

2.2.3 Developing the work breakdown structure (WBS)

One of the basic ingredients of planning process is preparation of work break down structure of the project. James defined work break down structure as the frame work to the functional organizational body of which each activities of the project is performed. That also includes analysis of resources to deal with planning and scheduling of the project. Therefore it is mandatory to verify the steps to be consisted in the general process of planning and scheduling. Then continuing methodologies should be discussed in order to approach best way of the WBS [5].

PMI summarizes, WBS is a deliverable-oriented decomposition of the project scope (Project Management Institute 2008) until a sufficient level of granularity enables easy definition of all information required to execute and manage detailed tasks [6].

According to James construction planning and scheduling may be said to consist of five steps: [5].

1. A determination of the general approach to the project
2. Breakdown of the project into job steps or activities that must be performed
3. Ascertainment of the sequential relationships among these activities
4. Graphic presentation of this planning information in the form of a network
5. Endorsement by the project team.

There are two different planning methodologies in general: beginning-to-end planning and top down planning. Beginning-to-end planning breaks the job into steps or activities, starting with mobilization of the project, and proceeds step by step through the project to completion. This method presumes some level of detail from the beginning or starts with limited detail and adds detail as planning proceeds [5].

Top-down planning, sometimes referred to as work breakdown structure, starts with the overall project, breaking it into its major pieces, then breaking the major pieces into their component pieces. This process continues until the pieces are of sufficient detail to satisfy the complexity of the project. Both methods arrive at the same result: job activities that can be used to form a graphical logic diagram. It utilizes the following common types of WBS, namely, the Project WBS, Standard WBS and Contract WBS [6].

Due to the complex behaviors and high cost of execution, road construction should follow top-down planning method because it precisely estimates resources needed and works to be done.

The Project WBS is an operational tool usually prepared by contractors to monitor and control the work. A contract WBS is agreed between owner and contractor. This is a decomposition of the scope of work into the main elements that will be used for progress measurement, control and payment of the contract price. It may include less detail than a Project WBS.

2.2.4 Job Activities

The segments into which a project is subdivided for planning purposes are called activities. An activity is a single work step that has a recognizable beginning and end and requires time for its accomplishment [7].

The extent to which a project is subdivided depends on a number of practical considerations, but the following eight are suggested as guidelines for use when activities are being identified: [7].

1. By area of responsibility, where work items done by the general contractor and each of its subcontractors are separated
2. By category of work as distinguished by craft or crew requirements
3. By category of work as distinguished by equipment requirements
4. By category of work as distinguished by materials such as concrete, timber, or steel
5. By distinct structural elements such as footings, walls, beams, columns, or slabs
6. By location on the project when different times or different crews will be involved
7. With regard to owner's breakdown of the work for bidding or payment purposes
8. With regard to the contractor's breakdown for estimating and cost accounting purposes

Based on the above guidelines activities should be identified. The use of each point to identify activities can vary from one work item to the other depending on the nature of the works methodology. The activities used may represent relatively large segments of a project or may be limited to small steps [7].

For example, a reinforced concrete wall only be a single activity, or it may be broken down into erect outside forms, tie reinforcing steel, erect inside forms and bulkheads, pour concrete, strip forms, and cure. Trial and error together with experience are the best guides regarding the level of detail needed. What is suitable for one project may not be appropriate for another. Too little detail will limit planning and control effectiveness [7].

2.2.5 Estimating Activity Durations

It is important that someone experienced in, and familiar with, the type of work involved be responsible when the activity durations are being estimated. With respect to work done by contractors, it is good practice to solicit input from them concerning the times required for those activities for which they are responsible. Contractors usually are in the best position to render judgments concerning the times required for the accomplishment of their works [8].

Greg broadly classifies common methods of preconstruction duration estimating into two.

- 1) setting the project completion date based on the client's time constraints, e.g., occupancy need,
- 2) Conducting a detailed analysis of the work to be done and resources available [8].

Both methods have shown a tendency to produce problematic estimates. Method 1 can lead to unrealistic construction time estimates driven by external factors, usually in the form of a fixed date of occupancy. Estimates based on a fixed date of occupancy is based on the actual project requirements in order to meet the occupancy need date, thereby resulting in an overly optimistic construction duration estimate. Additional problems with this optimistic estimate result when large portions of construction time are consumed by procedural issues, thus leaving little remaining time in which to meet the client's occupancy need date [8].

While method 2 provides a more comprehensive estimate of construction duration, it is often impractical because of the time and manpower limitations associated with estimating construction projects. In addition, estimates may vary widely since this method is highly dependent on the skill and experience of the planning engineer. The ability to estimate individual construction tasks may also be limited during the planning phase, as many of these specific tasks and materials have yet to be determined. This inability to establish a complete estimate during the project planning stage is a major drawback of this duration estimation technique [8].

Regardless of the construction stage at which the duration estimate is completed, most organizations simply do not have the resources to produce this type of comprehensive estimate for multiple construction projects [8].

Between the two methods of estimating time the second method is suitable for road constructions in Ethiopia. Because it will provide first hand resource and schedule controlling mechanism to the project stakeholders.

A review of the current state of preliminary duration estimating practices in the highway construction industry identifies a significant need for historically-based systematic methods for estimating construction duration early in project design. Other industry sectors have sought to resolve similar needs by using statistical regression analysis (SRA) to quantify and model the relationship between project parameters or factors and duration. This section presents a brief review of research performed in other construction industry sectors using SRA to reliably predict duration using early-known project details [9].

The works cited here are segregated into two sections (1) *Bromilow's Time-Cost Model*, and (2) *Parametric Regression Analysis to Predict Duration*. Bromilow's work stemmed a number of works in the project duration research field [9].

1 Bromilow's Time-Cost Model

Bromilow [1969] is the first author referenced to have studied the prediction of construction duration using early-known project details and statistical regression analysis (SRA). Bromilow [1969] developed a regression model for predicting building construction duration in terms of estimated cost. Bromilow's time-cost model (BTC) has been the basis for many additional research studies relating to construction time determination [Kaka and Price 1991, Kumaraswamy and Chan 1995, Chan 1999, Ng et al. 2001, Skitmore and Ng 2001]. The regression model developed by Bromilow [1969] is shown below: [9]

Bromilow's Time-Cost Model

$$T=KC^B \quad \text{[Eq 1]}$$

Where:

T = actual construction time in working days,

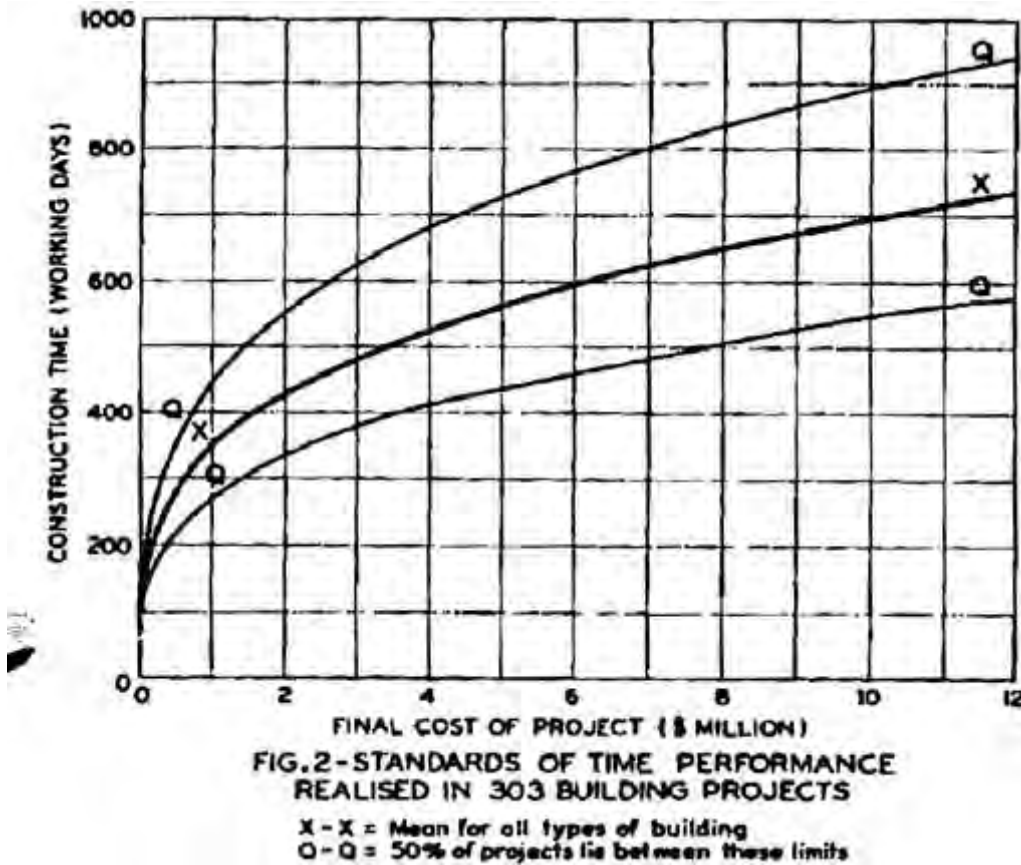
C = final cost of building in millions of dollars,

K = constant characteristic of building time performance,

B = constant indicative of the sensitivity of time performance to cost level.

The sole use of cost as indicator for time was found only after exploring gross or net floor area, ground area, number of floors, and building volume. In fact, Bromilow [1969] also found that the construction time for building does not depend “very strongly” on the type of building or its location. Figure 1 below shows the non-linear relationship between construction duration and project cost found through investigation of over 300 building construction projects in Australia [9].

Figure 1 Standards of Time Performance



While Bromilow's model did not incorporate additional factors in estimating construction time, other authors have not agreed. Ng et al. [2001] modified the BTC model and concluded that different parameter estimates are needed for different project types. To accommodate the differences between projects, Ng et al. modified the BTC's components to accommodate two different project types: one for industrial projects and one for non-industrial projects [9].

The work performed by Ng et al. [2001] was followed up by Skitmore and Ng [2001]. This study set out to determine whether a simpler ratio measure of the relationship between time and cost could be found. The authors developed the following ratio: [9]

Modified Time-Cost Model

$$B = \ln T / \ln C \quad \text{[Eq 2]}$$

Where:

T = construction time in working days,

C = project cost in dollars,

B = constant indicative of the sensitivity of time performance to cost level.

Kaka and Price [1991] extended beyond modeling construction time using only cost. Instead, they [1991] set out to demonstrate first, the difference between modeling public and private buildings, as well as civil engineering projects. Citing a work by the National Economic Development Office (NEDO) in 1988, the authors also supposed and tested the influence of the type of client (public or private), type of tender, and the form of tender. Through this study, Kaka and Price [1991] reached the following conclusions:

1. The type of bid competition did not affect the reliability of the BTC model;
2. The type of client (public or private) does influence the time-cost relationship with public building works generally taking longer than private works;
3. the type of project affected the relationship considerably with civil engineering works taking less time to complete than buildings of the same value; and
4. The form of the contract significantly influenced the time-cost relationship with adjusted price contracts being the largest (in dollars) and longest (in working days).

Kumaraswamy and Chan [1995] set out to determine the influences of building parameters on construction time in the Hong Kong construction market. Kumaraswamy and Chan [1995] first confirmed the BTC model. The authors also considered other expected influential factors, particularly, the influence of building floor area on construction time [Kumaraswamy and Chan 1995]. To explore this relationship, the authors developed a model in the form: [9].

Floor Area and Construction Duration

$$T=LA^M \quad \text{[Eq 3]}$$

Where:

A = floor area in square meters (m²).

T = construction time in working days,

The other model factors (T, L, and M) are the same as those in the BTC model. The authors found this model to be statistically significant, but recommended the consideration of numerous other project factors in additional phases of research [9].

Finally, Chan [1999] confirmed the original BTC model and established the factors generally applicable in Hong Kong. He also confirmed the findings by Kaka and Price that publicly funded building construction projects generally take longer than their similarly valued private counterparts [9].

2 Parametric Regression Analysis to Predict Duration

Collection of research relating to parametric regression analysis for predicting construction duration demonstrated a large detachment between the work taking place in the United States, and that being performed internationally in the United Kingdom, Australia, and Hong Kong.

Orczyk [1989] proposed identifying and modeling milestone dates for construction projects using conceptual design parameters. To do so, he first surveyed construction industry professionals to determine those project milestones and parameters most crucial to construction duration for a small office building (1 to 4 story).

The survey results indicated that the five most crucial factors to construction schedules were type of frame, owner's schedule requirements, subsurface conditions, type of cladding, and number of floors. He next developed a survey requesting actual historical data on these parameters from across the United States. Through model development and schedule simulation, Orczyk [1989] was able to explain 72% of the variation in the parameters and the timing or occurrence of events. The total area of the building accounted for 45% of variation explained [Orczyk 1989]. Finally, Orczyk [1989] reviewed the results of surveys sent to highway and bridge constructors. While there was not a sufficient amount of data returned for analysis, he cites the most commonly reported influential parameters for highway and bridge construction as weather and the volume of earthwork. Meanwhile, completion of sub-grade, paving, bridge substructure, and bridge superstructure as significant milestones in the construction process [Orczyk 1989]. A study performed by the United States Army Corps of Engineers describes the prevalence of underestimating construction duration within in military and civil works [East et al. 1992]: *“In fiscal year 1988, actual duration of military construction projects took an average of 17 percent longer than estimated. Similarly, actual duration of civil construction projects averaged 19 percent longer than estimated.”* [9].

To remedy this problem, the study incorporates three factors found to unexpectedly extend construction activities: work delays, weather delays, and productivity delays. From this information, a contract scheduling system is developed that requires the input of project parameters and specific activity information and durations [9].

In the Hong Kong public housing sector, Chan and Kumaraswamy [1999a, 1999b] found that prediction equations typically included the number of stories, gross floor area, ratio of gross floor area to ground floor plan area, external cladding area, type of foundation, information exchange between architect/contractors, ground conditions, and labor productivity [Chan and Kumaraswamy 1999a, Chan and Kumaraswamy 1999b]. Notice several of these same factors exist in their earlier building industry prediction models [9].

Burrows et al. [2005] studied the relationship between project sector, procurement route, contractor selection method, client type, building function, and location to the building construction duration using data from more than 1,500 new building construction projects in the U.K. between 1998 and 2002. Each of these categories was subdivided into a number of more

detailed classifications, each of which analyzed for their relationship to building construction duration [Burrows et al. 2005]. The results provided a number of important insights regarding the relationship between the aforementioned factors and the construction duration. First, there is a significant relationship between project cost and duration [9].

As seen, other construction industry sectors have investigated the relationships between early-known design parameters and project duration (both contract and construction duration). SRA is the most commonly cited method for identifying and quantifying the relationships between early-known project details and duration. It is expected that the highway construction industry would realize similar results [9].

Abraham Assefa in his thesis discussed that the Bromilow's principle has been found valid for IC projects carried out under International Competitive Bidding Contracts. The formula to calculate time for the project categories would be: [10]

$$\begin{aligned} & \text{IC - AC Road Projects} \\ & \text{Log } (T) = - 47 .058 + 8 .7640 \text{ Log } (C) - 0 .0394 (\text{Log } (C))^3 \end{aligned} \quad \text{[Eq 4]}$$

$$\begin{aligned} & \text{IC - DBST Road Projects} \\ & \text{Log } (T) = - 32 .759 + 6 .1661 \text{ Log } (C) - 0 .0268 (\text{Log } (C))^3 \end{aligned} \quad \text{[Eq 5]}$$

Where

T – Time in calendar days

C – Cost in Ethiopian Birr

The Bromilow's principle has been found to invalid for domestic contractor projects carried out under National Competitive Bidding Contracts. Though, the relationship with final Time and cost was weak for projects the relationship between contract Time and length has been found to be strong enough to yield the result shown below:

$$\begin{aligned} & \text{DC – gravel surfacing Road Projects} \\ & (T_c) 15 .0615 + 20 .2224 (L) - 0 .2631 (L)^2 + 0 .0013 (L)^3 \end{aligned} \quad \text{[Eq 6]}$$

Where

T – Time in calendar days

L –project length in km [2].

2.2.7 Time contingency

The main goals of any successful construction project management system(s) are to complete the project on time, within the planned budget, and with the required quality limits. The three goals are inter-related where each of them is affecting, and being affected by, the others. In order to meet the time deadline of a project, an accurate scheduling should be sought. Due to the unique nature of construction projects, time contingency and project uncertainty are essential for accurate scheduling, which should be flexible enough to accommodate changes without negatively affecting the overall duration of the project. It is essential to allocate a contingency value to both cost and time (Touran, 2003). Yet, there are situations where there could be delays in activities that result in a delay in the overall project duration. These delays will consequently have a negative impact on the quality and budget of the project [10].

After the proper time estimation of projects are successfully completed it is very essential to consider some unexpected risk factors that affect normal working environment. Therefore, estimating time contingency is seen as a major factor for achieving a successful construction project time. Although several industrial sectors developed and used software for estimating time and cost contingencies in order to minimize delays and over budget, yet limited efforts are reported in the literature in the area of predicting time contingency in the construction sector [10].

