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PROJECT TIME SCHEDULING AND ITS IMPACT ON IMPLEMENTATION: THE CASE OF ERA PROJECTS AROUND EAST HARARGHE

A Thesis Submitted to School of Graduate Studies of Jimma University, in partial fulfillment of the requirements for Degree of Master of Science in Civil Engineering (Construction Engineering and Management).

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ABSTRACT

From a scheduling point of view, the goal of every project is to be delivered on time and within budget, with desired functionality and acceptable quality level. In an ideal world, projects follow early starts and early finishes, float is not consumed, deadlines are met, the contractor never claims for time extension, and the owner never assesses liquidated damages. Such condition rarely exists on construction projects, events occur that potentially affect the planned completion of work, requiring a need to evaluate projects scheduling and its impact on implementation.

In Ethiopian construction industry, time claims are normally expected because of well-known project management system is not widely practiced in the country. Moreover, majority of local construction organizations manage their construction projects by employing engineers who have little or no training on construction project management. This results in poor time schedule administration. In addition to the complexity of projects being undertaken, these days, the type of project management system and improper schedule administration raises more problems. The main causes for these problems are thought to be the inappropriate project time management.

In this regard the paper recommends that an effective and efficient Scheduling system should be established within projects. Schedule has the potential to cause major impact to construction projects. Therefore, the thesis is mainly devoted to previous and current construction works were selected as a case study for improving schedule & minimizing its impact on implementation.

***Key Words**: project time scheduling, impact, implementation*

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LIST OF ABBREVIATIONS

CPM	Critical Path Method
JIT	Jimma Institute of Technology
JU	Jimma University
ERA	Ethiopia Road Authority
ERCC	Ethiopia Road Construction Corporation
PM	Project Management
TIA	Time Impact Analysis Method
GDP	Gross Domestic Product
FIDIC	Federation International Des IngenieursConseils
FDRE	Federal Democratic Republic of Ethiopia
CSA	Central Statistical Agency
PERT	Program Evaluation and Review Technique
PNA	Precedence Network Analysis

CHAPTER ONE

INTRODUCTION

1.1 Background

The Federal Democratic Republic of Ethiopia is a land-locked country located in East Africa, and is bordered by Eritrea to the north and northeast, Djibouti and Somalia to the east, Sudan and South Sudan to the west, and Kenya to the south, covers a territory of 1.127 million square km, has a population of 100, 802 031, of which more than 84 percent live in rural areas, and has a GDP per head of $769.45 per person. Ethiopia is a Federal Democratic Republic composed of 9 National Regional states: namely Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and People Region (SNNPR), Gambella and Harari and two Administrative states Addis Ababa City administration and Dire Dawa city council (CSA, 2015). The states are further subdivided into 11 zones, with the exception of Harari state which has no zonal divisions. East Hararghe zone in the Oromiya National Regional State which have heavy population density, high ratio of cash to food crops, unpredictable rainfall, and significant differences between the agricultural practices within the three main altitude zones create a complicated agricultural profile, and at the same time support a population that is in general highly susceptible to food insecurity (CSA, 2015).

In the context of Ethiopia's geography, pattern of settlement and economic activity, transport plays a vital role in facilitating economic development. It is road transport that provides the means for the movement of people, utilization of land and natural resources, improved agricultural production and marketing, access to social services, and opportunities for sustainable growth(CIA, 2015).Ethiopia has a total of 136,044 km of federal and regional roads, of asphaltic or gravel construction. However, large parts of the country still have no access to road transport resulting in difficult access to social services and markets for agriculture outputs and goods inputs (MOFED, 2015).

According to the proclamation No 80/1997 of Ethiopia, Ethiopian road authority (ERA) is legally autonomous agency responsible for the management of the country's roads. The proclamation further stipulates that trunk and major link, which make up the federal road network system, are administered by the Ethiopian Roads Authority. Accordingly, ERA has reorganized its operations and regulatory departments as independent institutions. The former operations department has been reorganized as a public contractor as Ethiopian Roads

Construction Corporation (ERCCO) by council of Ministries Regulation No.248/2011 with the purposes of engaging in domestic and overseas and the regulatory department has been reorganized as ERA by council of Ministries Regulation No.247/2011 with responsibility to plan and manage the road network and supervise road works and is accountable to Ministry of Transport (ERA, 2011).

To address constraints in the road sector, related to restricted road network coverage and poor condition, the Government formulated the Road Sector Development Program in 1997. The RSDP has been implemented over a period of seventeen years and in four separate phases, as follows:

1. RSDP I – Period from July 1997 to June 2002 (5 year plan)
2. RSDP II – Period July 2002 to June 2007 (5 year plan)
3. RSDP III – Period July 2007 to June 2010 (3 year plan)
4. RSDP IV - Period July from 2010 to June 2015 (5 year plan, 4 years elapsed)

The seventeen years of the RSDP has seen significant improvements in the restoration and expansion of Ethiopia's road network. Physical achievements have been matched by significant improvements in the maintenance of the network, strengthening of the management capacity of the road agencies and delivery on policy reform. It was planned to upgrade 5,283 km of link roads at a total estimated cost of ETB 29,598.0 billion million. During the 17 years of the RSDP, a total of 4,501 km of link roads were upgraded (85% accomplishment). Disbursement as of October 2014 amounted to some ETB 36,407.2 billion million (ERA, 2014).

Within the above road sector development program, most projects are not completed within the agreed contract period and for the price it was tendered for. Notable recent examples in the Ethiopian include the road construction from Arba Minch to Humbo, the road construction from Jimma-Bonga-Mizan and from Sodo- Arbaminch projects suffered time and cost overruns (ERA, 2011).

ERA (2011) indicates that time and costs for performance of projects are usually of the fundamental nature to the owner and the contractor. This is because late completion of project can disagree with employers the benefits or profits that accumulate through use of the project and may also expose them to serious financial and economic risks such as lower interest rates and loss of market opportunities. On the contractor's side, delay in completion entails additional

cost accruing from extended home office and site office over heads, labor and equipment standby costs and other intangible cost such as opportunity cost.

Cost and time factors are inherent in all of project construction's undertakings. Construction projects have long been recognized as particularly cost, time and risk-laden. Some of the time factors associated with the construction process are fairly predictable or identifiable; others may be totally unforeseen. The constructed project may not perform as anticipated because the owner may have unrealistic expectations regarding the time of construction forcing contractors into unrealistic gambles, corner-cutting or commitments that may not be realistic (Frimpong 2003).

Project success can be defined as meeting goals and objectives as prescribed in the project plan. A successful project means that the project has accomplished its technical performance, maintained its schedule, and remained within budgetary costs. Project management tools and techniques play an important role in the effective management of a project. Therefore, a good project management lies in the management tools and techniques used to manage the project. Project management involves managing the resources-workers, machines, money, materials and methods used. Some projects are effectively and efficiently managed while others are mismanaged, incurring much delay and cost overruns (Frimpong 2003).

Reducing project duration can be done by adjusting overlaps between activities or by reducing activities' duration. What is the reason for an increase in direct cost as the activity duration is reduced? A simple case arises in the use of overtime work. By scheduling weekend or evening work, the completion time for an activity as measured in calendar days will be reduced. However, extra wages must be paid for such overtime work, so the cost will increase. Also, overtime work is more prone to accidents and quality problems that must be corrected, so costs may increase. The activity duration can be reduced by one of the following actions:

- Applying multiple-shifts work.
- Working extended hours (over time).
- Offering incentive payments to increase the productivity.
- Working on weekends and holidays.
- Using additional resources.
- Using materials with faster installation methods.
- Using alternate construction methods or sequence.

Hence the improvement of project planning and effective scheduling become extremely important for completion of projects with positive results. Consequently, it is necessary to analyze scheduling and its impact on implementation in construction projects to evaluate their adverse impacts on the project.

Figure 1.1: Ethiopian road network

1.2 Statement of the problem

Nowadays, most of road construction projects in Ethiopia are experiencing time and cost overrun problems (ERA, 2014). The problems come from variety of reasons, the major sources are caused by poor project planning and scheduling. The increased of time claim cases in the Ethiopian road construction sector of the Ethiopian road authority is poor schedule preparation, and is creating an atmosphere of schedule impact. Unless a systematic approach schedules are prepared and awareness created, this issue will continue to affect the proper handling of projects

and significantly affect project implementation. This thesis is therefore an attempt to address such issues.

1.3 Objectives of the study

1.3.1 General objective:

- To evaluate the impact of project scheduling on the implementation of eastern region ERA projects around east Hararghe.

1.3.2 Specific objectives

The specific objectives of this research was to weigh up the impact of project time scheduling on the implementation to the case study project in order to analyze the net impacts of construction schedule on project implementation. The issues of the study were:

1. To determine project time scheduling practices,
2. To determine the major types of construction scheduling problems and challenges,
3. To determine the common schedule impact analysis techniques used,
4. To identify the impacts of construction time schedule on project implementation.

1.4 The research questions

In order to achieve a practical and realistic conclusion, the research should address the following questions:

- What are the scheduling practices of ERA?
- What are the key scheduling challenges?
- What are their impacts on project implementation?
- What are the best practices in scheduling?

1.5 Limitation of the study

The present study has been conducted with all positive efforts and sufficient technical inputs in the form of actual field data collection, analysis and technical interpretation. However, this study has certain limitations which are highlighted below;

1. Detail scheduling practices
2. Challenges and schedule impacts data

Data collection and analysis was therefore limited to the data received from project supervisors in the field of project construction.

1.6 Significance of the study

All construction contracts allocate schedule between owners and contractors. Hence the significance of this study would better inform improved project scheduling practices and schedule challenges & problems solving, minimizing schedule impact on implementation and enhance schedule impact analysis practices between owners and contractors.

The findings would also enhance planning of wide range of risks that could prepare during the design, and the schedule of a project which would subsequently result in better and more realistic.

1.7 The research methodology

Both primary and secondary data was used. The primary data for the study was obtained through distribution of questionnaires as well as direct personal interviews with project supervisors involved in project construction. In order to enrich the questionnaire for the research, a review of text books and journals were used to identify the various efforts that have been made in the past to evaluate and examine the effects of time schedules on project construction. Simple statistical analysis involving tables, graphs and percentages were used in analyzing the results from the questionnaire. Descriptive explanations were also employed in making the analysis more meaningful. Secondary sources of data were obtained from relevant literature that covered research and publication on the subject matter.

CHAPTER TWO

LITERATURE REVIEW

According Oberlender (2000) project schedule is the tool that communicates what work needs to be performed, which resources of the organization will perform the work and the timeframes in which that work needs to be performed. The project schedule should reflect all of the work associated with delivering the project on time. On the other way, Zack (2003) define schedule as the act of developing a schedule which is a series of tasks that need to be accomplished in a specific sequence within a given period of time. These tasks grouped together achieve a common goal on a project or program.

In addition to above, construction project scheduling involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. In the study of Assaf (2006) construction delay was defined as "the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project." Delay was also defined as an "act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work" by (Zack, 2003). In a perfect world, projects follow early starts and early finishes, float is not consumed, deadlines are met, the contractor never files claims for time extension, and the owner never assesses liquidated damages. Such a situation rarely exists on construction projects – events occur that potentially affect the planned completion of work, requiring a need to evaluate the coming impact of this event on the project schedule (Frank, 2007).

For the evaluation of the coming impact of project scheduling, we can use different types of schedule impact analysis method. Schedule impact analysis is defined as the process of quantifying and apportioning the effect of change on a project schedule. This literature review focused on construction project planning and scheduling, objectives of scheduling, scheduling techniques, shortening project duration, causes of construction schedule review, types of schedule impact and scheduling analysis techniques.

2.1 Construction Project planning and scheduling

a) Construction Project planning

Oberlender (2000) defines construction project planning as "the heart of good project management because it provides the central communication that coordinates the work of all parties. Planning also establishes the benchmark for the project control system to track the quantity, cost, and timing of work required to successfully complete the project. Although the most common desired result of planning is to finish the project on time, there are other benefits that can be derived from good project planning".

In addition, Songul (2010) pointed out the explanation of Arıkan and Dikmen (2004) that " planning is trying to anticipate what will happen and devising ways of achieving the set of objectives and targets; and point out that in planning concept there are always objectives to be reaches in future. The authors describe planning as a process during which efforts and decisions are made to achieve the goals at the desired time in the desired way."

Project planning has also been defined as the way of selecting the one method and order of work to be used on a project from among all the various methods and sequences in which it could be done (Callahan, 1992).

Mubarak (2005) further explains that project planning works include several functions such as: cost estimating, scheduling, project control, safety management, etc. In addition, Arıkan and Dikmen (2004) the main function of planning is to provide the primary functions of the manager, namely, direction and control. The authors further describe the second objective of planning is to organize all the relationships and information systems among the many parties involved in the construction project. In another study, Smith, (2002) defined that construction project planning as planning the entire project from its start to completion requires a vast coverage, varied skills and different types of plans and planning aims at formulation of a time based plan of action for coordinating various activities and resources to achieve specified objectives. Planning is the process of developing the project plan. The plan outlines how the project is to be directed to achieve the assigned goals. It specifies a predetermined and committed future course of action, based on discussions and decisions made on the current knowledge and estimation of future trends.

Oberlender (2000) also agrees with Smith that "planning coordinates all works of the construction to reach a completed quality project". The contractor determines the basic benefit of project planning and scheduling as an effective tool of preventing some of the problems like

delays in work, cost overrun or decline in productivity and principally puts in order the desired results of project planning and scheduling as indicated below:

1. Finish the project on time.
2. Continuous (uninterrupted) flow of work (no delays).
3. Reduced amount of rework (least amount of changes).
4. Increased knowledge of status of project by everyone.
5. Meaningful and timely reports to management.
6. Knowledge of scheduled times of key parts of the project.
7. Knowledge of distribution of costs of the project.
8. Accountability of people, defined responsibility/ authority.
9. Clear understanding of who does what, when, and how much.
10. Integration of all work to ensure a quality project for the owner.

b) Construction project scheduling

A project schedule establishes the start date, duration, completion date, and resource needs for each activity in the project scheduling. The construction scheduling process is essential not only so that projects can be completed, profitably and on time, but also so that any delays can be evaluated in order to prove claim to time and cost compensation. As problems are encountered, the schedule helps project managers rearrange project tasks and resources so that they can meet the primary objectives of time, cost, and quality under limited resource and budget constraints.

According to Oberlender (2000) define project scheduling as " the plan on calendar basis and a project network shows the sequence and inters dependencies of activities, their time and their earliest and latest completion time, but these needs to be scheduled to determine start and termination dates of each activity".

In another study the definition of project planning and scheduling are often mistakenly thought of as similar. However, as Mubarak (2005) also indicates "Scheduling is the process of determining when project activities will take place depending on defined durations and precedent activities. Schedule constraints specify when an activity should start or end based on duration, predecessors, external predecessor relationships, resource availability, or target dates. Therefore, while project planning is a general term that sets a clear road map that should be followed to reach a destination.

In addition to above Trauner, (2009) also agree with Mubarak and define project schedule as graphical representation of the Contractor's plan for completing a construction project that emphasizes the elements of time and sequence. According to Trauner (2009), the project schedule should display all the construction tasks from the beginning of the project through completion, the time periods for each tasks, and the sequence of these tasks in a logical order.

