



# **CHALLENGES OF SCHEDULING OF FEDERAL ROAD CONSTRUCTION PROJECTS IN ETHIOPIA**

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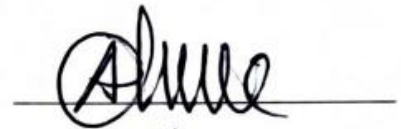
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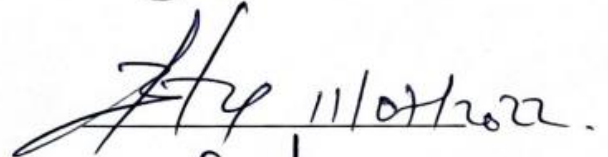
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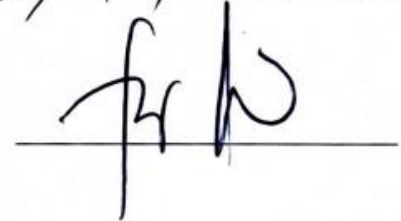
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## DECLARATION

I, the undersigned, hereby declare that this research paper entitled “CHALLENGES OF SCHEDULING OF FEDERAL ROAD CONSTRUCTION PROJECTS IN ETHIOPIA” is my original work and I have not previously in its entirety or in part submitted at any university for a degree. All sources of materials used for the research paper have been duly acknowledged.

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# TABLE OF CONTENTS

DECLARATION .....	I
ACKNOWLEDGEMENTS.....	II
ABSTRACT .....	VII
<b>CHAPTER ONE: INTRODUCTION.....</b>	<b>1</b>
<b>1.1 BACKGROUND OF THE STUDY .....</b>	<b>1</b>
<b>1.2 STATEMENT OF THE PROBLEM .....</b>	<b>2</b>
<b>1.3 RESEARCH QUESTIONS .....</b>	<b>3</b>
<b>1.4 RESEARCH OBJECTIVE .....</b>	<b>3</b>
<i>1.4.1 General Objective .....</i>	<i>3</i>
<i>1.4.2 Specific Objectives .....</i>	<i>3</i>
<b>1.5 SIGNIFICANCE OF THE STUDY .....</b>	<b>3</b>
<b>1.6 SCOPE OF THE STUDY .....</b>	<b>3</b>
<b>1.7 DEFINITION OF OPERATIONAL TERMS .....</b>	<b>4</b>
<b>1.8 ORGANIZATION OF THE STUDY.....</b>	<b>5</b>
<b>CHAPTER TWO: REVIEW OF RELATED LITERATURE .....</b>	<b>6</b>
<b>2.1 THEORETICAL REVIEW.....</b>	<b>6</b>
<i>2.1.1 Basics of Scheduling.....</i>	<i>6</i>
<i>2.1.2 Resource Leveling .....</i>	<i>12</i>
<i>2.1.3 Schedule Crashing.....</i>	<i>12</i>
<i>2.1.4 Importance of Schedule Crashing.....</i>	<i>15</i>
<i>2.1.5 Steps of Schedule Crashing in Project Management.....</i>	<i>15</i>
<b>2.2 EMPIRICAL REVIEW .....</b>	<b>16</b>
<b>2.3 RESEARCH FRAMEWORK.....</b>	<b>18</b>
<b>CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY .....</b>	<b>19</b>
<b>3.1 RESEARCH DESIGN .....</b>	<b>19</b>
<b>3.2 RESEARCH APPROACH.....</b>	<b>20</b>
<b>3.3 RESEARCH POPULATION.....</b>	<b>21</b>
<b>3.4 SAMPLING .....</b>	<b>21</b>
<b>3.5 DATA SOURCES AND TYPE .....</b>	<b>22</b>
<b>3.6 MEASUREMENT.....</b>	<b>22</b>
<b>3.7 VALIDITY AND RELIABILITY.....</b>	<b>23</b>
<b>3.8 DATA ANALYSIS TECHNIQUE.....</b>	<b>24</b>
<b>3.9 ETHICAL CONSIDERATION.....</b>	<b>25</b>

<b>CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION .....</b>	<b>26</b>
<b>4.1    RESPONSE RATE AND DEMOGRAPHIC DATA .....</b>	<b>26</b>
<b>4.2    RESULTS OR FINDINGS.....</b>	<b>28</b>
<b>4.2.1    IMPLEMENTATION OF PROJECT TIME MANAGEMENT PROCESSES .....</b>	<b>31</b>
<b>4.2.2    CHALLENGES IN PREPARATION AND REVISION OF WORK SCHEDULES.....</b>	<b>36</b>
<b>4.2.3    LEVELS OF NEGATIVE IMPACTS OF UNREALISTIC WORK SCHEDULE.....</b>	<b>52</b>
<b>4.2.4    FREQUENCY OF REVISION OF WORK SCHEDULE.....</b>	<b>55</b>
<b>4.2.5    INITIATION OF REVISION OF WORK SCHEDULE .....</b>	<b>56</b>
<b>4.2.6    PRESENCE OF STANDARD OPERATING PROCEDURES OF SCHEDULING .....</b>	<b>57</b>
<b>4.2.7    IMPLEMENTATION OF RESOURCE LEVELING .....</b>	<b>57</b>
<b>4.2.8    IMPLEMENTATION OF SCHEDULE CRASHING .....</b>	<b>58</b>
<b>4.2.9    FORMS OF RELATIONSHIPS AMONG TASKS TO PREPARE WORK SCHEDULES .....</b>	<b>58</b>
<b>4.3    INTERPRETATION AND DISCUSSION .....</b>	<b>59</b>
<b>CHAPTER FIVE: SUMMARY, CONCLUSION, AND RECOMMENDATIONS.....</b>	<b>60</b>
<b>5.1    SUMMARY .....</b>	<b>60</b>
<b>5.2    CONCLUSIONS.....</b>	<b>61</b>
<b>5.3    RECOMMENDATIONS.....</b>	<b>62</b>
<b>REFERENCES .....</b>	<b>63</b>
<b>APPENDICES .....</b>	<b>65</b>
<b>DATA COLLECTION INSTRUMENT .....</b>	<b>66</b>

## List of Tables

Table 1: Sample Size Determination .....	21
Table 2: Response Rate of Questionnaires Distributed .....	26
Table 3: Academic Qualification of Respondents .....	26
Table 4: Work Experience of Respondents .....	27
Table 5: Job Title of Respondents .....	27
Table 6: Reliability Test - Project Time Management Processes .....	28
Table 7: Reliability Test - Challenges of Scheduling .....	29
Table 8: Reliability Test - Negative Impacts of Unrealistic Work Schedule .....	30
Table 9: Summary of Reliability Test using Cronbach's $\alpha$ .....	30
Table 10: Difficulties in Implementation of Project Time Management Processes according to Employer .....	31
Table 11: Difficulties in Implementation of Project Time Management Processes according to Consultant .....	32
Table 12: Difficulties in Implementation of Project Time Management Processes according to Contractor .....	34
Table 13: Overall Difficulties in Implementation of Project Time Management Processes .....	35
Table 14: Summary of Overall Implementation of Project Time Management Processes .....	36
Table 15: Challenges in Preparation and Revision of Work Schedules according to Employer .....	37
Table 16: Challenges in Preparation and Revision of Work Schedules according to Consultant .....	39
Table 17: Challenges in Preparation and Revision of Work Schedules according to Contractor .....	41
Table 18: Overall Challenges in Preparation and Revision of Work Schedules .....	43
Table 19: Summary of Challenges in Preparation and Revision of Work Schedules according to Employer .....	45
Table 20: Summary of Challenges in Preparation and Revision of Work Schedules according to Consultant .....	46
Table 21: Summary of Challenges in Preparation and Revision of Work Schedules according to Contractor .....	47
Table 22: Summary of Overall Challenges in Preparation and Revision of Work Schedules .....	48
Table 23: Correlation of Challenges as Perceived by Employer and Consultant .....	49
Table 24: Correlation of Challenges as Perceived by Employer and Contractor .....	50
Table 25: Correlation of Challenges as Perceived by Consultant and Contractor .....	51
Table 26: Summary of Negative Impacts of Unrealistic Work Schedules according to Employer .....	52
Table 27: Summary of Negative Impacts of Unrealistic Work Schedules according to Consultant .....	53
Table 28: Summary of Negative Impacts of Unrealistic Work Schedules according to Contractor .....	54
Table 29: Overall Summary of Negative Impacts of Unrealistic Work Schedules .....	55

## List of Figures

Figure 1: Frequency of Revision of Work Schedule .....	56
Figure 2: Who usually initiates the Revision of Work Schedule .....	56
Figure 3: Presence of Standard Operating Procedures for Scheduling .....	57
Figure 4: Implementation of Resource Leveling .....	57
Figure 5: Implementation of Schedule Crashing .....	58
Figure 6: Commonly Used Forms of Relationships among Tasks .....	58

## **ACRONYMS**

CCM - Critical Chain Method

CPM - Critical Path Method

EV - Earned Value

EVM - Earned Value Management

PERT- Program Evaluation and Review Technique

PV - Planned Value

SPI - Schedule Performance Index

SV - Schedule Variance

WBS - Work Breakdown Structure

## ABSTRACT

Many road construction projects in Ethiopia are facing challenges of scheduling. Schedules are not usually prepared properly; the schedules are not realistic in most cases; and there are no timely revisions of work schedules. Though there is huge budget being allocated to the road construction industry in Ethiopia, there are prominent delays of completion of projects due to improper scheduling and lack of controlling work schedules. Therefore, this research was conducted to identify the major challenges of scheduling of Federal road construction projects in Ethiopia.

Questionnaire survey was used to collect data of challenges of Federal road construction projects. A total of 58 questionnaires from the staffs of Employers, Consultants and Contractors of twenty projects were collected. The data collected was analyzed using descriptive statistics. The results of the study showed that *Controlling Schedule, Planning Schedule Management* and *Estimation of Activity Durations* are the major difficulties observed from “Project Time Management Processes”. Respondents rated 12 major challenges of scheduling of road construction projects. The most important challenges observed according to the study were: *not considering risks in schedule, improper allocation resources, using similar variables of other projects* and *absence of training on scheduling*. The major negative effects of having unrealistic work schedule were *delayed completion time, increased project cost, low profitability of contractor* and *low satisfaction of Employer*. Resource leveling and schedule crashing were not being implemented by 53% of road construction projects.

Spearman rank order correlation analysis was used to evaluate whether consensus of opinions exists between groups of respondents. From the analysis of the results it was found that consensus of opinion exists between the groups. It is anticipated that these findings will guide efforts to improve the planning, preparation and controlling of schedules of road construction industry.

**Key Words:** Schedule, Challenges, Delay, Project Management, Road Construction

## CHAPTER ONE: INTRODUCTION

### 1.1 Background of the Study

The principal function of roads is to provide accessibility and mobility thereby improving the transportation system. Currently, most developing countries around the world are prioritizing the improvement and linking of their road networks. Road projects are being enumerated as the primary emphasis in their national budget as a good road network contributes to the development of the economy and national growth. Therefore, road projects should be completed in accordance with the schedule to serve the immediate needs of stakeholders. Unfortunately, delays in road construction projects due to various reasons are a major problem facing the road construction industry. It has been proven that the incapability to finish projects punctually and within a given budget continues to be a persistent issue worldwide (Ahmed et al, 2002).

Although the causes of delays are quite comparable across developing countries, several factors unambiguously pertain to local industries, socio-economic backgrounds, cultural matters, and project features, such as land disputes and problems of the right of way for roads. With road construction projects already producing a multitude of issues to the community, such as heavy traffic and increased possibilities of road accidents, among others, project personnel is also facing the consequences of project failure, profit decrease, and loss of faith to the public in government-funded projects. Therefore, on-time completion of a road project is exceptionally crucial.

Delays in schedules of road construction projects are widespread and are not limited to developed countries. Developing countries also experience the same issues (Kaliba et al, 2009).

Federal road construction projects are administered by Ethiopian Roads Administration involving local and international contractors. Federal road projects are reported to have been faced critical problems with respect to work schedules. The schedules are not usually submitted in time and they are not realistic in most circumstances.

Project success is evaluated by three dimensions: time, cost and quality. When a project is completed within time and within budget by satisfying the required quality, it is said to be a successful project. When the cost of project exceeds the targeted budget, the client faces a problem and should be convinced to release additional funds. Hence, when compared to time, the budget and running costs of the projects should be monitored and controlled more. Effective project scheduling is a critical component of successful time management.

Accordingly, this study attempts to identify the major challenges of scheduling of Federal road construction projects under Ethiopian Roads Administration, which can serve as a way forward for future work in coping up with this problem. A thorough literature review and desk study was done, through which a number of challenges of scheduling were identified in Federal road construction projects.

## **1.2 Statement of the Problem**

Data published by Ethiopian Roads Administration show that Federal road construction projects face challenges of work scheduling and many projects face schedule delays. Therefore, this study tries to identify the most important and frequent challenges of scheduling of Federal road construction projects in Ethiopia. It is also aimed to provide an input to mitigate the challenges of scheduling in construction of Federal road construction projects in Ethiopia.

### **1.3 Research Questions**

This research attempts to answer the following basic research questions:

- What are the major challenges of scheduling in Federal road construction projects in Ethiopia?
- What are the negative effects of having unrealistic work schedules in Federal road construction projects?