It is an amount of money or time (or other resources) added to the base estimated amount to achieve a specific confidence level or allow for changes where experience shows obligation. It can also be defined as the budget that is set aside to cope with uncertainties during construction or the amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to an acceptable level to the organization (PMI, 2000). Department of Treasury (United States 1993) identified two major categories of contingency for construction projects: [10].

- i. *Design Contingency* – it addresses the changes during the design process for factors, such as incomplete scope definition and inaccuracy of estimating methods and data (Clark & Lorenzo, 1996).
- ii. *Construction Contingency* – it addresses the changes during the construction process. Under a traditional procurement arrangement, the contract typically contains a variation clause(s) to allow for changes and provide a mechanism for determining and valuing variations (Staugas, 1995). [11].

Most engineers, planners, and agencies depend on their experience to estimate cost and time contingency. The contractor's contingency was represented as a fixed percentage of the contract value or as a percentage of total project cost or duration. Smith and Bohn (1999) estimated the contingency as 5-10% of the contract value. On the other hand Park and Peña-Mora (2004) estimated time contingency as 20% of the project duration [10].

Documents from various contractors and consultants engaged in Federal road constructions engineer's used 5-10% of time and cost contingency to road constructions.

2.3 Project scheduling

Scheduling is the process of assigning activities duration and identifying the start and completion times of activities and project. [1]

According to Saleh Mubarak et al scheduling is the determination of the timing and sequence of operations in the project and their assembly to give the overall completion time. As mentioned previously, scheduling focuses on one part of the planning effort. It is also timing and sequence of operations are considering that is an expanded explanation than others definitions of Scheduling. Scheduling determines the timing and specific sequence of tasks necessary to carry out the plan. The schedule is a result of the planning process and reflects the selected plan. Therefore, an inability to schedule stems from a reluctance or incapacity to plan [11].

2.3.1 Scheduling process

Project scheduling involves charting the resources requirements or anticipated progress in completing component activities over the project's time horizon. Scheduling is an inevitable part of life and essential part of every plan. Without scheduling, managers cannot be certain that they are actually processing towards their goals. It could be said that scheduling put the plan on calendar basis. Therefore, a time schedule outlines the project work programme; hence, it is a time table of work planned. Development of accurate work schedules is a challenge to managers due incompetence into consideration the factors that affect work scheduling. Construction project with effective work schedule is a recipe for progress monitoring and control as it depicts the activities to be executed on a time scale [11].

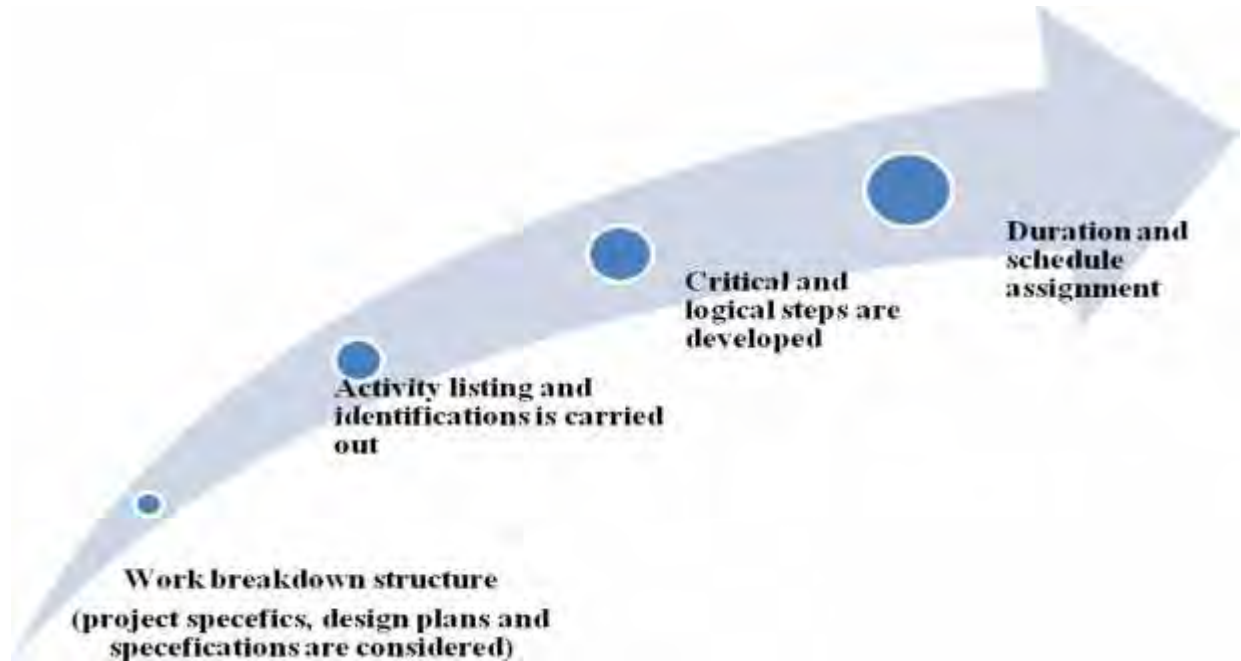
Without scheduling of work activities, it could be difficult to monitor activity progress and take corrective and control actions on the control milestone. It will also provide platform for measurement of the actual work progress and comparing it with the schedule work progress, determine if there is any deviation for corrective action. Project control puts the project plan on course again after determination of activities variance [11].

Applying Critical Path Method (CPM) for planning and scheduling of construction projects starts with identifying the list of activities by using Work Breakdown Structure (WBS). Then, the activities' logical constraints or relationships and duration need to be defined in order to identify the work sequences and start and completion dates'. Activities' duration is normally assigned by an experienced engineer familiar with the operation or by using the historical equipment performance record. Figure 2 shows the conventional planning and scheduling process [3].

The initial steps to developing a schedule are

1. Estimating the time required for each activity
2. Computing the time required for project completion
3. Establishing time intervals in which each activity must start and finish
4. Identifying the activities crucial to timely project completion [Clough et al. 2000].

Figure 2 Conventional activity planning and scheduling [3]



The work duration is normally comprised of productive, supportive, and non productive time. Basically, the duration of supportive time (scheduled maintenance, resetting machine, etc.) and non-productive time (unscheduled downtime, delays, etc.) is not well documented. However, for activities requiring conventional construction equipment, the work duration can be subjectively and realistically estimated based on the equipment availability, past performance data and experiences of engineers or operators. From all steps listed in figure 2, defining logical relationships between activities is the most critical step regarding the commonly found mistakes that make the schedule unrealistic. Planning and scheduling of activities using automated equipment requires planners to pay close attentions to activities' duration assignment due to several reasons [3].

The basic problem in inexperienced engineers to estimate the period is first, the automated equipment has not been employed in the organization before; then, experiences of engineers or operators related to supportive and non-productive time cannot be accurately estimated. Secondly, past performance data pertinent to the work natures may not be available. Finally, the availability of automated equipment may not be as widely as conventional one. The planning and scheduling process of activities is shown in figure 2.

From all steps listed in figure 2, defining activities' duration should be the most critical step of overall process [3].

Project scheduling of the highway consisted of dividing the project into activities and establishing the logical relationships between them. This process established what was going to be done on the project and when each activity was to be accomplished [3].

Prior to beginning the process of project scheduling it is mandatory to establish what is known as work break down structure (WBS) of the specific project. It is very strong tool to establish sound scheduling to the best working projects [3].

WBS should consist the following fundamental characteristics:

1. It identifies all work to be done in the project graphically, so that it can be reviewed by all stakeholders to ensure that nothing has been forgotten.
2. It provides a graphical representation of the scope (or magnitude) of the job. This is important because people are sometimes surprised at the cost estimates you give them, and this helps them see why the job is going to cost as much as you have said it would.
3. The WBS provides the basis on which resource assignments are made.
4. It allows you to estimate working times for each task.
5. Knowing the working times then allows you to calculate labor costs for all work, so that you develop a *labor budget for* the project. The times also provide the basis for developing a schedule.
6. You can also identify material, capital equipment, and other costs associated with each activity (such as insurance costs) [3].

There are different tools to help scheduling process in construction; According to PMI the followings are the most common used in construction industry

1. Mathematical analysis method: it involves calculating theoretical early and late start finish dates for project activities without regarding any resources pool limitations.
 - ❖ Critical path method (CPM): calculates a single deterministic early and late start and finish date for each activity based on a single duration estimate.
 - ❖ Program evaluation and review technique (PERT): uses a weighted average duration estimate to calculate the activity durations.
 - ❖ Graphical evaluation and review technique (GERT): allows the probabilistic treatment of both network logic and activity duration estimates [3].
2. Duration compression is a special case of mathematical analysis that looks for ways to shorten the project schedule without changing the project scope.
 - ❖ Crashing: in which cost and schedule tradeoffs are analyzed to determine how, if at all, to obtain the greatest amount of compression for least incremental cost.
 - ❖ Fast tracking: doing activities in parallel that would normally be done in sequence.
2. Simulations: it involves multiple project durations with different sets of activity assumptions. Monte Carlo simulation analysis method is the common one.

Simulation methods are usually built to forecast uncertain outcomes and then to select the most attractive of feasible outcome scenarios from those calculated to inform decision making. Monte Carlo simulations are applied to project networks (cpm and pert) to output results from large number of trials. The output is then analyzed statistically to predict the most likely durations and completion date for any project activity the probability of specific targets being achieved [12].

Therefore in order to use simulations to the purpose of the duration estimating of activities it is mandatory to answer the following risk associated crucial questions

- What are the risks associated with achieving specific cost and time targets?
- What impact do changes in time of an activity have on the whole project?
- When can the project as whole be completed?
- Can it be delivered on time?

The general scheme of Monte Carlo simulation is as follows

- Generate random values for each of activity duration with in critical path of the project.
- Add each series of random values to arrive the total project durations.
- The expected duration of this project will be the average of these values.

The random value for each selected activity

- =Rand(0,1)*(period1-2)(1)

Determining the number of iterations

The Monte Carlo method provides an estimate of the expected value of a random variable and also predicts the estimation error.

The total error $\hat{\epsilon}$ is given by:

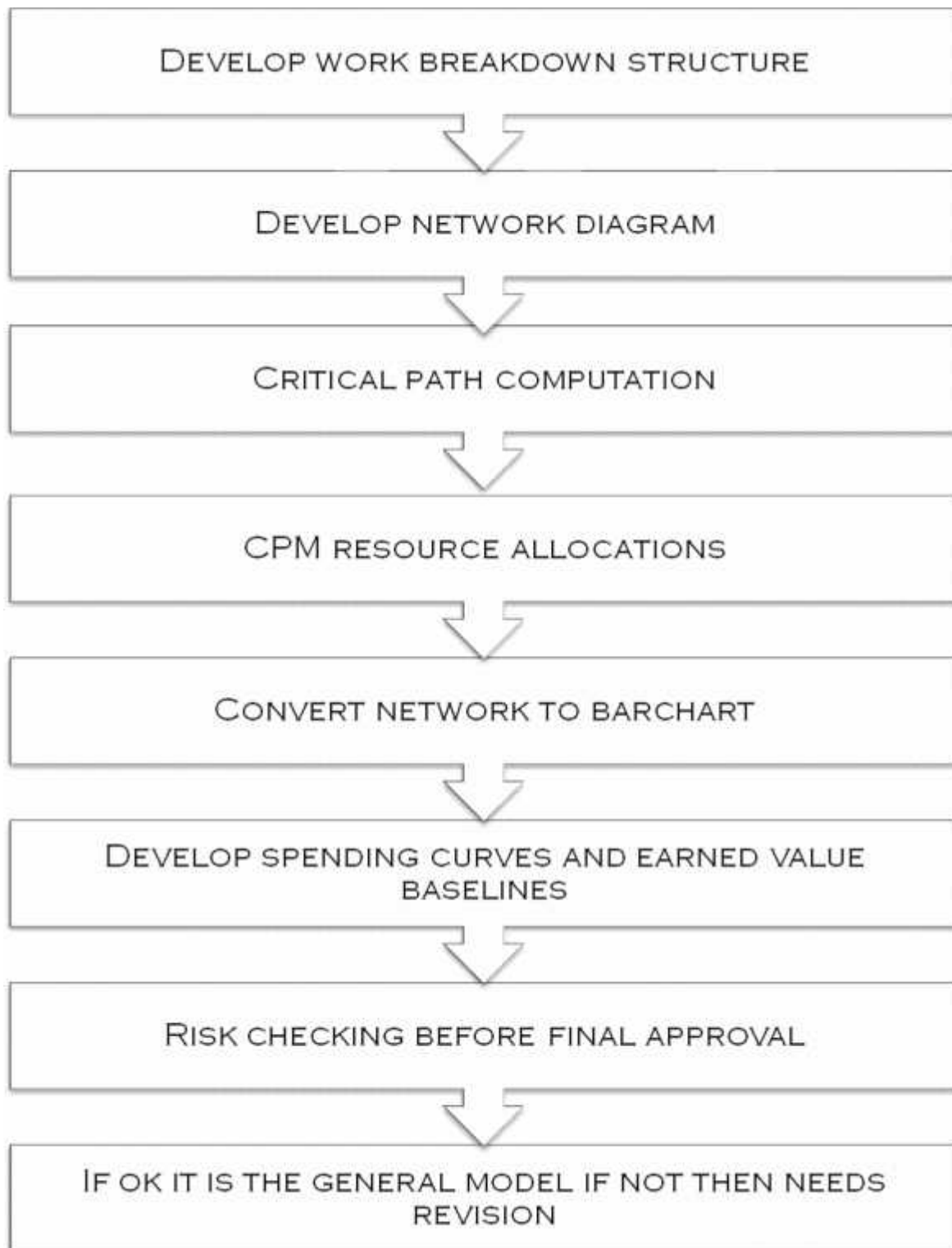
$$\hat{\epsilon} = 3\delta / (\sqrt{N}) \dots \dots \dots [Eq7]$$

Where δ is standard deviation of the random variable, N is the number of iteration.

The probability of the iteration's error should be as minimum as possible to 0.2%.

Most road construction projects follow common theories to achieve workable plan and schedule. At the beginning of the project execution project management team develops WBS. After achieving the first step network diagram will be prepared. This will help to achieve the project critical path. Then the resource allocation to the critical path will be done based on the above project analysis. Finally by converting the above findings to bar charts the project management team will develop spending and earned value baselines to project resource flow forecasting. The figure below illustrates the above work flows of projects [20].

Figure 3 developing the work breakdown structure and network diagrams [11].



2.3.2 Resource allocations and management:

In planning and scheduling of a construction projects the major factors that affect are resource allocation and management. These should carefully analyze in order to achieve successful delivery of the project goals. The word resource is used in many ways. In construction management the term is used to indicate three categories: Human, materials and equipment [3].

According to saleh human resource can be further classified into two as direct and indirect. Direct human resources are hired to execute a specific task or activity. (Carpentry, mason, iron workers electricians, foremen etc.....). Indirect human resources are hired and tied to the projects but not connected to the specific tasks or activities. (Superintendents, engineers, project managers, secretaries etc.....)

Materials resources are direct inputs to the productions of the project deliverables which are standardized in the contracts. Its management is defined as the planning and controlling of all necessary efforts to ensure that the correct quality and quantity of materials and equipment are appropriately specified in a timely manner, are obtained at a reasonable cost, and available when needed [5].

There three important objectives of materials management are as follows [3].

1. Ensure that materials meet the specifications and are on hand when and where required.
2. Obtain the best value for purchased materials.
3. Provide efficient, low cost transport, security and storage of materials at constructions sites.

Equipment resources: are tools that are used continuously in production process of the project deliverables. Equipment resources are divided into two.

1. Movable construction equipments: these type of equipments are used for the construction process but is not permanently installed. Eg. Bulldozers, backhoes, cranes, forklifts etc....
2. Immovable equipments: this type of equipment and materials stays permanently in the projects after completion. Examples of installed equipment are heat pumps, emergency generators, equipment installed in kitchens etc....

Hence based on the resource need to works to be executed, the planning and scheduling should be done properly with a very precise skill. That means resource assignment plays the most significant role in the scheduling of works, keeping in mind well thought is well done. In general resource allocation is the major consideration to planning and scheduling of road constructions. [3]

2.3.3 Planning vs scheduling

According to Jerry Glover, consultant understanding the distinction between planning and scheduling can best be approached by first defining management and briefly reviewing the functions of management, which includes planning - paramount of the functions. Most authorities define management as the establishment and maintenance of an internal environment in which people working together in groups can perform effectively and efficiently to attain group objectives. In addition to operational functions such as marketing, manufacturing, finance, engineering, construction, or some other endeavor, managers perform several functions which are common to all managers. These managerial functions are planning, organizing, staffing, directing, and controlling. These functions frequently overlap. For example, as group members plan to attain their objectives, they must often consider the adequacy of the organizational structure, staffing availability, or some other function of management [3].