In similar way Oxley and Poskitt (1996) define project scheduling as "the process of determining the actual time periods during which the activities are planned to take place: that is, start and finish dates for each activity. In order to determine the construction activities and their time periods, project planning should have been done before project scheduling".

2.2 The Objectives of construction Project

After a successful planning process, the schedule of the project is prepared. There are major objectives that are expected from good project scheduling according to Mubarak (2005) there are seven important objectives of scheduling as noted below:

1. To calculate the project completion date.
2. To calculate the start or end of a specific activity.
3. To predict and calculate the cash flow.
4. To evaluate the effect of changes.
5. To improve work efficiency.
6. To resolve delay claims.
7. To serve as an effective project control tool.

Trauner (2009) further explain the basic purposes of a project schedule as effectively depicting the construction plan to the project participants, permitting management to control and measure the progression of the work, and finally accommodating the participants with information for timely decisions.

Callahan (1992) claim that "the probabilities of on-time, on budget, and dispute free completion may be increased by means of a schedule and the purpose of the schedules is specified by the individual using the schedule." He further explains that the purpose to predict project completion for contractors is that they can arrange crew sizes, shifts or equipment to speed or slow progress.

In addition to above, Callahan (1992) also indicate that "schedules are used for measuring delay and time extensions. The schedules are regularly updated including work sequences,

unanticipated delays, actual activity completion dates and change orders, then the owner and contractor can measure the effect of additional works and unanticipated delays, thus avoiding disputes".

2.3 Scheduling Techniques

The technique used for project scheduling will vary depending upon the project's size, complexity, duration, personnel, and owner requirements. The project manager must choose a scheduling technique that is simple to use and is easily interpreted by all project participants. There are two general methods that are commonly used: the bar chart (sometimes called the Gantt chart) and the Critical Path Method.

Menesi (2010) explained Gantt chart as the usual format for the activities to be listed in a vertical column on the left-hand side of the chart, with a horizontal bar for each activity plotted against a timescale to mark the start and finish times of the activities. In the same way with Oberlender (2000) and Menesi (2010), Callahan (1992) defines bar charts as a collection of activities listed in a vertical column with time represented on a horizontal scale and it show duration, start and finish times of project activities in chronological order. Henry L. Gantt developed bar charts during World War I. This tool is widely preferred since it is simple, easy to prepare and has an easily understandable format.

The Critical Path Method (network analysis system) was developed in 1956 by the DuPont Company, with Rernington Rand as consultants, as a deterministic approach to scheduling. The Critical Path method is commonly used in the engineering and construction industry. A similar method, Program Evaluation and Review Technique (PERT), was developed in 1957 by the U.S. Navy, with Booz, AIIen, & Hamilton Management consultants, as a probabilistic approach to scheduling. It is more commonly used by the manufacturing industry; however, it can be used for risk assessment of highly uncertain projects. Both methods are often referred to as a network analysis system.

Oberlender (2000) defines CPM as "provides interrelationships of activities and scheduling of costs and resources. It is also an effective technique for overall project scheduling and detailed scheduling of construction. However, it does have some limitations when applied to detailed engineering design work during the early stages of a project because it requires an extensive description of the interrelationships of activities".

Hegazy (2008): defined the steps to be followed:

- A forward pass to determine the early start times of the activities
- A backward pass to determine the late finish times of the activities
- Identification of critical activities

Menesi (2010) point out a number of researchers and practitioners have studied CPM and reported both benefits and criticisms. The following list includes the most important critical views of CPM and the pitfalls inherent in commercial software:

- Floats, the critical path, and the project status can be inaccurate due to the extensive use of leads and lags (Wickwire 2003).
- Start-to-Start (SS) or Finish-to-Finish (FF) relationships have time dependence but not work-amount dependence (Lowsley and Linnett 2006).
- Schedule analysis is not a straightforward task under multiple baseline updates and under resource allocation (Hegazy and Menesi 2008a).
- Networks with multiple relationships (FF and SS) are complex to analyze (Lu and Lam 2008).
- Schedule analysis is difficult, particularly when the contractor changes the logical relations to show fewer delays and does not notify the owner (Hegazy and Menesi 2008b, Livengood and Anderson 2006).
- CPM cannot quantify the effect that consuming the floats has on the project duration and cost (Sakka and El-Sayegh 2007).
- CPM analysis can be wrong if the level of detail used to prepare the analysis is inappropriate (Lowsley and Linnett 2006).
- Some of the ENR's Top 400 Contractors have commented about CPM (Kelleher 2004) as follows :
    - "It does not always simulate actual conditions."
    - "Changes in the field and deviations from the baseline often take a long time to be reflected on the schedule."
    - "Cannot easily trace network logic graphically."
    - "We need the detail to make the schedule easy to update and able to quantify impact properly and in a timely manner."

2.4 Shortening Project Duration

The minimum time to complete a project is called the project-crash time. This minimum completion time can be found by applying critical path scheduling with all activity durations set to their minimum values. This minimum completion time for the project can then be used to determine the project-crash cost. Since there are some activities not on the critical path that can be assigned longer duration without delaying the project, it is advantageous to change all crash schedule and thereby reduce costs (Diekmann et al 1992).

In particular, a simple approach is to first apply critical path scheduling with all activity durations assumed to be at minimum cost. Next, the planner can examine activities on the critical path and reduce the scheduled duration of activities which have the lowest resulting increase in costs. In essence, the planner develops a list of activities on the critical path ranked with their cost slopes. The heuristic solution (any approach to problem solving) proceeds by shortening activities in the order of their lowest cost slopes (Dawood et al 1997).

According to Frimpong, (2000) as the duration of activities on the shortest path are shortened, the project duration is also reduced. Eventually, another path becomes critical, and a new list of activities on the critical path must be prepared. Using this way, good but not necessarily optimal schedules can be identified.

2.5 Causes of Construction Schedule review

According to Kaliba et al. (2009) the main causes of schedule review in road construction projects which are determined according to their survey as: financing, materials, contractual relationships, project changes, government relations, manpower, scheduling and control, equipment, and environmental factors. The financing group of scheduling review factors was selected as the most significant construction scheduling review factor by all parties and that environment group was selected as least significant.

In the other way, Ahmed et al. (2003) defined as: there are two groups of causes for scheduling review in construction projects: external and internal causes. Internal causes of scheduling review cover the causes, which come from four parties involved in that project. These parties are the owner, designers, contractors, and consultants. Other scheduling reviews, which do not come from these four parties, are based on external causes for example from the government, material

suppliers, or weather. Ahmed et al. (2003) writes some of the possible causes of schedule reviews are as follows:

- Decision-making mechanism,
- Bureaucratic in organization,
- Inadequate data collection and survey before design,
- Site's topography is changed after design
- Different attitude between the consultant and contractors
- Financial difficulties
- Inexperienced personnel
- scarce number of staffs
- Poor in project coordination
- Often changing Sub-contractors Company
- insufficient, and old equipment
- Lack of high-technology equipment

Chitkara (2004) define the cause of scheduling review as "a project planning has to take in to consideration many variables like time, resources and financial constraints. It is difficult to enumerate principles governing all such factors which may vary from project to project. Street (2000) also in a review of pitfalls of CPM scheduling on construction projects noted that most contractors do not have in-house CPM expertise. This situation is likely to result in poorly developed and poorly maintained schedules".

Improper communication between project stakeholders particularly site managers, subcontractors and architect/engineer team will affect the availability of information for effective programmer's management. Laufer (1994) explain Timely, reliable and clear information gathering and distribution is an essential issue in planning during construction. And in addition to the above improper communication, a study by Faniran (1994) shows that the extent to which emphasis is placed on the determination of construction methods during planning has a significant effect on the improvement of construction planning effectiveness.

Adequate planning time prior to commencement of work on site is one of the factors significantly responsible for effective planning Faniran (1994). However, research by Kelsey (2001) also shows that most planners work under shorter time constraints during tender

preparation which may affect the quality of pre-contract programmers submitted with the contractors' tenders.

2.6 Types of Schedule Impacts

2.6.1 Delays

A delay is an event that prevents the contractor from completing the work within the contractually specified performance period (Wickwire et al. 2003). In addition to Wickwire, Bartholomew (2002) defined delay as: a slowing down of the work without stopping it entirely, triggered by something other than a formal directive from the owner to stop work or simply put, a delay is a loss of time.

2.6.2 Disruptions

A disruption can be defined as an impact that alters the contractor's planned work sequence or flow of work expected at the time of bidding, which results in increased difficulty, cost, and/or time (Bramble et al. 1990). When this occurs, the contractor cannot perform work in the manner anticipated during bid preparation, thus resulting in a schedule impact. As opposed to delays, damages associated with disruption are likely to be increased labor costs due to inefficiency, the activation/deactivation of increased manpower, and additional equipment costs (Wickwire et al. 2003).

2.6.3 Change

Another major type of potential schedule impact involves changes. When a contractor takes on any type of work that deviates from the original contract, or from the scope of work or plan of action reasonably anticipated under the contract, that results in an increase in performance time, the contractor may seek an adjustment (Bramble et al. 1990). Before determining the impact of the change on the schedule, the change must be identified as truly being a change from the original contract or merely a situation that should have been anticipated by the terms of the original agreement (Bramble et al. 1990).

2.6.4 Suspensions

A suspension of work is a written directive by the owner to stop all work on the project, either because the contractor has failed to perform in accordance with contract documents, or at the owner's convenience (Wickwire et al. 2003). Work will not continue until the owner has raised the suspension of work. A cost and time adjustment shall be made for any suspension of work ordered by the owner, as long as the contractor was not responsible for the suspension of work.

As opposed to a pure delay, when an owner issues a suspension of work, the contractor is also entitled to equitable adjustment for profit (Wickwire et al. 2003).

2.6.5 Termination

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

There are two categories of termination, the first type being default termination, which gives the owner the right to terminate the contract when the contractor's performance is either:

1. Far behind a reasonable time schedule or
2. Results in work that fails to meet contract quality requirements or
3. When the contractor becomes financially insolvent. (Bartholomew 2002)

The second type of termination, convenience termination, allows the owner to terminate the contract for its convenience, based on specific needs of the owner. For example, if the owner is unable to fund the remainder of the project and there is a termination for convenience clause in the contract, the owner is allowed to terminate the contract.

2.7 Schedule impact analysis techniques

After each delay has been isolated from scheduling review, the next step is to identify when the delays occurred and their effect on project completion. To determine the total impact of the schedule review, one of the following schedule review impact analysis techniques can be used:

2.7.1 Global impact approach

The method involves plotting all delays, disruptions, and similar occurrences, of which the contractor is not accountable for, on an as-built bar chart. Start and finish dates of each event are determined, which follows by a calculation of total delay. The total delay to the project is the sum of the durations of all delaying events.

The contractor has ignored concurrency between the delaying events, simply summing the durations of the delays. An additional fault in this method is that there is no attempt to analyze sequence of construction and how each delay affected the project completion. The frequent result of this approach is a claim for time extensions that extend well beyond the actual project delay (Bramble et. al. 1990).

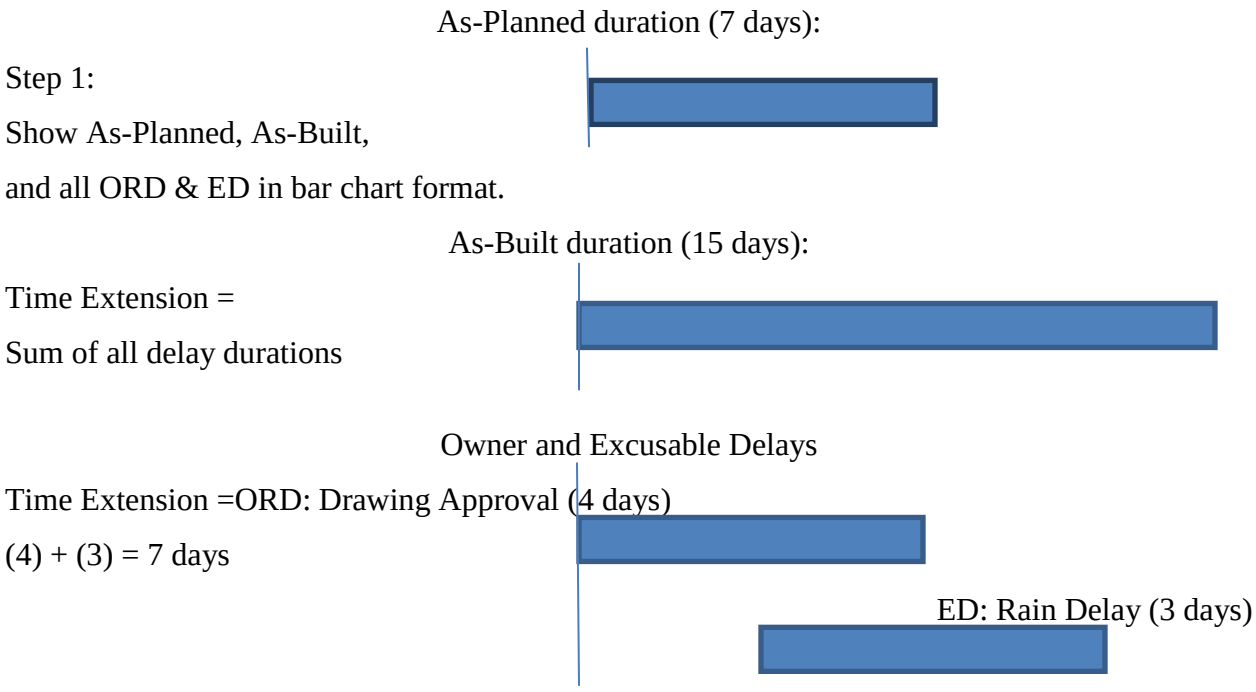

Figure 2.1: Global Impact Approach

2.7.2 Net impact approach

In this method, all delays and disruptions, including those of the contractor, are plotted on a bar chart, similarly as done in the global impact approach. The widespread number of delays leads the client to argue that the only logical conclusion is that the combined effect of these delays is the net delay on the entire project. Although the start, finish, and duration of each delay are noted, their use is nonexistent. The contractor's request for time extension will be the difference between the as-planned duration and the as-built duration.

Although the client has not counted parallel delays more than once, the individual impact of any delay is not calculated, rather assuming the total impact of all delays has a net effect on project completion. Without network analysis, such a method is nearly impossible to compute (Bramble et. al. 1990). The net impact approach fails to take into account any project logic – the main component of CPM scheduling (Bramble et. al. 1990).

