JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF EFFECTIVE TIME SCHEDULING PRACTICES AND CHALLENGES IN BUILDING CONSTRUCTION PROJECTS IN JIMMA ZONE

A Thesis submitted to School of Graduate Studies, Jimma University, Jimma Institute of Technology, Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree Master of Science in Construction Engineering and Management

By
Fuad Jemal Abasimel

June 2022

Jimma, Ethiopia

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Advisor: Dr. BIEN MAUNAHAN Signature
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Co - Advisor: Engr. MAMARU DESSALEGN Signature
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June 2022

Jimma, Ethiopia

DECLARATION

I declare that this research proposal entitled "**Assessment of Effective Time Scheduling Practices and Challenges in Building Construction Projects in Jimma Zone"** is my original work and has not been submitted as a requirement for the award of any degree in Jimma University or elsewhere.

FUAD JEMAL ABASIMEL _____ _____

Name Signature Date

As research Adviser, I hereby certify that I have read and evaluated this thesis paper prepared under my guidance, by First Father, Grand Father Name entitled "**ASSESSMENT OF EFFECTIVE TIME SCHEDULING PRACTICES AND CHALLENGES IN BUILDING CONSTRUCTION PROJECTS IN JIMMA ZONE**" and recommend and would be accepted as a fulfilling requirement for the Degree Master of Science in Construction Engineering and Management.

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ABSTRACT

Creating Effective time scheduling is one of the major inputs for a given project, but it's a challenging activity that directly influences the performance of the construction completion time. Having this in mind ineffective schedule will cause scheduling delays. The scope of this research is limited to the building construction that exists in the selected Jimma zone mainly on public buildings. The primary objective of this study was to assess effective time scheduling practices and identify challenges and forwarded improvement parameters. To achieve the main goal of the study, the current practices of effective time scheduling, adopted tools and techniques for time scheduling on building construction projects were assessed and the critical challenge faced to process effective time scheduling was identified. The study adopted mixed research approach. The sample size was selected by non-probability purposive sampling techniques. A total of 50 questionnaire surveys were distributed and 40 questionnaires were collected from construction professionals. To achieve the research objectives semi structured interview and questionnaire survey were used. Data was analyzed by a simple statistical approach relative important index (RII). The study's findings indicate that more projects are running behind schedule and experienced traditional time scheduling approach, most of them used time planning at the construction stage, and MS Project software is a frequently used tool. The most adopted and frequent techniques are Network Planning Techniques, Gantt chart and Critical Path Method respectively. Lack of Project management software application was identified most critical and very high significant challenge also Lack of fast re-planning and recovery from unexpected changes in the baseline schedule and Lack of Effective resource leveling in scheduling were from high significant challenges faced for effective time scheduling process. Establishing the schedule management process to accomplish any activity step by step, creating *a well-planned project schedule, applying appropriate scheduling software, assigning competent project manager and team* and *preparing detailed specification for individual action respectively were pointed as the most scheduling improvement parameters. . Finally Using 4D-scheduling technology, taking full training on effective scheduling were forwarded recommendations.*

***Keywords**: Effective Scheduling, scheduling Challenges Project Delay, Scheduling Tools*

ACKNOWLEDGMENT

In the name of Allah, the Most Merciful and the Most Gracious, I give praise and thanks to Him for giving me the strength to complete this research. Next to that I would like to thank **Engr. BIEN MAUNAHAN** my advisor and **Engr. MAMARU DESSALEGN** my CO-Advisor for their invaluable advice, tremendous support, guidance and engagement in my thesis.

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ABBREVIATIONS

4D Four Dimensional

CAD Computer Aided Design

CPM Critical Path Method

EVM Earned Value Management

IFC Industry Foundation Classes

LOB Line of Balance

MUDC Ministry of urban development and construction

OLE Object linking and embedding

PERT Program Evaluation and Review Technique

RII Relative Important Index

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Successful projects continuously lead to increase in profit in a Construction company. Delivering projects successfully is one of the key obligations of construction project management, and it includes planning and scheduling of construction projects[1]. Competitive environments, the place building and infrastructures projects are taking place, planning and scheduling are crucial to understanding challenge of overall performance[2].