Planning establishes *what, how, where* and *in what order* work will be performed, while scheduling sets forth *who* and *when*. Construction planning is the development of a feasible operational design for completing the work. The process involves the selection of work sequence and methods, and provides information for the scheduling process. Scheduling determines the timing and specific sequence of tasks necessary to carry out the plan. The schedule is a result of the planning process and reflects the selected plan. Therefore, an inability to schedule stems from a reluctance or incapacity to plan [3].

2.3.4 Constructability

i. Definition of Constructability

The concept of constructability was introduced by CII (1986), in which it stated “Constructability is the optimum use of *construction knowledge and experience* in planning, design, procurement, and field operations to achieve overall project objectives” (CII 1986). Constructability is also defined as a measure of the ease of expediency with which a facility can be constructed. Caltrans states that constructability is “The optimum use of construction knowledge & experience in planning, design, and procurement & field operations to achieve overall project objectives. They further definite constructability as, “the ease or expediency with which a facility can be constructed.”[13].

Constructability is an "attitude" that must prevail through conceptual planning, design and procurement and field operations. If performed right, constructability has been shown to reduce construction cost, by 10 to 20 times its implementation cost (More 1983) [12].

ii. Benefits of Constructability

Constructability leads to some important benefits due to early integration of construction knowledge and experience into the engineering and design of a project. Constructability has demonstrated the potential to minimize the number and magnitude of changes, disputes, cost overruns, and delays during construction (CII 1986).

Shortening construction time and improving project management by using constructability is expected to decrease overall project cost and thus reduce capital investment risk. The following are some direct benefits from constructability: [13]

- Construction planning is made easier
- Both design and construction costs can be reduced
- Likewise the construction schedule may be shortened
- Better quality can be required and expected
- More realistic commitments can be made to subsequent trades, and to
- Earlier owner occupation indirect benefits are more difficult to quantify, but nevertheless include.
- Building a collaborative team committed to project goals
- Parties working for mutual benefit
- Cross discipline training
- Transfer of expertise from other projects
- Constructors better understanding design intent, and vice versa
- Increased innovation in both design and construction.
- Shorter learning curves.
- Competitive advantage [13].

2.3.5 Planned Schedules and its Impacts

According to Abbas (2006), late completion of works as compared to the planned schedule or contract schedule is what is known as delay. Delay occurs when the progress of a contract falls behind its scheduled program. It may be caused by any party to the contract and may be a direct result of one or more circumstances. A contract delay has adverse effects on both the owner and contractor (either in the form of lost revenues or extra expenses) and it often raises the contentious issue of delay responsibility, which may result in conflicts that frequently reach the courts. A cost overrun occurs when the final cost of the project exceeds the original estimates [13].

There is a relationship between schedule, the scope of work and project conditions. Changes to any one or more of the three can affect the cost of the project and time of completion. It has been argued that it is necessary to create awareness of causes of project schedule delays, their frequency, and the extent, to which they adversely affect project delivery [13].

Planning and scheduling have direct relationships with delays which eventually cause cost and time overruns of the project. Therefore the remedial to possible cost and time overruns should be thought while one is preparing plan and schedule to a project [13].

The following 20 causes of schedule impacts for non excusable delays have been sorted out as major civil works construction worldwide.

Table 2 Ranked top 20 causes of non-excusable construction impacts [13]

Rank	Non-excusable causes of construction delay
1	Not selecting competent subcontractors
2	Poor management of the project changes
3	Lack of mechanism for recording, analyzing, and transferring project lessons learned
4	Delay in forwarding material and equipment to the site
5	Delay in awarding subcontractors' contracts
6	Lack of effective managing and controlling subcontractors
7	Delay in detail design by project engineer subcontractor
8	Delay in supplying shortage of the equipment
9	Poor management of project site
10	Poor management of project contract
11	Issues on recruiting, attaining, and promoting expert and experienced project team
12	Lack of effective communication and coordination with project stakeholders specially with the client/client's consultant
13	Delay in obtaining technical information from subcontractors
14	Conflicts among performing organization, client and client's consultant
15	Slow decision making by project manager
16	Detail design errors by project engineer subcontractor
17	Delay in basic design by performing organization
18	Lack of applying contractual tools (liquidated damage or acceleration of work) against subcontractor
19	Delay in basic design by project engineer subcontractor
20	Conflicts in work schedules of the subcontractors

Schedule impacts are incidents happened in projects that eventually causes counter effects to the baseline schedule [14].

➤ Types of Schedule Impacts

- Delays

A *delay* is an event that prevents the contractors from completing the work within the contractually specified performance period [Wickwire et al. 2003], a slowing down of the work without stopping it entirely, triggered by something other than a formal directive from the owner to stop work [14].

Damages from pure delays are those resulting from an extended performance period, including increased overhead and job site costs, equipment standby costs, wage escalation, and financing costs [Wickwire et al. 2003].

- Classifying Schedule Delays

Once recognized that an event has occurred in the as-built completion of a project that differs from the established schedule of record, which potentially has an impact on the schedule and is attributable to a party, the next step is to classify the delay, so that a schedule impact technique can be applied. Delays are classified into one of the following three categories: excusable, non-Excusable and Concurrent [14].

- Disruptions

A *disruption* can be defined as an impact that alters the contractor's planned work sequence or flow of work expected at the time of bidding, which results in increased difficulty, cost, and/or time [Bramble et al. 1990, Wickwire et al. 2003]. As opposed to delays, damages associated with disruption are likely to be increased labor costs due to inefficiency, the activation/deactivation of increased manpower, and additional equipment costs [Wickwire et al. 2003][14].

- Change

Another major type of potential schedule impact involves *changes*. When a contractor takes on any type of work that deviates from the original contract, or from the scope of work or plan of action reasonably anticipated under the contract, that results in an increase in performance time, the contractor may seek an adjustment [Bramble et al. 1990][14].

- Suspensions

A *suspension* of work is a written directive by the owner to stop all work on the project, either because the contractor has failed to perform in accordance with contract documents, or at the owner's convenience [Wickwire et al. 2003]. Work will not continue until the owner has raised the suspension of work. A cost and time adjustment shall be made for any suspension of work ordered by the owner, as long as the contractor was not responsible for the suspension of work. As opposed to a pure delay, when an owner issues a suspension of work, the contractor is also entitled to equitable adjustment for profit [14].

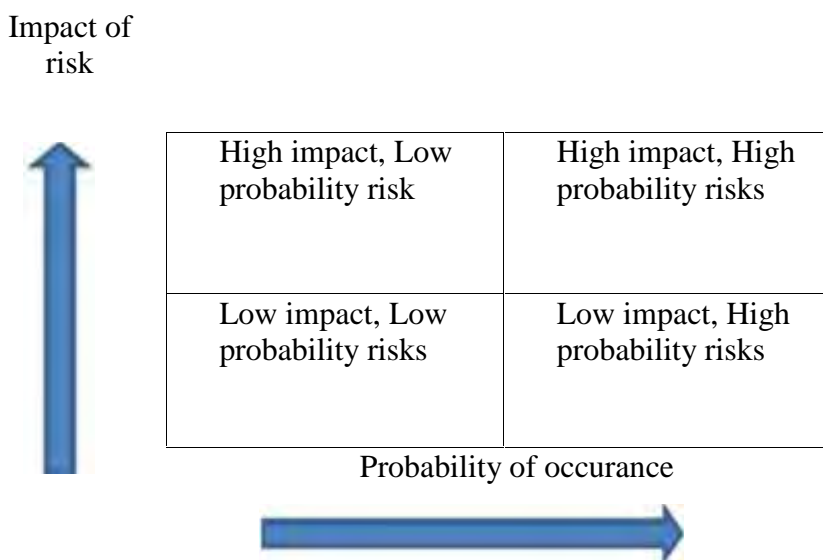
- Termination

Termination is a permanent stoppage of work of all or a portion of the contract and the contract is terminated. For a party to possess the right for termination, a termination clause must be specifically included in the contract. Most contracts allow the owner the right to terminate the contract, while some contracts grant the contractor this right [14].

2.4 Risk assessment and classification

Risk assessment or analysis process is the vital link between systematic identification of risks and rational management of the significant risks. It has as its primary objective the systematic consideration of risk events, their likelihood of occurrence, and the consequences of such occurrences. The risk analysis process aims to evaluate the consequences associated with risks and to assess the impact of risk by using risk analysis and measurement techniques (Flanagan and Norman 1993). In this phase the probability of occurrence and severity of impact for each identified risk are estimated, and risks for further attention are prioritized; Figure 4 below demonstrates the risk matrix. The main input to risk analysis process is the identified risks from risk identification process. The probability and impact of identified risks are two key variables in assessing the risk [15].

Figure 4 Risk assessment matrixes [14]



In assessment of risk, there are two general types: qualitative and quantitative risk assessment (Flanagan and Norman 1993 and Smith 1999). Qualitative Risk Analysis assesses the priority of identified risks using their probability of occurrence, the corresponding impact on project objectives if the risks do occur, as well as other factors such as the time frame and risk tolerance of the project constraints of cost, schedule, scope, and quality. Typically, a project's qualitative risk analysis will recognize some risks whose occurrence is so likely or whose consequences are so serious that further quantitative analysis is warranted. The analysis includes methods for prioritizing the identified risks for further action, such as quantitative risk analysis or Risk Response Planning. The direct judgment, ranking options, comparing options and descriptive analysis are also considered as the qualitative risk measurement [15].

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. The analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks. A key purpose of quantitative risk analysis is to combine the effects of the various identified and assessed risk events into an overall project risk estimate. For quantitative risk assessment, probability analysis, sensitivity analysis, scenario analysis, simulation analysis, correlation analysis, portfolio theory, Delphi method, influence diagrams, decision trees, are lists of available techniques [15].

Three basic risk analyses can be conducted during a project risk analysis: technical performance analysis (will the project work?), schedule risk analysis (when will the project be completed?), and cost risk analysis (what will the project cost?). This overall assessment of risks can be used by a Highway agency to make informed decisions about a project. More commonly, the overall risk assessment is used to determine cost and schedule contingency values and to quantify individual impacts of high-risk events. The ultimate purpose of the analysis, however, is not only to compute numerical risk values but also to provide a basis for evaluating the effectiveness of risk management or risk allocation strategies [15]. Quantitative risk analysis in general uses various analysis methods. Portfolio theory and Delphi methods are widely used techniques to assess the risk factors with the help of mathematical modeling methods.

2.4.1 Portfolio Theory:

Portfolio theory deals with the problem of constructing for a given collection of assets an investment with desirable features. A variety of different asset characteristics can be taken into consideration, such as the amount of value, on average, an asset returns on over a period of time and the riskiness of reaping returns comparable to the average [16].

For an investor, the total risk of an investment consists of two components: market risk (systematic risk) and specific risk (unsystematic risk). For any asset, the total risk of any portfolio is the sum of these components such that:

$$\text{Total risk} = \text{market risk} + \text{specific risk} \quad [\text{Eq8}]$$

Characterizing the Rates of Return of Assets and Portfolios

There are primarily two basic features of an asset. The first is the average return of an asset over a period of time. The second characteristic is how risky it is to obtain similar returns comparable to the average over the investment period.

For an asset with value $S(0)$ at time 0 and value $S(T)$ at time T , the rate of return is defined by:

$$S(T) = (1 + r)S(0) \quad [\text{Eq9}]$$

The rate of return of an asset is also sometimes referred to as the “yield” of the asset.

Since the outcome of an investment in an asset has some level of uncertainty, the value $S(T)$ is unknown exactly at time 0. To model the uncertainty we shall consider the value of the asset at time T as a random variable. Correspondingly, the rate of return defined by above equation is also a random variable. To characterize the asset we shall consider the average rate of return defined by:

$$\mu = E(r) \quad [\text{Eq10}]$$

Where $E(r)$ denotes the expectation of a random variable. This is also sometimes referred to as the “expected rate of return”. While the expected rate of return is a useful way to characterize an asset and gives us some indication of how large the returns may be, it does not capture the uncertainty in obtaining a comparable return rate to the average [16].

The *standard deviation* (or *variance*, which is the standard deviation squared), measures the total risk of an investment (Reilly, 1989). It is a statistical measure of the dispersion or variability of a risk profile, which represents the spread around the expected or historical value of the criterion [16].

2.4.2 The Delphi technique:

The Delphi technique, mainly developed by Dalkey and Helmer (1963) at the Rand Corporation in the 1950s is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain topic areas. Predicated on the rationale that, “two heads are better than one, or...n heads are better than one” (Dalkey, 1972, p. 15), the Delphi technique is designed as a group communication process that aims at conducting detailed examinations and discussions of a specific issue for the purpose of goal setting, policy investigation, or predicting the occurrence of future events (Ulschak, 1983; Turoff & Hiltz, 1996; Ludwig, 1997). Common surveys try to identify “what is,” whereas the Delphi technique attempts to address “what could/should be” (Miller, 2006).

Delphi technique can be used for achieving the following objectives:

1. To determine or develop a range of possible program alternatives;
2. To explore or expose underlying assumptions or information leading to different judgments;
3. To seek out information which may generate a consensus on the part of the respondent group;
4. To correlate informed judgments on a topic spanning a wide range of disciplines, and;
5. To educate the respondent group as to the diverse and interrelated aspects of the top

The Delphi process

Theoretically, the Delphi process can be continuously iterated until consensus is determined to have been achieved. However, Cyphert and Gant (1971), Brooks (1979), Ludwig (1994, 1997), and Custer, Scarcella, and Stewart (1999) point out that three iterations are often sufficient to collect the needed information and to reach a consensus in most cases. The following discussion, however, provides guidelines for up to four iterations in order to assist those who decide to use the Delphi process as a data collection technique when it is determined that additional iterations beyond three are needed or valuable [17].

Round 1:

In the first round, the Delphi process traditionally begins with an open-ended questionnaire. The open-ended questionnaire serves as the cornerstone of soliciting specific information about a content area from the Delphi subjects. This questionnaire is used as the survey instrument for the second round of data collection.

Round 2:

In the second round, each Delphi participant receives a second questionnaire and is asked to review the items summarized by the investigators. Based on the information provided in the first round, accordingly, Delphi panelists may be required to rate or “rank-ordered” items to establish preliminary priorities among items. As a result of round two, areas of disagreement and agreement are identified” (Ludwig, 1994, p. 54-55).

In some cases, Delphi panelists are asked to state the rationale concerning rating priorities among items (Jacobs, 1996). In this round, consensus begins forming and the actual outcomes can be presented among the participants’ responses.

Round 3:

In the third round, each Delphi panelist receives a questionnaire that includes the items and ratings summarized by the investigators in the previous round and are asked to revise his/her judgments or “to specify the reasons for remaining outside the consensus” (Pfeiffer, 1968, p. 152). This round gives Delphi panelists an opportunity to make further clarifications of both the information and their judgments of the relative importance of the items.

Round 4:

In the fourth and often final round, the list of remaining items, their ratings, minority opinions, and items achieving consensus are distributed to the panelists. This round provides a final opportunity for participants to revise their judgments.

Time Requirements

Conducting a Delphi study can be time-consuming.

Specifically, when the instrument of a Delphi study consists of a large number of statements, subjects will need to dedicate large blocks of time to complete the questionnaires. Delbecq, Van de Ven, and Gustafson (1975), Ulschak (1983), and Ludwig, (1994) recommend that a minimum of 45 days for the administration of a Delphi study is necessary. With regard to the time management between iterations, Delbecq et al. (1975) note that giving two weeks for Delphi subjects to respond to each round is encouraged.

Data Analysis

Regarding data analysis, decision rules must be established to assemble and organize the judgments and insights provided by Delphi subjects. However, the kind and type of criteria to use to both define and determine consensus in a Delphi study is subject to interpretation. Basically, consensus on a topic can be decided if a certain percentage of the votes falls within a prescribed range (Miller, 2006).

2.4.3 Risk classification

Risk classification is a significant step in the risk management process, as it attempts to structure the diverse risks affecting a construction project. In order to manage risks effectively, many approaches have been suggested in the literature for classifying risks. Perry and Hayes (1985) presented a list of factors extracted from several sources which were divided in terms of risks retainable by contractors, consultants and clients. Combining the holistic approach of general systems theory with the discipline of a work breakdown structure as a framework, Chapman (2001) grouped risks into four subsets: environment, industry, client and project. Of the 58 identified risks associated with Sino-Foreign construction joint ventures, Shen (2001) categorized them into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks [15].

In a word, many ways can be used to classify the risks associated with construction projects and the rationale for choosing a method must service the purpose of the research. The research by Patrick. X.W. Zou¹, Guomin Zhang² and Jia-Yuan Wang, team aims seek to study the risks from the perspective of project stakeholders and life cycle, and hence classify the risks in accordance with their origins concerned with stakeholders are [18].

- Tight project schedule
- Design variations
- Excessive approval procedures in administrative government departments
- High performance/quality expectations
- Inadequate program scheduling
- Unsuitable construction program planning
- Variations of construction programs
- Low management competency of contractors
- Variations by the client.
- Incomplete approval and other documents
- Incomplete or inaccurate cost estimate
- Lack of coordination between project participants
- Unavailability of sufficient professionals and managers
- Unavailability of sufficient amount of skilled labor

- Bureaucracy of government
- General safety accident occurrence
- Inadequate or insufficient site information (soil test and survey report)
- Occurrence of dispute
- Price inflation of construction materials
- Serious noise pollution caused by construction [18].