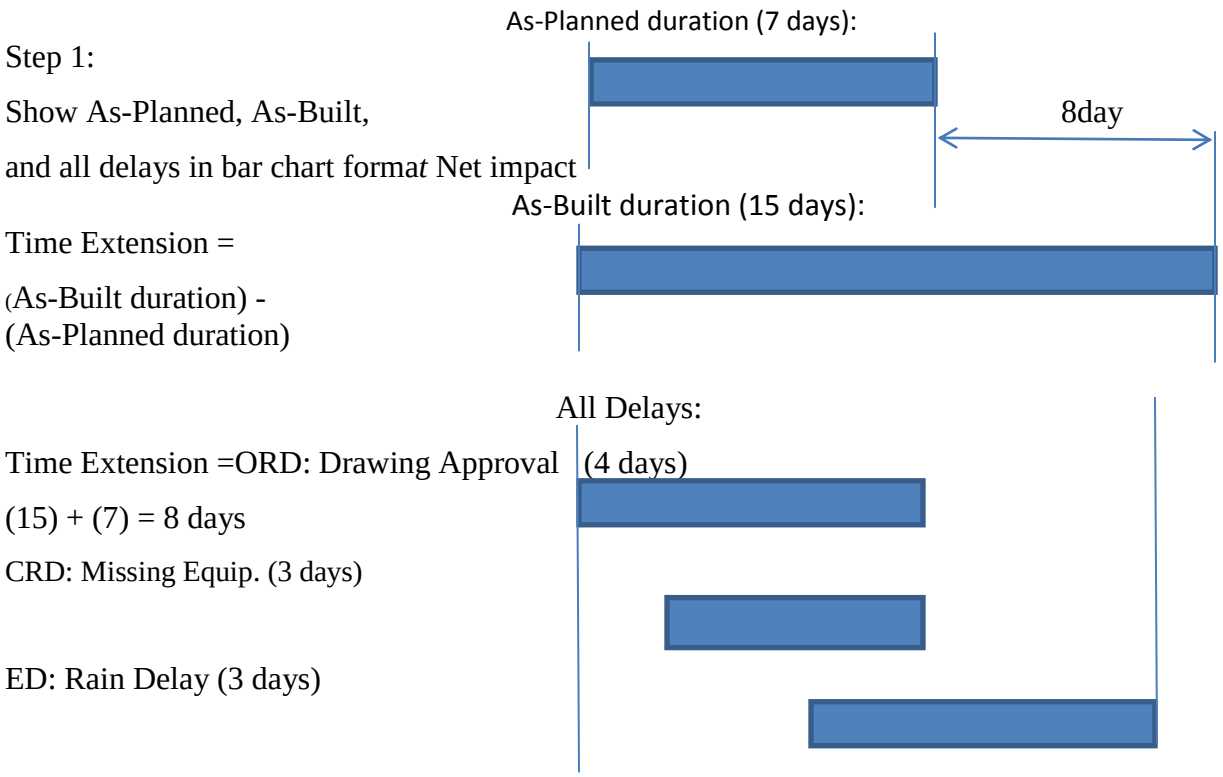

Figure 2.2: Net impact approach

2.7.3 Adjusted as-planned CPM approach

The impact of delays is measured by inserting all contractor delays into the original baseline schedule. These delaying events are depicted as activities and spliced into the schedule. Actual progress and historical work activity data are ignored in this method. To calculate warranted time extension, Contractor Responsible Delay is inserted into the as-planned schedule, resulting in adjusted planned completion duration. Assuming this approach is performed retrospectively, the adjusted planned completion duration is then subtracted from the as-built completion duration (Bramble et. al. 1990).

The shortcoming with this method is that it ignores the actual construction progress and utilizes a theoretical schedule. It is possible that the original plan was unworkable and unrealistic, and may not have been followed. Furthermore, delays may have changed the critical path on an incremental basis (Bramble et. al. 1990). Without representation of changes in a schedule, relying on a very outdated train schedule is useless when looking back to determine if the train was late at some prior moment in time.

2.7.4 Adjusted As-Built CPM Approach

In a continuation of the adjusted as-planned CPM approach, the adjusted as-built CPM approach attempts to use the actual progress history with what appears to be CPM scheduling techniques. Activities linked in a network with restraints form an as-built schedule for the entire project, with delaying events shown as distinct activities. The critical path is determined only twice – once in the as-planned analysis and again at the end of the project. Not always, but a good way to rig the system is for claimants to tie the delaying events to what they identify as the "critical path" (Bramble et. al. 1990).

The calculation of the critical path is somewhat manufactured, since it is a onetime, after-the-fact calculation, rather than a contemporaneous analysis of the impact of each delay, at the time of the delay. CPM scheduling is intended to be a forward-looking technique used to predict the end of the job, not a method to establish the past; "CPM Schedule" and "as-built" are contradictory terms. When client use this technique, they generally will show only delays that are not their responsibility. They may acknowledge their delays on the as-built schedule in a way that appears the delays were not critical. Most importantly, no thorough effort is made to determine the individual impact of each delay on project completion (Bramble et. al. 1990).

2.7.5 Collapsed As-Built Schedule (But-for) Approach

The collapsed as-built schedule impact approach utilizes the "but-for" technique. The owner and excusable delays are removed from the as-built schedule, "collapsing" the schedule, and demonstrating "but-for" the owner and excusable delays, the project would have been completed in a timely fashion (Bramble et. al. 1990).

1. Once construction is complete, develop an as-built CPM schedule.
2. Remove Owner Responsible Delay from the as-built CPM schedule.
3. The remaining duration represents what it would have been but-for the owner's delays.
4. Subtract the "but-for the owner's delays" duration from the as-built duration; the resulting days are solely the fault of the owner, warranting *x* amount of days of delay damages and time extension.

5. Remove excusable delay from the schedule. The resulting schedule is what would have been had it not been for owner and excusable delays. The difference between this and the previous schedule is all attributed to the excusable delay – justification for *y* amount of day's time extension. Using the formula shown in the figure below, quantify the impact of the contractor by solving for "Contractor's Liability."
6. Tally results from all steps.

The collapsed (but-for) logic relies on the presumption of a hypothetical outcome from what the analyst says would have happened, had a portion of historical events not occurred. This method places too much weight on theoretical situation, not giving enough attention to cause and effect relationships. In addition, construction scheduling should reflect the schedule in light of current situations and cumulative events, not a retrospective subtraction of events is performed on a one time basis (Bramble et. al. 1990).

2.7.6 Impacted Updated CPM (Veterans Administration) Approach

Another approach to schedule impact analysis is the impacted updated CPM method, used by the Veterans Administration. The original project schedule, as updated, is used to measure delay. The analysis will take place often during the course of construction rather than after the project is complete. However, if the update information still exists, the technique may be applied after project completion. Each delaying event, not at the fault of the contractor, is analyzed to define where it should be inserted into the schedule. Revisions to successive activities caused by the delay or change are determined by comparing the schedules before and after the changes have been incorporated. The effect that a delay or change has on the CPM schedule is determined by a comparison of the schedules before and after the delaying events are incorporated into the CPM Network; and only if the project completion is extended, the contractor is entitled to a time extension (Veterans, 1989). In the event of concurrent delays, a single analysis must be made for all delaying events, rather than making separate calculations for each change.

This approach analyzes all delays that have occurred since the last update at one time, assuming that the project schedule, as updated and approved, is correct. It does not determine whether actual construction in the field differs from the approved schedule. This is another method that

fails to properly use the CPM approach in a contemporaneous manner by updating after each delay (Bramble et. al. 1990).

2.7.7 Modification Impact Analysis (U.S. Army Corps of Engineers') Approach

The U.S. Army Corps of Engineers' Modification Impact Evaluation Guide directs another method of schedule impact analysis. This approach can be broken down into three steps:

Step 1: The time impact analyst determines the actual status of the job when each owner or excusable delay occurred, without influence from the contractor's formal project schedule. This eliminates situations where the contractor's real plan may not be the same as indication in the schedule, or the schedule may not have been revised to reflect the effects of previous modifications.

Step 2: The effects of modifications or delay-causing events should be evaluated to determine which ensuing changes to the schedule must be made to accommodate these events. New activities may need to be created if all or part of the work does not fit into an existing activity.

Step 3: The schedule as revised is used for new calculations to determine the new critical path and project completion date. From this new completion date, time extensions and/or delay damages can be granted.

Particular to this method is that a schedule revision is required for each modification, ensuring that the project status is known and future changes predicted at the time of each possible delaying event. Adjustments to the schedule and impact analysis shall be performed at or near the time of the delay, not at the completion of the project. If there are no modifications or owner-caused delays or disruptions, then the contractor is solely responsible for late completion and is not warranted a time extension (Bramble et. al. 1990).

2.7.8 Time Impact Analysis Approach

Of all the methods described, the time impact analysis method is the most comprehensive, incorporating the actual project history into a dynamic plan. Any delay, change, or disruption to

the schedule calls for time impact analysis to isolate and quantify the event. To do so, a "picture" of the CPM network is taken when the event occurs, followed by inserting the change into the network. All variations that may occur in the schedule – such as the critical path may shift, float may be consumed, or new links between activities may be required – are analyzed to determine what the effect of the event is. Any additional or revised activities will be reflected in the as-built schedule.

The goal of the systematic time impact analysis approach is to give full consideration to the actual effect of events individually and acting together, and to evaluate the effect of ongoing delays. The goal of the method is to examine the evolution of the critical path and the impact of delaying events on that path (Bramble et. al. 1990). The time impact analysis approach is often the most time-consuming delay analysis method; however, it can be very accurate, has the potential to be the least controversial and most analytical, and can be equitable to all parties (Stumpf, 2000).

Hence each project starts with a plan – the what, how, where and in what order – of the matter in which work will be completed. The plan is then given greater detail –who and when – that develop the baseline schedule, or the contractor's original understanding and plan of action for the project. Once the project commences, schedule updates and revisions – whether at scheduled intervals or as result of a change – create new schedules of record that shall meet the owner's approval. Eventually, the final schedule of record will be the as-built schedule – a final documentation of actual starts and finishes of activities, any delays, change orders, extra work, weather, and other factors that affected project completion.

Events that influence project completion are of various type, including delays, disruptions, change, suspension, and termination. One of three parties is responsible for these sources of schedule impact: the owner, the contractor, or a third party not to be at fault of the owner or contractor. When classifying delays, those caused by a third party, such as unusually severe weather, are "excusable delays" and warrant time extensions to the contractor. Owner responsible delays are "compensable" delays, and in addition to rewarding the contractor time extension, may involve delay damages. On the other hand, when the contractor is responsible for a delay, it is a "non-excusable delay", and not only is the contractor declined a time extension,

but they may also be held accountable for liquidated damages. These different types of delay do not always take place independently of each other – "concurrent delays" happen at the same time and/or on separate parallel paths of the CPM network.

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Each of the eight time impact techniques as described in full detail gives an overview of how each is applied, its strengths, and in many cases, its weaknesses. The comparison of time impact methods emphasizes using the most relevant, updated, and revised schedule, while minimizing hindsight – a contemporaneous method based on the as-built schedule that is a true representation of the actual project. Such a formula is considered the most comprehensive and accurate means for determining the impact that delaying events have on the schedule and project completion.

CHAPTER THREE

RESEARCH METHODOLOGY

This research work is designed to use desk study and questioner for obtaining views from clients, consulting firms and construction firms in regard to project scheduling and its impact on implementation. The questionnaire was designed according to the objectives of research by reviewing literature dealing with scheduling and other relevant topics. It was designed to be brief, concise and simple to encourage a high response rate from the potential contractors, clients and consultants. The respondents have to express their views and opinions by selecting the appropriate answer or giving short answers to the questions. The sources of literature review included relevant thesis, books, journals, thesis's written on related titles and seminar proceedings. The review of literature provided useful information on the implications of schedule impact, options available and strategic methods to improve planning and scheduling of contractors.

3.1 Research Design

Biklen and Bogdan (1998) define research design as the overall plan for collecting and analyzing data including measures to enhance both internal and external validity. Research design is the term often used to describe a number of decisions which need to be taken in the data collection process (Durrheim, 1992). To begin with, the main research objectives were analyzed to identify the basic questions that need to be addressed. For this research, desk study and questionnaires survey were used.

3.2 Population and Sample Size

In order to evaluate and assess time impacts of construction projects, a wide range of respondents in different categories of firms i.e. clients, consulting firms, contracting firms involved in road construction projects of the study area were targeted and respondents also selected by using purposive sampling method because we were dealing with Grade-1 and Grade-2 contractors and/or consultants whose data were selected from the Ethiopian road authority.

The study covered on current projects of federal road projects around eastern region (Harar By-Pass, Dredawa- Dewele and Gelemso Alberekete) and the bases for the selection of the projects area are:

1. Grade-1 and Grade-2 contractors and/or consultants usually undertake most of the large projects given to local contractors; hence impact of any improvement achieved will significantly contribute to the overall improvement of the construction industry's performance.

2. Grade-1 and Grade-2 contractors and/or consultants have better organizational, human and financial capability than contractors at lower level; hence they are better for starting efforts of schedule development and improvement in the construction industry.

All current projects were selected, which have several years of road project construction in Ethiopia and enable the researcher obtain differences in perceptions on the topic among the various construction firms thereby increasing the utility of information obtained.

3.3 Sampling procedure

According to Walliman (2005), Purposive sampling is a useful sampling method which allows a researcher to get information from a sample of the population that one thinks knows most about the subject matter. Hence purposive sampling was used to select projects and respondents from the available previous and current projects. The goal of the sampling method used was to obtain a sample that is a representative of the population. The information derived from the sample was expected to be the same had a complete sample of the population been carried out. The techniques used by the researcher to select the sample size required prior knowledge of the target population which allowed a determination of the size of the sample needed to achieve a reasonable estimate with accepted precision and accuracy of the population.

Sampling procedure in this research:

1. Decide on the research problem.
2. Determine the type of information needed
   - Information is held by only certain members of the population

3. Define the qualities the informant(s) should or should not have.
4. Use appropriate data gathering techniques.
5. Analyzing data and interpreting results.

3.4 Data collection Procedure

The researcher personally manages the questionnaire preparation and distribution to different respondents. Respondents were allowed sufficient time to complete the questionnaire. The questionnaires were with a series of questions which were related to the research work and directed to respondents with the aim of gaining first-hand information. The questionnaire consisted of both open ended and close-ended questions. Thus, in some cases, respondents were to choose the option that best reflected their opinion.

The respondents were asked to respond questions and the questionnaires which meet the need of respondents much flexibility and privacy in answering the questions without any undue influence. The questionnaire was in simple and unambiguous language and as such, did not cause any problem as regards interpretation. The researcher personally traveled to the selected project offices in Addis Ababa to conduct the interview. This method was purposefully selected so that the researcher could interact on a personal level with respondents.

3.5 Data Organization and Analysis

Descriptive and analytical data from in-depth referring documentation, questionnaires and desk study has analyzed. In data process and analysis, the main difficulty is how to process and analyze the data to determine the magnitude of time impact on project implementation. In order to ensure clarity of expression and accuracy, information gathered was foremost checked. The raw data was then organized considering the issues for which the questionnaire was designed to address. Bogdan and Biklen (1998) indicate that data analysis is a mechanism for reducing and organizing the bulk data to produce findings. These findings ultimately aid researchers in the interpretation of their work using simple statistical analysis involving tables, graphs and percentages which were used in analyzing the responses to the questions on the questionnaire survey. Descriptive explanations were also used to make the findings of the analysis more meaningful.