Construction delays are wide spread in most initiatives around the world. Some delays may additionally appear in the preconstruction phase which is described as the length beginning from the preliminary conception of the project to the signing of the contract between the owner and the contractor; alternatively some of them might also occur in the construction phase that is the period when true construction is under way. Project schedules are consistently dynamic and uncertain. Several controllable and uncontrollable factors can adversely affect the challenge time table and cause delays. These delays definitely create negative impacts on project [3].

Construction projects are present process all over Ethiopia as part of the national development plan. Construction industry plays an important role in social, financial, political improvement of a country. The construction industry in Ethiopia, as in most developing countries, has made a significant contribution to the increase of the economy through infrastructure development and job creation.

The construction industry is at its booming stage, delay in completion time is a common practice in the industry. According to the report through (MUDC, 2012), most of the projects have failed to meet the predetermined time frame due to limited capacity of consultants and contractors to manage their initiatives and their expert incompetency[4].

In Ethiopia and particularly in public building projects, the number of construction projects is increasing from time to time. However it became very difficult to complete a project in a stipulated time and cost given in the initial contract document. Time and

cost overruns are the common phenomena in almost all construction projects. Number of unexpected problems and changes from original design arise during construction phase, leading to time and cost overruns. Frequent causes of time and cost overruns such poor cost estimation and poor time planning[5]. the main cause of time overrun in construction industry is Infective project planning and only 8.25% projects have been finished to the original targeted completion date[6]. Delays are usually accompanied by cost and time overruns there is a visual phenomenon in which clients and contractors lose their profitability. To minimize these problems, stakeholders of the construction projects need to enhance their planning. Effective preparation and implementation of time schedule will contribute to the successful implementation of projects and eliminate excessive delays.

So the main goal of this study was to assess effective Time schedule of on building projects its practice and challenges in the case of Jimma zone.

1.2 Statement of the problem

Construction companies are narrowing their focus, becoming specialists in certain types of construction projects. This specialization requires more focused project planning and controlling techniques that prove to be better for certain type of projects while providing specialized construction services. The advantages of effective planning, scheduling and control of construction projects are reduced construction time, reduced cost overruns and the minimization of disputes[7].

One of the important activities of Project Management is the Project Scheduling. Success of the Project depends upon the Project Scheduling. Time scheduling is the backbone for the construction projects planning, controlling, and success. An effective Project Schedule will be helpful to control all the Project Activities, also able to determine that how resources are efficiently used[8]. Also Planning and scheduling methods and tools are regarded as essential parts of project planning and scheduling. It could be argued, therefore, that failures in project schedule performance should call for a specific focus on the effectiveness of existing methods and tools for managing construction schedules[9]. Insufficient planning and scheduling due to poor communication between personnel will also give negative effect to the project performance. In a highly competitive environment, it is crucial for the construction

industry (CI) to have a proper planning and scheduling strategy in order to improve their performance[10].

Infective project planning and Scheduling or resource management are among the main critical factors that cause construction delays in Ethiopia. In Ethiopia only 8.25% projects have been finished to the original targeted completion date. The remaining 91.75% delayed 352% of its contractual time[11]. The building construction involves high level of technology and employs huge human resources, materials and types of machineries however; the industry has been experiencing such problems as delayed in completion time and cost overruns due to lack of effective time planning and scheduling. Therefore, it is crucial to Assess the current practices and challenges with time scheduling that have been recognized as prospective areas that require improvement. This research assessed and identified the current practice and challenges of effective time scheduling also techniques and methods adopted in the Jimma zone building Construction projects as well as recommending the possible improvement practice and scheduling technique.

1.3 Research questions

1. What are the current time-scheduling practices for building construction projects in Jimma Zone?
2. What are the tools and techniques for time-scheduling construction projects in Jimma Zone effectively?
3. What are the critical challenges facing effective time scheduling in Jimma zone building construction?