2.5 *Applications of constructability*

2.6.1 **Constructability review:**

The Constructability Review Process is intended to help improve the constructability and consequently the quality of a design. The resulting benefit is a cost-effective design that is biddable, buildable, and maintainable [2].

- Constructability Review

Constructability Review is a formalized process that utilizes a team with extensive construction knowledge to ensure that a design is buildable while also cost-effective, biddable, and maintainable, with reduced overruns and delays. A Constructability Review is to be conducted separate from and independent of the design team. The scope of Constructability Review is to be flexible to suit the individual project requirements [19].

- *Internal Review*

An Internal Review is managed by the successful service provider firm as identified in their EOI and RFP submissions to the regulatory body and is undertaken by their team not involved with the design. The Review is conducted in a workshop format at the specified milestone completion(s) and will result in specific observations or recommendations for implementation in design. At this time, Internal Review may be considered at 50 and 80 Percent Stages of Design [19].

- *External Review*

An External Review is conducted by one or more individual(s) listed in the regulatory body's roster of external reviewers for constructability review. The requirement for an External Review is identified by the ministry. A firm selects the individual(s) from the Ministry's Roster, based on the qualifications and expertise indicated. The firm identifies the individual(s) selected for External Review in their EOI and RFP submissions to the Ministry. An External Review is conducted at the schedule agreed and recommendations forwarded to the firm for implementation in design. At this time, External review is considered at 80 Percent Stage only [19].

- Frequency of Constructability Review

For large/complex assignments, the Constructability Review may be carried out at both 50 Percent and 80 Percent Stages. For other assignments, a Constructability Review may be conducted at 80 Percent Stage only [19].

- Staffing/Expertise Requirements

Depending on the scope of an assignment, typically, construction related expertise and knowledge in one or more of the following areas are required from the team members for Internal and External Review [19].

- Traffic / Staging
- Construction Supervision / Administration (biddability, construction claims, construction delays)
- Scheduling
- Estimating
- Bridge / Culvert Construction
- Temporary / Permanent Drainage
- Foundations
- Highway and Worker Safety
- Pavement / Geotechnical
- Electrical
- Utilities
- Environmental
- Maintenance (including maintainability, Maintenance access, etc.).

According to Department of Transport in United States, depending upon the assignment, a minimum of five years of experience in Construction Supervision / Administration / Management or otherwise proven successful experience is required. The individual must have worked on at least three projects of similar size and scope in the above areas [19].

2.6.2 Rescheduling and scheduling updating

Rescheduling is common in project management, especially in the manufacturing industry. Generally, unexpected events adversely affect projects when necessary treatments are not adopted. Therefore, the dominant issues in rescheduling are how to adapt to a changing environment and reschedule incomplete work and resources [20].

A rescheduling problem consists of general scheduling problems that develop after a schedule is updated. Project information modifications and schedule updating may generate additional constraints due to the altered environment. Based on schedule updating results, rescheduling must rearrange incomplete work and resources while generating a practical schedule that meets the project goal. Compared to the manufacturing industry, construction projects have more unpredictable factors, such as environmental and productivity issues, that make maintaining schedules difficult [20].

Although construction schedules are regularly updated and controlled during construction, few studies have investigated the effects of rescheduling issues on the rescheduling process. Therefore, applying manufacturing rescheduling concepts to the construction field is worthy of investigation [20].

- Construction rescheduling

It classifies rescheduling problems and can be used as a reference for construction rescheduling problems. For classification details, refer to Vieira et al. The terms used in this study are quoted from Vieira et al. as follows [20].

- ✦ Rescheduling is the process of updating an existing production schedule in response to disruptions or other changes. This includes arrival of new jobs, machine failures, and machine repairs.
- ✦ Rescheduling environment identifies the set of jobs that the schedule should include.
- ✦ A Rescheduling strategy describes whether or not production schedules are generated.
- ✦ A Rescheduling policy specifies when and how rescheduling is done. The policy specifies the events that trigger rescheduling.
- ✦ Rescheduling methods generate and update production schedules.
- ✦ Complete regeneration reschedules the entire set of operations (jobs) not processed before the rescheduling point, including those not affected by the disruption.

- * Partial rescheduling reschedules only the operations affected directly or indirectly by the disruption [20].

- Construction Schedule updating

Identifying project changes due to actual progress is the first task in schedule updating. Environmental changes may require information modifications, which are represented as parameter revisions. Additional constraints may be required. A schedule can be updated for the following four activity types [20].

- I. Finished activity Scheduling updating removes finished activities from the rescheduling activity list and retains information regarding actual progress and expenses to determine the impact of project changes on the initial schedule. The information for finished activities must be corrected. If any inconsistency is discovered, the causes, which may be due to environmental factors or an incorrect productivity assessment, must be investigated.
- II. In-progress activity In-progress activity may be the primary reason for requiring rescheduling. Generally, in-progress activities can be schedule updated by splitting activities. Splitting activity means when a single task activity is changed into various activities in order to create convenience to the whole work schedule. Non splitting activities are when tasks in activity are partially actualized then changing into various activities would be inconvenient.
- III. Changed orders and other risks can add new activities to a construction project. Although such additions sometimes significantly influence the initial schedule, these new activities reflect real situations and resource requirements. Parameters also define information about these new activities [20].

2.6 Ethiopian Context planning and scheduling:

2.6.1 Ethiopia, general information and brief history of roads

Ethiopia is located in the North Eastern part of Africa. It covers an area of about 1.13 million square km and the topography of the country is rugged ranging with an altitude from 125m below sea level to 4,620m above sea level. The population of Ethiopia in 2007 was 76,511,887 (Population (2008)). In that year approximately 3% of the population was over 65 years of age, with another 44% of the population under 15 years of age. The capital city, Addis Ababa, had a population of 2,739,551 in 2007 (central statistics agency) and other urban centers include Dire Dawa, Desse, Harer, Jima, Nazret, and Gonder (Ethiopia Population (2008)).

Figure 5 Map of Ethiopia.



Construction industry in Ethiopia nowadays is at an infant stage as it has not developed well even to the level of other developing countries. This might be a reason why in the past construction time-cost relationships related factors have not been developed well.

Based on the firm's possession in general, two types of construction sectors exist in Ethiopia: private and public. Most of the construction works in the public sector are foreign fund initiated. Funding for a high percentage of construction projects come from multilateral development agencies (MDA) like the World Bank or African Development Bank.

For large MDA funded projects, it is a usual practice to go for international competitive bidding. Most public contracts are awarded on the basis of the lowest responsive tenders submitted by contractors. Local contractors are given a margin of preference to secure public sector tenders under MDA funding. The maximum premium is 7.5 percent. For the private sector the project owners initiate the funds.

According to Wubishet in 2004 Construction is second to agriculture in generating employment in Ethiopia. But the government of Ethiopia is predicting to be the first GDP in at the end of the GTP year 2015.

The earliest modern roads in Ethiopia connecting Addis Ababa to Addis Alem and Harar to Dire Dawa date back to the quarter of the twentieth century (Construction Ahead, 2005). These roads were part of Emperor Menelik's attempt to modernize Ethiopia, however much has not been done until the time of the Italian occupation (1936 – 41). The Italian government invested much capital to expand the very limited infrastructure that then existed. Within one year period, close to 60,000 Italians were working on these projects [1].

The road network even then was designed to radiate outward from Addis Ababa connecting the Italian occupied ports of Massawa and Mogadishu. When the occupation was terminated in 1941, the Italians left behind 7,000 km of roads, of which about half were surfaced with asphalt [1].

The reinstated Imperial regime was however unable to continue from where the Italians left off as it lacked expertise, adequate funds and equipment. The Government established the Imperial highway Authority in 1951 with the help of World Bank and technical assistance from the United States Bureau of Public Roads.

The Ethiopian highway network kept on lagging behind the countries need. After the overthrow of the Imperial Regime in 1974, Derg restructured the highway authority as the Ethiopian Roads Authority and the Rural Roads Task Force. The latter had the objective of developing rural roads outside the main system and extending feeder roads within the main system. The World Bank, African Development Bank and others provided assistance for new road construction and maintenance. Despite these efforts, Ethiopian's road network remained quite limited, even by African standards. Expansion of the rural road network accounted for much of the roads constructed thereafter until the change of government in 1991 and the network was further reduced with Eritrea as a new state. In 1993 the Ethiopian Roads Authority (ERA) was reestablished with a legal autonomy and being responsible for overall planning, construction, maintenance and management of the country's trunk and major link roads.

It now has three technical departments – each headed by deputy general manager: Regulatory and Engineering Services, Human Resources and Finance and the Operations Departments. In 1991, in addition to the 13, 000 kilometers of all-weather roads, of which about 4,000 were asphalted and 8,900 were all-weather gravel roads, there were 4,900 kilometers of rural dirt roads, making a total of nearly 18,000 kilometers of all types of roads. The total road network of the country has reached to 39,477 km in June 2006. With a total land area of 1.1 million sq. km, the current road density is 35.9 km per 1000 sq. km. Overall road network in Ethiopia has been increasing on the average by 8% each year between 1997 and 2006.

Road transport by now is the means of movement accounting for about 93 percent of freight and 95 percent of all passengers (ERA, 2006) [1].

2.6.2 The road sector development program (RSDP)

According to Government of FDRE it has recognized the importance of road transport in supporting social and economic growth and its role as a catalyst to meet poverty reduction targets, and placed increased emphasis on improvement of the quality and size of road infrastructure in the country. To address constraints in the road sector, mainly low road coverage and poor condition of the road network, the Government formulated the Road Sector Development Program (RSDP) in 1997 [1].

The RSDP has already been implemented over a period of sixteen years and in four successive phases, as follows:

- RSDP I - Period from July 1997 to June 2002 (5 year plan)
- RSDP II - Period July 2002 to June 2007 (5 year plan)
- RSDP III - Period July 2007 to June 2010 (3 year plan)
- RSDP IV - Period July 2010 to June 2015 (5 year plan, more than 3 years elapsed)

Over the Sixteen years of the RSDP, physical works have been undertaken on a total of 81,629 km of roads excluding routine maintenance work and community roads. The total budget for the planned works during this period amounted to **ETB 135.9 billion** (USD 9.9 billion). The total amount disbursed in the same period, is **ETB 142.1 billion** (USD 10.2). Physical and financial performance over the past 16 years against plan is 88% and 105 % respectively. Table 1 shows summary of 16 years assessment of physical and financial performance of RSDP [1].

Table 3 Summary of 16 years Performance of RSDP [1].

Program	Physical Plan Vs. Accomplishment, km			Finical Plan Vs. Disbursement, in million ETB		
	Plan	Actual	% age	Budget	Disb.	% age
Total RSDP I	8908	8709	98	9812.9	7284.6	74
Total RSDP II	8486	12006	141	15985.8	18112.9	113
Total RSDP III	20686	19250	93	34643.9	34957.9	101
RSDP IV (three years)	54747	41664	76	75,549.6	81765.7	108
Total RSDP (16 yrs)	92828	81629	88	135992.2	142121.0	105

As it is seen from the report, only RSDP III has fallen short to reach the plan. But the others achieve to succeed. According to ERA plan has been made for the future is to improve rural accessibility by expanding its network. One of the tools to improve the rural accessibility is URRAP which is not the scope of this study.

Hence based on the assessment report of 16 years of RSDP plans made to the future are

✓ Benchmarking of Good practice

Ethiopian Roads Authority had planned to continue evaluating the Performance of all ongoing road projects and to continue in the future against set criteria. There is now regular evaluation which categorizes projects into best performing, good performing, satisfactorily performing and poorly performing groups. Performance of contractors is also evaluated based on time performance of projects. This implies that planning and scheduling of the projects are key elements of the projects in order achieve best performance in the execution of the projects. From the future plan contractors which have most of their projects under best performing and good performing category are selected as best performing contractors. Best performing contractors share their best practice to other contractors. That means best planners of the best their practice to the other planners. It is mandatory to have detailed program in addition to experience sharing between professionals of the field. There should be competency measuring tools. [1]

✓ Certification of Technicians:

Certification of technicians will definitely improve the road sectors technical performance. In addition to that there should be certifications of professionals in project planning, highway, geotechnical, structural and hydraulics engineers [1].

✓ *Modernizing and Transforming ERA*

Ethiopian Roads Authority is in the process of modernizing itself to ensure organizational excellence in order to better satisfy its customers' needs. To achieve this, modernizing the core processes like Engineering Procurement, Design Management, Contract Management, Asset Management, Quality Assurance and Performance Monitoring; and key enablers such as Engineering Innovation and Research, Right of Way Management, Project Handover, Human Resource Development and Management, Financial Management, Facility Management, etc. is underway [1].

2.6.4 The GTP and road constructions

Developing and improving the country's road network and building the capacity of road authority so as to manage and administer the road network were the main objectives of road sector development plan. Generally during the five year GTP it was planned to rehabilitate 728 km of trunk roads, upgrading 5023 km of trunk and link roads, construction of 4,331 km of new trunk and link roads, periodic maintenance of 4700 km of asphalt and gravel roads and routine maintenance of 84,649 km of road network as well as construction of 71,522 kilometers of new all-weather that connect all rural woredas. The regional roads Authorities have also a plan to construct 11,212 kilometers of rural roads in the five years period. Based on this plan, the performance of regional and federal road construction in 2010/11 fiscal year was remarkable [21].

During the year under review, several new road construction, maintenance of roads, rehabilitation and upgrading works have been carried out by the Federal, Regional and Woreda level governments of the country and other development partner. In addition, design, feasibility study, environmental impact assessment (EIA), civil service reform, and capacity building activities were accomplished. During 2010/11 the physical accomplishment of federal roads was above the level planned for the fiscal year except the construction of new roads [21].

The construction of new roads was accomplishment was 90 percent of the plan, because of delays in the bid process and the withdrawal of certain contractors [22].

In 2010/11, the target at country level was to construct and maintain a total of 39,723 Kms by federal, regional and district road authorities and offices. At the end of the fiscal year, it was possible to construct 34,795 Kms, indicating that 88 percent of the target and 86 percent of the previous year performance achieved. Disaggregating the performance by federal, regions and districts, it can be shown that the federal target was to construct 16,538 Kms; the achievement was 19,159 Kms, 116 percent of the target. Similarly, the performance of the regional road offices was also very encouraging. The target for regional road offices was to construct 13,357 Kms for the fiscal year 2010/11. At the end of the fiscal year, it was constructed 14,650 KMs; an achievement of 110 percent of the target. With regard to the performance of the district road offices, however, the performance was only 9 percent of the target. The low performance was due to the fact that the focus of the target was mainly on activities related to preparatory works [21].

The national level road length (federal and regional total road length) has increased from 48,793 kilometers in 2009/10 to 52,042 kilometers in 2010/11. There was no all-weather woreda road in 2009/10, but in 2010/11 a total of 854 kilometers of woreda road was constructed. As a result of the increased road construction and maintenance in the country, road density measured by kilometers per 1000 square kilometers of area increased from 44.5 to 48.1 and the proportion of Kebeles connected by all-weather roads increased from 39 percent in 2009/10 to 42 percent in 2010/11 fiscal year. Moreover, roads in acceptable condition (good + fair conditions) increased from 79.7 percent in 2009/10 to 82 percent in 2010/11 indicating improvement in the quality of roads. Owing to increase in road density and improvement in the quality of roads, the average vehicle coverage per day (measured by km of travel per day) has increased from 9.6 million km to 12.1 million km. As a result of all these accomplishments in the road sector, the average travel time to all-weather roads declined to 3.5 hours in 2010/11 from the 3.7 hours in 2009/10 [21].

Table 4 Road to be constructed in between 2011-2016 according GTP [1].

Major Tasks	Five year plan (2011-2016)
Federal Roads	
Major roads reinforcement	728.00km
Major roads upgrading in km	1,089.00Km
Linking roads upgrading in km	3,934.00 Km
New roads construction in km	4,331.00 Km
Temporary road maintenance in km	4,700.00 Km
Subtotal in km	10,451.00
Regional roads	
Rural roads new construction in km	11,212.00 Km
Subtotal in km	11,212.00 Km
Woreda roads	
Woreda roads new construction in km	71523.00 Km
Subtotal in km	71,523.00 Km
Overall total	93,186.00 Km

Source: Ethiopian Roads Authority

2.6.5 Planning and Scheduling in road Construction of federal road projects

Wubishet suggests the application of time performance evaluation as critically important criteria in bidding process in Ethiopia construction industry because the Government of Ethiopia waived the use of completion time and allowed low evaluated cost award system for tender evaluation in 1993 (Wubishet (2004)). Accordingly, the consultant shall estimate a reasonable time for the completion and announce the same on invitation to bid and the estimated time for completion should satisfy the interest and schedule of the client (Wubishet (2004)).