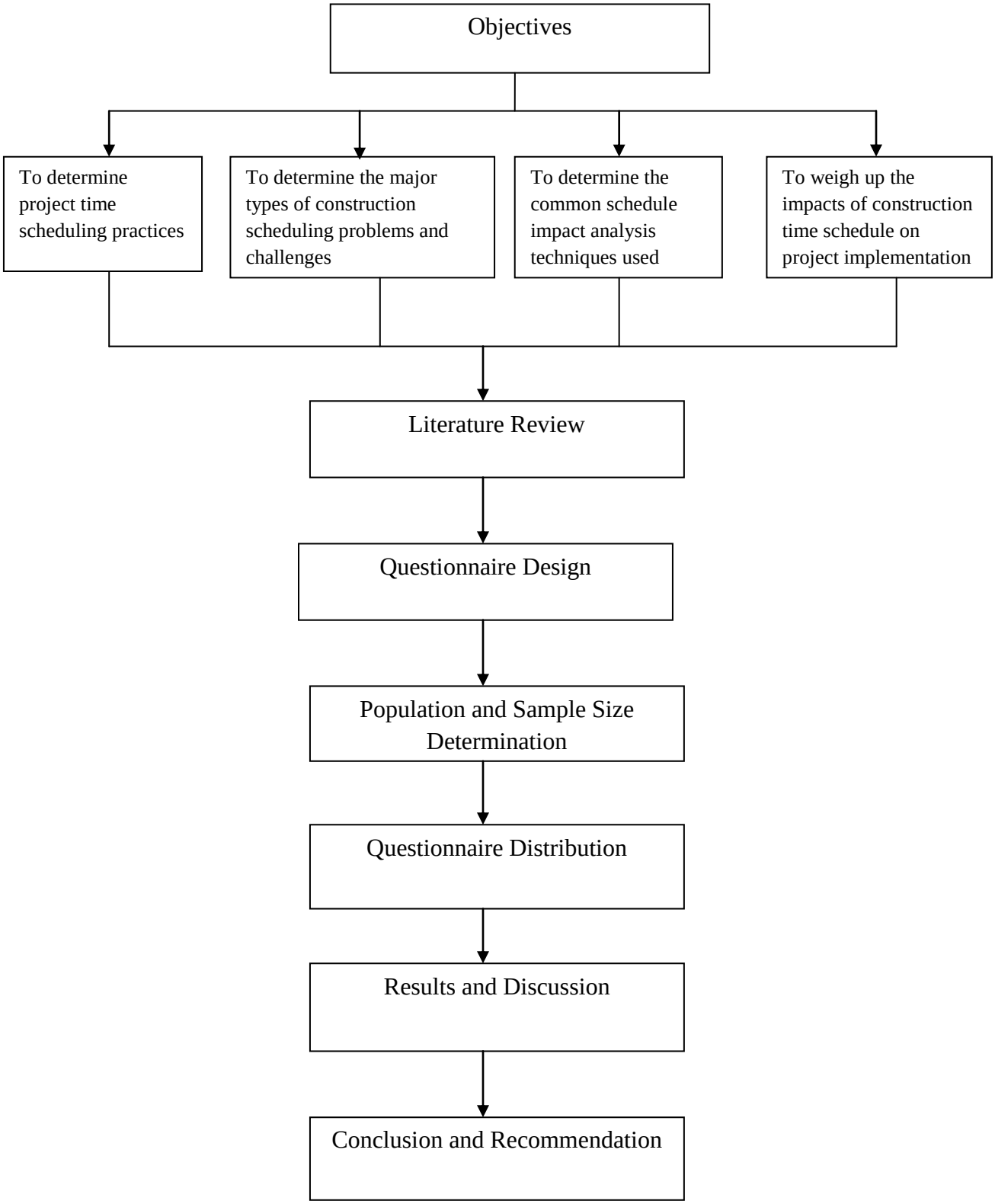

Fig. 3.1 Summary of methodology used in this research

CHAPTER FOUR

RESULT AND DISCUSSION

This chapter examines and analyses the data gathered from the questionnaire and personal interviews conducted at Ethiopian road authority, contractors and consultants. The procedure used in analyzing the results was aimed at establishing the relative importance of the assessment of scheduling practice, key scheduling problems & challenges and schedule impacts on project implementation.

4.1 Analysis of findings

The results from the data in the, graphs, charts and tables are analyzed and interpreted in order to find answers to the research problems. The numbers are summarized and interpreted by using statistics. The statistics provide a means through which numerical data can be made more meaningful.

An analysis of the summarized research results is done in order to make meaningful conclusions and recommendations. Tables, charts and descriptive explanations have been employed to illustrate data gathered from the field to make the research findings more meaningful. The following analysis shows the responses received from ten (10) project supervisors each from Ethiopian road authority, contractors and consultants.

A table is a collection of related data held in a structured format within a database. It consists of columns and rows. And graph is a diagram showing the relation between variable quantities, typically of two variables, each measured along one of a pair of axes at right angles. A chart, also called a graph, is a graphical representation of data, in which the data is represented by symbols, such as bars in a bar chart, lines in a line chart, or slices in a pie chart. A chart can represent tabular numeric data, functions or some kinds of qualitative structure and provides different information.

4.2 Findings from Project Supervisors of ERA, contractors and consultants

The available thirty (30) project supervisors were selected from Ethiopian road authority, contractors and consultants like to provide answers to the questionnaire. The project supervisors

were expected to provide reasons for their choice of an answer. Table 4.1 gives the responses obtained from the Project Supervisors as shown below.

Table 4.1 Years of Experience in Project Construction

Years of Experience	Frequency	Percentage (%)
0-5 Years	2	7%
5-10 Years	14	47%
10-15 Years	10	33%
15-20Years	3	10%
More than 20 years	1	3%
Total	30	100%

Source: Field Research, November 2015

As can be seen in Table 4.1, approximately 46 % of the sampled project supervisors of Ethiopian road authority, contractors and consultants have more than 10 years experience in project construction, (that is on average 50% of the respondent do perform all the necessary data that are required to successfully of my research). Further, 47% of the respondents had 5-10 years of experience and only 7% of the respondents had 0-5 years. It could therefore generally be inferred from the foregoing that, the sample population is quite old and could therefore provide reasonably constructive and valid answers.

Table 4.2: Project management training status and position of project manager

Training received/ as PM	Frequency	Percentage (%)
Yes	28	93%
No	2	7%
Other	-	0%
Total	30	100%

Source: Field Research, November 2015

The survey revealed that most of the respondents had had a project management training courses and works at position of project manager. Twenty eight (28) of the respondents, representing 93%, reported they had been working at position of project manager with the exception of only two (2) representing 7% had not experienced position of project manager (see Table 4.2). It could therefore generally be inferred from the foregoing that, the sample population have sufficient knowledge and could therefore provide reasonably constructive and valid answers.

Table 4.3 Time schedule preparation mechanism

Method used	Frequency	Percentage (%)
Manual	0	0%
Using computer	30	100%
Total	30	100%

Source: Field Research, November 2015

Table 4.3 shows the method of preparing time schedule. When questioned about method used for preparing time schedule, total respondents representing 100% interviewed indicated it was very important using computer for schedule preparation. This implies that most supervisors are using the modern techniques for schedule preparation and manage.

Table 4.4: Responsibility of time schedule preparation

Schedule prepared by	Frequency	Percentage (%)
Project manager	27	90%
Site engineering	0	0%
Office engineering	3	10%
Other	0	0%
Total	30	100%

Source: Field Research, November 2015

An analysis of the respondents indicated that 90% of project supervisors respond that preparation of time schedule were accomplished by project manager, 10% by office engineer and none for site engineer. This shows that construction supervisors would strict in schedule preparation and no separate section for schedule preparation in their office as shown in table 4.4

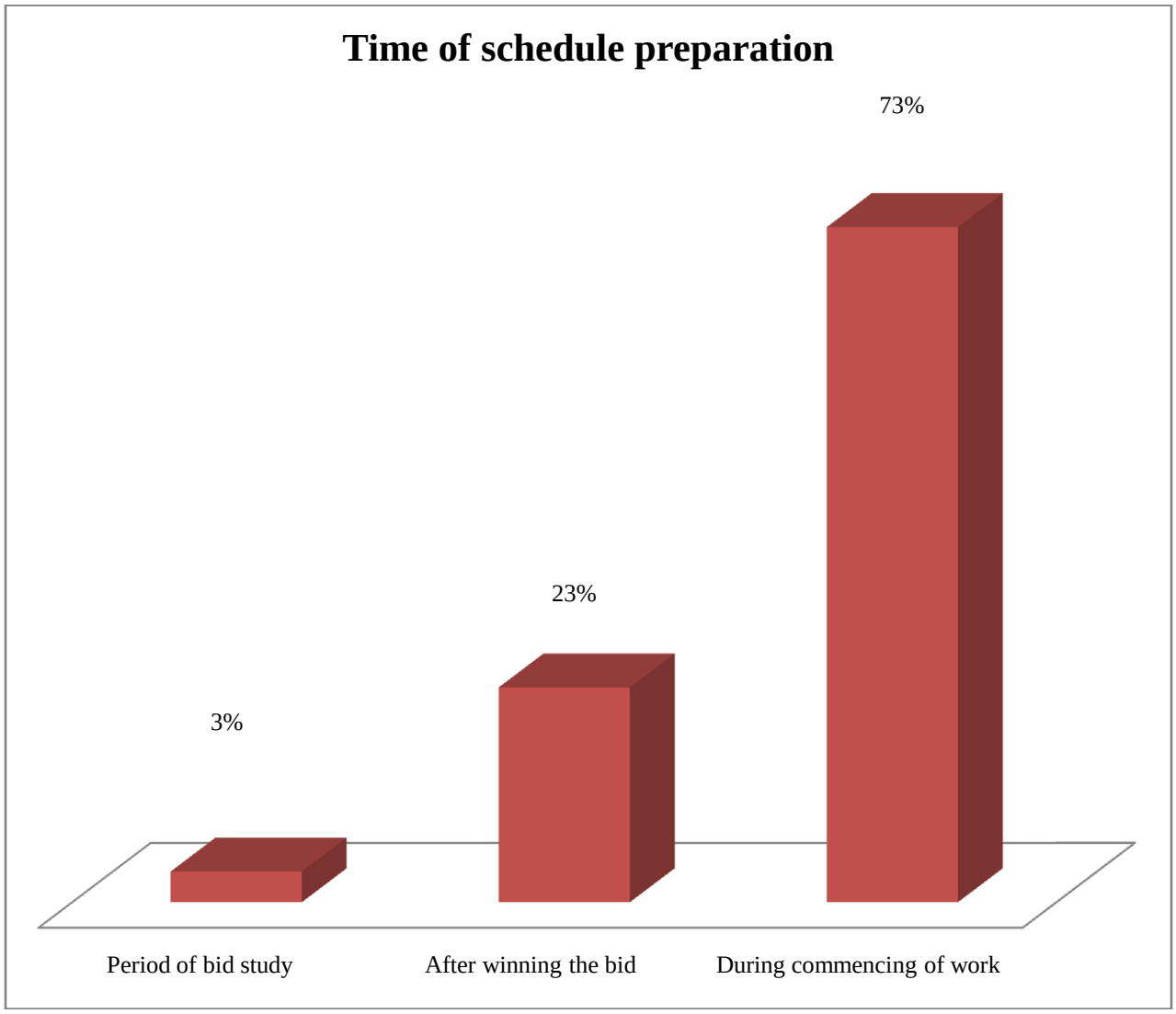

Figure 4.1: Time of schedule prepared

The survey revealed that about 73% of total respondents usually prepared schedule of project construction during commencing of work, 23%after winning the bid whilst 3% indicated that they prepare the schedule at the period of bid study. This implies that most supervisors are focused only the bid winning but not the schedule.

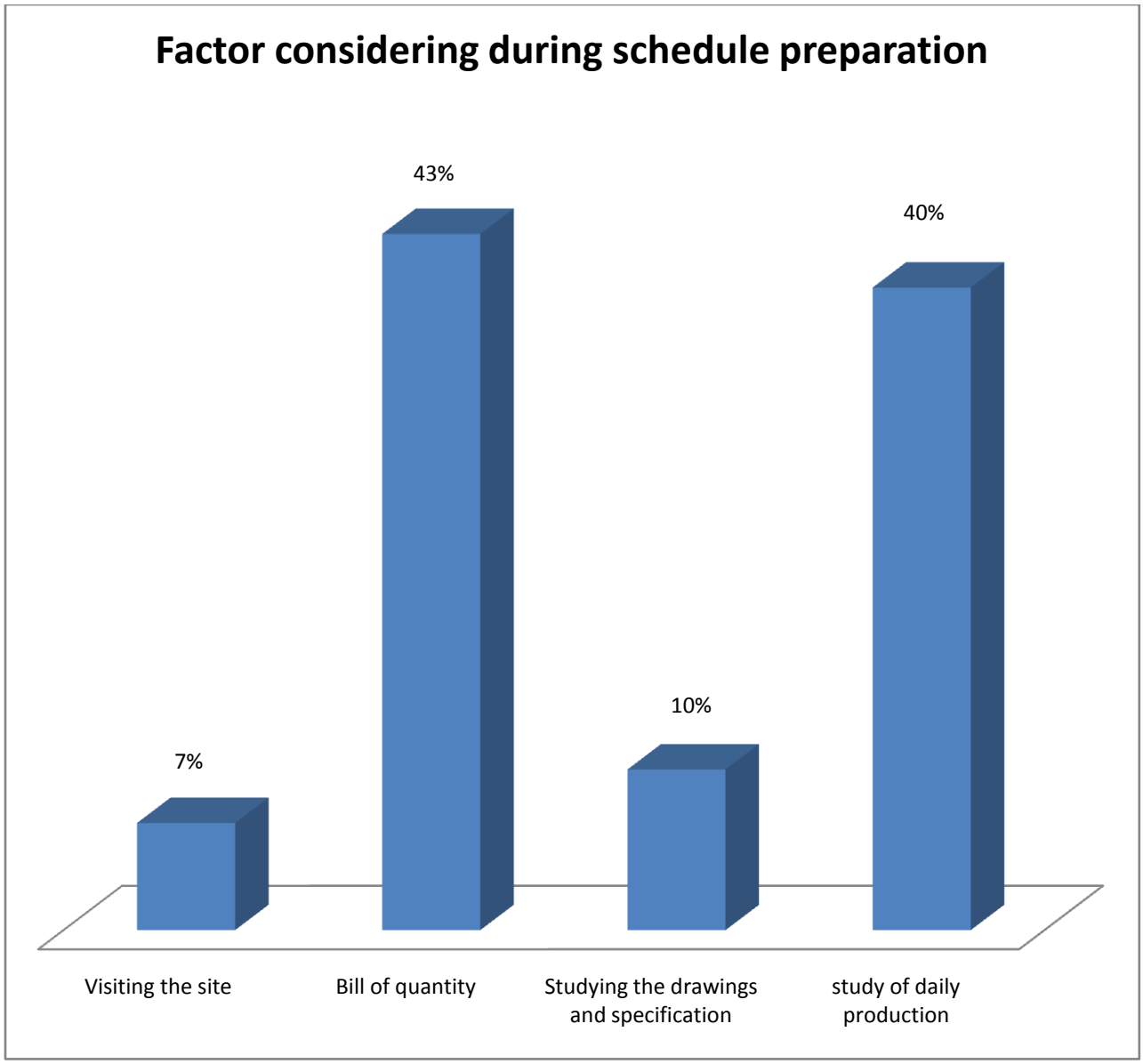

Figure 4.2: Factor considered during schedule preparation

Regarding figure 4.2, the Project Supervisors were asked to indicate the key factor for schedule preparation. 43% of total respondents said the key objective was to check the bill of quantity. 10% of the respondents said the key objective was to study the drawings and specification, 40% of the respondents said the key objective was to study daily production, whilst 7% mentioned the key factor as to visiting the site. None consider for weather conditions and analytic the determined time by the owner. This implies key issues in dealing with schedule preparation are bill of quantity and studying the drawings and specification.