### **1.4 Research Objective**

#### **1.4.1 General Objective**

The general objective of the study is to identify the major challenges of scheduling of Federal road construction projects in Ethiopia.

#### **1.4.2 Specific Objectives**

The specific objectives of the study are:

- To assess the implementation status of project time management processes;
- To identify what project parameters are affected by unrealistic work schedules;
- To study whether road construction projects exercise program crashing or not;
- To study whether road construction projects exercise resource leveling or not

### **1.5 Significance of the Study**

The study is important to clearly identify the challenges of scheduling of Federal road construction projects in Ethiopia and the outcome of the study helps in devising methods to mitigate scheduling problems. The study also identifies the negative effects of having unrealistic schedules on road construction projects.

### **1.6 Scope of the Study**

The scope of this study is to identify the major challenges of scheduling of ongoing Federal road construction projects in Ethiopia.

## 1.7 Definition of Operational Terms

- a. **Project:** It is a temporary endeavor undertaken to create a unique product, service, or result (PMI, 2013).
- b. **Scheduling:** Scheduling in project management is the process of defining a project in detail and creating a plan for when and how it will be completed. A schedule includes a planned start and finish date, duration, and resources assigned to each activity (PMI, 2013).
- c. **Critical Path Method (CPM):** The critical path method is a method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the logical network paths within the schedule model. The critical path is the sequence of activities that represents the longest path through a project, which determines the shortest possible project duration (PMI, 2013).
- d. **Critical Chain Method (CCM):** The critical chain method (CCM) is a schedule method that allows the project team to place buffers on any project schedule path to account for limited resources and project uncertainties. It is developed from the critical path method approach and considers the effects of resource allocation, resource optimization, resource leveling, and activity duration uncertainty on the critical path determined using the critical path method (PMI, 2013).
- e. **Work Breakdown Structure (WBS):** A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables (PMI, 2013).

## **1.8 Organization of the Study**

This research paper contains five chapters. The first chapter is an introduction. It discusses the background of the study, statement of the problem, research questions, research objective, significance of the study, scope of the study, definition of operational terms, and organization of the study. The second chapter deals with review of related literatures. In this chapter, theoretical review, empirical review and conceptual framework are discussed. The third chapter focuses on research design and methodology. In this chapter, there is a discussion on research design, research approach, research population, sampling, data sources and type, measurement, validity and reliability, data analysis technique, and ethical considerations. The fourth chapter deals with data analysis and discussion. The fifth chapter discusses the summary, conclusion and recommendations.

## CHAPTER TWO: REVIEW OF RELATED LITERATURE

### 2.1 Theoretical Review

#### 2.1.1 Basics of Scheduling

Until about 1960, projects were scheduled using bar charts. Henry Gantt worked out a system of notation for creating such charts and using them to report progress, so they are commonly called Gantt charts. This is the way Gantt charts were drawn before 1960. The chart gives no indication of whether activities depend on each other. Because of this, a method of showing such dependencies was developed in the late 1950s. The relationships among tasks were shown using arrow diagrams. Two different forms were developed. One was called critical path method (CPM), and the other was called program evaluation and review technique (PERT). The difference between the two systems is that PERT makes use of a calculated task duration and allows estimating probabilities of completing work, whereas CPM just makes use of estimated task durations without considering for probabilities. Both systems allow determining which series of activities or path in a project will take the longest time to complete. When the project is scheduled to end at the point where the critical path ends, it will have no latitude. Shorter paths, however, will have latitude, which is called slack or float. The slack or float provides some protection from unexpected events or from inaccurate estimates. One never wants to have a schedule that has no float, as the risk is extremely high that completion date may not be met (James, 2011).

There are ten knowledge areas of modern project management, namely project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management, project procurement management and project stakeholder management.

As project time management is one of the ten knowledge areas of project management, preparation of realistic work schedule is considered to be an integral part of any project as it defines the overall success. The success of a project includes not only completing the project within budget and as per the specification, but it also considers completing the project in time as scheduled. There are seven project time management processes (PMI, 2013: P141):

i. ***Plan Schedule Management***

Planning Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.

ii. ***Define Activities***

Defining activities is the process of identifying and documenting the specific actions to be performed to produce the project deliverables.

iii. ***Sequence Activities***

Sequencing activities is the process of identifying and documenting relationships among the project activities.

iv. ***Estimate Activity Resources***

Estimating activity resources is the process of estimating the type and quantities of material, human resources, equipment, or supplies required to perform each activity.

v. ***Estimate Activity Durations***

Estimating activity durations is the process of estimating the number of work periods needed to complete individual activities with estimated resources.

vi. ***Develop Schedule***

Developing schedule is process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model.

vii. ***Control Schedule***

Controlling schedule is the process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan.

These processes interact with each other and with processes in other knowledge areas project management. Distinguishing the project schedule from the schedule data and calculations that produce the project schedule is practiced by referring to the scheduling tool populated with project data as the schedule model. A schedule model is a representation of the plan for executing the project's activities including durations, dependencies, and other planning information, used to produce project schedules along with other scheduling artifacts.

On some projects, especially those of smaller scope, defining activities, sequencing activities, estimating activity resources, estimating activity durations, and developing the schedule model are so tightly linked that they are viewed as a single process that can be performed by a person over a relatively short period of time. These processes are presented here as distinct elements because the tools and techniques for each process are different.

The project time management processes and their associated tools and techniques are documented in the schedule management plan. The schedule management plan is a subsidiary plan of, and integrated with, the project management plan through the "Develop Project Management Plan" process. The schedule management plan identifies a scheduling method and scheduling tool, and sets the format and establishes criteria for developing and controlling the project schedule. The selected scheduling method defines the framework and algorithms used in the scheduling tool to create the schedule model. Some of the better known scheduling methods include critical path method (CPM) and critical chain method (CCM).

Project schedule development uses the outputs from the processes to define activities, sequence activities, estimate activity resources, and estimate activity durations in combination with the scheduling tool to produce the schedule model. The finalized and approved schedule is the baseline that will be used in the "Control Schedule" process. As the project activities are being performed, the majority of effort in the "Project Time Management Knowledge Area" will occur in the "Control Schedule"

process to ensure completion of project work in a timely manner. (PMI, 2013: P141-142).

There are challenges of preparation of realistic work schedule in Federal road construction projects in Ethiopia. Moreover, the work schedules prepared at the beginning of road construction projects are not usually revised when actual accomplishment deviates significantly from baseline plan. Though there are provisions in the contracts to enforce contractors to revise work schedules as per the stipulated time, there are frequent reluctances by contractors to revise work schedules.

A study on the factors affecting delays in road construction projects determined that the most severe aspects are related to human induced problems. They can be managed and reduced by refining the skills of the construction sides. Schedule delays affect not only the completion time of the project but also the cost and quality.

To decrease schedule delays in road construction projects, all major parties should act in the early stage of the project. Consistent meetings with the authorities are imperative to recognize their needs and accommodate them during the first phase of the project. This approach offers the authorities of services a chance to design their work packages and control the procurement of the materials required for the project. Studies indicate that the administrative skills of construction parties should be enhanced, the labor motivation system developed, and communication among construction parties enhanced at the early project stages to minimize late changes during the construction phase. In addition, the procedure of contract awarding could be improved. The resources and capabilities of bidders should be verified carefully for minimizing schedule delays in public construction projects (Rivera et al, 2020).

To measure a project's time and cost performance, the Earned Value Management (EVM) method is used. It gives an overview of all Earned Value Management metrics and performance measures to monitor the time and cost dimension of a project's

current progress to date. Moreover, it also illustrates how this performance information can be used to predict the expected remaining time and cost to finalize the project that serve as triggers to take corrective actions to bring the project back on track, when needed (Vanhoucke, 2013).

Earned Value Management (EVM) is a project performance management methodology utilizing earned value. Earned Value Management refers to the discipline of applying Earned Value and Earned Value Analysis as an integral part of managing a project. Performing EVM on a project requires that the project Scope, Schedule, and Budget be integrated into a time-phased Performance Measurement Baseline. The Performance Measurement Baseline is maintained with strict change control to ensure the integration of scope, schedule, and budget. Earned value management (EVM) integrates schedule, costs, and scope to measure project performance.

Earned Value Management utilizes the concepts of Undistributed Budget and Management Reserve as part of the methodology to manage the Performance Measurement Baseline. This allows the project manager to add or remove scope, and schedule, along with the associated budget, to or from the Performance Measurement Baseline in a disciplined manner as changes occur on the project.

An Earned Value Management system provides a more accurate assessment of project financial status than simple comparisons of budget and actual and can even improve measures of schedule progress by quantifying the volume of work completion.

Earned Value (EV) is a project Key Performance Indicator (KPI) that represents a quantified value of the work accomplished to date. EV is calculated as the sum of the budget for all completed work on a project or portion of a project (i.e., a WBS element, Control Account, or Work Package). This includes the budget of all work that is 100% complete, plus partial budgets for work that is in-progress. The amount of EV calculated for work-in-progress is based on a pre-assigned calculation rule

called an EV Method. EV Methods are used to provide objective measures of progress and avoid subjective estimates of completion that can introduce bias into the calculations.

Earned Value Analysis is the act of using the EV metric, along with other project KPIs, to identify and quantify problems, assess risk, and forecast costs at completion. An experienced EV Analyst utilizes basic and advanced techniques to assess project performance and supply project managers with the information they need to make critical decisions. One of the most basic analyses that can be done with Earned Value is to compute Schedule Variance (SV) from Earned Value (EV) to Planned Value (PV) using the following formula:

$$SV = EV - PV$$

A negative SV indicates that the project is completing less work than planned, while a positive SV indicates the project is completing more work than planned. A significant negative SV could indicate resource issues on the project that need to be addressed.

These values can also be expressed as percentage (SV%), or as index (Schedule Performance Index – SPI) to provide insight into the significance of the variances and help project managers focus on the most important problem areas for corrective actions. The Schedule Performance Index (SPI) is defined as the ratio of cumulative Earned Value to cumulative Planned Value (PMI, 2013).

$$SPI = EV/PV$$

The Schedule Performance Index (SPI) shows how the project is progressing compared to the planned project schedule. According to the PMBOK Guide, “The Schedule Performance Index (SPI) is a measure of schedule efficiency. The Schedule Performance Index gives information on the time efficiency of your project.

Earned Value Management provides project managers with triggers or early warning signals of project trouble. Better planning and resource allocation associated with the

early periods of a project might be the cause of this reliability. Earned Value Management (EVM) helps project managers to measure project performance. Earned Value Management helps project managers see clearly 'where a project stands' and 'how far is the journey ahead.' This accuracy helps spot discrepancies, change plans, correct mistakes, and makes timely yet quality delivery possible. It also helps in forecasting, enabling project managers to adjust accordingly.

### **2.1.2 Resource Leveling**

A schedule is initially developed under the assumption of unlimited resources. Once this is done, one can see where the resources are overloaded. If there is enough float in the schedule, that float can be used to schedule tasks so that resources are no longer overloaded and the end date can be met. This is called time-critical resource allocation.

However, if there is insufficient float in the schedule to level resources completely, the overloads can be relieved, even if it means sliding out the end date. This is called resource-critical allocation. Under this condition a schedule will be extended because it is starved for resources (James, 2011).

### **2.1.3 Schedule Crashing**

According to the Project Management Institute (PMI), crashing in project management is: "Taking action to decrease the total project duration after analyzing several alternatives to determine how to get the maximum duration compression for the least cost." The objective of crashing in project management is to compress the project schedule to deliver the product, service or result earlier than what was originally planned. Work schedules are constantly subjected to change. To decrease a project's duration with crashing, a project manager adds appropriate project resources to the project's critical tasks. Adding resources to non-critical tasks does not affect the timeline. Schedule compression requires additional resources and therefore incurs additional cost to the project budget.

In project management, each project has a triple constraint consisting of schedule, cost, and scope. When crashing is used in a project, the triple constraint will be modified. Crashing will modify a project's schedule and cost, but the scope is not changed. Project sponsors who want a project to be crashed are often unconcerned about costs or simply want the project completed as quickly as possible.

There are two types of techniques which are used to shorten project duration while maintaining the scope. These techniques are fast tracking and crashing. Cost and schedule trade-offs are analyzed to determine how to obtain the greatest amount of compression for the least incremental cost. Crashing analyzes and categorizes activities based on the lowest crash cost per unit time. Crashing only works for critical path activities where it is possible to shorten schedules. In project management, direct cost is the basis for crashed cost calculation. Schedule crashing serves the purpose of effective time management. Fast tracking is the process of performing tasks in parallel so as to be able to finish the project sooner. However, it is important to note that overlapping tasks in this way leads to an increase in the risk of rework. Fast tracking typically carries a lower cost but higher risk and a change to the project path. In fast-tracking, activities in the critical path that can be performed concurrently instead of consecutively are determined and performed in parallel.

The main differences between fast tracking and crashing are that: fast tracking involves the performance of activities in parallel, whereas crashing involves the addition of resources to a project. In fast tracking there is increased risk, whereas in crashing there is increased cost.