1.4 Objective of the study

1.4.1 General objective

The General objectives of this study is to assess the current effective time scheduling, practices and identify challenges in effective time scheduling in the case of Jimma Zone on building construction projects.

1.4.2 Specific objectives

- To assess the current time-scheduling practices being used for building projects in the Jimma Zone.
- To evaluate scheduling tools and techniques for effective time scheduling on building construction projects in Jimma Zone
- To identify the most significant challenges to effective time scheduling of building construction projects in the Jimma Zone.

1.5 Scope of the study

This study was mainly initiating to assess the current practices of time scheduling and identifying the major challenges of effective time scheduling in selected Jimma zone building projects. Therefore, the scope of this was limited to the building construction exist in selected Jimma zone mainly on public buildings. The data was collected from the contractors, consultants and clients engaged in execution of building construction projects in Jimma zone.

1.6 Significance of the study

Building Construction projects in Ethiopia like other developing country exposed to meet desired completion time or not meeting as per predetermine planned schedule or its exposed to delay because of many reasons and factors. This problem also shown in Oromia so that in Jimma zone building construction.

Therefore, the study will inform those who are involved in the building construction industry about the current time scheduling experiences, as well as the differentiate tools and techniques will provide information to those involved in the building construction industry regarding the variables that affect effective time scheduling of construction projects, as well as methods for enhancing time schedule performance.

- Finally, the study will be beneficial for other potential researchers as source material in the related researches and initiating researchers to do further also the large community and Local contractors and consultants as well as other interested stakeholders.

CHAPTER TWO

LITERATURE REVIEW

2.1. Concept of Time Scheduling

2.1.1. Schedule

The time table is a work program which is created in a logical order using time. It's a timetable for action. Scheduling is a procedure of making a work plan. Its miles measured. The programming method varies with the making plans method and the form of venture to be performed. Simple projects may be planned using "bar chart method". The line of balance (LOB) method is extensively prevalent for making plans of repetitive work projects, even as network making plans is appropriate for all varieties of initiatives. There are many different programming strategies. The manner a program is presented relies upon the programming strategies used. In general, they all use a time scale alongside the horizontal axis. This timescale in the main makes use of a "week" as a unit of time[7].

Project scheduling is the application of skills, techniques, and instinct received via information and experience to develop powerful schedule models. The schedule model integrates and logically organizes diverse project components, which include activities, resources, and logical relationships, to beautify the probability of a successful project completion in the baseline duration[12]. Also Project scheduling is to determine starting and finishing dates of project activities, the objective of resource allocation is to ensure the sufficient and timely supply of resources for project execution.

2.2. Schedule Input

Types of inputs to create a project schedule are as follows[13]:-

2.2.1. Personal and project calendars

Understanding working days, shifts, and resource availability is critical to complete a project schedule.

2.2.2. Description of project scope

From this we can determine key start and end dates, key assumptions behind the plan, and key caveats and limitations. We can also include stakeholder expectations, which often determine project milestones.

2.2.3. Project risks

We need to understand these to make sure there's enough extra time to deal with identified risks and with unidentified risks (risks are identified with thorough Risk Analysis).

2.2.4. Lists of activities and resource requirements

Again, it is crucial to determine if there are different constraints to consider whilst developing the schedule. Understanding the resource capabilities and experience you've got available in addition to company holidays and personnel holidays will have an effect on the schedule.

2.2.5. A project manager

Project manager should be aware of deadlines and resource availability issues that may make the schedule less flexible.