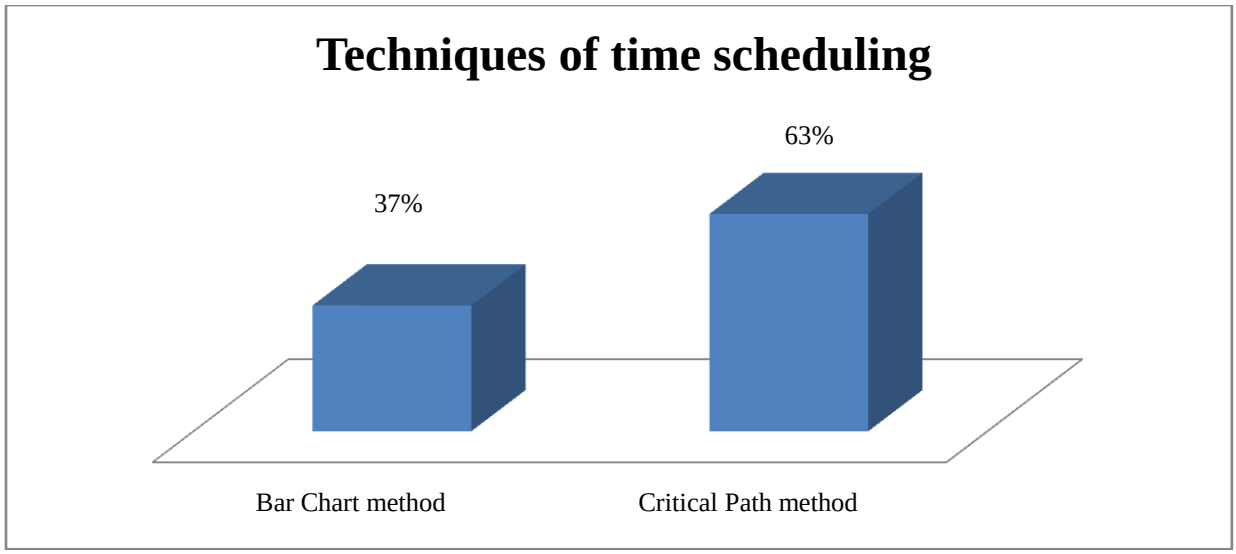

Figure 4.3: Method used for preparing time schedule

Details from figure 4.3 analysis of project supervisors surveyed showed that 63% of total respondents manage, evaluating and quantify the overall schedule of project construction by using Critical path method because it provides interrelationships of activities and scheduling of costs and resources whilst 37% indicated that it is simple to manage, evaluating and quantify the overall schedule of project construction by using Bar chart method. None used program evaluation and review technique, graphical evaluation and review technique and line of balance method. This implies key methods in dealing with schedule preparation are bar chart and critical path method.

Table 4.5: Revising frequency of time schedules

Schedule revising	Frequency	Percentage (%)
Daily	-	-
Weekly	-	-
Monthly	30	100%
If any other please specify	-	-
Total	30	100%

Source: Field Research, November 2015

The survey revealed that most of the respondents had had an experience of schedule update which they expressed the presence of scheduling problem and challenges. Thrifty (30) of the respondents, representing 100%, reported they had been schedule update every month (see Table 4.5).

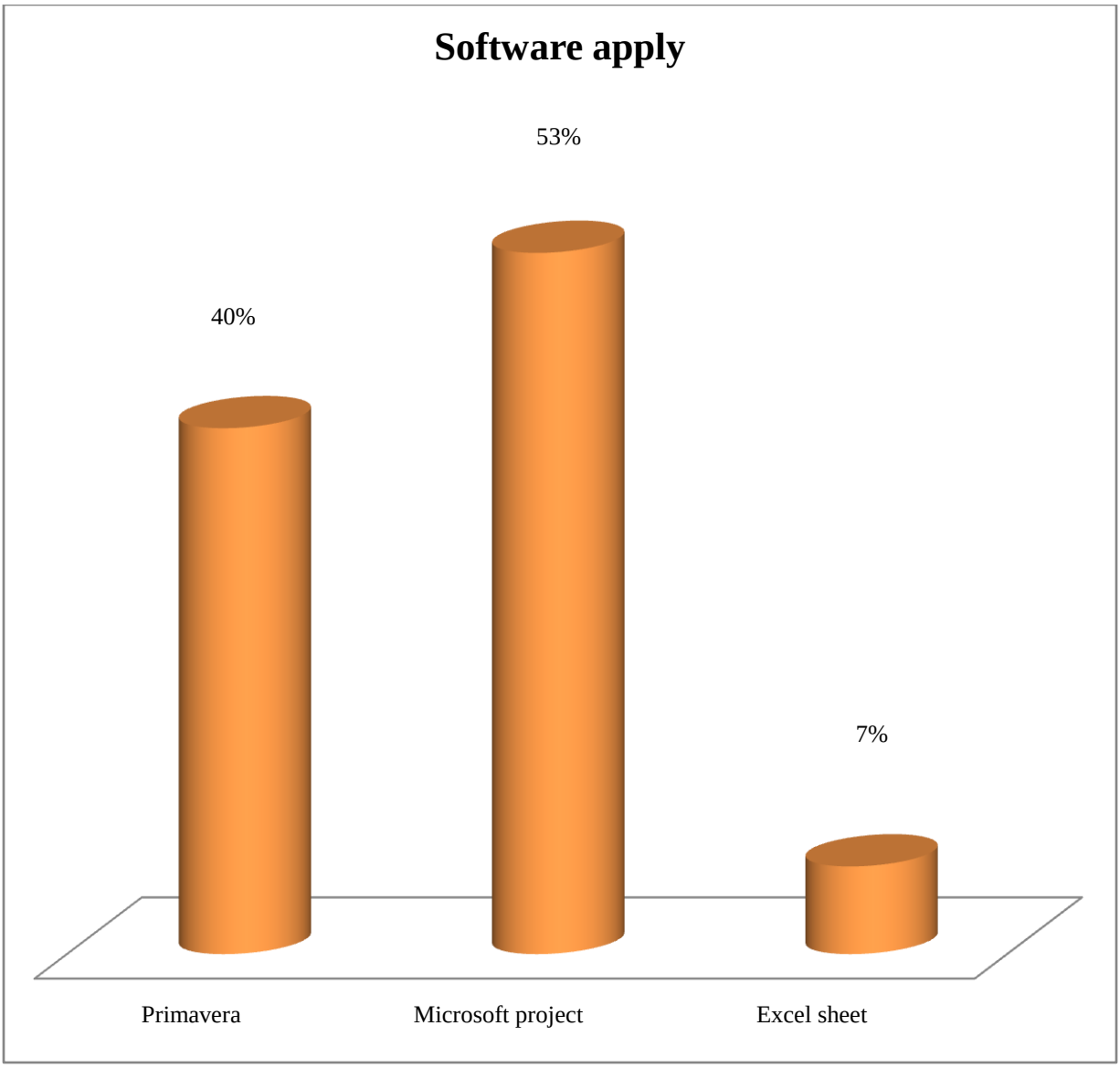

Figure 4.4: Software's apply for planning and scheduling of the project

As it can be seen in the above figure 4.4, the sampled project supervisors have experience to use software in schedule preparation. The result of the study shows that 53% of the sampled project supervisors have used Microsoft project software, 40% have primavera software, whilst 7% have used Excel sheet. It could therefore be indicated that, primavera and Microsoft project software were the most widely used.

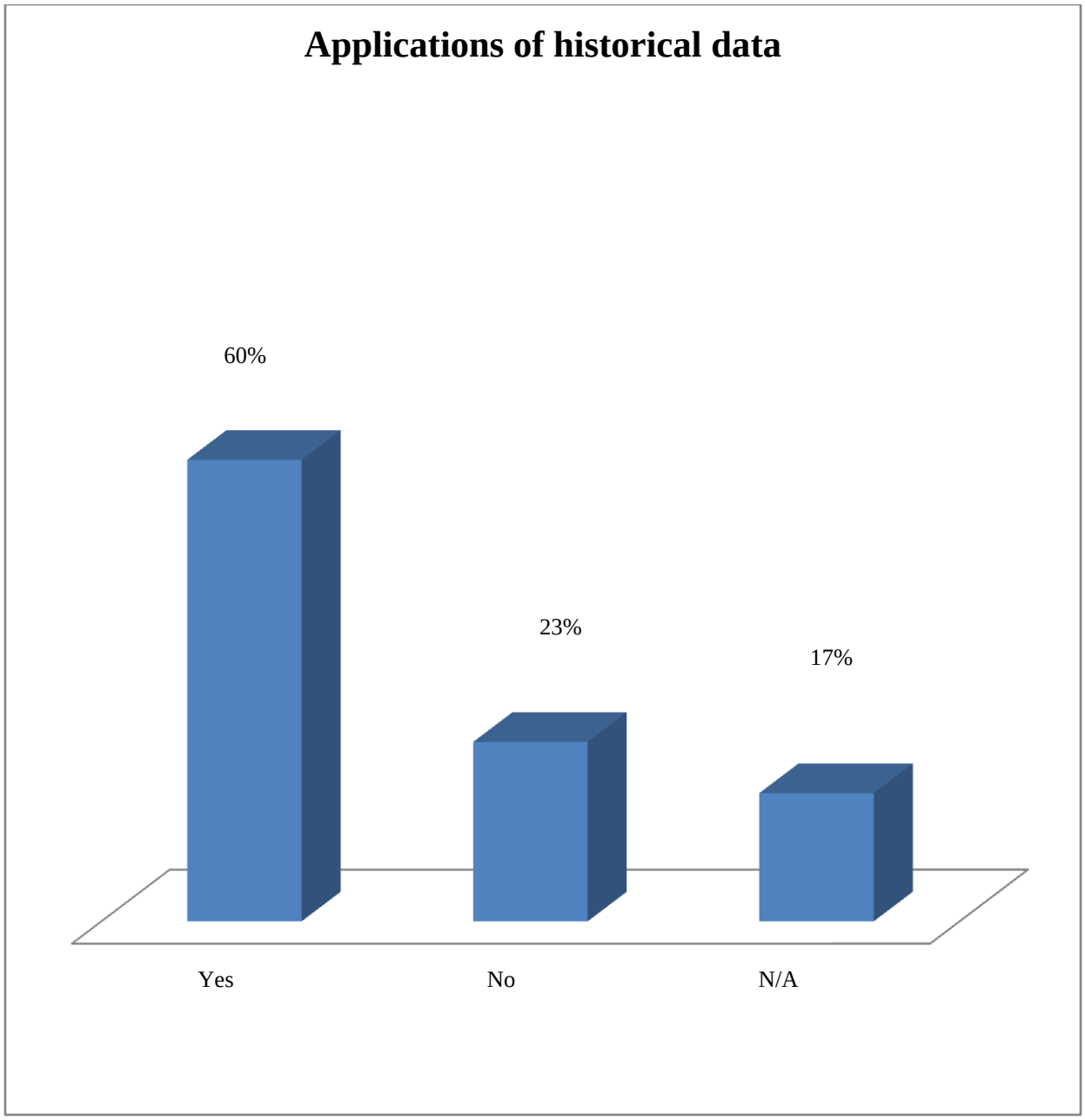

Figure 4.5: Applications of historical data in estimating activity duration

Figure 4.5 shows the importance of historical data in estimating activity duration to scheduling preparation. When questioned about the importance of historical data in estimating activity duration, 60% of the sampled project supervisors have used historical data, 23% have not used historical data and 17% have not applied historical data. This implies project supervisors thus consider historical data as important input for accurate estimation of activity duration.

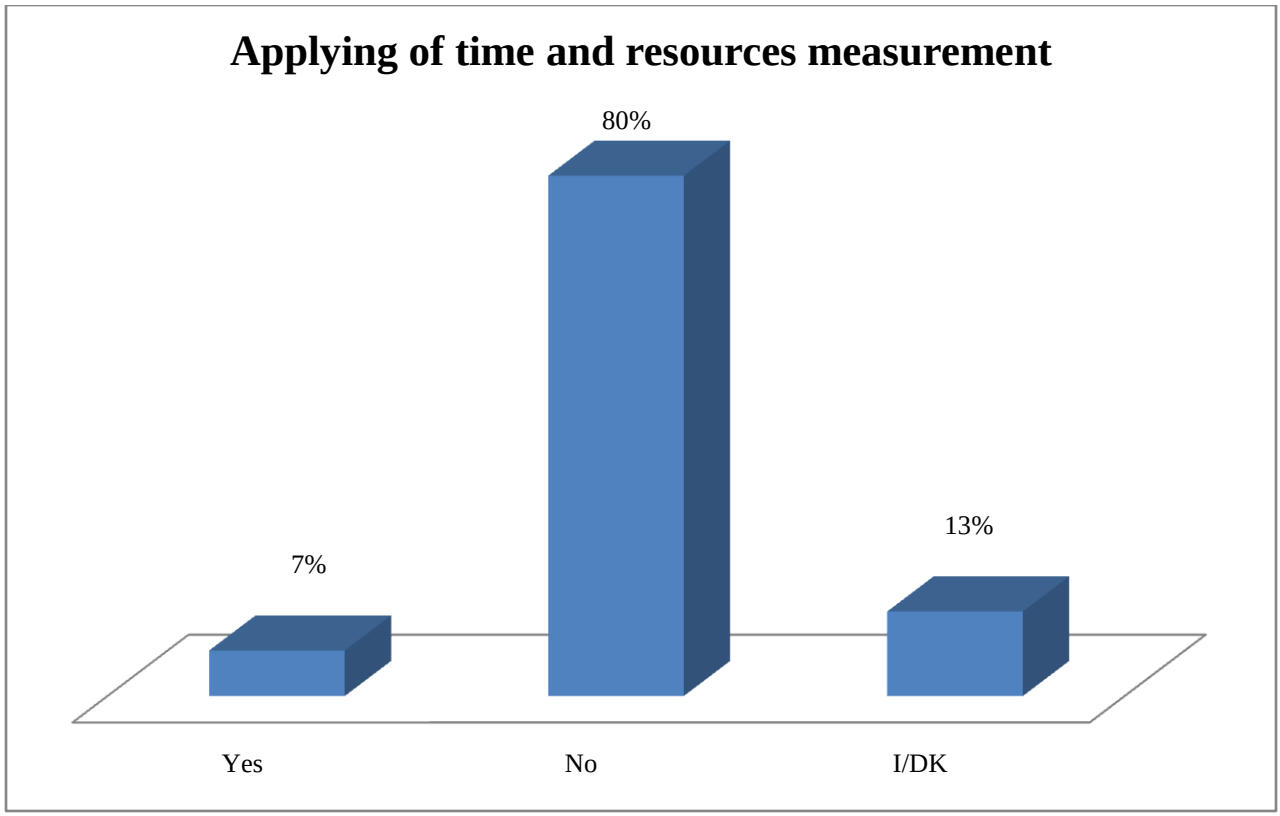

Figure 4.6: Applying of time and resources measurement

Figure 4.6 shows the companies use the method of time and resources measurement. When questioned about use the method of time and resources measurement use 80% of the sampled project supervisors have not use time and resources measurement, 13% response they do not know and 7% respond they use it. This implies Project supervisors have used unrealistic project schedule techniques.