There is an increasing need for prediction of construction time at planning and bid preparation stages for including realistic project duration in the bid package. It represents a problem of continual concern and interest to both researchers and contractors. It is also important for the studies related to estimating, scheduling, and management of construction works taught both at the graduate and undergraduate levels in the schools of construction science [22].

The growth of constructing road projects will make the planning and scheduling works to be given more and strict emphasis due to the following reasons [7]

- 1 The government has planned to build so many projects with in short period of time. Therefore in order to achieve it, there should be well planned and scheduled projects and strict control with updated scientific appraisal methods.
- 2 The routine from various discussion with the project managers and engineers it is learnt that project completion on due time has not been achieved in most of the projects. Hence planning and scheduling should be executed in great emphasis.

In the traditional practice of road construction in Ethiopia, determining the period to complete the road construction is primarily set by the client's need for occupancy to the specific project. But in order to fulfill client's need of occupancy, do the engineers give proper emphasis and attention towards planning of the road construction process ahead of the commencement?. It is discussed below with reference to the time cost models set to estimate construction times and desk study findings from stakeholders documents on Federal road constructions [22].

2.6.6 Time estimation comparisons

Based on the time a cost relation analysis developed by Abraham Assefa, the durations to complete projects have been estimated and compared to the period client has approved to the respective projects. Accordingly projects which started more years ago have show some exaggeration of time estimate by the client. In other case for projects whose commencement is in recent time, the client estimation to project completions is lesser than the time cost model. It is because the period where time cost model developed is not recently and needs to be updated in order to be adaptive to the current projects. Projects from 3-5, which had been commenced five years ago had shown that client has assigned exaggerated time by 30-80% from the total duration of the projects necessary according to the time cost model of Abraham Assefa. This implies that the time set by the need of client's hasn't coincided with developed model estimations. Hence there was a difference in time estimation to project delivery in the selected projects.

Table 5 Time elapsed vs estimation of time cost model

Item	Project Name	Time estimation based on Abraham Assefa Time cost model(cal days)	Actual time approved by the client for the project(cal days)	Time elapsed till December 2012 cal days (% accomplishment)
1	Modjo-Ejere- Arerti- Gobensa road project (Contract 2 :Arerti – Gobensa)	-	-	-
2	Shire–Shiraro –Humera - Lugdi Road Upgrading Project. Lot 1: Shire –Adigoshu–Adigoshu	1716.98	1688	1533(93%)
3	Shire– Gondar - Debark Road Upgrading Project	1691.66	1520	1568(87.1%)
4	Shiraro – Humera - Lugdi Road Upgrading Project. Lot 2:	1590.87	2180	1630(87%)
5	Abala Road Upgrading Project Hawusewa – Abala - Irebti Afdera Contract 1	902.02	1632	1320(80.52%)
6	Adiremet-Dejena-Dansha Upgrading Road Project, Contract 3	1067.68	1461	-
7	Assosa-Kurmuk Road Upgrading Project	1739.66	1429	1452(95.54%)
8	Gedo – Nekempte Road Rehabilitation Project Contract 1:	1752.41	913	1242(84.64%)
9	Gedo – Nekempte Road Rehabilitation Project Contract 2:	1736.45	914	-
10	Wolkite-Hossana road upgrading Project Contract 1: Wolkite-Arekite	1730.83	912	-(23%)

The other crucial planning and scheduling setbacks noticed in Federal road projects is the absence constructability review teams. There is no team used to review the constructability of the projects in none of the selected projects. It is clear that the projects needed to have the advantages of the team. The professional approach of modern highway organizations had used it for years. As a result they have developed standardize schedule and plan to their projects.

The risk factors that are causes to the non excusable delays had been seen in the selected projects. For instance 90% of the projects had shown delay in supplying shortage of the equipment, delay in forwarding material and equipment to the site and delay in forwarding material and equipment to the site. According to the literature review, these are the major reasons that contributes to the non excusable delays. Hence resource management during planning and scheduling should be given stress so that the material's delivery sources should be confirmed and prioritize by the client.

2.6.7 Major planning and scheduling problems

During the desk studies one of the major finding was planning and scheduling problems in Federal road projects. According to stakeholder's documents, the following are risk factors to impacts of scheduling in the Federal road projects.

- i. It is learnt that the common problems encountered in the road projects Right of way cases should be resolved in advance to the commencement of the project executions. It triggered non- excusable delays to the schedule of the contractors. This cause is one of the major problems raised in progress reports. It simple refers to the planning process of the client had shown problems of its implementation.
- ii. Lack of follow up to the contractor is the one of the other problems in planning and scheduling. It was clearly stated in the literature review that planning of resources is the major work process of planning and scheduling in the construction. From the desk studies and experiences of engineers, it is learnt that the client had problems of follow up to the schedule for equipment mobilization and deployment and in turn it has affected the progress adversely.

- iii. Late designs and design reviews which should have been made prior to the project, design has been delayed due to recklessness. Readiness of design on due time is very essential to complete the project deliveries on the intended duration. According to stakeholders experience and desk study of selected projects being late in designs and design reviews is common experience in Federal road projects.
- iv. The lack in covetous follow up from the start to the end project of and swift notice towards contractor's status is the major problems that affect the plan and schedule of the projects which all reports from desk study had agreed to be as common phenomenon. Hence the stakeholders should act on it to reverse that lack on this case and rectify to foster the planning and scheduling of the projects.
- v. The other problem that is being seen in the Federal road projects is the contractors not paying enough attention to the project at the commencement stage which is reflected in delay on mobilizations. It is very essential to pay enough attention to the projects from the commencement till completion of the project.

3 Research methodology

3.1 Research applications

The planning and scheduling of road construction projects is one of major areas of construction management. Understanding the basic relationship of project delivery and the plan and schedule is the issue of the cost quality and time of the project. Hence once it is given the proper understanding and action it is easy to achieve on timely completion of the projects. The results of this research will enable the parties in construction industry to:

- 1 Enhance the necessity of the proper planning and scheduling of the projects.
- 2 Widens the scope of the planning and scheduling of works as a result on timely completions of the projects.
- 3 Avoids delays due to weak planning and scheduling.
- 4 Minimizes EOT and avoids loss due to forgone opportunities due to delays.
- 5 Plays positive roles in building proper resources utilizations.

3.2 Methodology

The research methodology is structured in theoretical exploration of relevant topics in planning and scheduling of road construction projects with the relationships to non excusable delays, desk study on relevant documents, practical views of the stakeholders on the subject through interviews and case study to selected projects.

The mean score (MS) for each causing factors are computed by the following formula:

$$MS = \frac{\sum (f \cdot S)}{N} \dots \dots \dots \text{[Eq 11]}$$

Where

f=frequency of responses to each rating (1-3)

S=score given to each factor

N= the total number of responses concerning the factor.

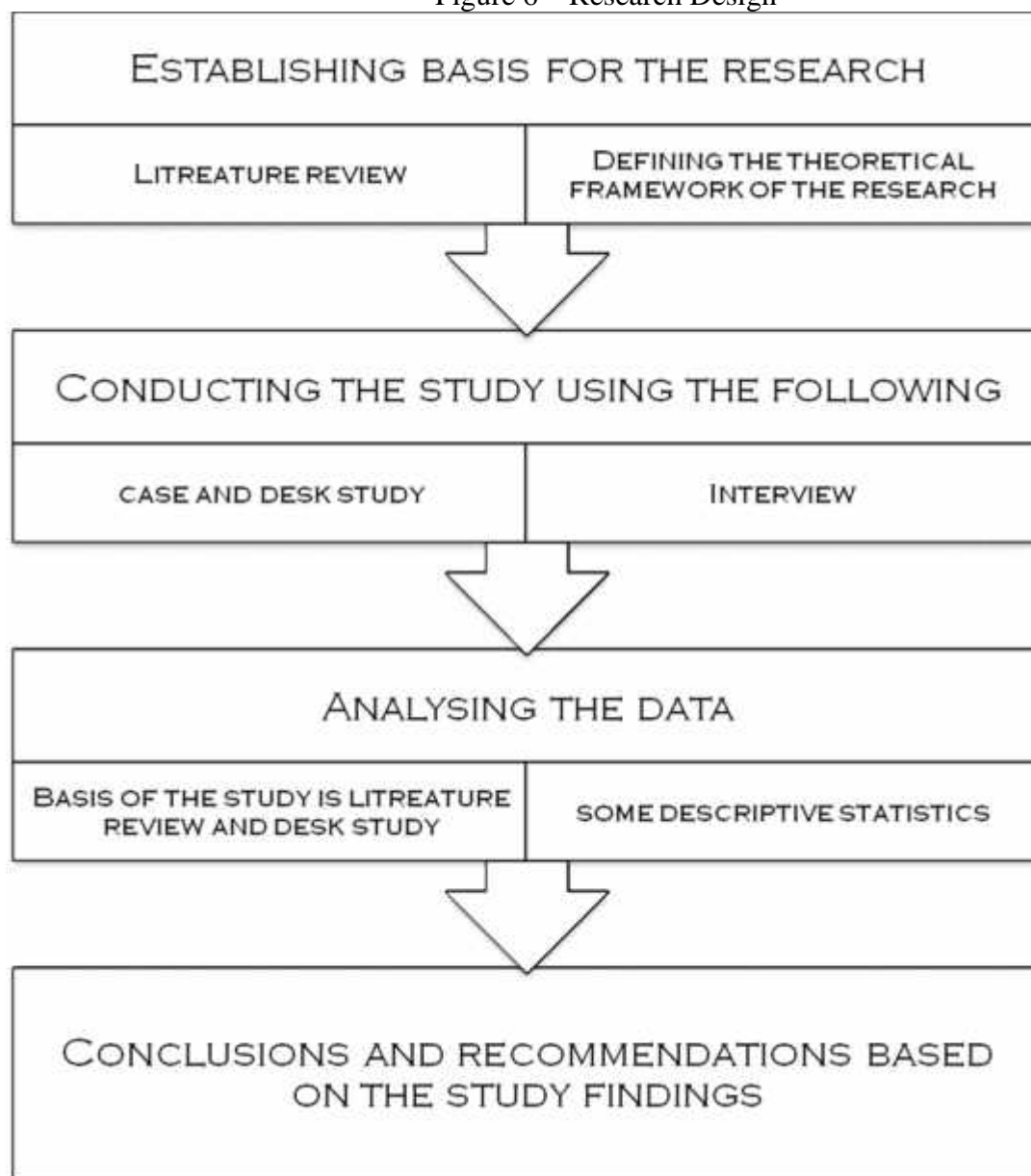
For evaluation of impacts of durations and probability of occurrences to the non excusable delays the following numerical values are assigned to the ratings.

1=low

2=medium

3=high

Figure 6 Research Design



3.2.1 Literature review

The literature survey includes definitions of basic project, planning and scheduling terminologies. It also consist of determining the duration of the project through cost time relationships, preliminary work schedule preparations, the impacts of planning and scheduling to the projects, causes of non excusable delays in the construction industry. The past and future plans of FDRE government RSDP and GTP are consisted respectively.

3.2.2 Interviews

Interviews were made with engineers, who work as client's representatives responsible for evaluating and administering contract matters, consulting engineer's representative, and planners who work for various contractors. Interview questions have been formulated to fit with the objectives of the research.

Question # I: Focuses on the backgrounds of the informants.

Questions # II: Questions under this part are focused on to identify the trends in the current practice and major problems in planning and scheduling of road construction projects. Do the Federal road construction projects have standard procedures to plan and schedule? What are the common mandatory procedures in plan and schedule preparations? Is there in efficiencies among the professionals to plan and schedule? Do the professionals understand the difference between plan and schedule? What is the dominant planning mistake made by planners in road projects? What is the major problem in estimating the durations of activities?

Question # III: Questions under this part are focused on to analyze the impact of schedule in which delay is inherent as an impact. What are the major causes in planning and scheduling inherent delays in federal road projects activities? What are the factors that affect the schedule effectiveness of the road construction projects?

Question # IV: Questions under this part are focused on to assess the appraisal and constructability review methods of the planning and scheduling activities in the federal road construction projects. What are the common impacts in planning and scheduling of federal road projects? How are risks evaluated associated with the impacts of schedule? These questions are responded by tabular prepared closed questions which are subjected to further risk analysis methods mentioned in the literature review.

Question # V: Questions under this part are focused on to provide remedial in tackling the effects due to the shortcomings of planning and scheduling techniques in federal road constructions. How is the plans and schedules evaluated and reviewed in road projects? Do you have schedule review team in your road construction project? Is the review done internally as

well as externally? How frequent is the review done? When delays or change orders occur, is there a practice to have a reschedule and schedule updating?

The type of sampling adapted for this research is selected sampling. The key informants targeted for this research were professionals from procurement, and contract implementation departments of the Ethiopian Roads Authority (ERA), engineers who are participated in planning, scheduling and contract administrations of various contractors and consulting firms. Those professionals who specifically worked as mentioned above were selected for the interview. Accordingly, 32 key Informants were selected for interview structured questions. Among 32 informants, 26 have responded to the interview. The Informants profile is shown in Tables 6 and 7 below.

Table 6 Informants Profile

Educational Status	Number of informants based on their stream		
	Civil Engineer	Construction Management	Total
M.Sc	-	3	3
B.Sc	10	13	23
Total	10	16	26

Table 7 Informants' years of experience

Experience in years	Number of Informants
0-5 years	9
6-12 years	17
Total	26

3.2.3 Case Study:

It is conducted to the selected projects. The project datas are selected and gathered from Ethiopian roads authority various regions of contract management. With in case studies the following information are given prior notice

- Project Basic data:
- The problems encountered within the executing months.
- Do the problems have a relationship with the plan and schedule that leads to detrimental situations to?
- What are the possible measures taken or order to be taken in order to avoid or minimize the schedule?

3.2.4 Desk study

The current trend and approach of planning and scheduling in federal road construction projects is evaluated from case studies through reviewing documents, responses from interviews.

3.2.5 Data Analysis,

The case and desk study were analyzed in relation to the theoretical propositions. The method used to analyze the interview data is descriptive statistics method. This method of analysis helps to analyze the responses in actual numbers. Accordingly, Frequency distribution was used to distribute the data into categories and determine the number of individual or cases belonging to each category.

4 Results and discussion

4.1 Trends and major problems in the current road construction projects

In order to achieve the objectives of the research, desk studies, questions as an interview and case study on projects have been carried out. Based on the desk studies, the client predetermines the duration to complete the projects on the basis of the period to which financial resources are available for the particular project. When the financiers are foreign institutions there is an expiry date to the fund or loan. Therefore the client is sensitive to the expiry date. In such cases the tender will contain the completion date to comply with as mandatory towards the award of the contract.

- i. A response by all informants to the interview question, do you have standard procedure to plan and schedule construction project's activities? Has revealed that no standard procedure to plan and schedule construction project. Summarized responses by informants to interview question to the common trend to prepare plan and schedule includes the following.
 - Duration is fixed based on the client's occupancy need stated in tender documents.
 - Plan submitted on the bidder's document is done only to meet the duration of the client's occupancy need.
 - Schedule is prepared based on various productions and work methodology standards available. Since standard duration estimation is not available it is not able to evaluate the estimate.
- ii. According to the respondents, the major problem in estimating the durations of activities, the following are responses summarized
 - There is no projects performance database which could have been helpful to develop credible time estimate that would have been used in scheduling.
 - Failing to consider time contingency for the estimation of time.

4.2 Analyze the impact of schedule in which delay is inherent as an impact.

According to Hamidreza Afshari, Shahrzad Khosravi, Abbas Ghorbanali, Mahdi Borzabadi, Mahbod Valipour, Identification of Causes of Non-excusable Delays of Construction Projects the delays that causes non excusable ones are categorized and in this research it is included to the respondents in order to assess the risks in Federal roads [11].

Planned schedules have direct relationships with delays which eventually cause cost and time overruns of the project. Therefore the remedial to possible cost and time overruns should be thought while one is preparing plan and schedule to a project [11].

The Informants responses with regard to sources of risks in road construction are shown in table 8.