The basic and precise crashing method is the manual method, where activities are crashed on a day by day basis. This method, although resulting in correct results, is time consuming and requires repetitive work and trials. The project manager needs to prepare a list of the activities, with the following attributes for each activity: normal cost, normal duration, crash cost, and crash duration. Determining the normal and crashed durations, requires the assessment of the normal rate of productivity and the

maximum rate of productivity. By estimating the quantities of work, the normal and crashed duration are evaluated using the following equations.

$$\text{Normal Duration} = \text{Estimated Quantity} / \text{Nominal Rate of Productivity}$$

$$\text{Crashed Duration} = \text{Estimated Quantity} / \text{Maximum Rate of Productivity}$$

Likewise, it needs to calculate the normal cost and crashed cost after determining the material cost, equipment cost and manpower cost. Then, the slope is calculated, which is the daily increase in an activity cost using the following equation.

$$\text{Slope} = [\text{Crashed Cost} - \text{Nominal Cost}] / [\text{Normal Duration} - \text{Crashed Duration}]$$

At this stage, the project manager determines the critical paths, and selects from each path the critical activity that has the lowest slope, resulting in the lowest cost increase. Those slopes of the selected activities are then summed up, and compared to the slopes of common activities, or a combination of common activities and lowest slope activities. Thus, the activities selected to be crashed need to have the lowest possible project cost increase. After selecting the activities to be crashed, the project manager will reduce the duration of each of those activities by one unit of time, and increase the project cost by the sum of their slopes. In that way, the project total duration will be reduced by one unit of time (i.e. one day). If the project manager wishes to reduce the project duration more, the same procedure will have to be applied again, until the desired decrease in the total project duration is achieved. Furthermore, when crashing the project, a new set of critical paths may emerge and the crashing procedure needs to take those new critical paths into consideration.

On the other hand, when crashing an ongoing project schedule, the project manager will follow the same instructions discussed above, but with one major difference. An ongoing schedule has completion percentages for activities, and therefore the originally schedule durations should be replaced by remaining durations, and the crash duration shall be multiplied by the remaining percentage till completion, and

rounded up. The completion percentage shall be determined using the actual work performed (Gerges et al, 2014)

### **2.1.4 Importance of Schedule Crashing**

Schedule crashing is initiated by a variety of reasons. These include:

- Realizing the original project schedule is unrealistic. Once a project begins, it may become evident that it will take longer than planned;
- The overall project plan was delayed;
- Planned resources needed to complete the project are delayed or are unusable;
- When a future delay of schedule is anticipated;
- There is a change of availability of assigned project staff;
- New resources become available;
- A newly proposed project is highly prioritized, so an active project is crashed to begin the new project.

### **2.1.5 Steps of Schedule Crashing in Project Management**

Once a decision is made to use crashing in project management, the following steps are to be followed:

- Analyzing the critical path - The tasks that can be shortened without adding resources that will reduce the project timeline overall are to be determined. Opportunities for fast-tracking are to be sought.
- Identifying tasks that can be shortened with the appropriately skilled resources - Working with the production team to find tasks that can be shortened.
- Creating a table showing the trade-off of time reduction versus the costs for each task - Determining the net time savings versus the cost for each task identified above.
- Choosing the least costly approach.
- Providing and deploying the updated schedule and budget.

## 2.2 Empirical Review

A research conducted to assess the performance of Ethiopian construction industry with respect to construction project management practices and its challenges in order to identify the major issues for intervention, revealed that the level of construction project management practice in terms of adapting general project management procedures, project management functions, tools & techniques were found to be unsatisfactory. The major challenges observed by the research in construction industry in Ethiopia were: time (scheduling) management challenges, cost management challenges, resources management (allocation and utilization) challenges, risk and uncertainty management challenges, safety management challenges, handling Multiple Project management challenges, quality management challenges, organizational management challenges, change management challenges and Communication management challenges.

Principally, the level of practices in terms of time (scheduling), cost, resource and risk management were found to be very low, with time (scheduling) management ranking first from top ten challenges. According to the study conducted the recorded schedule slippage ranges between 61-80% (Ayalew et al, 2016).

Delays in schedules of road construction projects are widespread (Battaineh, 1999). The typical proportion of the real completion time to the scheduled length is around 160% for new road projects. Delays have undesirable results on every participant in the project. They affect the growth in confrontational relations, mistrust, lawsuit, arbitration, cash-flow issues, and an overall sense of anxiety (Ahmed et al, 2003).

According to Contract Administration Manual of Ethiopian Roads Authority (Now called Ethiopian Roads Administration), the graph of planned amount versus time should resemble "S". The S-curve indicates the rate of completion of work during the first few months as being slower than the average (straight line) rate necessary to complete the works within the contract period. This reflects the period during which the site is being established and the contractor is gearing up to full production. The rate of completion of work then increases beyond the average rate during which time

the Contractor makes up for time lost during the first few months. Then, having completed sufficient work to ensure completion on time, the rate of completion of work again drops below the average indicating the completion of the works and de-establishment of the site. If the graphs of Planned Physical Works and Value of Work Done do not reflect an S-curve format a reason should be sought from the Consultant as there could be a fault in the Contractor's planning.

The most likely reason for not reflecting an S-curve format is that insufficient attention was paid to the programming and that an average production rate has been assumed by dividing the work and value thereof by the contract period in order to obtain a rate and value per month. This would result in straight line graphs in both cases. There may, however, be valid reasons for deviating from the S-curve e.g. large advance payments, high cost items delivered to site early in the contract, an agreed payment schedule based on time rather than work done etc.

The Contractor is generally required, in terms of the contract, to furnish a programme detailing planned progress and a cash flow. The Contractor intends executing the works in an order which is quite sensible logistically but sometimes does not suite Employer's delivery obligations or availability of funds.

The Contractor may believe that early completion would entitle him to payments for acceleration. The Employer may not be in a position or prepared to take over the works earlier than originally anticipated. The project cash flow may not permit the disbursement of funds in advance of the planned rate.

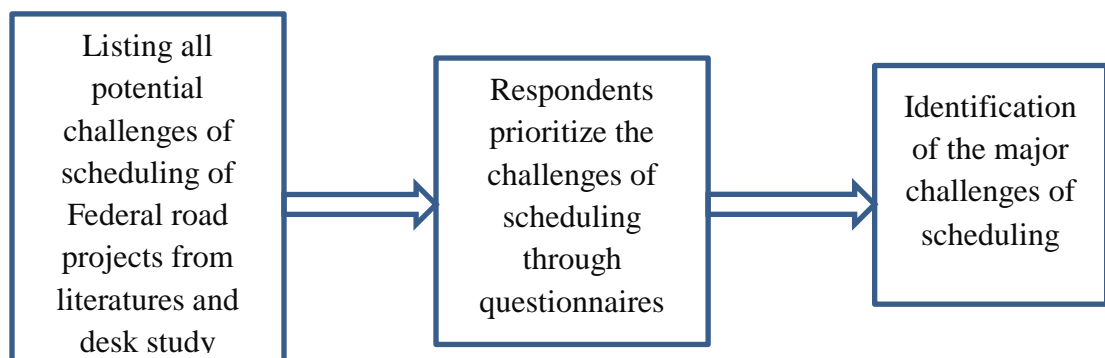
According to Contract Administration Manual of Ethiopian Roads Authority (Now called Ethiopian Roads Administration), the main activities required in the planning and scheduling of the project include:

- Preparing a program of the work to be completed;
- Preparing a schedule of the activities necessary;
- Determining any significant time restraints;
- Establishing cash flow predictions where applicable;
- Preparing staff and resource histograms;

- Modifying the initial plan to optimize the use of resources, the project cash flow, capitalized interest charges, and to take into account any constraints;
- Preparing a refined schedule of activities;
- Establishing a flowchart of information to record whom is to be advised of what;
- Arranging finance and reviewing resources with regard to the revised schedule of work;
- Preparing specifications, drawings and other technical documentation as necessary;
- Arranging for the quotation and supply of goods and services;
- Arranging for the transport, storage, delivery and installation of plant and equipment.

### 2.3 Research Framework

All potential challenges related to scheduling of Federal road construction projects were listed and their levels of significance were identified by this study. Then the major challenges were selected and the result serves as an input to properly schedule and control time overruns of future road projects. The following figure shows research framework used in this research.



## **CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY**

### **3.1 Research Design**

Research design is the plan and structure of investigation so conceived as to obtain answers to research questions. The plan is the overall scheme or program of the research. It includes an outline of what the investigator does from writing hypotheses and their operational implications to the final analysis of data. Research design aids the researcher in the allocation of limited resources by posing crucial choices in methodology. Research design expresses the structure of the research problem-the framework, organization, or configuration of the relationships among variables of a study-and the plan of investigation used to obtain empirical evidence on those relationships (Cooper and Schinder, 2014).

Research design specifies the methods and procedures for conducting a specific research project. It constitutes the blueprint for the collection, measurement, and analysis of data (Workineh, 2019).

Different research designs can be conveniently described if we categorize them as: (1) research design in case of exploratory research studies; (2) research design in case of descriptive and diagnostic research studies, and (3) research design in case of hypothesis-testing research studies (Khotari, 2004).

The major types of research design are exploratory or formative Research, descriptive or statistical research, explanatory research, and experimental or analytical research (Inaam, 2016).

This research used descriptive research design method because a descriptive study is concerned with the attitude or views towards anything. The objective of descriptive research is 'to portray an accurate profile of persons, events or situations' (Robson 2002).

### 3.2 Research Approach

Research approach is a plan and the procedure for research that spans the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation. This plan involves several decisions, and they need not be taken in the order in which they make sense to me and the order of their presentation here. The overall decision involves which approach should be used to study a topic. The types of research approaches are qualitative, quantitative and mixed.

Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. The final written report has a flexible structure. Those who engage in this form of inquiry support a way of looking at research that honors an inductive style, a focus on individual meaning, and the importance of rendering the complexity of a situation.

Quantitative research is an approach for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures. Like qualitative researchers, those who engage in this form of inquiry have assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings.

Mixed methods research is an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone (Creswell, 2009).

This study used quantitative type of research approach because quantitative research method emphasizes objective measurements and the statistical or numerical analysis of data collected. In addition, quantitative type of research approach is used to describe the nature of a phenomenon. Quantitative research techniques are applicable to questionnaire surveys.

### 3.3 Research Population

The population of the study was the ongoing Federal road construction road projects. There were 148 ongoing Federal road construction road projects currently active as of the publication of Ethiopian Road Administration on its official website in February 2022. The sample size determination was developed from Carvalho (1984).

**Table 1: Sample Size Determination**

POPULATION SIZE	SAMPLE SIZE		
	Low	Medium	High
51-90	5	13	20
91-150	8	20	32
151-280	13	32	50
281-500	20	50	80
501-1,200	32	80	125
1,201-3,200	50	125	200
3,201-10000	80	200	315
10,000-35,000	125	315	500
35,001-150,000	200	500	800

Source: Carvalho, 1984

Therefore, from the 148 ongoing road construction projects, sample of 20 projects were considered for this study.

### 3.4 Sampling

There are probability and non-probability methods of sampling. The probability methods of sampling are simple random sampling, systematic sampling, stratified

sampling, cluster sampling, and multi-stage cluster sampling. The non-probability methods of sampling are convenience sampling, snowball sampling, quota sampling, and judgmental sampling.

In this research simple random sampling technique was employed. The numbers of active Federal road construction projects according to the database of Ethiopian Roads Administration as of February 2022 was 148. Accordingly, twenty projects were randomly selected to conduct the study.

### **3.5 Data Sources and Type**

The data sources of this research were middle to top level employees of the three major parties of Federal road construction projects: the Employer, the Contractor and the Consultant who had been actively involved in preparation, review and approval of work schedules.

The study approach involved the use of self-administered structured questionnaire. The designed questionnaire was distributed to 60 key professionals selected through random sampling from employer, contractors and consultants in the following proportions from Federal road construction projects in Ethiopia: 20 from employers, 20 from consultants, and 20 from contractors.

It is evident that the unit of sampling for this study was project. Each project was expected to fill a questionnaire. However, as there are three major parties: employer, consultant and contractor in every Federal road construction project, three questionnaires were distributed to the randomly selected projects to obtain responses from all perspectives.

### **3.6 Measurement**

The data types used in this research were primary data collected through a structured questionnaire, which was considered to be the most appropriate tool to reach the population of the study. The literature review was conducted to extract the variables

for the assessment and to have a conceptual bases on the subject matter. Accordingly, a structured questionnaire was designed based on variables extracted from literatures and organized in three parts which includes questions related to respondent general profiles, scheduling challenges and extent of the challenges in Federal road construction project.

### 3.7 Validity and Reliability

Reliability describes the consistency, or correlation, of a set of data. A data is consistent if the measuring instrument accurately measures the intended construct. Poor reliability, or a lack of correlation between data, is generally a result of measurement error.

Data from the independent category of the questionnaire were analyzed for its Cronbach's  $\alpha$  value. This is to confirm that the data collected are valid and reliable for advance analysis. Cronbach's  $\alpha$  value the data was calculated and compared to cutoff value of 0.7 (George and Malley, 2003).

$$\text{Cronbach's } \alpha = [K / (K-1)] * [1 - (\sum \sigma_k^2 / \sigma_{\text{TOTAL}}^2)]$$

Where, K = the number of items

$\sigma_k^2$  = the sum of individual item score variances

$\sigma_{\text{TOTAL}}^2$  = the test score variances

Spearman's rank correlation coefficient test was conducted to check the validity of the data among the employer, the consultants and the contractors. The pairs of parties tested for agreement were employer versus consultants, employer versus contractors, and consultants versus contractors. Spearman's formula is given as:

$$\rho = 1 - 6\sum D_i^2 / (n(n^2 - 1))$$

Where:  $\rho$  = Spearman's rank correlation coefficient

$D_i$  = the difference between ranks

n = number of observations

### 3.8 Data Analysis Technique

The respondents were asked to indicate, based on their experience, the level of severity of each one of the identified challenges of scheduling of Federal road construction projects on a five-point Likert scale as: very low, low, average, high, and very high.