Table 4.6: Jointly schedule prepared b/n the contractor and consultant

Jointly schedule preparation	Frequency	Percentage (%)
Yes	-	-
No	30	100%
N/A	-	-
I/DK	-	-
Total	30	100%

Source: Field Research, November 2015

Table 4.6 shows schedule prepared jointly by the contractor and consultant and be accepted as the baseline schedule. When questioned about the jointly preparation of schedule to project construction, total respondents representing 100% interviewed indicated schedule have not prepared jointly. This implies project supervisors have prepared project schedule individually.

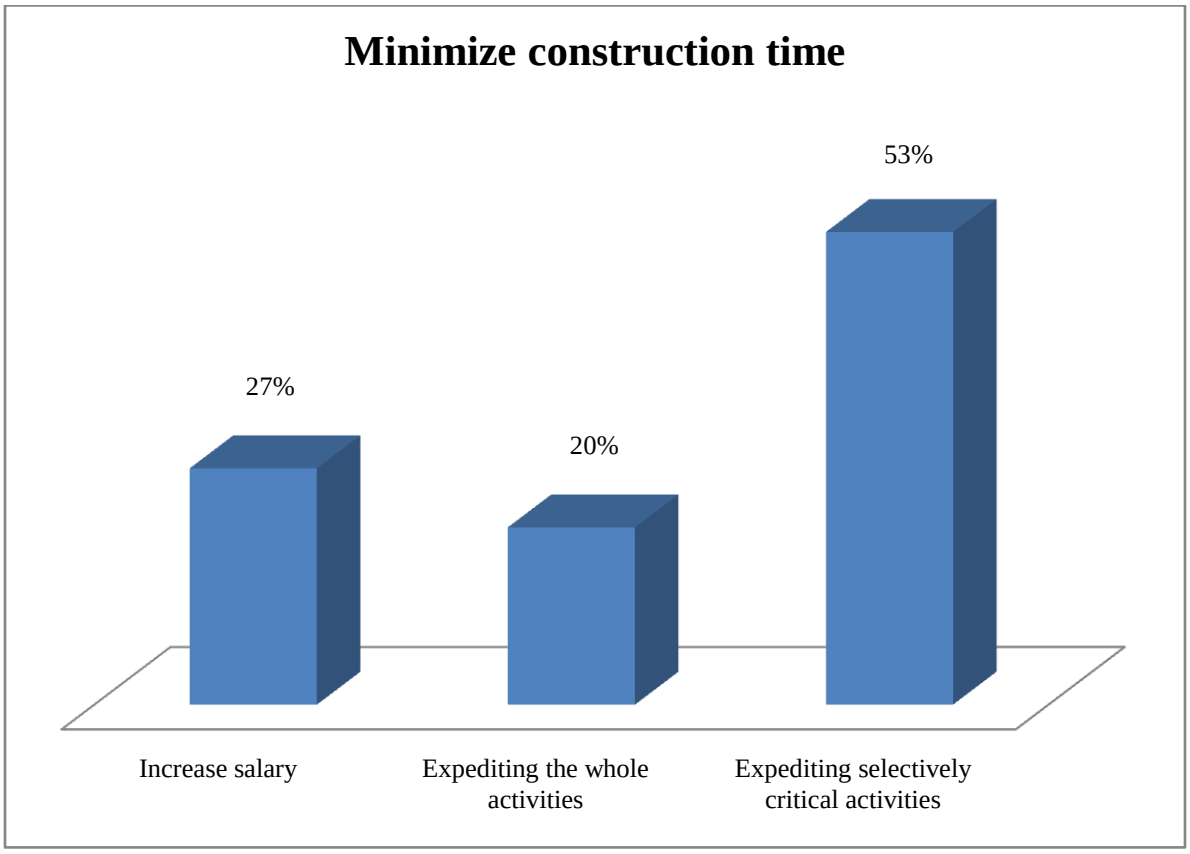

Figure 4.7: Key practice to minimize construction time

Regarding figure 4.7, the Project Supervisors were asked to indicate the method used for minimize construction time of project construction.53% mentioned the key objective as expediting selectively critical activities to minimize construction time, 27% of total respondents said increase salary whilst 20% of the respondents said expediting the whole activities. This implies a key issue in dealing with minimizing construction time is expediting selectively critical activities.

Table 4.7: Some of the possible causes of schedule impact

No	Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total sum
1	Contractor's improper planning	0	6	0	15	9	30
2	Contractor's poor site management	0	2	0	5	23	30
3	Inadequate contractor experience	0	6	0	20	4	30
4	Inadequate client's finance and payments for completed work	0	0	0	16	14	30
5	Problems with subcontractors	0	27	1	2	0	30
6	Shortage in material	0	0	0	6	24	30
7	Labor supply	0	7	5	12	6	30
8	Equipment availability and failure	0	3	0	23	4	30
9	Lack of communication between parties	0	1	0	22	7	30
10	Mistakes during the construction stage	0	10	7	13	0	30
11	Design problems	0	3	0	19	8	30
12	Slow decisions for changes	0	0	0	27	3	30
13	Obstructions from other utility suppliers	0	17	1	12	0	30
	Total sum	0	82	14	192	102	390
	% of the total	0%	21%	4%	49%	26%	

However, in my research work is to identify possible causes of schedule impact in construction projects. Accordingly to responds that 49% of project supervisors agreed on causes of schedule impact. 26% indicated that they strongly agreed, 21% indicated that they disagree whilst 4% said they were strongly disagreeing. This implies that generally construction supervisors would know causes of schedule impact.

Table 4.8: Has your project completed without any schedule impact?

No schedule impact exists	Frequency	Percentage (%)
Yes	1	3%
No	29	97%
If any other please specify	0	0%
Total	30	100%

Source: Field Research, November 2015

Results from table 4.8 shows that a majority 97% of total respondents indicated that schedule impact exists, and 3% respondents say no. This implies schedule preparation and its management is important part in project construction.

Table 4.9: Existence of projects delay due to change order

Existence of delay because of change order	Frequency	Percentage (%)
Yes	21	70%
No	9	30%
If any other please specify	0	0%
Total	30	100%

Source: Field Research, November 2015

It is obvious from table 4.9 that out of a total sample size, only 30% of the respondents said that they were no delay because of change order. Meanwhile, 70% of the respondents said they were delay because of change order. This implies that change order is one of the main causes for schedule impact.

Table 4.10: Applying resources allocation and leveling

Applying resources allocation and leveling	Frequency	Percentage (%)
Yes	25	83%
No	5	17%
If any other please specify	0	0%
Total	30	100%

Source: Field Research, November 2015

The experts were able to minimize schedule impact by applying resources allocation and leveling in schedule preparation. With table 4:10, the project supervisors were asked to indicate projects use resources allocation and leveling. 83% majority of project supervisors indicated that they have not use resources allocation and leveling whilst 17% mentioned they have used. This implies more than half projects supervisors have not use resources allocation and leveling becomes risk for the contractors.

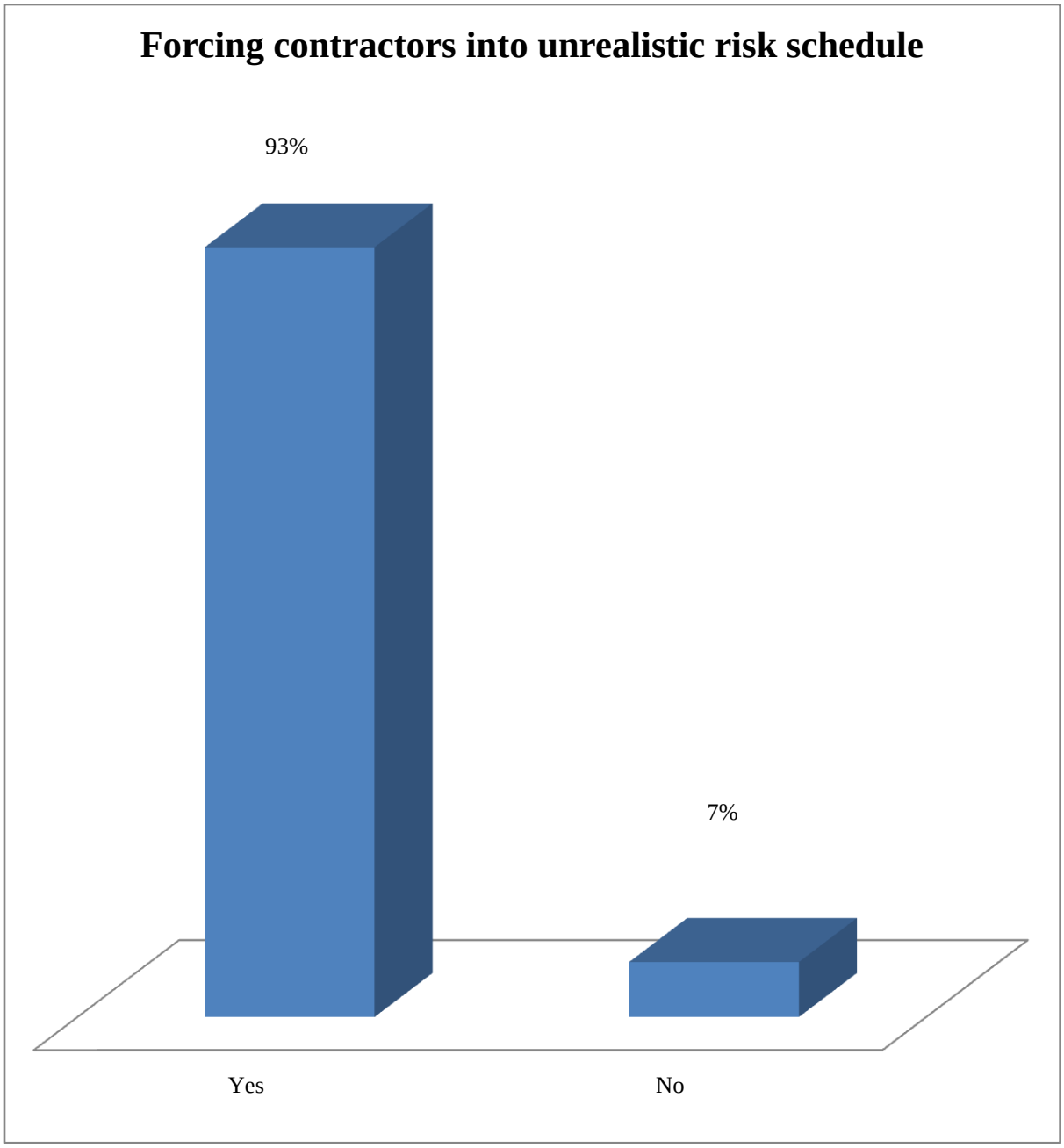

Figure 4.8 Forcing contractors into unrealistic risk schedule

The Informants were asked to respond to a question whether the schedule prepared at the time of bid is unrealistic schedule duration. Accordingly, 93% of the Informants answered "Unrealistic schedule" and 7% answered "realistic schedule". As a result, more than 90% of respondents indicate the time schedules given are not sufficient for completion of the projects (see figure 4.8).

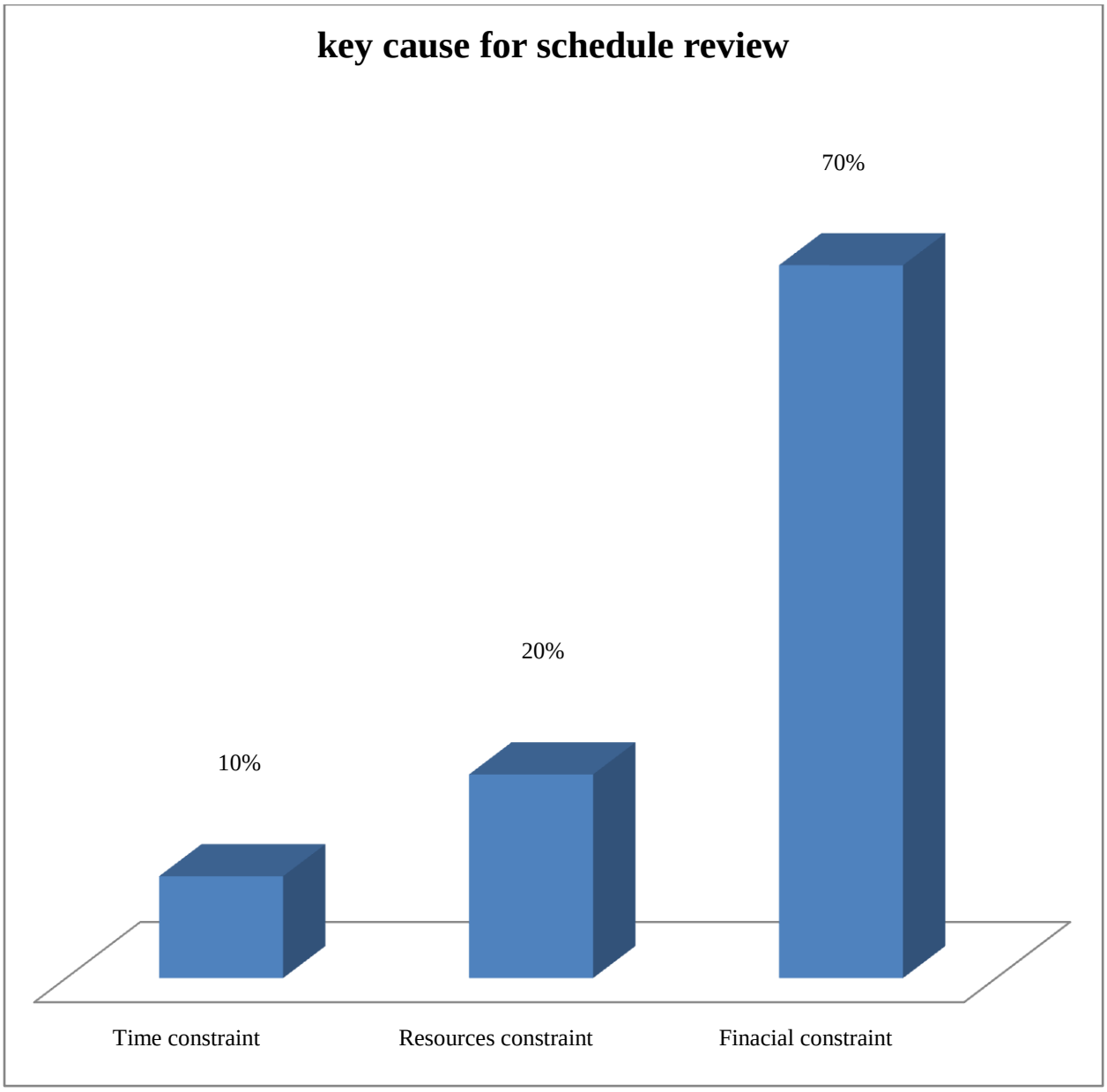

Figure 4.9: Leading cause for schedule review

The extents were you able to minimize schedule impact by identifying major cause for schedule review. In this regard 70% of the respondents answered “financial constraint”, 20% answered “resources constraint”, 10% answered “time constraint; if the personnel really involve in the design, which is unlikely as mentioned above”, and 12.5% answered “satisfactorily”. This implies the more simplified the financial and resources constraint becomes the less risk for the contractors to the schedule impact (see figure 4.9).