2.3. Project time management

Time control entails making plans and tracking procedures that shows the scope of labor and facilitates, to assess the overall performance of the task and to fulfill of entirety time. The strategies are plan agenda control, outline activities, outline the series of activities, estimate interest duration, estimate interest resources, develop a schedule, and manipulate schedule[14]. The appropriateness of projects time control may be visible as an applicable indicator that would be used to assess the effectiveness and capacity of contractors to finish a challenge successfully. Most tasks that have been finished on time additionally made greater use of challenge time control processes[15]

2.4 Benefit of scheduling

Different parties are involved in each project (stakeholders). They all need and gain from project scheduling, however with different perspectives. Contractors want project planning to: calculate the completion date of the project, calculate the begin or end of

a selected activity, predict and calculate cash flow, enhance work efficiency, function an effective steering tool for projects, and investigate the effect of changes evaluate. and calculate cash flow, function an powerful project monitoring tool, and investigate the effect of changes[16].

2.5 Types of scheduling

There are three types of scheduling[17]. These are time, resource, and target scheduling

2.5.1 Time schedule

Sometimes a schedule can be created to present a logical sequence of activities with only theoretical information about the duration of the activities. The main goal would be to see the logic of the production process and its approximate duration. Schedules created for this purpose are referred to as "Schedules". A program is created with the assumption that its activities will receive all necessary resources when needed. In other words, scheduling assumes resources are unlimited and available if required. However, this is an unrealistic assumption as resources may simply not be available when needed, or be available in limited quantity, size and type of technical specification. Additionally, assuming unlimited resources leads to inefficient resource allocation and the likelihood of higher costs. Timelines are useful for developing an overall strategy within a broadly defined time frame. But since they assume that the resources will be available when required, they may not create a realistic plan of the actual production process. More realistic planning can be achieved by using resource plans.

2.5.2 Resource schedule

When resources are limited in availability, technical specification, cost, or some other means, those resources that are available then drive the scheduling task. In resource schedules, the work to be accomplished is assigned to available or committed resources. When the volume of resources is insufficient to carry out the work that has been scheduled, the project manager would need to either inject more resources or reschedule the work to free over-committed resources. Injecting additional resources is likely to incur extra costs while keeping to the same schedule. Control of time and cost are more likely to be achieved using resource-based scheduling.

2.5.3 Target schedule

When specific targets, such as starting or finishing dates, are added to activities in a resource schedule, a 'target schedule' is created. The phrase 'target date' implies that a particular activity or task must be completed by that date. A contract will usually impose target dates. A realistic scheduling tool is one that is resource-based and includes target dates.

2.6 Effective Time Scheduling

Proper planning and scheduling are critical in projects for sinking and scheming project delays. Each year, large amounts of time, money, and resources are wasted in the construction industry due to poor planning and scheduling. Construction projects have become infinite and complex as a result of globalization. Such projects necessitate a large amount of documentation, which can be reduced with the help of project management software[18].

One of the project management software used in reducing large amount of documentation is Primavera P6. And it’s simultaneously can done estimation, activity sequencing, resource allocation, and timing, So provides excellent control[19].

Having effective construction project planning, scheduling, and controlling results for shorter construction times, lower cost overruns, and fewer disputes. It aids in avoiding construction interruptions, maintaining crew continuity, and avoiding construction delays and cost overruns.

The purpose of this study was to understand the role of monitoring and control in the progress and timely completion of a construction project, as well as the need for and effectiveness of project management software such as Primavera P6 in a construction project[20].

2.7 Scheduling Tools and Techniques

2.7.1 Gantt chart

The Gantt chart also known as bar chart is useful for the illustration of work items and their estimated times[21]. A bar chart is a graphical representation of project activities that are displayed as a time-scaled bar line with no links between them. The Gantt chart

is a bar graph with time on one axis and resources on the other. The chart has the advantages of being simple to create, interpret, and comprehend. In comparison to most planning tools, the Gantt chart is an excellent communicative tool, particularly in an industry where the majority of artisans are not highly educated. As a result, it is the most commonly used method of displaying project plans[22].