The relative importance index (RII) method was used to determine employers, consultants, and contractors perceptions of the relative importance of the identified challenges of scheduling of Federal road construction projects.

Relative Importance Index,  $RII = (\sum (W \times n)) / (A \times N)$

Where,

W= Constant expressing the weighting given to each response

A= Highest Weighting

n= Frequency of responses

N= Total number of responses

The RII value ranges from 0 to 1 with 0 not inclusive. The relative importance indices (RII) were used to determine the rank of challenges of scheduling of road construction projects. These rankings made it possible to cross-compare the relative importance of the elements as perceived by the three groups of respondents. The weighted average for each item for the three groups of respondents was determined, and ranks were assigned to each item representing the perception of the three groups. Five important levels are transformed from RII values: high ( $0.8 \leq RII \leq 1$ ), high-medium ( $0.6 \leq RII < 0.8$ ), medium ( $0.4 \leq RII < 0.6$ ), medium-low ( $0.2 \leq RII < 0.4$ ) and low ( $0 \leq RII < 0.2$ ) (Akadiri, 2011).

Finally, Spearman's coefficient of rank correlation was used to test whether there was agreement or disagreement among each pair of parties (the respondents) in ranking the challenges of scheduling of road construction projects.

This study primarily used a descriptive approach to analyze the collected data to identify the top rated challenges among all three parties that affect the scheduling of Federal road construction projects. A descriptive approach is used to directly interpret survey results to identify the magnitudes and the top rated challenges. SPSS version 20 and Excel spreadsheet were used to analyze the data. The statistical analyses of the data are presented using tabular form, graphs and percentages.

### **3.9 Ethical Consideration**

The researcher abides by the following ethical considerations: the questionnaires were distributed with the consent of the respondents; names of the respondents are not disclosed; the study serves only for academic purpose; the research participants have the right to be informed of all aspects of a research task; all respondents have the right to privacy; and the respondents' responses are kept confidential.

## CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION

### 4.1 Response Rate and Demographic Data

Structured questionnaire was designed and distributed to identify major challenges of scheduling of road construction projects in Ethiopia. According to the published data on the website of Ethiopian Roads Administration for the month of February 2022, there are 148 ongoing road construction projects. Twenty projects were randomly selected and sixty questionnaires were distributed to key staffs of the major stakeholders (Employers, Contractors and Consultants) in the road construction projects. Fifty eight respondents filled and returned the questionnaire as shown in Table 4.1. This makes the response rate 96.7% as presented in the following table.

**Table 2: Response Rate of Questionnaires Distributed**

No.	Respondents	Number of Questionnaire Distributed	Number of Questionnaire Returned	Response Rate (%)
1	Employer	20	18	90
2	Consultant	20	20	100
3	Contractor	20	20	85
<b>Total</b>		<b>60</b>	<b>58</b>	<b>96.7</b>

Source: Own Survey

According to Table 2, the response rate of the employer is 90%, whereas the response rate of consultants and contractors is 100%. The overall response rate was 96.7%.

**Table 3: Academic Qualification of Respondents**

Qualification	Employer	Consultant	Contractor	Total	Percent
BA/BSc	11	10	16	37	63.8
MA/MSc and above	7	10	4	21	36.2
<b>Total</b>	<b>18</b>	<b>20</b>	<b>20</b>	<b>58</b>	<b>100.0</b>

Source: Own Survey

According to Table 3, the respondents were well educated and comprehend the questionnaires and there was no gap of understanding.

**Table 4: Work Experience of Respondents**

<b>Experience</b>	<b>Employer</b>	<b>Consultant</b>	<b>Contractor</b>	<b>Total</b>	<b>Percent</b>
5-10 Years	17	3	5	25	43.1
>10 Years	1	17	15	33	56.9
<b>Total</b>	<b>18</b>	<b>20</b>	<b>20</b>	<b>58</b>	<b>100.0</b>

Source: Own Survey

According to the above table, 43.1% of the respondents have work experiences from five to ten years. The remaining 56.9% of the respondents have work experience more than ten years. The respondents were with adequate work experience in road construction and had experiences in preparing, revising and reviewing work schedules.

**Table 5: Job Title of Respondents**

<b>Job Title</b>	<b>Employer</b>	<b>Consultant</b>	<b>Contractor</b>	<b>Total</b>	<b>Percent</b>
A. Resident Engineer	0	5	0	5	8.6
Claim Expert	0	1	0	1	1.7
Construction Engineer	0	0	2	2	3.4
Department Manager	0	0	1	1	1.7
Engineer	1	0	0	1	1.7
Lead Civil Engineer	0	0	1	1	1.7
Lead Engineer	8	0	0	8	13.8
Office Engineer	0	0	2	2	3.4
Office Engineering Head	0	0	3	3	5.2
Planning Engineer	0	0	1	1	1.7
Project Engineer	1	0	1	2	3.4
Project Manager	0	0	9	9	15.5
Quantity Surveyor	0	1	0	1	1.7
Resident Engineer	0	10	0	10	17.2
Senior Engineer	8	0	0	8	13.8
Senior P/Material Engineer	0	3	0	3	5.2
<b>Total</b>	<b>18</b>	<b>20</b>	<b>20</b>	<b>58</b>	<b>100.0</b>

Source: Own Survey

The majority of the respondents were Resident Engineers (17.2%), Project Managers (15.5%), Lead Engineers (13.8%) and Senior Engineers (13.8%).

## 4.2 Results or Findings

Data from the independent category of the questionnaire was analyzed for its Cronbach's  $\alpha$  value to confirm that the data collected was reliable for analysis. Cronbach's  $\alpha$  value for the data was calculated and compared to cutoff value of 0.7.

Using the equation, Cronbach's  $\alpha = [K / (K-1)] * [1 - (\sum \sigma_k^2 / \sigma_{TOTAL}^2)]$ , the Cronbach's  $\alpha$  value was calculated as presented in the following table.

**Table 6: Reliability Test - Project Time Management Processes**

Research Question	Sub- Questions	Mean Score	Standard Deviation ( $\sigma_k$ )	$\sigma_k^2$
Difficulties of Project Time Management Processes	Planning Schedule Management	3.16	1.056	1.115
	Defining Activities	2.81	0.963	0.927
	Sequencing Activities	2.76	0.942	0.887
	Estimation of Activity Resources	3.07	1.041	1.084
	Estimation of Activity Durations	3.16	1.005	1.01
	Developing Schedule	2.93	1.122	1.259
	Controlling Schedule	3.71	1.009	1.018
<b>Total</b>		21.59	5.551	30.814
$\sum \sigma_k^2 =$		7.301		
$\sigma_{TOTAL}^2 =$		30.814		
K =		7		
Cronbach's $\alpha =$		<b>0.89</b>		

Cronbach's  $\alpha$  for questions of the *Implementation of Project Management Processes* is above the cut value of 0.7 and the data is internally consistent and is reliable.

**Table 7: Reliability Test - Challenges of Scheduling**

Research Question	Sub- Questions	Mean Score	Standard Deviation ( $\sigma_k$ )	$\sigma_k^2$
Challenges of Scheduling	Not assigning experienced professionals	3.28	1.121	1.257
	Improperly defining project scope	2.97	1.042	1.086
	Design delays	3.36	0.968	0.937
	Not using scheduling software	2.57	1.126	1.268
	Using similar variables of other projects	3.40	0.990	0.98
	Not considering risks in schedule	3.64	0.986	0.972
	Absence of training on scheduling	3.40	1.008	1.016
	Not defining WBS	3.03	1.042	1.086
	Not defining sequences of activities	2.91	0.996	0.992
	Not properly allocating resources	3.59	1.044	1.09
	Improperly setting project calendar	2.90	1.252	1.568
	Crew formation is not standardized	3.28	1.196	1.43
	<b>Total</b>		21.59	38.31
	$\sum \sigma_k^2 =$		13.681	
	$\sigma_{TOTAL}^2 =$		71.826	
	K =		12	
	Cronbach's $\alpha =$		<b>0.88</b>	

Cronbach's  $\alpha$  for questions of *Challenges of Scheduling* is above the cut value of 0.7 and the data is internally consistent and is reliable.

**Table 8: Reliability Test - Negative Impacts of Unrealistic Work Schedule**

Research Question	Sub- Questions	Mean Score	Standard Deviation ( $\sigma_k$ )	$\sigma_k^2$
Negative Impacts of Unrealistic Work Schedule on	Project Completion time	4.28	1.022	1.044
	Project Cost	4.21	0.744	0.554
	Project Quality	3.26	1.036	1.073
	Satisfaction of Employer	3.95	1.083	1.173
	Communication with Stakeholders	3.52	0.978	0.956
	Contract Administration	3.90	0.872	0.76
	Claim Management	3.86	1.034	1.069
	Settlement of Disputes	3.29	1.108	1.228
	Profitability of Contractor	4.05	1.161	1.348
<b>Total</b>		21.59	34.31	5.930
$\sum \sigma_k^2 =$		9.206		
$\sigma_{TOTAL}^2 =$		35.165		
K =		9		
Cronbach's $\alpha =$		<b>0.83</b>		

Cronbach's  $\alpha$  for questions of *Negative Impacts of Unrealistic Work Schedule* is above the cut value of 0.7 and the data is internally consistent and is reliable.

**Table 9: Summary of Reliability Test using Cronbach's  $\alpha$** 

Major Questions in the Questionnaire	Cronbach's $\alpha$ value
The implementation of Project Time Management Processes	0.89
The challenges in preparation and revision of road construction work schedules	0.88
The levels of negative impacts of unrealistic work schedule	0.83

All computed Cronbach's  $\alpha$  values are greater than the cutoff value of 0.7 and the data collected are internally consistent and are reliable for analysis.

### 4.2.1 Implementation of Project Time Management Processes

The implementation difficulties of project time management processes were rated by staffs of Employer, Consultants and Contractors as presented in the following tables.

**Table 10: Difficulties in Implementation of Project Time Management Processes according to Employer**

Difficulties in Implementation of Project Time Management Processes	Likert Scale	Weight	Frequency	Mean
Improper Planning Schedule Management	Very low	1	0	3.56
	Low	2	2	
	Average	3	6	
	High	4	8	
	Very High	5	2	
Gap in Defining Activities	Very low	1	0	3.22
	Low	2	1	
	Average	3	12	
	High	4	5	
	Very High	5	0	
Difficulty in Sequencing Activities	Very low	1	0	3.33
	Low	2	2	
	Average	3	8	
	High	4	8	
	Very High	5	0	
Wrong Estimation of Activity Resources	Very low	1	0	3.56
	Low	2	3	
	Average	3	2	
	High	4	13	
	Very High	5	0	
Wrong Estimation of Activity Durations	Very low	1	0	3.44
	Low	2	3	
	Average	3	4	
	High	4	11	

Difficulties in Implementation of Project Time Management Processes	Likert Scale	Weight	Frequency	Mean
	Very High	5	0	
Difficulty in Developing Schedule	Very low	1	0	3.22
	Low	2	4	
	Average	3	8	
	High	4	4	
	Very High	5	2	
Reluctance in Controlling Schedule	Very low	1	0	4.11
	Low	2	0	
	Average	3	4	
	High	4	8	
	Very High	5	6	

From the analysis made in the above table, *Reluctance in Controlling Schedule*, *Improper Planning Schedule Management* and *Wrong Estimation of Activity Resources* are the most difficulties observed according to Employers.

**Table 11: Difficulties in Implementation of Project Time Management Processes according to Consultant**

Difficulties in Implementation of Project Time Management Processes	Likert Scale	Weight	Frequency	Mean
Improper Planning Schedule Management	Very low	1	0	3.30
	Low	2	4	
	Average	3	8	
	High	4	6	
	Very High	5	2	
Gap in Defining Activities	Very low	1	2	2.80
	Low	2	7	
	Average	3	5	
	High	4	5	
	Very High	5	1	
Difficulty in Sequencing	Very low	1	2	2.65

<b>Difficulties in Implementation of Project Time Management Processes</b>	<b>Likert Scale</b>	<b>Weight</b>	<b>Frequency</b>	<b>Mean</b>
Activities	Low	2	8	
	Average	3	6	
	High	4	3	
	Very High	5	1	
Wrong Estimation of Activity Resources	Very low	1	0	3.05
	Low	2	6	
	Average	3	9	
	High	4	3	
	Very High	5	2	
Wrong Estimation of Activity Durations	Very low	1	0	3.25
	Low	2	5	
	Average	3	8	
	High	4	4	
	Very High	5	3	
Difficulty in Developing Schedule	Very low	1	1	3.25
	Low	2	5	
	Average	3	5	
	High	4	6	
	Very High	5	3	
Reluctance in Controlling Schedule	Very low	1	0	4.00
	Low	2	2	
	Average	3	1	
	High	4	12	
	Very High	5	5	

From the analysis made in the above table, *Reluctance in Controlling Schedule*, *Planning Schedule Management*, *Wrong Estimation of Activity Durations* and *Difficulty in Developing Schedule* are the most difficulties observed according to the Consultants.