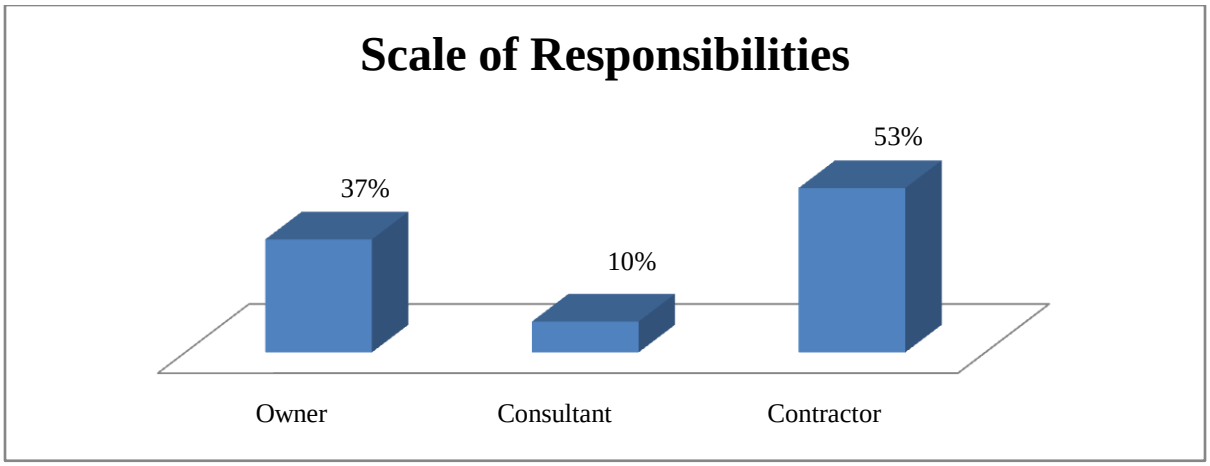

Figure 4.10: Responsibilities for schedule impact

According to the information gathered during the study 53% of responses said contractor's responsibilities. 37% indicated owner, and 10% each indicated the consultant responsibility for the causes of schedule impact. This implies the responsibility being more on the contractor and owner.

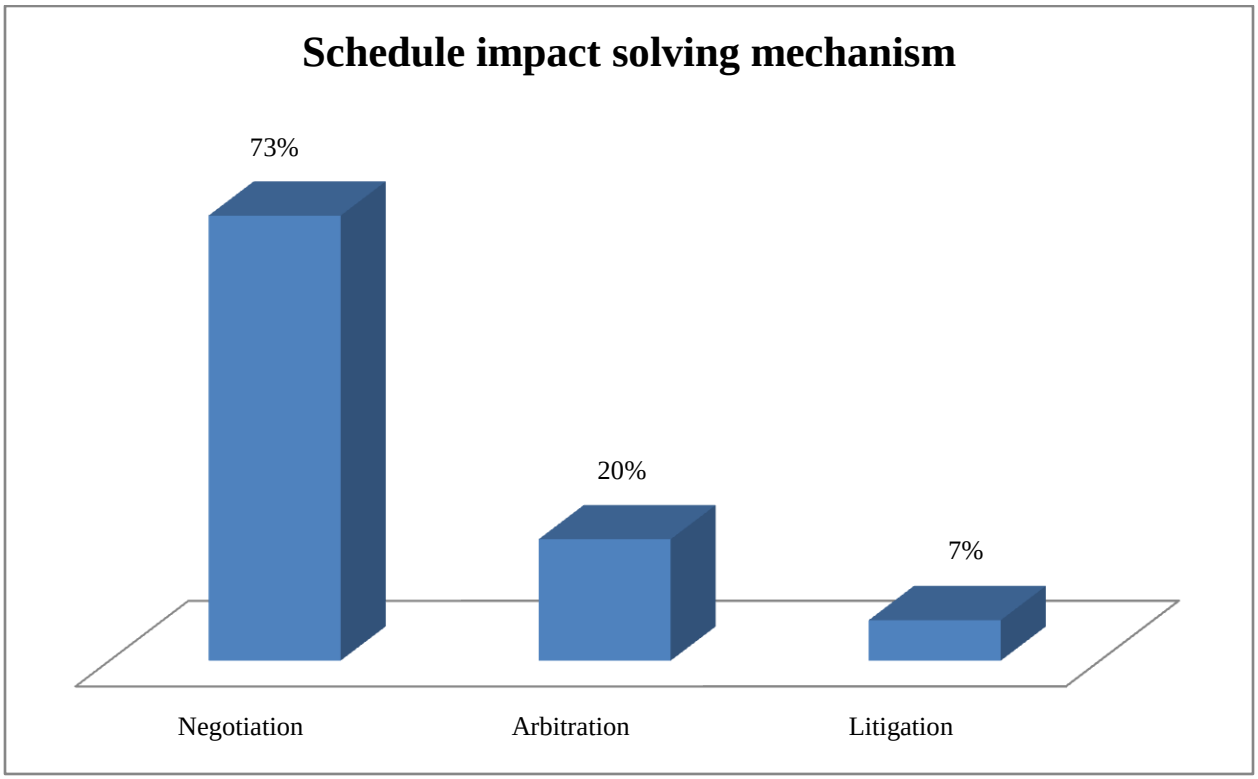

Figure 4.11: Projects schedule impact (time claim) solving mechanism

The dispute settlement systems practiced by local contractors were assessed using questionnaire survey. Thus, 73% of respondents settle their time claim case by negotiation. Negotiated settlements are a desirable objective for both parties to the contract. Moreover, 20% of respondent indicate arbitration and 7% indicated that they have used litigation. This implies that minimizing measures should therefore being taken on before project schedule impact (see figure 4.11).

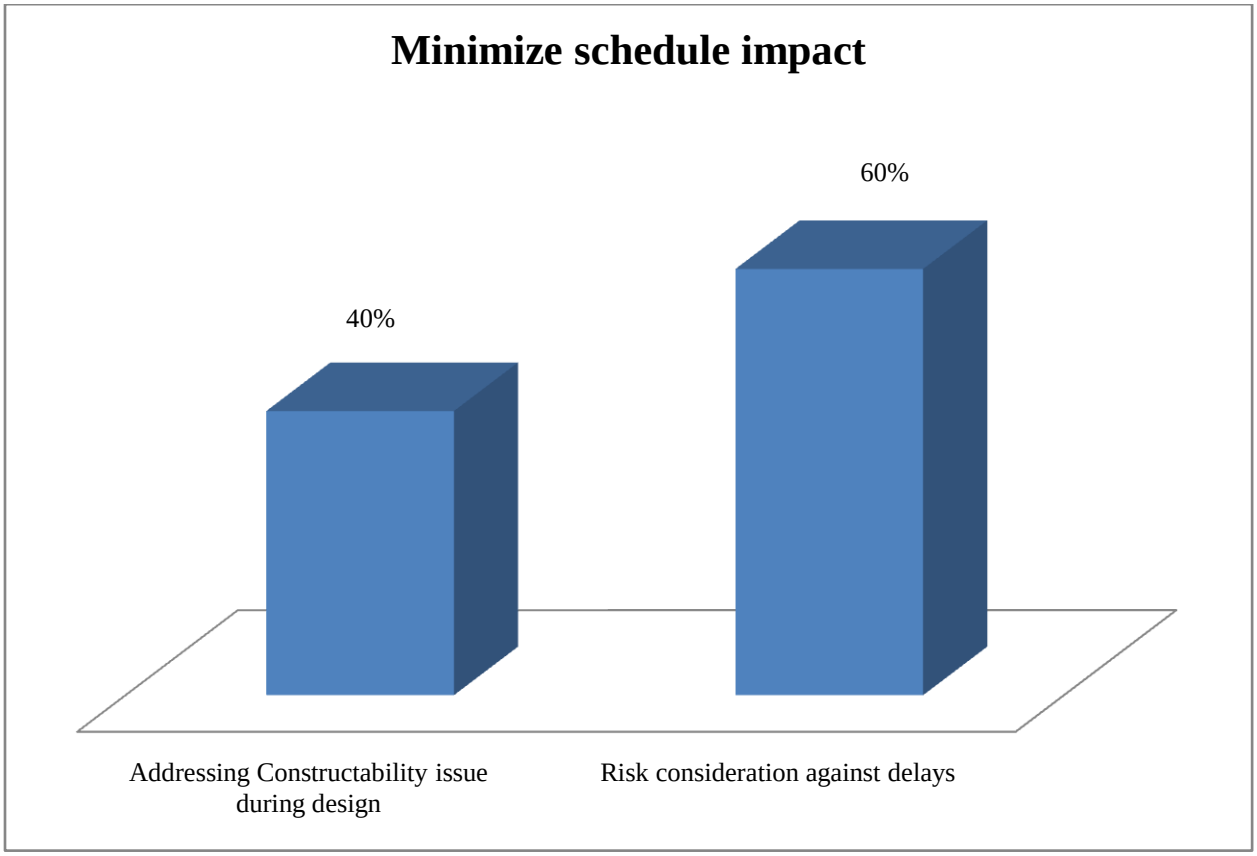

Figure 4.12: How to solve schedule impact on your construction project

According to the information gathered during the study 60% of the respondents cite the impact of time has minimized by addressing constructability issue during design whilst 40% said risk consideration against delays. This implies addressing constructability issue during design and risk consideration against delays become important for the contractors to schedule impact minimization (See From figure 4.12).

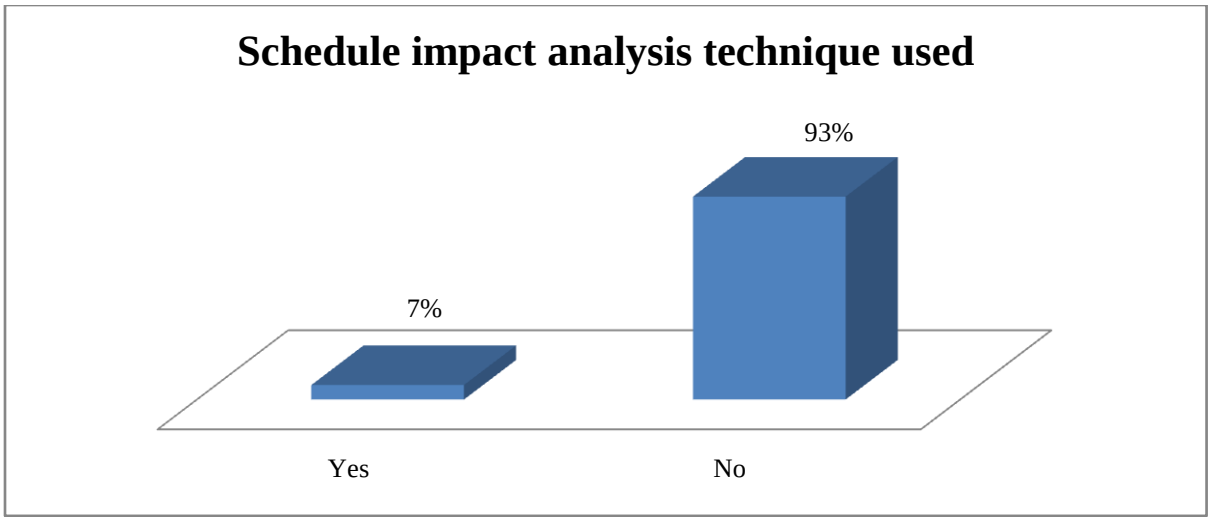

Figure 4.13: Schedule impact analysis technique used (time impact analysis)

Schedule impact analysis techniques used are widespread to the construction projects in Ethiopia. By examining respondents 93% indicated that they not perform time impact analysis, whilst 7% said perform time impact analysis. This implies most of project supervisor did not used schedule analysis technique as a result it could be a source of poor schedule impact determination (see Figure 4.13).

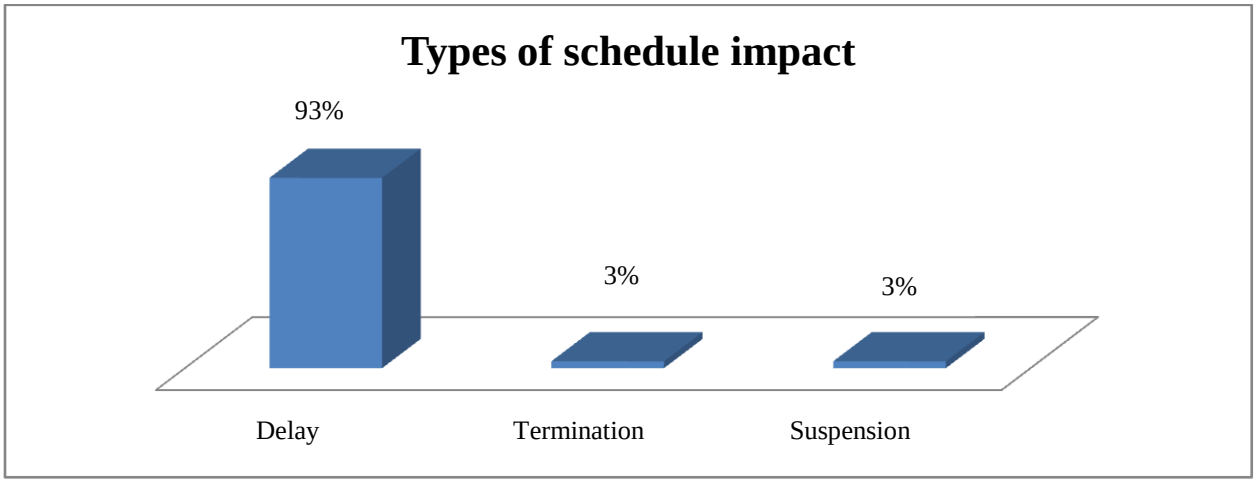

Figure 4.14: Types of schedule impact do you observe in your project

With figure 4.14, the project supervisors were asked to indicate which of the following schedule impact type there. 93% majority of project supervisors indicated that delay has the major schedule impact, 3% said termination and 3% mentioned suspension. This implies delay is the major problems.