Table 8 Responses from the interview on the causes of non excusable delays in Ethiopian federal road constructions

Causes for the non excusable delays	Impact on duration			Probability of occurrence		
	Low	Medium	High	Low	Medium	High
Not selecting competent subcontractors	3	6			6	3
Poor management of the project changes		12	15	10	3	4
Lack of mechanism for recording, analyzing, and transferring project lessons learned	6	9	6	11	4	77
Delay in forwarding material and equipment to the site	12	6	3	18	3	
Delay in awarding subcontractors' contracts		6	12	6	4	8
Lack of effective managing and controlling subcontractors		12	6	6	9	3
Delay in detail design by project engineer subcontractor						
Delay in supplying shortage of the equipment	12	6	3	15	3	3
Poor management of project site	3		6		3	6
Poor management of project contract	9	6	9	12	6	6
Issues on recruiting, attaining, and promoting expert and experienced project team	6	6	3	12	3	
Lack of effective communication and coordination with project stakeholders specially with the client/client's consultant	3		9	6	6	
Delay in obtaining technical information from subcontractors						
Conflicts among performing organization, client and client's consultant.	15	9	2	12	8	6
Slow decision making by project manager	6		6	9	1	2
Detail design errors by project engineer subcontractor		6	15	6	8	7
Delay in basic design by performing organization	6	15		8	9	4
Lack of applying contractual tools (liquidated damage or acceleration of work) against subcontractor	-	-	-	-	-	-
Delay in basic design by project engineer	-	-	-	-	-	-
Conflicts in work schedules of the contractors	18	3	2	12	6	5

Table 9 Risk factors level of probability of occurrence and impact on time of causes of non excusable delays

<ul style="list-style-type: none"> • Poor management of the project changes. • Poor management of project contract. • Issues on recruiting, attaining, and promoting expert and experienced project team. 	<ul style="list-style-type: none"> • Delay in supplying shortage of the equipment. • Conflicts among contractors, client and consultants. • Conflicts in work schedules of the contractors.
<ul style="list-style-type: none"> • Lack of mechanism for recording, analyzing, and transferring project lessons learned. • Poor management of project site. • Lack of effective communication and coordination with project stakeholders especially with the client/client's consultant. • Slow decision making by project manager. 	<ul style="list-style-type: none"> • Detail design errors by project engineer subcontractor. • Delay in basic design by consulting organization.

Probability of occurrence

The mean scores of these responses were further categorized in the form of risk matrix; i.e. high impact-low probability of occurrence, low impact-low probability occurrence, high impact-high probability of occurrence, and low impact-high probability of occurrence. The risk matrices in figure above show the impact on time in relation to their probability of occurrences for each factor.

i. The above matrices reveal that the following risk factors are reasons that cause non excusable delays in high probability with high impact on time Delay in forwarding material and equipment to the site:

- Delay in supplying shortage of the equipment.
- Conflicts contractors, client and consultants.
- Conflicts in work schedules of the contractors.

The risk factors that cause non excusable delays in low probability with high impact on time are:

- Poor management of the project changes.
- Poor management of project contract.
- Issues on recruiting, attaining, and promoting expert and experienced project team.

4.3 Case study of selected road construction projects

4.3.1 An overview project selection

4.3.2 Case study

For this research 10 road construction projects are selected. The bases for selecting the projects are:

- Represent geographic locations of the country with difficult nature of road constructions.
- Executions of most of the projects must be beyond 60%.
- Should include domestic and foreign contractors.
- All projects are asphalt surfacing projects. It is believed asphalt road projects consists gravel road project activities in addition to asphalt works. Hence it needs more strict planning and scheduling efforts than gravel roads.

The selected projects are:

- 1 Modjo-Ejere- Arerti- Gobensa road project (Contract 2 :Arerti – Gobensa)
- 2 Shire–Shiraro –Humera - Lugdi Road Upgrading Project.Lot 1: Shire – Adigoshu
- 3 Shire– Gondar - Debark Road Upgrading Project
- 4 Shiraro – Humera - Lugdi Road Upgrading Project, : Lot 2: Adigoshu – Humera- Lugdi
- 5 Abala Road Upgrading Project Hawusewa – Abala - Irebti Afdera Contract 1
- 6 Adiremet-Dejena-Dansha Upgrading Road Project, Contract 3
- 7 Assosa-Kurmuk Road Upgrading Project
- 8 Gedo – Nekempte Road Rehabilitation Project Contract 1 Gedo-Bako
- 9 Gedo – Nekempte Road Rehabilitation Project Contract 2: Bako-Nekempte
- 10 Wolkite-Hossana road upgrading Project Contract 1: Wolkite-Arekite

The explanations to the above projects are given below with basic information. All necessary basic datas are obtained from the respective contract administration bodies of regional directorates of Ethiopian roads authority.

Table 9 Selected road construction case study projects details

It No.	Projects	Total Length	Contractor	Types of surfacing	Physical length		Revised contract (million birr)	VO birr	Revised contract duration (calendar days)	Extension of Time (Calendar days)	Slippage (%)
					Plan	Actual					
1	Modjo-Ejere- Arerti- Gobensa road project (Contract 2 :Arerti – Gobensa)	33.5	Local	Asphalt surface	Nil	31.16	484.58	39.9	912	520	8.92
2	Shire–Shiraro –Humera - Lugdi Road Upgrading Project. Lot 1: Shire –Adigoshu–Adigoshu	156	Foreign	Asphalt surface	146	135.9	704.03	34.9	1260	767	6.49
3	Shire– Gondar - Debark Road Upgrading Project	99.2	Foreign	Asphalt surface	82	90.36	774.09	83.3	1520	475	-
4	Shiraro – Humera - Lugdi Road Upgrading Project. Lot 2: Adigoshu – Humera Lugdi	168	Foreign	Asphalt surface	89.2	95.68	980.32	176	2182	902	-
5	Abala Road Upgrading Project Hawusewa – Abala - Irebti Afdera Contract 1	94.14	Foreign	Asphalt surface	75.8	60.87	1,397	123	1,632	372	19.65
6	Adiremet-Dejena-Dansha Upgrading Road Project, Contract 3 Adiremet Dejena-Dansha Upgrading Road Project	97.66	Foreign	Asphalt surface	58.4	68.7	1,189.05	10.3	1461	365	-
7	Assosa-Kurmuk Road Upgrading Project	96.68	Foreign	Asphalt surface	97	92.36	561.72	8	1,429	334	4.46
8	Gedo – Nekempte Road Rehabilitation Project Contract 1:	66	Foreign	Asphalt surface	66	57.3	502.11	24	913	92	55.71
9	Gedo – Nekempte Road Rehabilitation Project Contract 2:	65	Foreign	Asphalt surface	64	53.62	528.15	31	914	14	52.7
10	Wolkite-Hossana road upgrading Project Contract 1: Wolkite- Arekite	66	Foreign	Asphalt surface	Nil	66.18	502.11	24	913	92	6.4

4.3.2.1 Contract 2 :Arerti – Gobensa:

Arerti – Gobensa road project is part of contract 2 of Modjo-Ejere- Arerti- Gobensa road project which is intended to connect the trunk roads of Addis Modjo to Addis Debrebrehan that is found central part of the country.

I. Particulars of the project under study

Project: Arerti – Gobensa Contract road

Location: Oromia and Amhara regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of FDRE

User: Public

Type of the road surface: Asphalt surface (Triple surface treatment)

Total length: 33.5 km

Construction type: road upgrading

Work plan: No plan attached.

Designer and Supervisor: CORE consulting engineers Plc.

Contractor: YENCOMAD ICN Plc.

Type/ base of contract: unit rate

Main Contract Amount (including day work, provisional sum, 10% contingencies and 15% V.A.T): ETB 444,696,050.17

Variations order amount: ETB 39,885,279.00

Revised total contract amount: ETB 484,581,329.17

Original time for completion time: 912 calendar days

Extension of time to date of August, 2012: 520 calendar days

Revised contract time: 1,588 calendar days

Commencement date according to contract: August 17, 2010

Commencement date: June 23, 2010.

Original date for completion: December 21, 2010

Revised date of completion: October 25, 2012

Time elapsed as of August 2012: 1533 calendar days (96.54%)

II. Physical progress reports assessment

As of August, 2012(in terms of physical accomplishment)

Plan according to monthly progress report the project had no accomplishment based on physical (in kilometer or percentage) accomplishment. Actual performance according to monthly progress report the project had been 93.014% of the job and 31.16 km of the road length as it is described.

As of August, 2012(in terms of financial accomplishment)

Plan according to the monthly progress report the project has plans shown in May, 2012 but June, July and August have no plan.

Summary

The following major findings are noticed from the progress report August, 2012.

Extension of time (EOT): 520 days

Delay from time in original completion date (in %): 57.9%

Delay from the revised completion date (in %): 3.32%

According to the report by the consultant it is learnt that

- The contractor has not paid enough attention to the project at the commencement of the project.(delay on mobilizations)
- Key personnel like project managers, material engineers, and administrators have not been mobilized on time.
- Due to late arrival of material engineer and arrival of necessary equipments for testing from abroad, the preparatory work such as testing of construction materials establishing of site laboratory etc are delayed.
- The equipments available on site were not adequate and relevant to the works.
- Repeated equipment technical failures (graders, loaders, rollers, chip spreaders and crusher plants.)
- mismanagement of finances

- unsatisfactory pavement works
- Shortage of cements and logistics to the concrete works activities.

Analysis of S curve.

The cumulative accomplishment shows 96.54% percentage and the slippage shown in the report is 8.92%.

When a project is planned, it should be visualized prior to the execution. Project planning and scheduling should have included each and every possible activity outline and explicitly explained with that of physical and financial accomplishment goals. On the other hand, in this project, the physical accomplishments evaluations are done by converting the corresponding executed financial amount divided by the initial per kilometer cost. Then the physical accomplishment is considered to be the analytical result. Hence it does not show the real practical works done on the ground. From this it is simple to learn that the planning evaluation has shortcomings in making it coincide to the jobs done on the ground.

The original time was 912 calendar days. The contractor has been granted 502 working days of EOT by the client. The EOT granted by the client is considered to be unreasonable due to the following reasons:

There are no outstanding causes such as change order (addition of works) to the levels up to which such long period to be extended. Because the variation order is less than 10% and but the EOT is more than 50%. In the progresses reports from the consultant's, there is no extraordinary reasons such as unpredicted sub-structural soil formations, force majeure incidents, lengthy and unprecedented weather conditions etc... happened in the project executions.

The problems shown from contractor in the summary had potential to make considerable delays in road construction projects.

4.3.2.2 Lot 1: Shire –Adigoshu

I. Particulars of the project under study

Project: Shire-Adigoshu Contract road

Location: Tigray regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of FDRE

User: Public

Type of the road surface: Asphalt surface (Triple surface treatment)

Total length: 156 km

Construction type: road upgrading

Work plan: No plan attached.

Designer and supervisor: Saba consulting

Contractor: CGGC

Type of contract: unit rate

Original contract amount: 616,414,995.16 ETB

Revised final contract amount: 704,032,869.20 Birr with vat

Total price adjustment: 250,923,142.75 ETB

Variations order amount: 34,935,171.65 Birr year to date variation.

Original time for completion: November 3, 2010.

Extension of time to date: 767 calendar days.

Revised completion time: December 8, 2012.

Commencement date according to contract: May 2, 2007.

Original contract period: 42 months + 1year of D.L.P.

II. Physical progress reports assessment

As of December, 2012(in terms of physical accomplishment)

Plan according to monthly progress report the project had been 93.59% which is 146 km plan to accomplish based on physical accomplishment. Actual performance according to monthly progress report the project had been 87.1% of the job and 135.88 km of the road length as it is described.

As of August, 2012(in terms of financial accomplishment)

Plan according to the monthly progress report the project had been 115.52%.

Summary

The following major failures are notice from the progress report August, 2012.

Extension of time (EOT): 767 calendar days which is almost equivalent to the original contract period of 42 months (about 800 calendar days)? When we analyze the basic data it is found that only 34,935,171.65 Birr of variation orders are given it is less that 5% of the original contract amount. But the EOT given to the contractor is about 100% percent. With normal project time planning and forecasting it is not expected the project to be extended with such extended time.

According to the report by the consultant it is learnt that

- Lack of co-ordination and experienced management team.
- Shortages of resource for various activities especially dump trucks.
- Lengthy downtime of equipments due to spare part problems.
- Delay of the Contractor in renewing insurances and guarantees as per the requirement of the Contract.
- Delay of the Employer in effecting monthly statements of the Contractor.
- Shortage of grader for shoulder and sub grade works.

- Failure to commence the construction of gravel shoulder for hand-over section of the road.
- Line of credit is still not renewed.
- Performance guarantee has been expired and not renewed to date.
- No valid work program as the revised completion date is expired.
- The interim payments are not paid on due time.

Slippages in financial and physical accomplishments differ due to variation orders given to the contractor. The slippage due to financial accomplishment is 18% while physical slippage is 6.49%. Therefore it mandatory to adjust the plan and actual accomplishment of the project after any incident such as V.O or price adjustment.

According to the consultants findings the stakeholder's plan to deliver the project as it is planned should be guaranteed by keeping commitments.

4.3.2.3 Shire- Gondar - Debark Project

I. Particulars of the project under study

Project: Shire-Gonder - Debarqi road

Location: Amhara regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: International Development Agency (IDA) and the government of FDRE

User: Public

Type of the road surface: Asphalt surface (Triple surface treatment)

Total length: 99.2km

Construction type: road upgrading

Designers and supervisors: J Burrow South Africa [South Africa] in association with Omega Consulting Engineers [Addis Ababa]

Contractor: Sino Hydro Corporation Ltd.

Type/ base of contract: unit rate contract

Main Contract Amount (including day work, provisional sum, 10% contingencies and 15% V.A.T): ETB 690,779,965.26 with vat

Variations order amount: 83,306,143.30 Birr year to date variation.

Revised total contract amount: ETB 774,086,108.50 ETB

Original time for completion: 1095 Calendar Days

Extension of time to date of August, 2012: 425 calendar days

Revised contract time: 1520 calendar days

Commencement date according to contract: 1st April 2009

Revised completion date: 29th May 2013.

II. Physical progress reports assessment

As of December, 2012(in terms of physical accomplishment)

Plan report shown in monthly progress report is 82% which is 82 km plan to accomplish based on physical accomplishment. Actual accomplishment shown in monthly progress report the project has executed 91.09% of the job and 90.36 km of the road length as it is described.

As of August, 2012(in terms of financial accomplishment)

Financial plan report shown in monthly progress report on December, 2012 was 82%.

Summary

According to the report by the consultant it is learnt that

- The Contractor shall commence the delayed works of slope protection works especially on town sections in line with the engineer's instruction.
- The consultants did not mention in the reports that they have carried out planning the project executions details or updated project schedule due to variation orders.

The client also has to improve

- Resolution of the outstanding ROW compensation issues for the extended contract period
- Approval and/or final consent for the engineer's determination for outstanding claims.

4.3.2.4 Lot 2: Adigoshu – Humera Lugdi

I. Particulars of the project under study

Location: Tigray regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of FDRE

Selection: Competitive bid

User: Public

Type of the road surface: Asphalt surface (Triple surface treatment)

Total length: 168km

Construction type: Asphalt road upgrading

Consultants and supervisors: CORE Consulting Engineers Plc JV MCE

Contractor: Hunan Huanda Road and Bridge Corporation [HHRBC]

Type/ base of contract: unit rate

Main Contract Amount: ETB 627,709,145.85 [including VAT and Contingency]

Variations order amount: ETB 176,236,887.77 (Including VAT)

Revised total contract amount: ETB 980,315,129.48 (including price adjustments, VAT and contingency)

Original time for completion: 1280 Calendar Days

Extension of time to date of December, 2012: 902 calendar days

Revised completion time: June 30, 2013

Commencement date according to contract: July 10, 2007

II. Physical progress reports assessment

As of December, 2012(in terms of physical accomplishment)

Planned accomplishments according to monthly progress report showed that the project has 53.07% which is 89.15km plan to accomplish based on physical accomplishment. Actual accomplishments according to monthly progress report showed the project has executed 56.95% of the job and 95.68 km of the road length as it is described.

As of August, 2012(in terms of financial accomplishment)

Planned accomplishments according to the monthly progress report showed the project has plans shown in December, 2012 which accounts 61.32%.

Summary

The following major failures are notice from the progress report August, 2012.

Extension of time (EOT): 902 calendar days which is almost 78% to the original contract period of 1280 calendar days. When we analyze the basic data it is found that only 176,236,887.77 Birr of variation orders are given it is less that 18% of the original contract amount. But the EOT given to the contractor is about 78% percent. With normal project time planning and forecasting it is not expected the project to be extended with such time. Extension of time has cost related increments to the contractor.

Additionally well experienced engineers in road sector agrees, in most domestic contracts, contractors are privileged in generous extension of time in order to protect from contractual penalties that would have damaged their capacity and cause to the possible withdrawal from road construction sector.

According to the report by the consultant the following are risk factors to non-excusable delays

- The contractor did not strictly follow the schedule for equipment mobilization and deployment and in turn it has affected the progress adversely. For example, asphalt pavement equipment had not been mobilized as late as to the end of September 2010.
- As per the contractor's original work program, structural works have been planned to commence during the month of April 2008. However, there was no commencement of such works until June 2008 due to delay in finalizing the preparatory works.
- It has noted that, most of the constructions of the pavement works were delayed due to the Contractor's own problem. As an example, the planned commencement date of Sub base works was June 2008. However, there was no timely commencement due to poor preparatory works with regard to material production, testing and equipment mobilization. Delays for commencement of this activity created an adverse effect on the progress of works. Even after commencement of sub-base works during the month of July 2008, the progress was not that much satisfactory due to poor coordination and lack of produced qualified materials and enough resources. Lower sub base works have not been carried out as required mainly due to lack of equipments. In this fact the supervising consultant had to make written notice to the client and instructions to the contractor. But in the correspondence section of the reports there is no letters concerning this delay of works.
- Shortages of resource for various activities especially dump trucks.
- Lengthy downtime of equipments due to spare part problems.