**Table 12: Difficulties in Implementation of Project Time Management Processes according to Contractor**

<b>Difficulties in Implementation of Project Time Management Processes</b>	<b>Likert Scale</b>	<b>Weight</b>	<b>Frequency</b>	<b>Mean</b>
Improper Planning Schedule Management	Very low	1	4	2.65
	Low	2	4	
	Average	3	9	
	High	4	1	
	Very High	5	2	
Gap in Defining Activities	Very low	1	2	2.45
	Low	2	11	
	Average	3	4	
	High	4	2	
	Very High	5	1	
Difficulty in Sequencing Activities	Very low	1	2	2.35
	Low	2	11	
	Average	3	5	
	High	4	2	
	Very High	5	0	
Wrong Estimation of Activity Resources	Very low	1	2	2.65
	Low	2	10	
	Average	3	3	
	High	4	3	
	Very High	5	2	
Wrong Estimation of Activity Durations	Very low	1	1	2.80
	Low	2	9	
	Average	3	5	
	High	4	3	
	Very High	5	2	
Difficulty in Developing Schedule	Very low	1	5	2.35
	Low	2	6	
	Average	3	6	
	High	4	3	
	Very High	5	0	
Reluctance in Controlling Schedule	Very low	1	2	3.05
	Low	2	2	
	Average	3	11	
	High	4	3	
	Very High	5	2	

From the analysis made in the above table, ***Reluctance in Controlling Schedule and Wrong Estimation of Activity Durations*** are the most difficulties observed according to the Contractors.

**Table 13: Overall Difficulties in Implementation of Project Time Management Processes**

<b>Difficulties in Implementation of Project Time Management Processes</b>	<b>Likert Scale</b>	<b>Weight</b>	<b>Frequency</b>	<b>Mean</b>
Improper Planning Schedule Management	Very low	1	4	3.16
	Low	2	10	
	Average	3	23	
	High	4	15	
	Very High	5	6	
Gap in Defining Activities	Very low	1	4	2.81
	Low	2	19	
	Average	3	21	
	High	4	12	
	Very High	5	2	
Difficulty in Sequencing Activities	Very low	1	4	2.76
	Low	2	21	
	Average	3	19	
	High	4	13	
	Very High	5	1	
Wrong Estimation of Activity Resources	Very low	1	2	3.07
	Low	2	19	
	Average	3	14	
	High	4	19	
	Very High	5	4	
Wrong Estimation of Activity Durations	Very low	1	1	3.16
	Low	2	17	
	Average	3	17	
	High	4	18	
	Very High	5	5	
Difficulty in Developing Schedule	Very low	1	6	2.93
	Low	2	15	
	Average	3	19	
	High	4	13	
	Very High	5	5	
Reluctance in Controlling Schedule	Very low	1	2	3.71
	Low	2	4	
	Average	3	16	
	High	4	23	
	Very High	5	13	

Overall, *Reluctance in Controlling Schedule, Improper Planning Schedule Management and Wrong Estimation of Activity Durations* are the most difficulties observed by all parties in the projects studied.

**Table 14: Summary of Overall Implementation of Project Time Management Processes**

Difficulties in Implementation of Project Time Management Processes	Mean Score				Rank
	Employer	Consultant	Contractor	Overall	
Improper Planning Schedule Management	3.56	3.30	2.65	3.16	2
Gap in Defining Activities	3.22	2.80	2.45	2.81	6
Difficulty in Sequencing Activities	3.33	2.65	2.35	2.76	7
Wrong Estimation of Activity Resources	3.56	3.05	2.65	3.07	4
Wrong Estimation of Activity Durations	3.44	3.25	2.80	3.16	2
Difficulty in Developing Schedule	3.22	3.25	2.35	2.93	5
Reluctance in Controlling Schedule	4.11	4.00	3.05	3.71	1

As it can be seen from the above table, there is an overall noticeable difficulty noted by all project key stakeholders in “*Controlling Schedule*” of Federal road construction projects in Ethiopia. In addition, there are gaps of “*Planning Schedule Management*” and “*Estimation of Activity Durations*”.

#### 4.2.2 Challenges in Preparation and Revision of Work Schedules

The challenges of scheduling of road construction projects were rated and presented in the following tables. The corresponding relative importance indexes are also computed and presented.

**Table 15: Challenges in Preparation and Revision of Work Schedules according to Employer**

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
1	Not assigning experienced professionals	Very low	1	2	3.33	0.67
		Low	2	4		
		Average	3	2		
		High	4	6		
		Very High	5	4		
2	Improperly defining the scope of the project	Very low	1	0	3.22	0.64
		Low	2	6		
		Average	3	4		
		High	4	6		
		Very High	5	2		
3	Design delays to get workload of the project	Very low	1	2	3.44	0.69
		Low	2	0		
		Average	3	6		
		High	4	8		
		Very High	5	2		
4	Not using scheduling software	Very low	1	6	2.56	0.51
		Low	2	2		
		Average	3	4		
		High	4	6		
		Very High	5	0		
5	Using similar variables of other projects	Very low	1	0	3.56	0.71
		Low	2	2		
		Average	3	6		
		High	4	8		
		Very High	5	2		
6	Not considering risks in schedule	Very low	1	0	3.67	0.73
		Low	2	2		
		Average	3	2		
		High	4	14		
		Very High	5	0		
7	Absence of training on scheduling	Very low	1	0	3.22	0.64
		Low	2	5		
		Average	3	6		
		High	4	5		
		Very High	5	2		

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
8	Not defining Work Breakdown Structures	Very low	1	2	3.11	0.62
		Low	2	2		
		Average	3	6		
		High	4	8		
		Very High	5	0		
9	Not defining sequences of activities	Very low	1	0	3.33	0.67
		Low	2	2		
		Average	3	8		
		High	4	8		
		Very High	5	0		
10	Not properly allocating resources	Very low	1	0	3.89	0.78
		Low	2	0		
		Average	3	4		
		High	4	12		
		Very High	5	2		
11	Improperly setting project calendar	Very low	1	0	3.11	0.62
		Low	2	7		
		Average	3	4		
		High	4	5		
		Very High	5	2		
12	Crew formation is not standardized	Very low	1	2	3.56	0.71
		Low	2	2		
		Average	3	0		
		High	4	12		
		Very High	5	2		

From the analysis made in the above table, *Not Properly Allocating Resources* and *Not Considering Risks in Schedule* are the most challenges observed in scheduling of Federal road construction projects according to the Employers. The Relative Importance Index (RII) values are high-medium ( $0.6 \leq \text{RII} < 0.8$ ) and they are all important.

**Table 16: Challenges in Preparation and Revision of Work Schedules according to Consultant**

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
1	Not assigning experienced professionals	Very low	1	0	3.65	0.73
		Low	2	2		
		Average	3	4		
		High	4	13		
		Very High	5	1		
2	Improperly defining the scope of the project	Very low	1	0	3.20	0.64
		Low	2	5		
		Average	3	6		
		High	4	9		
		Very High	5	0		
3	Design delays to get workload of the project	Very low	1	0	3.15	0.63
		Low	2	3		
		Average	3	12		
		High	4	4		
		Very High	5	1		
4	Not using scheduling software	Very low	1	2	2.70	0.54
		Low	2	6		
		Average	3	9		
		High	4	2		
		Very High	5	1		
5	Using similar variables of other projects	Very low	1	0	3.65	0.73
		Low	2	3		
		Average	3	4		
		High	4	10		
		Very High	5	3		
6	Not considering risks in schedule	Very low	1	0	3.95	0.79
		Low	2	1		
		Average	3	5		
		High	4	8		
		Very High	5	6		
7	Absence of training on scheduling	Very low	1	0	3.65	0.73
		Low	2	2		
		Average	3	8		
		High	4	5		
		Very High	5	5		

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
8	Not defining Work Breakdown Structures	Very low	1	1	2.95	0.59
		Low	2	5		
		Average	3	9		
		High	4	4		
		Very High	5	1		
9	Not defining sequences of activities	Very low	1	3	2.75	0.55
		Low	2	5		
		Average	3	7		
		High	4	4		
		Very High	5	1		
10	Not properly allocating resources	Very low	1	1	3.70	0.74
		Low	2	1		
		Average	3	7		
		High	4	5		
		Very High	5	6		
11	Improperly setting project calendar	Very low	1	3	3.10	0.62
		Low	2	2		
		Average	3	8		
		High	4	4		
		Very High	5	3		
12	Crew formation is not standardized	Very low	1	1	3.45	0.69
		Low	2	2		
		Average	3	7		
		High	4	7		
		Very High	5	3		

From the analysis made in the above table, *Not Considering Risks in Schedule* and *Not Properly Allocating Resources* are the most challenges observed in scheduling of Federal road construction projects according to the Consultants.

The Relative Importance Index (RII) values of the above challenges are high-medium ( $0.6 \leq \text{RII} < 0.8$ ) except “Not using scheduling software”, “Not defining Work Breakdown Structures” and “Not defining sequences of activities”. The challenges: “Not using scheduling software”, “Not defining Work Breakdown Structures” and “Not defining sequences of activities” are with medium RII ( $0.4 \leq \text{RII} < 0.6$ ).

**Table 17: Challenges in Preparation and Revision of Work Schedules according to Contractor**

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
1	Not assigning experienced professionals	Very low	1	2	2.85	0.57
		Low	2	7		
		Average	3	3		
		High	4	8		
		Very High	5	0		
2	Improperly defining the scope of the project	Very low	1	4	2.50	0.50
		Low	2	6		
		Average	3	7		
		High	4	2		
		Very High	5	1		
3	Design delays to get workload of the project	Very low	1	1	3.50	0.70
		Low	2	2		
		Average	3	6		
		High	4	8		
		Very High	5	3		
4	Not using scheduling software	Very low	1	5	2.45	0.49
		Low	2	5		
		Average	3	7		
		High	4	2		
		Very High	5	1		
5	Using similar variables of other projects	Very low	1	1	3.00	0.60
		Low	2	6		
		Average	3	7		
		High	4	4		
		Very High	5	2		
6	Not considering risks in schedule	Very low	1	1	3.30	0.66
		Low	2	5		
		Average	3	5		
		High	4	5		
		Very High	5	4		
7	Absence of training on scheduling	Very low	1	0	3.30	0.66
		Low	2	6		
		Average	3	4		
		High	4	8		
		Very High	5	2		

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
8	Not defining Work Breakdown Structures	Very low	1	1	3.05	0.61
		Low	2	8		
		Average	3	2		
		High	4	7		
		Very High	5	2		
9	Not defining sequences of activities	Very low	1	3	2.70	0.54
		Low	2	4		
		Average	3	10		
		High	4	2		
		Very High	5	1		
10	Not properly allocating resources	Very low	1	1	3.20	0.64
		Low	2	5		
		Average	3	7		
		High	4	3		
		Very High	5	4		
11	Improperly setting project calendar	Very low	1	6	2.50	0.50
		Low	2	5		
		Average	3	4		
		High	4	3		
		Very High	5	2		
12	Crew formation is not standardized	Very low	1	2	2.85	0.57
		Low	2	8		
		Average	3	4		
		High	4	3		
		Very High	5	3		

From the analysis made in the above table, *Design Delays to get Workload of the Project, Not Considering Risks in Schedule* and *Absence of Training on Scheduling* are the most challenges observed in scheduling of Federal road construction projects according to the Contractors. The challenges: “Design delays to get workload of the project”, “Not considering risks in schedule”, “Absence of training on scheduling”, “Using similar variables of other projects”, “Not defining Work Breakdown Structures”, and “Not properly allocating resources” have RII value high-medium ( $0.6 \leq RII < 0.8$ ). The remaining challenges listed above are with medium RII ( $0.4 \leq RII < 0.6$ ).

**Table 18: Overall Challenges in Preparation and Revision of Work Schedules**

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
1	Not assigning experienced professionals	Very low	1	4	3.28	0.66
		Low	2	13		
		Average	3	9		
		High	4	27		
		Very High	5	5		
2	Improperly defining the scope of the project	Very low	1	4	2.97	0.59
		Low	2	17		
		Average	3	17		
		High	4	17		
		Very High	5	3		
3	Design delays to get workload of the project	Very low	1	3	3.36	0.67
		Low	2	5		
		Average	3	24		
		High	4	20		
		Very High	5	6		
4	Not using scheduling software	Very low	1	13	2.57	0.51
		Low	2	13		
		Average	3	20		
		High	4	10		
		Very High	5	2		
5	Using similar variables of other projects	Very low	1	1	3.40	0.68
		Low	2	11		
		Average	3	17		
		High	4	22		
		Very High	5	7		
6	Not considering risks in schedule	Very low	1	1	3.64	0.73
		Low	2	8		
		Average	3	12		
		High	4	27		
		Very High	5	10		
7	Absence of training on scheduling	Very low	1	0	3.40	0.68
		Low	2	13		
		Average	3	18		
		High	4	18		
		Very High	5	9		
8	Not defining Work Breakdown Structures	Very low	1	4	3.03	0.61
		Low	2	15		
		Average	3	17		
		High	4	19		
		Very High	5	3		

No.	Challenges of Scheduling	Likert Scale	Weight	Frequency	Mean	RII
9	Not defining sequences of activities	Very low	1	6	2.91	0.58
		Low	2	11		
		Average	3	25		
		High	4	14		
		Very High	5	2		
10	Not properly allocating resources	Very low	1	2	3.59	0.72
		Low	2	6		
		Average	3	18		
		High	4	20		
		Very High	5	12		
11	Improperly setting project calendar	Very low	1	9	2.90	0.58
		Low	2	14		
		Average	3	16		
		High	4	12		
		Very High	5	7		
12	Crew formation is not standardized	Very low	1	5	3.28	0.66
		Low	2	12		
		Average	3	11		
		High	4	22		
		Very High	5	8		

Overall, *Not Considering Risks in Schedule, Not Properly Allocating Resources, Using Similar Variables of Other Projects, Absence of Training on Scheduling and Design Delays to Get Workload of The Project* are the most challenges observed in scheduling of Federal road construction projects according to the three parties: Employers, Consultants and Contractors.