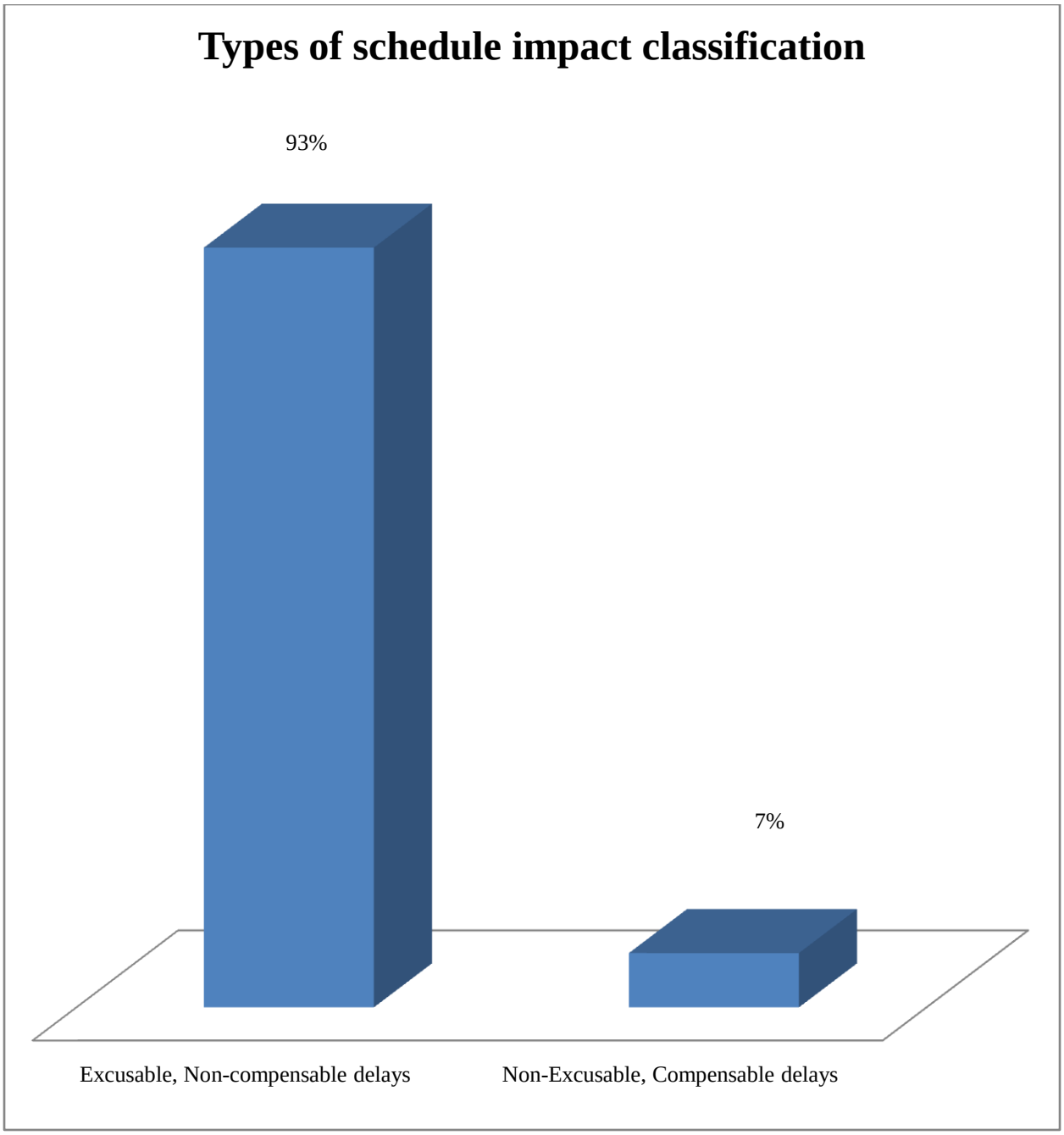

Figure 4.15: Types of schedule impact classification do you observe in your project

The assessment result shows in figure 4.15 that almost 93 % of responses said excusable, non-compensable delays is the major types of schedule impact observed. That means more than 90% of the respondents do not know the available types of schedule impact. The rest 7% indicated non-excusable, compensable delays as the second major types of schedule impact. This implies an excusable, non-compensable impact classification has been used.

4.3 Summary of findings

Many project managers of construction industries have recently started to utilize innovative time impact assessment methods that provide new incentives for improving construction schedule impact. These emerging strategies place an increasing pressure on decision makers in the construction industry to search for an optimal schedule utilization plan that minimizes construction time (Frimpong 2002).

The main survey of project supervisors as discussed in this research work relates to the construction of Ethiopian road authority projects which focus on assessing scheduling practice, problems and/or challenges in scheduling and its impacts on project implementation can be listed as follows:

1. **Scheduling practice and problem's or challenges of ERA projects**

1.1 Most of the contracting companies use computer software (primavera and Ms-project) during preparation of time schedules, while few contractors depend on consulting offices to prepare the required time schedule. This indicates that most of the contracting companies have engineers, with computer skills, for this purpose.

1.2 Both Grade-1 and Grade-2 contractors prepare time schedule (Bar chart and CPM) depending on their experience with similar previously executed projects.

1.3 Less than 10% of the companies use the method of time and resources measurement.

1.4 More than 95% of the contractors prepare time schedule after winning the bid.

1.5 About 15% of the contractors use production rates during the preparation of time schedule while, most of them depend on studying the drawings & specifications, BOQ and the distribution of the duration of activities in accordance with the determined period of the project by the owner.

1.6 More than 90% of the contractors have not used production rates methods to prepare time schedule. This indicates that current practices in preparing a time

schedule, for the construction projects in ERA, are not taking into consideration labor production rates measurement to determine the required time for each activity of project.

1.7 The contractors depend mainly on experience with similar projects for preparing time schedule. Therefore, most of the time schedules prepared in ERA projects are not true representation of projects, and so; this method usually results in many problems in the construction of ERA projects, especially, revising time schedule many times during implementation of the projects to accommodate for the changes.

1.8 The sample population does not extensively use resources leveling and allocation. All studies agreed that few contractors use resources allocation and leveling. Furthermore, resources leveling and allocation may consume many efforts and need wide range of data during the planning and scheduling stage, which is not dealt with seriously by contractors. The above mentioned result supports that there is a lack of using production rates measurement for preparing time schedule in ERA projects.

1.9 Construction of projects may not perform as expected because the owner may have unrealistic expectations regarding the schedule of construction forcing contractors into unrealistic risk, or commitments that may not be realistic.

2. Cause of schedule review and schedule impact on implementation

The study population indicated that the highest rated factors, which causes schedule review, were: “Good administration in the site“, “Financial position of the company“, “supplying the required materials for the work“, and “Observing the work by the contractor’s staff“. However, the least rated factor, which affects production rates, was the weather conditions. The rest of the factors moderately affect the production rates.

It was exposed that the issue of schedule impacts on project construction could not be managed by evaluating using construction recognized and accepted methodologies (time impact analysis method) and identifying and quantifying the overall impact to the project. In

addition to this construction of projects may not perform as expected because the owner may have unrealistic expectations regarding the schedule of construction forcing contractors into unrealistic risk, or commitments that may not be realistic.

Up to this point, the emphasis has been on determining accurate records of the execution of the project in its entirety. These records contain information on all events that will have a potential impact on the schedule and project completion and the study population indicated that the types of schedule impacts are: delays, disruptions, change, suspensions and termination

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusions

The first specific objective was to assess scheduling practices of Ethiopian road authority. The assessment revealed that projects scheduling are not prepared and managed with formal way. However, there are poor scheduling practices employed to manage the project. These scheduling practices, though contribute to project management, do not conform to the formal way of scheduling processes which involves estimating of cost, resources and duration of every activities. It is evident that the Federal road projects are not free of poor schedule preparation which have an impact on time and cost of the projects. Responding to scheduling practices without formal way does not bring about substantial improvement in schedule impact.

The second specific objective was to determine the major types of construction scheduling problems and challenges. The findings indicates that the major types of construction scheduling problems and challenges are poor contractor management, shortage of material, monthly payment difficulties from clients, poor planning, design problem, obstructions from other utility suppliers, escalation of material prices according to their degree of influence. Unless a good practice in planning, scheduling, coordinating, controlling and monitoring, the scheduling problems and challenges are not minimized

The third specific objective was to assess the existing schedule impact analysis techniques used. The assessment indicates that most of the projects under Ethiopian road authority are not used the proper schedule analysis techniques. However, they are used the traditional way of calculating the delay caused by the contractors, consultants and force majors. The schedule review, in turn, requires the involvement of experienced consultant's or contractor's to select appropriate schedule impact analysis techniques and calculating.

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The fourth specific objective was to assess the impacts of construction time schedule on project implementation. The assessment revealed that the major schedule impact on implementation are reworking, damaged the formwork, additional cost, wastage of material, excess idle manpower & equipment, decreasing efficiency of workers and build communication problems. Hence, it is essential to create awareness of the extent to which schedule impact can adversely affect project delivery with regards to time.

5.2 Recommendations

Based on this study, some recommendations are given as follows:

1. Developing effective and efficient project scheduling practices in project construction through different types of training programs. The training should cover method of schedule preparation and control techniques, types of schedule impact and analysis technique, major cases of schedule impact and its solution
.
2. ERA should allow more time; funds and experienced expert for the preparation of schedule and its impact analysis for identify the actual schedule and minimizing schedule impact on implementation.

3. Contractors should regularly try to identify and to bring to the attention of the client project risks such as schedule impact and its causes in the early stages of a project etc.

4. More attention should be paid to the study of schedule impact analysis techniques during the period of causes of schedule impacts identification, and classifying schedule impacts of the projects.

Regarding schedule impact in project construction, if the employer intends to gain the most advantage from the schedule, the schedule should be prepared jointly by the contractor and consultant and be accepted as the baseline schedule.

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APPENDI*X* A

QUESTIONNAIRE FOR PROJECT SUPERVISORS OF ERA PROJECT

This long essay is assessing project scheduling and its effect on implementation. You are assured of your greatest confidentiality as its only academic purpose and enhance road construction projects of Ethiopian road authority.

General Direction

Pleas answer all the Questions that follow based on your knowledge of practice of Project Management in the project you are participating or in the organization you are working...

Please tick (√): where applicable

Please Choose:

Yes: If the descriptions roughly represent the condition in your project (organization).

No: If the description does not come close to the condition in you project (organization).

N/A: (Not applicable): If you think the practice or the description is inapplicable for your case.

I/DK (I do not know): If you do not have information/knowledge about the question.

Please provide the requested information on the space provided

Thank you for your cooperation!

Section-1 – General Information

1. How many years of experience have you gained in construction project?
    a. 0-5 Years ( )
    b. 5-10 Years ( )
    c. 10-15 Years ( )
    d. 15-20 Years ( )
    e. If any other please specify _____

2. Have you received any project management related training?

    Yes ☐ No ☐

    If yes what was the highest level of training you received?

    (Please specify) _____

3. Have you worked as project manager?

    Yes ☐ No ☐

    If yes, for how long? (Please specify)

    _____

Section-2 Scheduling practice of ERA projects Yes No N/A I/DK

4. Method of preparing time schedule
    a. Manual
    b. Using computer
5. Preparing time schedule for any project accomplished by
    a. Project manager
    b. Site engineering
    c. Office engineering
    d. If any other please specify

    _____

    _____

    _____
6. When does time schedule usually prepared?
    a. Period of bid study
    b. After winning the bid and during preparing the work
    c. During commencing of work
7. Does any consideration taken during preparing time schedule for estimating time and supplying materials?
    a. Visiting the site ( )
    b. Bill of quantity and analytic of (BOQ) ( )
    c. Studying the drawings and specification ( )
    d. Analytic the determined time by the owner ( )
    e. Analytic and study of daily production ( )
    f. Weather conditions ( )
    e. If any other please specify

    _____

    _____

    _____

    _____

Section-2 Scheduling practice of ERA projects Yes No N/A I/DK

8. Which of the following methods is taken during preparing time schedule in the company?
    a. Bar Chart method ( )
    b. Critical Path method ( )
    c. Program Evaluation and Review Technique ( )
    d. Graphical Evaluation and Review Technique ( )
    e. Line of Balance Method ( )

    If any other please specify

    _____
    _____
    _____
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    _____
    _____
    _____

9. How often your project team does formally meet for discussion monitoring, updating and controlling your schedule with master schedule of the project owner?
    a. Daily ( )
    b. Weekly ( )
    c. Monthly ( )
    d. If any other please specify

    _____
    _____
    _____
    _____
    _____
    _____

Section-2 Scheduling practice of ERA projects Yes No N/A I/DK

10. Which software do you apply for planning and scheduling of the project?
    a. Primavera ( )
    b. Microsoft project ( )
    c. Excel sheet ( )
    d. If any other please specify

    _____

    _____

    _____

11. Does your company use historical data in estimating activity duration? ☐ ☐ ☐ ☐

12. Is the companies use the method of time and resources measurement ☐ ☐ ☐ ☐

    If any other please specify ( )

    _____

    _____

    _____

    _____

    _____

13. Among the projects you have under taken are schedule prepared jointly by the contractor and consultant and be accepted as the baseline schedule?

    Yes ☐ No ☐

    (If yes, Please specify the solution given)

    _____

    _____

    _____

14. What are your practices to minimize construction time?

a. Increase salary ( )
b. Expediting the whole activities ( )
c. Expediting selectively critical activities ( )
d. If any other please specify ( )

_____

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Section-3 key scheduling problems & challenges

15. To what extent do you agree with some of the possible causes of schedule reviews where strongly disagree=1, Disagree=2, Neutral=3, Agree=4, strongly agree=5?

No	Statement	Strongly disagree	Disagree	Neutral	Agree	strongly agree
1	Contractor's improper planning					
2	Contractor's poor site management					
3	Inadequate contractor experience					
4	Inadequate client's finance and payments for completed work					
5	Problems with subcontractors					
6	Shortage in material					
7	Labor supply					
8	Equipment availability and failure					
9	Lack of communication between parties					
10	Mistakes during the construction stage					
11	Design problems					
12	Slow decisions for changes					
13	Obstructions from other utility suppliers					

Section-3 key scheduling problems & challenges Yes No N/A I/DK

16. Among the projects you have under taken are there any projects completed without any schedule impact(delay)?

Yes ☐ No ☐

(If yes, Please specify the strong side of these projects that avoided the occurrence of time overrun)

_____

_____

_____

_____

17. Among the projects you have under taken, are there any projects subjected to delay because of change order?

Yes ☐ No ☐

(If yes, Please specify the solution given)

_____

_____

_____

18. Among the projects you have under taken, are there any projects use resources allocation and leveling?

Yes ☐ No ☐

(If yes, Please specify the solution given)

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19. Do you think the owner may have unrealistic expectations regarding the schedule of construction forcing contractors into unrealistic risk, or commitments that may not be realistic?

Yes ☐ No ☐

(If yes, Please specify the solution given)

_____

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_____

20. Do you think bad observing the work by the contractor's staff cause schedule impact?

Yes ☐ No ☐

(If yes, Please specify the solution given)

_____

_____

_____

21. Which of the following factors do you rate as leading cause forschedule review?

a. Time constraint ( )
b. Resources constraint ( )
c. Finacial constraint ( )

(If any other, please specify)

_____

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Section-4 impact of schedule on project implementation Yes No N/A I/DK

22. What was the cause of schedule impact?

a. Owner ( ) c. Contractor ( )

b. Consultant ( ) d. Government ( )

23. How was the schedule impact (time claim) settled in your project?

a. Negotiation ( ) c. Litigation ( )

b. Arbitration ( )

(If any other or combination of the above specify)

_____

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24. What do you recommend to minimize schedule impact on your constructionproject?

a. Addressing Constructability issue during design ( )

b. Risk consideration against delays ( )

(If any other pleas specify)

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Section-4 impact of schedule on project implementation Yes No N/A I/DK

25. Do you use schedule analysis technique (time impact analysis)? ☐ ☐ ☐ ☐

(If yes, Please specify the type)

_____

_____

_____

_____

_____

26. Among the projects you have under taken, which types of schedule impact do you observe?

a. Delay
b. Change
c. Termination
d. Disruption
e. Suspension
f. (If any other pleas specify and solution given)

_____

_____

_____

27. Among the projects you have under taken, which types of schedule impact classifcation do you observe?

a. Excusable, Non-compensable delays
b. Excusable, Compensable delays
c. Non-Excusable, Non-Compensable delays
d. Non-Excusable, Compensable delays

(If yes, Please specify the type)

_____

_____

_____

28. Do you have any further comment, suggestion or contribution relative to project time scheduling and its impact on immplementation?

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_____.

Date ----------

I truly appreciate your timely response and cooperation

Thank you!!!!

HIBRET KEBEDE

Mobile no.- 0911940994

DECLARATION

I hereby declare that the work presented in this thesis is the result of my research work and that it has not previously been submitted for a degree, diploma or other qualification at this or another University.

_____ _____

Signature Date