Comment: The client has to take contractual measures on due time to the contractors even though the outcome of the measure might end up in termination. The progress report in December 2012, after 5 years from the commencement date was 65%. It is very unlikely to complete the remaining 35% of the works to complete within the remaining period which is less a year. It clearly anticipates lack of proper measure from the project stakeholders. The contractor would have made increasing of the resources in areas shortages had been reported.

4.3.2.5 Hawusewa – Abala - Irebti Afdera Contract 1

I. Particulars of the project under study

Location: Afar regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of Federal Democratic Republic of Ethiopia

User: Public

Type of the road surface: Asphalt surface (Asphalt concrete)

Total length: 94.141 km

Construction type: road upgrading

Work plan: plan attached.

Consultant: Intercontinental Consultants Technocrats in J.V. with ICTE and Omega Consulting Engineers Plc.

Contractor: Jiangxi Zhongmei Engineering Construction Co. Ltd (JXZM)

Supervisor: Intercontinental Consultants Technocrats in J.V. with ICTE and Omega Consulting Engineers Plc.

Type/ base of contract: Unit Rate Contract

Main Contract Amount (including day work, provisional sum, 10% contingencies and 15% V.A.T): ETB 746,341,435.30 Birr

Variations order amount: ETB -5,112,118.00 (V.O N0.1) and ETB 123,721,187.58 (V.O N0.2).

Revised total contract amount:

Final project Amount: ETB 1,396,880,250

Commencement date: August 21, 2008

Original time for completion time: 1260 Calendar days (02 February, 2012)

Extension of time to date: 372 Calendar days

Revised contract time: February 08, 2013.

II. Physical progress reports assessment

As of December, 2012(in terms of physical accomplishment)

Plan according to monthly progress report the project has shown 80.52% which is 75.77km plan to accomplish based on physical accomplishment. Actual accomplishment according to monthly progress report the project has shown 64.69% of the job and 60.87 km of the road length.

As of August, 2012(in terms of financial accomplishment)

According to financial accomplishment, the monthly progress report the project has shown 60.87%.

Summary

The following major failures are notice from the progress report December, 2012.

According to the report by the consultant it is learnt that

- Lack of experienced management team and site co-ordination.
- Shortage of effective machineries particularly for Asphalt works, embankment and sub-base placing activities.
- The rate of progress is not satisfactory. The main reasons are the frequent breakdown of machineries and poor maintenance system, shortage of fuel for equipments due to poor fueling system , shortage of surveyors and survey equipments, poor coordination between each work teams and lack of experienced site Engineers and foremen.
- Lack of sufficient number of office engineers to prepare the working drawing has resulted in less number of approved drawings at hand. It is recommended that the contractor deploys experienced Structural Engineer to avoid delay in preparation of shop drawings for culverts.

- Absences of key staffs like Experienced Planning Engineer, Experienced Material Engineer, and Structural Engineer and Environmental officer have made poor management and site coordination. Moreover, qualified Sectional Site Foremen with knowledge of English languages for proper coordination with the Engineer's Staff are required. Besides, during several meetings, special attention has been drawn to the contractor to give great emphasis on mobilization of Planning Engineer for the preparation of project planning in order to get a realistic work program as per Clause 14.2 and incorporating the Engineer's comment provided on the last submission showing practical completion date based on revised final quantities.
- The sequences of activities are erratic and need to be streamed lined in a systematic order for day to day site operations for cross drainage structure works and Pavement works. In this respect, the contractor has been advised in meetings to improve the site management by deploying well-experienced key site personnel for the good progress of the project.

4.3.2.6 Contract 3 Adiremet Dejena-Dansha Upgrading Road Project

I. Particulars of the project under study

Location: Tigray regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of FDRE

User: Public

Type of the road surface: Asphalt Asphalt surface (Asphalt concrete)

Total length: 97.66 km

Construction type: road upgrading

Work plan: No plan attached.

Designer and Supervisor : LEA international Ltd. Canada in joint venture with LEA associates south asia Pvt. Ltd. India and CORE consulting engineers P.L.C., Ethiopia.

Contractor: Hunan Huanda Road and Bridge Corporation

Type of contract: unit rate

Main Contract Amount (including day work, provisional sum, 10% contingencies and 15% V.A.T): ETB 936,550,554.86 including 10% contingency, 15% Vat and provisional sum

Variations order amount: Positive (+) 10,258,277.37.

Revised total contract amount: ETB 1,189,047,035.43 including 10% contingency, 15% Vat and provisional sum

Final project Amount:

Original time for completion time: 1096 calendar days

Extension of time to date of December, 2012: 365 calendar days

Revised contract time: 8th February/ 2013

Commencement date according to contract: February 10/2009

II. Physical progress reports assessment

As of December, 2012(in terms of physical accomplishment)

According to monthly progress report the project had planned 59.86% of accomplishment, which is 58.44km. Actual accomplishment according to monthly progress report had been 70.37% of the job and 68.70 km of the road length.

As of August, 2012(in terms of financial accomplishment)

According to the monthly progress report, the project financial accomplishment has been 70.37%.

Summary

The following major failures are notice from the progress report December, 2012.

According to the report by the consultant it is learnt that

- Lack of experienced management team and site co-ordination.
- Shortage of effective machineries particularly for Asphalt works, embankment and sub-base placing activities.
- There has been shortage in the technical staff. Contractor needs to add technical staff to improve the execution of remaining works.
- Lack of sufficient number of office engineers to prepare the working drawing has resulted in less number of approved drawings at hand. It is recommended that the contractor deploys experienced Structural Engineer to avoid delay in preparation of shop drawings for culverts. Contractor has to increase structure and earthwork crews to complete the project with reasonable time.

4.3.2.7 Assosa-Kurmuk

I. Particulars of the project under study

Location: Benishangule Gumuze regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: The government of FDRE, the Arab Bank for Economic Development in Africa (BAEDA) and Saudi Fund for Development (SFD) with proportions of 14.45% BAEDA, 19.45% SFD and 66.10% FDRE

User: Public

Type of the road surface: Asphalt surface (Double surface treatment)

Total length: 96.675 km

Construction type: road upgrading

Work plan: No plan attached.

Designer: CORE consulting engineers Plc.

Contractor: Sinohydro Corporation Plc.

Type of contract: unit rate.

Supervisor: Arabian Consulting Engineers service JV Metafferia consulting engineers Plc

Type/ base of contract:

Main Contract Amount: ETB 502,877,507.19 (including VAT)

Variations order amount: ETB 7,977,093.83(as of March 2013)

Revised total contract amount: ETB 561,722,510.55 (with VAT, contingency & less PS)

Original time for completion time: 1095 calendar days

Extension of time to date of March, 2013: 334 calendar days

Revised contract time: 1,429 calendar days

Commencement date according to contract: April 9, 2009

Original date for completion: April 7, 2012

Revised date of completion: March 7, 2013

Time elapsed as of March 2013 compared to original period: 1452 calendar days (132.6%)

Time elapsed as of March 2013 compared to revised period: 1452 calendar days
(101.68%)

II. Physical progress reports assessment

As of March, 2013(in terms of physical accomplishment)

Plan according to monthly progress report the project had shown no plan to accomplish based on physical (in kilometer or percentage) accomplishment. Actual report has made the accomplishment in terms of various work activities than in kilometers. Hence it is difficult to assess the physical accomplishment of the project.

As of March, 2013(in terms of financial accomplishment)

Plan according to the monthly progress report the project has plans shown in March, 2013 is 101.95% of the original contract but the actual accomplishment is 95.54% of the revised contract amount.

Summary

The following major failures are notice from the progress report March, 2013..

Extension of time (EOT): 334 calendar days

Delay from time in original completion date (in %):

Delay from the revised completion date (in %): 4.46%

According to the report by the consultant it is learnt that

- The contractor has not paid enough attention to the project at the commencement of the project.(delay on mobilizations)
- Key personnel like project manager material engineer and administrator has not been mobilized on time.
- Due to late arrival of material engineer and arrival of necessary equipments for testing from abroad, the preparatory work such as testing of construction materials establishing of site laboratory etc are delayed.
- Unbalanced fleet of construction equipments. Shortage of relevant equipments to the works.
- Repeated equipment technical failures (graders, loaders, rollers, chip spreaders and crusher plants.)
- shortage of construction equipments
- mismanagement of finances
- unsatisfactory pavement works
- Shortage of cements and logistics to the concrete works activities.

4.3.2.8 Contract 1: Gedo – Bako

I. Particulars of the project under study

Location: Oromia regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: IDA/ Government of F.D.R.E

User: Public

Type of the road surface: Asphalt surface

Total length: 66 km

Construction type: road rehabilitation

Work plan: No plan attached.

Designer and supervisor: DHV Consultants in association with CWCE.

Contractor: China Highway Group Co. Ltd.

Type of contract: unit rate.

Main Contract Amount: ETB 354,350,909.62

Variations order amount: ETB 23,912,764.19

Revised total contract amount: ETB 502,109,297.11 (with V.O & price adjustment)

Original time for completion time: 821 calendar days

Extension of time to date of March, 2013: 92 calendar days

Revised contract time: 913 calendar days

Commencement date according to contract: January 21, 2010

Original date for completion: April 11, 2012

Revised date of completion: December 16, 2012

II. Physical progress reports assessment

As of March, 2013(in terms of physical accomplishment)

According to monthly progress report the project is planned to accomplish 100%, in terms of physical accomplishment 66.18km. The actual accomplishment reported is 84.64% in terms of physical accomplishment is 57.3km.

As of March, 2013(in terms of financial accomplishment)

According to the monthly progress report, the project had been planned to be in March, 2013 100% accomplished. But the actual is 64.72 %.

Summary

The following major failures are notice from the progress report March, 2013.

Delay from the revised completion date (in %): 55.71%

According to the report by the consultant it is learnt that

- The number of Equipments and Machineries deployed to the project are below that required by the provisionally accepted work program.
- Poor site management, organization and unclear line of responsibility.
- The numbers of interpreters assigned on the project site are not enough as compared to the various work location along the project road. The Contractor has been advised on several occasions either to deploy Chinese staff who can communicate in the contract language or to increase the number of interpreters.
- Unbalanced fleet of construction equipments. Shortage of relevant equipments to the works.

Analysis of progress.

The Supervision Consultant reported that the Contractor's progress to date attained is 81.64%. The time elapsed to date is 1,242 calendar days which accounts to 136.35% of the total Contract time period (913 calendar days).

The E.O.T to date is 92 calendar days. Most of the delays are caused due to the contractor's lack of commitment to the planned schedule execution.

4.3.2.9 2: Bako-Nekempte

I. Particulars of the project under study

Project: Bako-Nekempte road rehabilitation project

Location: Oromia regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: IDA/ Government of F.D.R.E

User: Public

Type of the road surface: Asphalt surface

Total length: 65 km

Construction type: road rehabilitation

Work plan: No plan attached.

Designer and supervision: Mouchel Ltd in Association with CWCE.

Contractor: China Highway Group Co. Ltd.

Type of contract: unit rate

Main Contract Amount: ETB 391,047,637.57

Variations order amount: ETB 30,788,193.66

Revised total contract amount: ETB 528,146,345.30(with V.O & price adjustment)

Original time for completion time: 900 calendar days

Extension of time to date of March, 2013: 14 calendar days

Revised contract time: 914 calendar days

Commencement date according to contract: October 10, 2009.

Original date for completion: April 9, 2012.

Revised date of completion: October 14, 2012

II. Physical progress reports assessment

As of March, 2013(in terms of physical accomplishment)

Plan shown in monthly progress report the project is to be 100% accomplishment in terms of kilometer 64.84km. The actually accomplishment is 82.64% and in terms of kilometers of 53.62km.

As of March, 2013(in terms of financial accomplishment)

The monthly progress report of the project planned in March, 2013 to be 100% but the actual accomplishment is 79.6 %.

Summary

The following major failures are notice from the progress report March, 2013.

Delay from the revised completion date (in %): 52.70%

According to the report by the consultant it is learnt that

- The number of Equipments and Machineries deployed to the project are below that required by the approved work program. More equipments have been promised to be deployed in the work plan than it is on the project during the executions.
- Poor site management, organization and unclear line of responsibility.
- The numbers of interpreters assigned on the project site are not enough as compared to the various work location along the project road. The Contractor has been advised on several occasions either to deploy Chinese staff who can communicate in the contract language or to increase the number of interpreters.
- The equipments available on site were not adequate and relevant to the works.
- Poor planning and management of the overall project activities.

- Delay in supply of manufactured materials such as cement, reinforcement steel, bridge bearings etc, has affected the progress of the works as the availability of those materials is not as the required.

Analysis of progress.

The Supervision Consultant reported that the Contractor's progress to date attained is 79.60%.

The time elapsed to date is 1,232 calendar days which accounts to 134.30% of the total Contract time period (913 calendar days).

The E.O.T to date is 14 calendar days. Most of the delays are caused due to the contractors' lack of commitment to the planned schedule execution.

4.3.2.10 Contract 1: Wolkite-Arekite

I. Particulars of the project under study

Project: Wolkite-Hossana road upgrading project

Location: SNNP regional states

Client: Ethiopian Roads Authority (E.R.A)

Financer: Government of FDRE and World bank

User: Public

Type of the road surface: Asphalt surface

Total length: 60.31 km

Construction type: road upgrading

Work plan: No plan attached.

Designer and supervisor: Comptran Engineering and planning associates (Ghana)
in Joint venture with Beza Consulting engineers plc.(Ethiopia).

Contractor: China Gezhouba Group Company Ltd.

Type of contract: unit rate.

Main Contract Amount: ETB 717,440,576.41

Variations order amount: ETB 67,012,353.489

Revised total contract amount: ETB 784,452,929.9(with V.O & price adjustment)

Original time for completion time: 912 calendar days

Extension of time to date of March, 2013: N/A

Revised contract time: N/A

Commencement date according to contract: October 7, 2011

Original date for completion: April 6, 2014

Revised date of completion: N/A

II. Physical progress reports assessment

As of March, 2013(in terms of physical accomplishment)

According to monthly progress report the project plan is 26.29%, 15.85km. Actually the report showed accomplishment of 23.51% in terms of kilometers of 14.18km.

As of March, 2013(in terms of financial accomplishment)

According to the plan the monthly progress report of the project had been 26.29% but the actual accomplishment is 23.51 %.

Summary

The following major failures are notice from the progress report March, 2013.

Delay (Slippage) from the revised completion date (in %): 2.78%

According to the report by the consultant it is learnt that

- The number of Equipments and Machineries deployed to the project are below that required compared to the approved work program.
- Unbalanced fleet of construction equipments. Shortage of relevant equipments to the works.

Analysis of the progress.

The Supervision Consultant reported that the Contractor's progress to date attained is 23.51%. The time elapsed to date is 541 calendar days which accounts to 59.32% of the total Contract time period (912 calendar days). The E.O.T to date is not mentioned in the report. Hence the contractor will definitely be subjected to liquidate damage unless justified time extension is granted.

4.3.3 Total summary of case study:

The problems identified in the case projects that creates the lack of execution of works as of the planned schedule works are committed by the three major stakeholders of the projects client, contractor and consulting and design engineers. These major problems are classified as to their corresponding parties as follows

- Clients
 - Delay of the Employer in effecting monthly statements of the Contractor.
 - Resolution of the outstanding ROW compensation issues for the extended contract period
 - Approval and/or final consent for the engineer's determination for outstanding claims.
 - Lack of follow up to the contractor. The client did not strictly follow the contractor's schedule for equipment mobilization and deployment and in turn it has affected the progress adversely.
 - There are irregularities in managing claims concerning E.O.T in some projects.
- Consultants
 - Late designs and design reviews which should have been made prior to the project, design has been delayed due to recklessness.
 - Late responses towards contractor's claims.
 - Lack of covetous follow up from the start to the end project of and swift notice towards contractor's status.
- Contractors
 - The contractors have not paid enough attention to the project at the commencement of the project. (Delay on mobilizations).
 - Key personnel like project manager material engineer and administrator has not been mobilized on time.
 - Due to late arrival of material engineer (professionals) and arrival of necessary equipments for testing from abroad, the preparatory work such as testing of construction materials establishing of site laboratory etc are delayed.

- Unbalanced fleet of construction equipments. Shortage of relevant equipments to the works.
- Repeated equipment technical failures (graders, loaders, rollers, chip spreaders and crusher plants.)
- Shortage of logistics to works activities.
- Lack of co-ordination and experienced management team.
- Lengthy downtime of equipments due to spare part problems.
- Lack of sufficient number of office engineers to prepare the working drawing has resulted in less number of approved drawings at hand.
- Absences of key staffs like Experienced Planning Engineer, Experienced Material Engineer, and Structural Engineer and Environmental officer have made poor management and site coordination. Moreover, qualified Sectional Site Foremen with knowledge of English languages for proper coordination with the Engineer's Staff are required. Besides, during several meetings, special attention has been drawn to the contractor to give great emphasis on mobilization of Planning Engineer for the preparation of project planning in order to get a realistic work program as per Clause 14.2 and incorporating the Engineer's comment provided on the last submission showing practical completion date based on revised final quantities.
- The sequences of activities are erratic and need to be streamed lined in a systematic order for day to day site operations for cross drainage structure works and Pavement works. In this respect, the contractor has been advised in meetings to improve the site management by deploying well-experienced key site personnel for the good progress of the project.
- Lack of experienced management team and site co-ordination.
- Contractor needs to mobilize additional technical staff to improve project planning and site works so that the project shall be completed in time.
- Lack of sufficient number of office engineers to prepare the working drawing has resulted in less number of approved drawings at hand. It is recommended that the contractor deploys experienced Structural Engineer to avoid delay in preparation of shop drawings for culverts

- Due to late arrival of material engineer and arrival of necessary equipments for testing from abroad, the preparatory work such as testing of construction materials establishing of site laboratory etc are delayed.
- Poor site management, organization and unclear line of responsibility.