The challenges: “Not considering risks in schedule”, “Not properly allocating resources”, “Using similar variables of other projects”, “Absence of training on scheduling”, “Design delays to get workload of the project”, “Not assigning experienced professionals”, “Crew formation is not standardized” and “Not defining Work Breakdown Structures” have RII value high-medium ( $0.6 \leq RII < 0.8$ ). The remaining challenges listed above are with medium RII ( $0.4 \leq RII < 0.6$ ).

**Table 19: Summary of Challenges in Preparation and Revision of Work Schedules according to Employer**

No.	Challenges of Scheduling	Mean Score	RII	Rank
1	Not assigning experienced professionals	3.33	0.67	6
2	Improperly defining the scope of the project	3.22	0.64	8
3	Design delays to get workload of the project	3.44	0.69	5
4	Not using scheduling software	2.56	0.51	12
5	Using similar variables of other projects	3.56	0.71	3
6	Not considering risks in schedule	3.67	0.73	2
7	Absence of training on scheduling	3.22	0.64	8
8	Not defining Work Breakdown Structures	3.11	0.62	10
9	Not defining sequences of activities	3.33	0.67	6
10	Not properly allocating resources	3.89	0.78	1
11	Improperly setting project calendar	3.11	0.62	10
12	Crew formation is not standardized	3.56	0.71	3

From the analysis made in the above table, *Not Properly Allocating Resources (RII=0.78)*, *Not Considering Risks in Schedule (RII=0.73)* and *Using Similar Variables of Other Projects (RII=0.71)* rank from 1<sup>st</sup> to 3<sup>rd</sup> major challenges of scheduling of Federal road construction projects according to the Employers.

**Table 20: Summary of Challenges in Preparation and Revision of Work Schedules according to Consultant**

No.	Challenges of Scheduling	Mean Score	RII	Rank
1	Not assigning experienced professionals	3.65	0.73	3
2	Improperly defining the scope of the project	3.20	0.64	7
3	Design delays to get workload of the project	3.15	0.63	8
4	Not using scheduling software	2.70	0.54	12
5	Using similar variables of other projects	3.65	0.73	3
6	Not considering risks in schedule	3.95	0.79	1
7	Absence of training on scheduling	3.65	0.73	3
8	Not defining Work Breakdown Structures	2.95	0.59	10
9	Not defining sequences of activities	2.75	0.55	11
10	Not properly allocating resources	3.70	0.74	2
11	Improperly setting project calendar	3.10	0.62	9
12	Crew formation is not standardized	3.45	0.69	6

From the analysis made in the above table, *Not Considering Risks in Schedule (RII=0.79)*, *Not Properly Allocating Resources (RII=0.74)* and *Using Similar Variables of Other Projects (RII=0.73)* rank from 1<sup>st</sup> to 3<sup>rd</sup> major challenges of scheduling of Federal road construction projects according to the Consultants.

**Table 21: Summary of Challenges in Preparation and Revision of Work Schedules according to Contractor**

No.	Challenges of Scheduling	Mean Score	RII	Rank
1	Not assigning experienced professionals	2.85	0.57	7
2	Improperly defining the scope of the project	2.50	0.50	10
3	Design delays to get workload of the project	3.50	0.70	1
4	Not using scheduling software	2.45	0.49	12
5	Using similar variables of other projects	3.00	0.60	6
6	Not considering risks in schedule	3.30	0.66	2
7	Absence of training on scheduling	3.30	0.66	2
8	Not defining Work Breakdown Structures	3.05	0.61	5
9	Not defining sequences of activities	2.70	0.54	9
10	Not properly allocating resources	3.20	0.64	4
11	Improperly setting project calendar	2.50	0.50	10
12	Crew formation is not standardized	2.85	0.57	7

From the analysis made in the above table, *Design Delays to get Workload of the Project (RII=0.70)*, *Not Considering Risks in Schedule (RII=0.66)* and *Absence of Training on Scheduling (RII=0.66)* rank from 1<sup>st</sup> to 2<sup>nd</sup> major challenges of scheduling of Federal road construction projects according to the Consultants.

**Table 22: Summary of Overall Challenges in Preparation and Revision of Work Schedules**

No.	Challenges of Scheduling	Mean Score	RII	Rank
1	Not assigning experienced professionals	3.28	0.66	6
2	Improperly defining the scope of the project	2.97	0.59	9
3	Design delays to get workload of the project	3.36	0.67	5
4	Not using scheduling software	2.57	0.51	12
5	Using similar variables of other projects	3.40	0.68	3
6	Not considering risks in schedule	3.64	0.73	1
7	Absence of training on scheduling	3.40	0.68	3
8	Not defining Work Breakdown Structures	3.03	0.61	8
9	Not defining sequences of activities	2.91	0.58	10
10	Not properly allocating resources	3.59	0.72	2
11	Improperly setting project calendar	2.90	0.58	11
12	Crew formation is not standardized	3.28	0.66	6

Overall, *Not Considering Risks in Schedule (RII=0.73)*, *Not Properly Allocating Resources (RII=0.73)*, *Using Similar Variables of Other Projects (RII=0.68)*, *Absence of Training on Scheduling (RII=0.68)* and *Design Delays to Get Workload of the Project (RII=0.67)* are the most challenges observed ranking from 1<sup>st</sup> to 5<sup>th</sup> in scheduling of Federal road construction projects according to the three parties: Employers, Consultants and Contractors.

Spearman's rank correlation coefficient test is conducted to check the validity of the data among the employer, the consultants and the contractors. The pairs of parties tested for agreement are employer versus consultants, employer versus contractors, and consultants versus contractors.

Spearman's rank correlation coefficient formula is given as:

$$\rho = 1 - \frac{6\sum D_i^2}{n(n^2-1)}, \text{ Where: } \rho = \text{Spearman's rank correlation coefficient}$$

$D_i$  = the difference between ranks

$N$  = number of observations

**Table 23: Correlation of Challenges as Perceived by Employer and Consultant**

No.	Challenges in Preparation and Revision of Work Schedules	Adjusted Rank		Rank Difference, D	D <sup>2</sup>
		Employer	Consultant		
1	Not assigning experienced professionals	6.5	4	2.5	6.25
2	Improperly defining the scope of the project	8.5	7	1.5	2.25
3	Design delays to get workload of the project	5	8	-3	9
4	Not using scheduling software	12	12	0	0
5	Using similar variables of other projects	3.5	4	-0.5	0.25
6	Not considering risks in schedule	2	1	1	1
7	Absence of training on scheduling	8.5	4	4.5	20.25
8	Not defining Work Breakdown Structures	10.5	10	0.5	0.25
9	Not defining sequences of activities	6.5	11	-4.5	20.25
10	Not properly allocating resources	1	2	-1	1
11	Improperly setting project calendar	10.5	9	1.5	2.25
12	Crew formation is not standardized	3.5	6	-2.5	6.25
<b>Total</b>					<b>69.0</b>

$$\rho = 1 - \frac{6\sum D_i^2}{n(n^2-1)} = 0.76$$

The calculated Spearman's rank correlation coefficient of 0.76 is greater than the critical value of 0.503 at 95% confidence level (as obtained from statistical table).

Therefore, there is strong positive correlation of the rating of the challenges of scheduling among Employers and Consultants.

**Table 24: Correlation of Challenges as Perceived by Employer and Contractor**

No.	Challenges in Preparation and Revision of Work Schedules	Adjusted Rank		Rank Difference, D	D <sup>2</sup>
		Employer	Contractor		
1	Not assigning experienced professionals	6.5	7.5	-1	1
2	Improperly defining the scope of the project	8.5	10.5	-2	4
3	Design delays to get workload of the project	5	1	4	16
4	Not using scheduling software	12	12	0	0
5	Using similar variables of other projects	3.5	6	-2.5	6.25
6	Not considering risks in schedule	2	2.5	-0.5	0.25
7	Absence of training on scheduling	8.5	2.5	6	36
8	Not defining Work Breakdown Structures	10.5	5	5.5	30.25
9	Not defining sequences of activities	6.5	9	-2.5	6.25
10	Not properly allocating resources	1	4	-3	9
11	Improperly setting project calendar	10.5	10.5	0	0
12	Crew formation is not standardized	3.5	7.5	-4	16
	<b>Total</b>				<b>125.0</b>

$$\rho = 1 - \frac{6\sum D_i^2}{n(n^2-1)} = 0.56$$

The calculated Spearman's rank correlation coefficient of 0.56 is greater than the critical value of 0.503 at 95% confidence level (as obtained from statistical table). Therefore, there is strong positive correlation of the rating of the challenges of scheduling among Employers and Contractors.

**Table 25: Correlation of Challenges as Perceived by Consultant and Contractor**

No.	Challenges in Preparation and Revision of Work Schedules	Adjusted Rank		Rank Difference, D	D <sup>2</sup>
		Consultant	Contractor		
1	Not assigning experienced professionals	4	7.5	-3.5	12.25
2	Improperly defining the scope of the project	7	10.5	-3.5	12.25
3	Design delays to get workload of the project	8	1	7	49
4	Not using scheduling software	12	12	0	0
5	Using similar variables of other projects	4	6	-2	4
6	Not considering risks in schedule	1	2.5	-1.5	2.25
7	Absence of training on scheduling	4	2.5	1.5	2.25
8	Not defining Work Breakdown Structures	10	5	5	25
9	Not defining sequences of activities	11	9	2	4
10	Not properly allocating resources	2	4	-2	4
11	Improperly setting project calendar	9	10.5	-1.5	2.25
12	Crew formation is not standardized	6	7.5	-1.5	2.25
	<b>Total</b>				<b>82.0</b>

$$\rho = 1 - \frac{6\sum D_i^2}{n(n^2-1)} = 0.71$$

The calculated Spearman's rank correlation coefficient of 0.71 is greater than the critical value of 0.503 at 95% confidence level (as obtained from statistical table). Therefore, there is strong positive correlation of the rating of the challenges of scheduling among Consultants and Contractors.

According to the analysis, "*Not considering risks in schedule*" ranks first among the challenges of scheduling. "*Not properly allocating resources*" ranks second challenge to schedule preparation and revision according to the analysis. "*Using*

*similar variables of other projects*”, “*Absence of training on scheduling*” and “*Design delays to get workload of the project*” are other noticeable challenges in preparation and revision of work schedules of Federal road construction projects.

### 4.2.3 Levels of Negative Impacts of Unrealistic Work Schedule

**Table 26: Summary of Negative Impacts of Unrealistic Work Schedules according to Employer**

No.	Levels of Negative Impacts of Unrealistic Work Schedule	Mean Score	RII	Rank
1	Negative Impact of Unrealistic Work Schedule on Project Completion time	3.78	0.76	4
2	Negative Impact of Unrealistic Work Schedule Project Cost	4.00	0.80	1
3	Negative Impact of Unrealistic Work Schedule on Project Quality	3.44	0.69	7
4	Negative Impact of Unrealistic Work Schedule on Satisfaction of Employer	4.00	0.80	1
5	Negative Impact of Unrealistic Work Schedule on Communication with Stakeholders	3.44	0.69	7
6	Negative Impact of Unrealistic Work Schedule on Contract Administration	3.78	0.76	4
7	Negative Impact of Unrealistic Work Schedule on Claim Management	3.67	0.73	6
8	Negative Impact of Unrealistic Work Schedule on Settlement of Disputes	3.44	0.69	7
9	Negative Impact of Unrealistic Work Schedule on Profitability of Contractor	4.00	0.80	1

According to the analysis in the above table, unrealistic work schedule has negative effects mostly on *project cost*, *satisfaction of the employer* and *profitability of the contractor* in the studied road construction projects according to Employers.

**Table 27: Summary of Negative Impacts of Unrealistic Work Schedules according to Consultant**

No.	Levels of Negative Impacts of Unrealistic Work Schedule	Mean Score	RII	Rank
1	Negative Impact of Unrealistic Work Schedule on Project Completion time	4.40	0.88	2
2	Negative Impact of Unrealistic Work Schedule Project Cost	4.30	0.86	5
3	Negative Impact of Unrealistic Work Schedule on Project Quality	3.40	0.68	9
4	Negative Impact of Unrealistic Work Schedule on Satisfaction of Employer	4.35	0.87	3
5	Negative Impact of Unrealistic Work Schedule on Communication with Stakeholders	3.95	0.79	7
6	Negative Impact of Unrealistic Work Schedule on Contract Administration	4.20	0.84	6
7	Negative Impact of Unrealistic Work Schedule on Claim Management	4.35	0.87	3
8	Negative Impact of Unrealistic Work Schedule on Settlement of Disputes	3.75	0.75	8
9	Negative Impact of Unrealistic Work Schedule on Profitability of Contractor	4.70	0.94	1

According to the analysis in the above table, unrealistic work schedule has negative effects mostly on *project completion time, profitability of the contractor and satisfaction of the Employer* in the studied road construction projects according to Consultants.

**Table 28: Summary of Negative Impacts of Unrealistic Work Schedules according to Contractor**

No.	Levels of Negative Impacts of Unrealistic Work Schedule	Mean Score	RII	Rank
1	Negative Impact of Unrealistic Work Schedule on Project Completion time	4.60	0.92	1
2	Negative Impact of Unrealistic Work Schedule Project Cost	4.30	0.86	2
3	Negative Impact of Unrealistic Work Schedule on Project Quality	2.95	0.59	8
4	Negative Impact of Unrealistic Work Schedule on Satisfaction of Employer	3.50	0.70	5
5	Negative Impact of Unrealistic Work Schedule on Communication with Stakeholders	3.15	0.63	7
6	Negative Impact of Unrealistic Work Schedule on Contract Administration	3.70	0.74	3
7	Negative Impact of Unrealistic Work Schedule on Claim Management	3.55	0.71	4
8	Negative Impact of Unrealistic Work Schedule on Settlement of Disputes	2.70	0.54	9
9	Negative Impact of Unrealistic Work Schedule on Profitability of Contractor	3.45	0.69	6

According to the analysis in the above table, unrealistic work schedule has negative effects mostly on *project completion time, project cost and contract administration* in the studied road construction projects according to Contractors.

**Table 29: Overall Summary of Negative Impacts of Unrealistic Work Schedules**

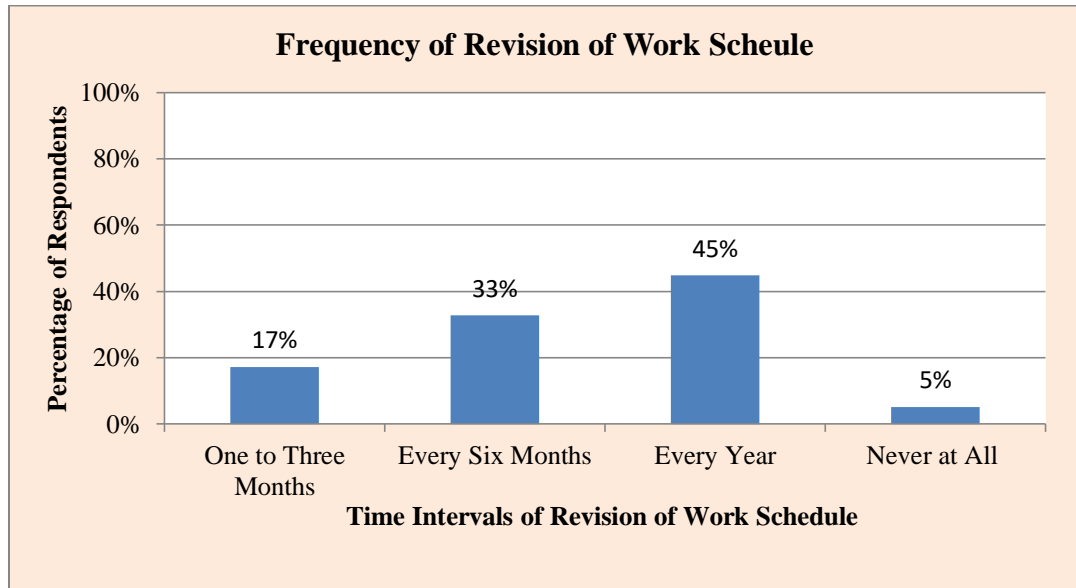
No.	Levels of Negative Impacts of Unrealistic Work Schedule	Mean Score	RII	Rank
1	Negative Impact of Unrealistic Work Schedule on Project Completion time	4.28	0.86	1
2	Negative Impact of Unrealistic Work Schedule Project Cost	4.21	0.84	2
3	Negative Impact of Unrealistic Work Schedule on Project Quality	3.26	0.65	9
4	Negative Impact of Unrealistic Work Schedule on Satisfaction of Employer	3.95	0.79	4
5	Negative Impact of Unrealistic Work Schedule on Communication with Stakeholders	3.52	0.70	7
6	Negative Impact of Unrealistic Work Schedule on Contract Administration	3.90	0.78	5
7	Negative Impact of Unrealistic Work Schedule on Claim Management	3.86	0.77	6
8	Negative Impact of Unrealistic Work Schedule on Settlement of Disputes	3.29	0.66	8
9	Negative Impact of Unrealistic Work Schedule on Profitability of Contractor	4.05	0.81	3

Overall analysis revealed that unrealistic work schedule has negative effects mostly on *Project Completion time*, *Project Cost* and *Profitability of Contractor* in the studied road construction projects.

#### 4.2.4 Frequency of Revision of Work Schedule

According to the study, 45% of road construction projects revise work schedules every year, 33% of them revise every six months, and 17% of projects revise work schedules from one to three months. There are about 5% projects which do not revise work schedules at all as shown in the following figure.

**Figure 1: Frequency of Revision of Work Schedule**

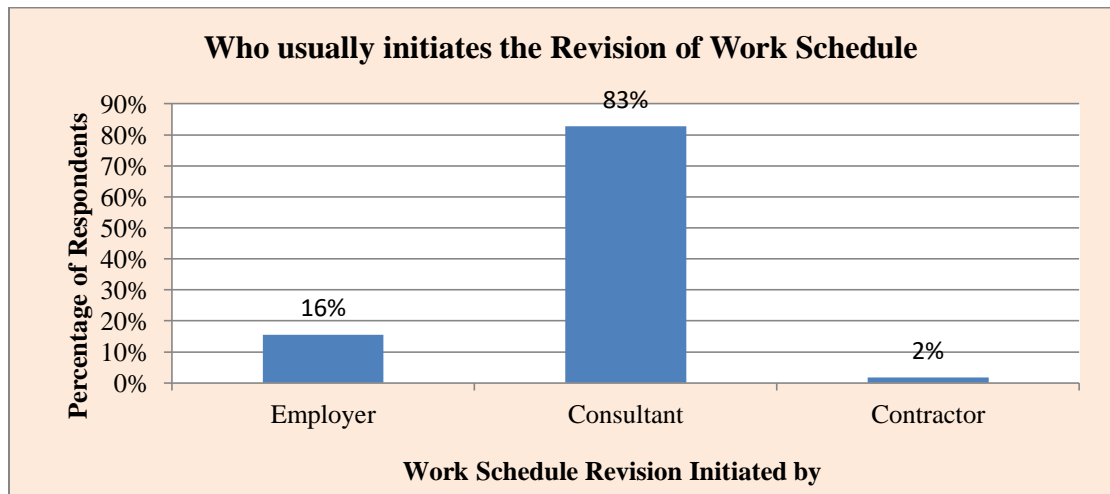


Source: Own Survey

### 4.2.5 Initiation of Revision of Work Schedule

Revision of work schedules are usually initiated by Consultants (83%) according to this study as presented in the following figure.

**Figure 2: Who usually initiates the Revision of Work Schedule**

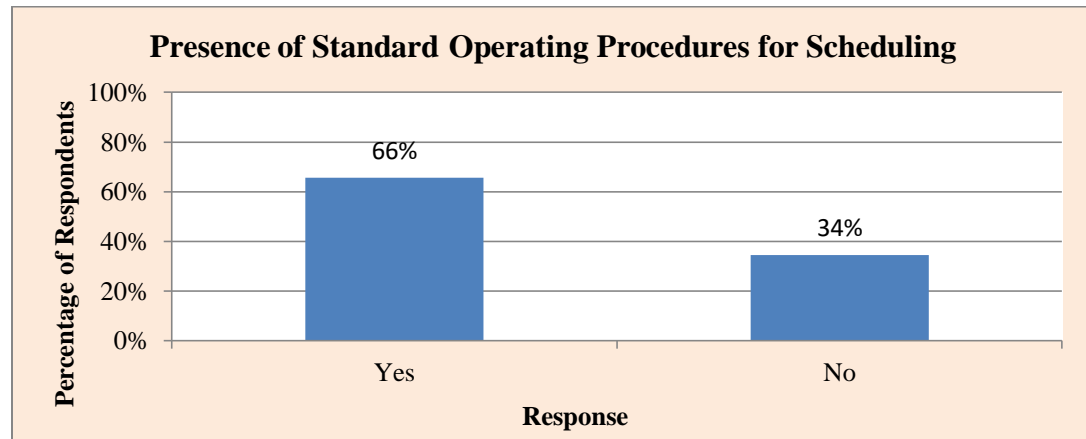


Source: Own Survey

### 4.2.6 Presence of Standard Operating Procedures of Scheduling

According to the study, there are standard operating procedures of preparation and revision of work schedules in 66% of road construction projects as presented in the following figure.

**Figure 3: Presence of Standard Operating Procedures for Scheduling**

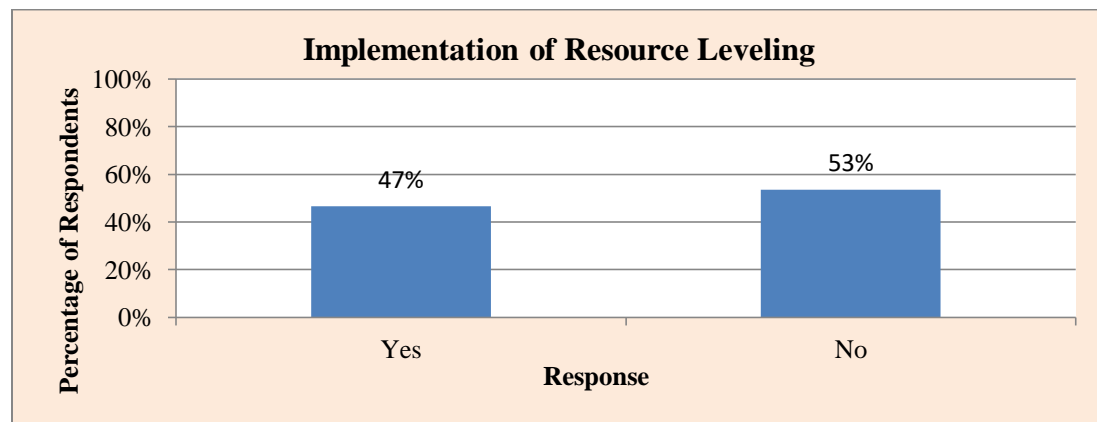


Source: Own Survey

### 4.2.7 Implementation of Resource Leveling

Resource Leveling is not being practiced by 53% road construction projects as presented in the following figure.

**Figure 4: Implementation of Resource Leveling**

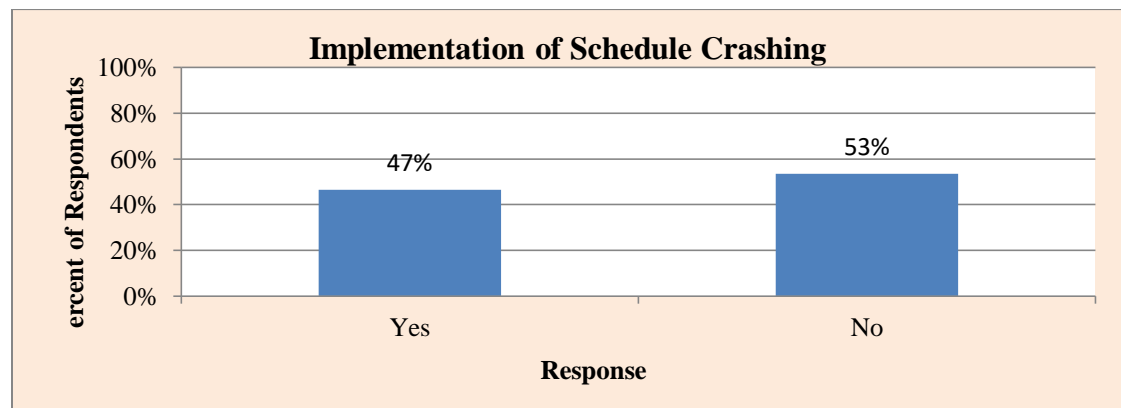


Source: Own Survey

### 4.2.8 Implementation of Schedule Crashing

Schedule crashing is not being implemented by 53% of road construction projects as presented in the following figure.

**Figure 5: Implementation of Schedule Crashing**

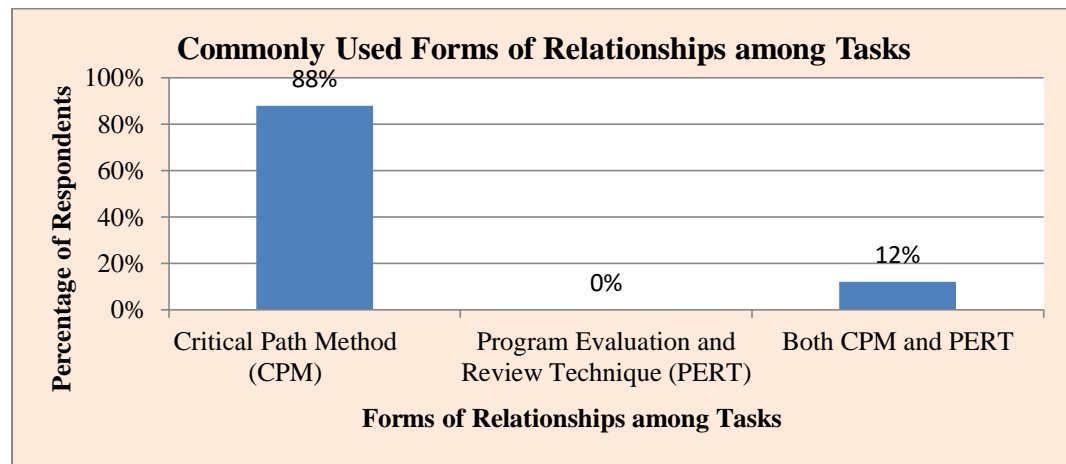


Source: Own Survey

### 4.2.9 Forms of Relationships among Tasks to Prepare Work Schedules

According to the study, about 88% of road construction projects use Critical Path Method (CPM) to create work schedules as presented in the following figure.