Table 10 Summary of case study.

	Causes for the non excusable delays	Selected Project for Case study									
		1	2	3	4	5	6	7	8	9	10
1	Not selecting competent subcontractors										
2	Poor management of the project changes									x	
3	Lack of mechanism for recording, analyzing, and transferring project lessons learned				X	x	x	x		x	
4	Delay in forwarding material and equipment to the site	x	x	X	X	x	x	x		x	
5	Delay in awarding subcontractors' contracts										
6	Lack of effective managing and controlling subcontractors										
7	Delay in detail design by project engineer subcontractor										
8	Delay in supplying shortage of the equipment	x	x		X	x	x		x	x	
9	Poor management of project site					x		x	x		
10	Poor management of project contract					x		x		x	
11	Issues on recruiting, attaining, and promoting expert and experienced project team	x	x						x		
12	Lack of effective communication and coordination with project stakeholders specially with the client/client's consultant										
13	Delay in obtaining technical information from subcontractors										
14	Conflicts among performing organization, client and client's consultant.										
15	Slow decision making by project manager										
16	Detail design errors by project engineer subcontractor										
17	Delay in basic design by performing organization										
18	Lack of applying contractual tools (liquidated damage or acceleration of work) against subcontractor										
19	Delay in basic design by project engineer					x	x	x	x		
20	Conflicts in work schedules of the contractors	x									

4.4 Assessment of the appraisal and constructability review methods of the planning and scheduling activities in the federal road construction projects.

- ii. Among the common impacts of planning and scheduling in road projects delays are exhibited in all respondent's projects and changes where as only 17%, 57% to see disruption, 53% experienced suspension and none of them had seen terminations.
- iii. The responses to the risk management strategy availability in projects specifically to plan and schedule, respondents said that 73% no plan to risk 17% unresponsive due to some reasons.
- iii. None of the respondents refer risk associated with non excusable delays avoidable, transferable or combinations of the any 100% of the responses showed that reducible.
- iv. From the responses gathered it is learnt that the following are major summarized factors that are associated to the risks of delay (excusable, non-excusable and concurrent).
 - Unsuitable construction program planning
 - Variations of construction programs
 - Inadequate or insufficient site information (soil test and survey report)
 - Unavailability of sufficient professionals and managers
- v. The respondents have responded that there is no other team constructed other than the team involved in design and execution of works.

4.5 Assess the how appraisals and controlling is done in planning and scheduling techniques in federal road constructions.

- i. From the respondents to the plans and schedules evaluation and review in road projects the following summarized responses have been found
 - The contents of the work's methodology and plan of the projects are evaluated at the bidding stage. The experience of updating it in relation to the practical execution is very weak.
 - Progress reports are primarily prepared based on financial progress of the project than fiscal accomplishments.
 - Slippage analysis is the key factor to the schedule review process.
- ii. The response to the types of the schedule impacts happened in the projects respondents have been working, what was/were the major reason/s to make schedule updates/rescheduling to happen about 46% of the respondents said change order due to unforeseen circumstances was the major cause to schedule updates/rescheduling, the rest 54% the combination of delays due to all parties.(client, consultant and contractors).

5. Conclusions and recommendations

The main objective of this research was to assess and make recommendations on the practice and impacts of the planning and scheduling of road projects to Federal road projects. Based on the research objectives the following conclusions and recommendations were drawn.

5.1 Conclusions

1. In the assessment to identify the trends in the current practices and major problems of planning and scheduling in road construction projects, the following major findings are observed.
 - Duration set to complete projects is basically determined with the period to which funds available and occupancy need (finances expire date).
 - There are no standard procedures prepared by the respective authority to the stakeholders to determine the durations of project schedules.
 - There are no project performance databases which could be used to develop project duration estimates.
 - Time contingencies are not considered during scheduling of the activities.
2. The second specific objective was to analyze the risk factors that impacts of schedule are accompanied by non-excusable delay in Federal road construction projects. The findings obtained are selected factor with high probability of occurrence and high impact on time
 - Delay in forwarding material and equipment to the site.
 - Delay in supplying shortage of the equipment.
 - Conflicts among contractor, client and consultant.
 - Conflicts in work schedules of the contractors.

Other findings which causes non-excusable delays with low probability of occurrence and high impact on time risks are

- Poor management of the project changes.
- Poor management of project contract.
- Issues on recruiting, attaining, and promoting expert and experienced project team.

3. The third objective was to assess the impacts of scheduling and constructability review methods of the planning and scheduling activities in the federal road construction projects. The findings to the common impacts in federal road construction projects are as follow

- Delays.
- Changes.
- Disruptions.
- Suspensions.

The following are summarized factors that are associated to the risks of delay (excusable, non-excusable and concurrent)

- Unsuitable construction program planning
- Variations of construction programs
- Inadequate or insufficient site information (soil test and survey report)
- Unavailability of sufficient professionals and managers
- There is no team organized for the project constructability review other than the team involved in design and execution of works (no basis to constructability review).

4. The fourth objective was to assess how is controlling is done in planning and scheduling techniques in federal road constructions. According to the responses the following has been concluded.

The following summarized responses have been found to express how plans and schedules are evaluated and reviewed

- The contents of the work methodology of the project are analyzed at the bidding stage.(without standard procedures)
- Financial progress of the project is very crucial to the evaluation and review of the projects progress than the fiscal accomplishments.
- Slippage analysis is the key factor to the schedule review process.

From the above responses it is easy to find that controlling of the project progress has the following weakness

- Due to lack of acknowledged standards personal biases could easily arise in evaluation of work schedule.

The types of the schedule impacts happened in the projects you have been working, what was/were the major reason/s to make schedule updates/rescheduling to happen change orders and the combination of delays due to all parties. (client, consultant and contractors).

5.2 Recommendations

1. The client, consultants and contractors in the Federal roads construction have to work on the preparations of standard and procedures to the planning and scheduling of the executions of works.
2. In order to provide the feedbacks to update planning and scheduling procedures of road construction projects, the project performance database should be systematically developed throughout the projects.
3. In the scheduling process of Federal road projects time contingency should be considered.
4. Building the capacity of clients, consulting and construction companies as well as investing in good pre tendering work, implementation and planning are essential to improve the project time management.
5. Make sure that adequate and realistic project time estimation is given by using developed and updated time cost models to Federal road construction projects.
6. These recommendations are made to minimize risk factors of non excusable delays. The following risk factors have high probability of occurrences and impact on time risk when they occur in the projects
 - i. Delay in forwarding material and equipment to the site.
 - ii. Delay in supplying shortage of the equipment.
 - iii. Conflicts among contractors, client and consultants.
 - iv. Conflicts in work schedules of the contractors.

Even though the following risk factors have low probability of occurrences, care should be given because when happened there high impact on time risk could adversely affect the project.

- i. Poor management of the project changes.
- ii. Poor management of project contract.
- iii. Issues on recruiting, attaining, and promoting expert and experienced project team.

8. Constructability review teams have to be organized in order to benefit from the modern thinking of project management. The team, independent from project design and construction team, should be engaged in various activities such as, construction supervision / Administration (construction claims, construction delays) scheduling estimating. This will help to avoid the risk factors that are associated with the excusable/non excusable/ concurrent delays such as unsuitable construction program planning, variations of construction programs, inadequate or insufficient site information (soil test and survey report), unavailability of sufficient professionals and managers. The experience of updating/rescheduling in relation to the practical execution should be considered on major activity on daily basis.
9. Evaluation of the Terms of References (TOR) for design services and qualification criteria for contractors should be used as criteria in such a way that it will be all-inclusive, sufficient key personnel inputs, with reasonable service period and with consideration of use of expertise in the area of proper planning and scheduling of works and risk mitigation for impacts factors.
10. The final recommendation is made in order to avoid personal biases and have common platform in controlling of the project progresses it is mandatory to create acknowledged standards of production, planning and scheduling of road construction projects with common efforts of stakeholders. Constructability review team should be organized to exempt delays due to stakeholders (client, consultant and contractors).

References

1. Chotchai Charoenngam, (2002) Planning and Scheduling Consideration and Constraints in Automated Construction Environment, Assistant Professor, School of Civil Engineering, Asian Institute of Technology, G.P.O Box 2754 Bangkok 10501 Thailand.
2. Abraham Assefa, (May 2008), Time-cost relationship for public road construction projects in Ethiopia, A thesis submitted to the partial fulfillment of the requirements for the degree of Masters of Science in Civil Engineering (Construction Technology and Management major), Addis Ababa university, Addis Ababa.
3. Saleh Mubarek, Construction project scheduling and control, Pearce Education Company, 2005
4. Ibrahim Hassan, Road sector development and economic growth in Ethiopia, Ethiopian Development Research Institute, September 2011.
5. Lewis James P., Project planning scheduling and control, Fifth edition, McGraw Hill, 2011.
6. Marco, Project Management for Facility Constructions, Planning and Scheduling, Springer-Verlag Berlin Heidelberg 2011.
7. National Defense industrial association, planning and scheduling excellence guide (PASEG) published release V.2.0, June 2012.
8. Greg J. H, Estimating performance time for air force military construction projects, USAF AFIT/GEM/ENV/05M-05 Department of the air force air university, Department of Systems and Engineering Management Graduate School of Engineering and Management, March 2005.
9. Williams R C (November, 2008), the development of mathematical models for the preliminary prediction of high construction duration, Dissertation submitted to the

faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for degree of Doctor of Philosophy in Civil Engineering, Virginia Polytechnic Institute and State University, Virginia, U.S.A.

10. Dalia M, Florida S, Wael T, and Tarek Z, A prediction model for construction project time contingency Department of Building, Civil and Environmental Engineering, Concordia University, Montreal, Quebec, 2009, Canada.
11. Moneke U U , Evaluation of factors affecting work schedule effectiveness in the management of construction projects, Department of Project Management Technology Federal University of Technology, Owerri – Nigeria, February 2012.
12. David A. Wood, risk simulation technique to aid project time planning management, International Journal Lincoln, England 2001.
13. Constructability: A case study in Transportation Project Delivery: San Francisco-Oakland Bay Bridge New East, Span, June 2002.
14. Frank J. Arcuri John C. Hildreth Virginia Tech, The Principles of Schedule Impact Analysis, VDOT-VT Partnership for Project Scheduling, Department of Civil and Environmental Engineering, May 2007.
15. Getachew Tsegaye, Design Risk Management In Ethiopian Federal Road Projects, A thesis submitted to the partial fulfillment of the requirements for the degree of Masters of Science in Civil Engineering (Construction Technology and Management major), Addis Ababa university, July 2009 Addis Ababa.
16. Hishamuddin Mohd Ali, Modern Portfolio Theory, Department of Property Management Faculty of Geoinformation Science and Engineering University Teknologi Malaysia.
17. Tversky, A. and D. Kahneman, “The Framing of Decisions and the Psychology of Choice,” Science, 211, 453-458, January 30, 1981.

18. Patrick, Z, Guomin Z and Wang J, Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder Perspectives, 1 and 2: Faculty of Built Environment, University of New South Wales, Sydney 2052, Australia; 3: College of Architecture and Civil Engineering, Shenzhen University, Shenzhen, P.R. China.
19. Constructability Review Process Guide, Contract Management Office Contract Management & Operations Branch, DoT, April 2010.
20. Liu S S , Shih K C, Construction rescheduling based on a manufacturing rescheduling framework, Department of Construction Engineering, National Yunlin University of Science and Technology, No. 123, Section 3, University Road, Touliu, 640 Taiwan, ROC, b Graduate School of Engineering Science and Technology, National Yunlin University of Science and Technology, No. 123, Section 3, University Road, Touliu, 640 Taiwan, ROC.
21. James P. Lewis, Project planning scheduling and control, Fifth edition, McGraw Hill, 2011.
22. Bordat C, Bob G Mccullogh, Kumares C sinah and Samuel L, Analysis of cost overruns and time delays INDOT projects, Indian department of transportation, December 2004.

Appendix

Addis Ababa University

Addis Ababa institute of Technology

School of Civil and Environmental Engineering

M.Sc program in Construction Technology and Management

**A study on planning and scheduling of federal road construction projects in Ethiopia
(Case studies on selected projects)**

I.Objective:

The objective of this study is to analyze the current trends of planning and scheduling in the federal road projects and identify the problems in it then finally to provide possible solutions to the problems raised with respect to the practical approaches of the stakeholders in the sector.

It is implicit that well planned and scheduled construction projects will be delivered keeping on the equilibrium of the three basic project ingredients time cost and quality. Therefore, for all stakeholders in the federal construction projects, project planning and scheduling is basic tool to assure their basic interest is met in the process of project delivery processes.

Thus this research is conducted to enhance the planning and scheduling in works of federal road construction projects and the results are intended to serve for academic purposes only. The name of the professionals and institutions participated will be recorded confidentially. Finally it is with enthusiasm to thank you in advance for your willingness to answer the interview for further study and analysis.

Addresses: Nejbel Mohaamed, Email- njjcool@yahoo.com

Phone #: 091-1047-942 or 091-2644-005

II. Opinion of participants (structured interview)

- 1 Name: _____
- 2 Profession:_____
- 3 Organization(client, consultant, contractor or other):_____
- 4 Current Job Title:_____
- 5 Experience: _____ as _____
_____ as _____

III Basics of planning and scheduling

- 6 How long do you have experiences in relations to the preparations of road construction planning and scheduling?
 - (a) _____years in clients role
 - (b) _____years in the engineers role

(c) _____ years in the contractors role

7 Do you have standard procedure to plan and schedule construction project's activities?

O yes O no

8. What are the common trends in the preparations of plan and schedule to project executions? (Federal road projects).

9. Do the plan and schedule often executed without non-excusable delays?

O yes O no

10. Do you assess risks to the project construction in planning and schedule stage ?If yes elaborate

11. What is the major problem in estimating the durations of activities?

IV The major causes in planning and scheduling delays in federal road projects activities From your experience of the sector the following tables are to be filled by you.

Causes of non excusable schedule delays in federal road constructions.

Causes for the non excusable delays	Impact on duration			Probability of occurrence		
	Low	Medium	High	Low	Medium	High
Not selecting competent subcontractors						
Poor management of the project changes						
Lack of mechanism for recording, analyzing, and transferring project lessons learned						
Delay in forwarding material and equipment to the site						
Delay in awarding subcontractors' contracts						
Lack of effective managing and controlling subcontractors						
Delay in detail design by project engineer subcontractor						
Delay in supplying shortage of the equipment						
Poor management of project site						
Poor management of project contract						
Issues on recruiting, attaining, and promoting expert and experienced project team						
Lack of effective communication and coordination with project stakeholders specially with the client/client's consultant						
Delay in obtaining technical information from subcontractors						
Conflicts among performing organization, client and client's consultant.						
Slow decision making by project manager						
Detail design errors by project engineer subcontractor						
Delay in basic design by performing organization						
Lack of applying contractual tools (liquidated damage or acceleration of work) against subcontractor						
Delay in basic design by project engineer						
Conflicts in work schedules of the contractors						

V the impacts of planning and scheduling of federal road projects

13. What are the common impacts of planning and scheduling in road projects you have worked?

- Delays _____
- Disruptions _____
- Changes _____
- Suspensions _____
- Terminations _____
- If multiple

14. Is there risk management strategy in road construction project?

- Yes _____
- No _____

15. What is your opinion in risks associated with delay?

- Avoidable _____
- Reducible and common. _____
- Transferable _____
- Combination of

16. What are associated to the risks from the perspective of project stakeholders and life cycle of the projects?

17. Is there a process of study on team of expertise other than participants of design concerning constructability of projects?

VI Controlling to the planning and scheduling of the projects

18. How is control and appraisals of the plan and schedule done in road projects? Elaborate

19. Based on the types of the schedule impacts happened in the projects you have been working, who was/were the major reason/s to make schedule updates/rescheduling to happen?

- a Change orders due to unforeseen circumstances
- b Delay due to contractors
- c Delay due to consultants
- d Delay due to client
- e Combinations of _____

General comments on the research

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university. All sources of materials used for the thesis have been duly acknowledged.

Name: Nejbel Mohaamed Abdela

Signature: _____

PLACE:

Addis Ababa University, School of Graduate Studies,
Institute of Technology,
School of Civil and Environmental Engineering

DATE: 28th May, 2014.