**Figure 6: Commonly Used Forms of Relationships among Tasks**



Source: Own Survey

### 4.3 Interpretation and Discussion

The implementation of the seven project time management processes was analyzed and found that *Controlling Schedule, Planning Schedule Management* and *Estimation of Activity Durations* are the most difficulties observed by all major parties or road construction projects.

The major challenges of scheduling of Federal road construction projects observed in their significance order are:

- Not considering risks in schedule
- Not properly allocating resources
- Using similar variables of other projects
- Absence of training on scheduling
- Design delays to get workload of the project
- Not assigning experienced professionals
- Crew formation is not standardized
- Not defining Work Breakdown Structures
- Improperly defining the scope of the project
- Not defining sequences of activities
- Improperly setting project calendar
- Not using scheduling software

Having unrealistic work Schedule affects road construction projects in the following significance order: project completion time, project cost, profitability of contractor, satisfaction of employer, contract administration, claim management, communication with stakeholders, settlement of disputes and project quality.

According to the study, the majority of road construction projects (45%) revise work schedules every year. There are also projects which do not revise work schedules at all (5%). Revision of work schedules are usually initiated by Consultants. Resource Leveling and Schedule crashing are not being implemented by 53% of road construction projects. The majority of road construction projects (88%) use Critical Path Method (CPM) to create work schedules.

## CHAPTER FIVE: SUMMARY, CONCLUSION, AND RECOMMENDATIONS

### 5.1 Summary

The results of the research depict that *Controlling Schedule, Planning Schedule Management* and *Estimation of Activity Durations* are the most difficulties noticed by all major parties or Federal road construction projects with regard to the implementation of project management processes.

The major challenges of scheduling of Federal road construction projects are *Not Considering Risks in Schedule, Not Properly Allocating Resources, Using Similar Variables of Other Projects, Absence of Training on Scheduling and Design Delays to Get Workload of the Project*. Schedules which are not realistic have major negative impacts on project completion time, project cost, profitability of contractor and satisfaction of Employer. According to the study, unrealistic work schedules have less negative effect on quality of works and settlement of disputes.

According to the study, 45% of road construction projects revise work schedules every year, 33% of them revise every six months, and 17% of projects revise work schedules from one to three months. There are about 5% projects which do not revise work schedules at all. Revision of work schedules are usually initiated by Consultants according to this study.

There are standard operating procedures of preparation and revision of work schedules in 66% of road construction projects. Resource Leveling is not being practiced by 53% road construction projects. Schedule crashing is not being implemented by 53% of road construction projects. According to the study, about 88% of road construction projects use Critical Path Method (CPM) to create work schedules.

## 5.2 Conclusions

It is evident that road construction projects that are well planned and managed have better project performance. Preparation and revision of work schedules of Federal road construction projects is challenging. Work schedules are not properly planned in most road construction project. There are also gaps of controlling the already developed work schedules. This leads to delays of project completion time. It also increases project cost significantly.

The analysis made on the implementation difficulties of the seven project management processes indicated that ***Controlling Schedule*** is the most difficult task in the projects studied. Other implementation difficulties of project management processes in their significance order are: ***Improper Planning Schedule Management***, ***Wrong Estimation of Activity Durations***, ***Wrong Estimation of Activity Resources***, ***Difficulty in Developing Schedule***, ***Gap in Defining Activities*** and ***Difficulty in Sequencing Activities***.

The major challenges of scheduling of Federal road construction projects are: ***Not Considering Risks in Schedule***, ***Not Properly Allocating Resources***, ***Using Similar Variables of Other Projects***, ***Absence of Training on Scheduling*** and ***Design Delays to Get Workload of the Project***.

Though the majority of projects have standard operating procedures of preparation and revision of work schedules, there are projects which do not revise work schedules at all. The revision of work schedules are usually initiated by Consultants. Resource leveling and schedule crashing are not being implemented by the majority of Federal road construction projects.

### 5.3 Recommendations

This study recommends that the proper implementation of project time management processes with emphasis to *Controlling Schedule, Planning Schedule Management* and *Estimation of Activity Durations*.

The researcher recommends the proper implementation of Controlling Schedule during the course of works. The progress of project activities should be compared against schedule baseline to understand whether project is ahead of the schedule or behind. Based on the deviation corrective or preventive actions should be taken. This manages changes to the baseline. This process helps to reduce the risk of slippage of works.

In preparing of work schedules, *risks* should be given utmost attention. Project managers need to understand how to use a schedule risk analysis to provide information crucial to a project's success, before they embark on their project.

There should also be proper allocation of resources to prepare and revise work schedules. As projects are specific by their nature, similar variables of other projects should not be used to prepare and revise work schedules. It is recommended that the best practices of other project can be used customizing the variables specifically to a project.

The researcher recommends the timely and regularly revision of work schedules to take corrective actions and to materialize the timely completion of road construction projects. It is also recommended that to make use of proper time management, work schedules should be crashed when there is a noticeable slippage from the baseline.

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## APPENDICES

## DATA COLLECTION INSTRUMENT

Addis Ababa University

College of Business and Economics

School of Commerce

Postgraduate Program in Project Management

### Questionnaire to be filled by Key Staffs from Federal Road Construction Projects

This questionnaire is designed to obtain primary data for the research entitled “Challenges of Scheduling of Federal Road Construction Projects in Ethiopia” for academic purpose. I kindly request you to fill the questionnaire genuinely and return it back.

If you need any explanation concerning the study and the questions listed, don’t hesitate to contact me. The questionnaire will be used for academic purpose only. Please note that the information you provide will be treated with utmost confidentiality.

I thank you for your valuable cooperation in advance!

Getu Feyera

Email: getutr@yahoo.com

### Section A: Personal Profile

Tick the choice that describes you.

- Your Job Title \_\_\_\_\_
- Your Company                      Employer     Consultant     Contractor
- Academic Qualification    Certificate/Diploma     BA/BSc     MA/MSc & above
- Experience in Road Construction Projects    <5 years     5-10 Years     > 10 Years

## Section B: Questions Related to Challenges of Scheduling of Federal Road Construction Projects in Ethiopia

Please answer the questions listed below using “√” mark.

**1=Very Low; 2=Low; 3=Average; 4=High; 5=Very High**

### 1. Please rate the implementation of *Project Time Management Processes* in scheduling of Federal road construction projects

	1	2	3	4	5
1.1. Improper Planning Schedule Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2. Gap in Defining Activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3. Difficulty in Sequencing Activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4. Wrong Estimation of Activity Resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5. Wrong Estimation of Activity Durations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6. Difficulty in Developing Schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.7. Reluctance in Controlling Schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### 2. Please rate the challenges in preparation and revision of road construction work schedules

	1	2	3	4	5
2.1. Not assigning experienced professionals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2. Improperly defining the scope of the project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3. Design delays to get workload of the project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4. Not using scheduling software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.5. Using similar variables of other projects	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6. Not considering risks in schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.7. Absence of training on scheduling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.8. Not defining Work Breakdown Structures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.9. Not defining sequences of activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.10. Not properly allocating resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.11. Improperly setting project calendar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.12. Crew formation is not standardized	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**4. What are the levels of negative impacts of unrealistic work schedule on:**

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
4.1. Project Completion time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2. Project Cost	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3. Project Quality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4. Employer's Satisfaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5. Communication with Stakeholders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.6. Contract Administration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.7. Claim Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.8. Settlement of Disputes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.9. Contractor's Profitability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**5. How often work schedules are revised in your current project(s)?**

One to Three Months  Every Six Months  Every Year  Never at All

**6. Who usually initiates the revision of work schedule in road construction projects?**

Employer  Consultant  Contractor

**7. Are there *Standard Operating Procedures* of preparation and revision of work schedules in your project(s)?**

Yes  No

**8. Is resource leveling being practiced in your project(s)?**

Yes  No

**9. Is crashing program being exercised in your project(s)?**

Yes  No

**10. Which form(s) of relationships among tasks is/are usually used in the preparation of work schedules in your project(s)?**

Critical Path Method (CPM)

Program Evaluation and Review Technique (PERT)

Both CPM and PERT

**Critical Values of Spearman's Ranked Correlation Coefficient**Critical Values of the Spearman's Ranked Correlation Coefficient ( $r_s$ )

Taken from Zar, 1984 Table B.19

$\alpha(2)$ :	0.50	0.20	0.10	0.05	0.02	0.01	0.005	0.002	0.001
$\alpha(1)$ :	0.25	0.10	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
n									
4	0.600	1.000	1.000						
5	0.500	0.800	0.900	1.000	1.000				
6	0.371	0.657	0.829	0.886	0.943	1.000	1.000		
7	0.321	0.571	0.714	0.786	0.893	0.929	0.964	1.000	1.000
8	0.310	0.524	0.643	0.738	0.833	0.881	0.905	0.952	0.976
9	0.267	0.483	0.600	0.700	0.783	0.833	0.867	0.917	0.933
10	0.248	0.455	0.564	0.648	0.745	0.794	0.830	0.879	0.903
11	0.236	0.427	0.536	0.618	0.709	0.755	0.800	0.845	0.873
12	0.217	0.406	0.503	0.587	0.678	0.727	0.769	0.818	0.846
13	0.209	0.385	0.484	0.560	0.648	0.703	0.747	0.791	0.824
14	0.200	0.367	0.464	0.538	0.626	0.679	0.723	0.771	0.802
15	0.189	0.354	0.446	0.521	0.604	0.654	0.700	0.750	0.779
16	0.182	0.341	0.429	0.503	0.582	0.635	0.679	0.729	0.762
17	0.176	0.328	0.414	0.485	0.566	0.615	0.662	0.713	0.748
18	0.170	0.317	0.401	0.472	0.550	0.600	0.643	0.695	0.728
19	0.165	0.309	0.391	0.460	0.535	0.584	0.628	0.677	0.712
20	0.161	0.299	0.380	0.447	0.520	0.570	0.612	0.662	0.696
21	0.156	0.292	0.370	0.435	0.508	0.556	0.599	0.648	0.681
22	0.152	0.284	0.361	0.425	0.496	0.544	0.586	0.634	0.667
23	0.148	0.278	0.353	0.415	0.486	0.532	0.573	0.622	0.654
24	0.144	0.271	0.344	0.406	0.476	0.521	0.562	0.610	0.642
25	0.142	0.265	0.337	0.398	0.466	0.511	0.551	0.598	0.630
26	0.138	0.259	0.331	0.390	0.457	0.501	0.541	0.587	0.619
27	0.136	0.255	0.324	0.382	0.448	0.491	0.531	0.577	0.608
28	0.133	0.250	0.317	0.375	0.440	0.483	0.522	0.567	0.598
29	0.130	0.245	0.312	0.368	0.433	0.475	0.513	0.558	0.589
30	0.128	0.240	0.306	0.362	0.425	0.467	0.504	0.549	0.580
31	0.126	0.236	0.301	0.356	0.418	0.459	0.496	0.541	0.571
32	0.124	0.232	0.296	0.350	0.412	0.452	0.489	0.533	0.563
33	0.121	0.229	0.291	0.345	0.405	0.446	0.482	0.525	0.554
34	0.120	0.225	0.287	0.340	0.399	0.439	0.475	0.517	0.547
35	0.118	0.222	0.283	0.335	0.394	0.433	0.468	0.510	0.539
36	0.116	0.219	0.279	0.330	0.388	0.427	0.462	0.504	0.533
37	0.114	0.216	0.275	0.325	0.383	0.421	0.456	0.497	0.526
38	0.113	0.212	0.271	0.321	0.378	0.415	0.450	0.491	0.519
39	0.111	0.210	0.267	0.317	0.373	0.410	0.444	0.485	0.513
40	0.110	0.207	0.264	0.313	0.368	0.405	0.439	0.479	0.507
41	0.108	0.204	0.261	0.309	0.364	0.400	0.433	0.473	0.501
42	0.107	0.202	0.257	0.305	0.359	0.395	0.428	0.468	0.495
43	0.105	0.199	0.254	0.301	0.355	0.391	0.423	0.463	0.490
44	0.104	0.197	0.251	0.298	0.351	0.386	0.419	0.458	0.484
45	0.103	0.194	0.248	0.294	0.347	0.382	0.414	0.453	0.479
46	0.102	0.192	0.246	0.291	0.343	0.378	0.410	0.448	0.474
47	0.101	0.190	0.243	0.288	0.340	0.374	0.405	0.443	0.469
48	0.100	0.188	0.240	0.285	0.336	0.370	0.401	0.439	0.465
49	0.098	0.186	0.238	0.282	0.333	0.366	0.397	0.434	0.460
50	0.097	0.184	0.235	0.279	0.329	0.363	0.393	0.430	0.456