Gantt charts are the most commonly used method of scheduling and controlling in the construction industry because they are simple and easy to create. Bar charts have gained widespread acceptance and popularity, owing to their simplicity and ease of preparation and comprehension. There is no "theory" or complicated calculations involved. They are understandable to anyone. They can be made anywhere with a pencil and paper[23]. There are some limitations of bar charts, including the fact that links between activities may show interdependency but do not show what needs to be done to complete the task, links between activities on a single bar chart quickly become confusing, lines intersect, overlap, cross bars, and lines become lost against the background, links between activities may show interdependency but do not show what needs to be done to complete the task, and most bar charts are drawn in a grid format. They rarely explain float/contingency[24]

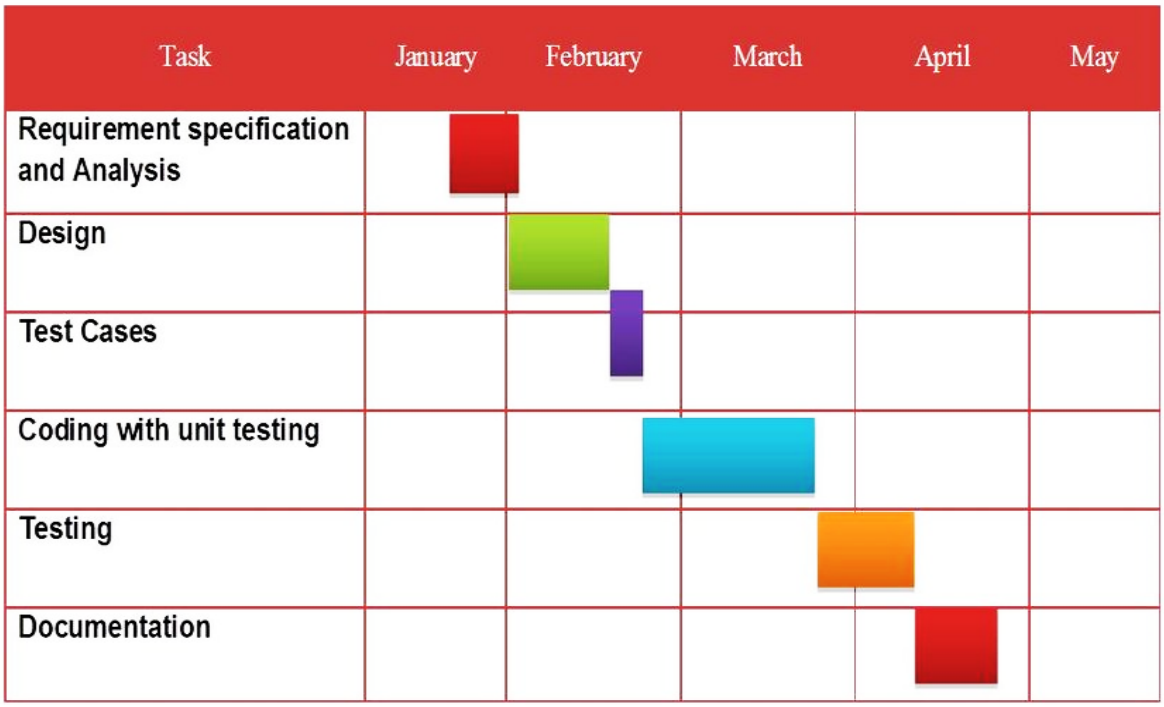

Table 2.7. 1 Gantt chart

(Source: - https://www.researchgate.net/figure/Development-process-through-Gantt-chart-Project-Scheduling_fig3_281610563)

2.7.1.1 Advantage of Bar Chart

- Bar charts are time scaled, the length of the activity bar represents the time duration of the activity). Both the node, in the node networks, and the arrow, in the arrow networks, are not time-scaled.
- Bar chart are simple to prepare
- Bar chart are easy to understand
- Bar chart are acceptable for presentation, especially for field people and people who are unfamiliar with the CPM

2.7.1.2 Limitation of Bar Chart

The main disadvantage of bar charts is their lack of logical representation. Bar charts do not reveal relationship answers. Although some software developers attempted to depict logical relationships using bar charts, the results were not always clear. The logic lines would become entangled, and unlike networks, bar charts do not allow for the length of the bars to be changed or moved around to make items clearer or more visually appealing[18]. While applying the bar chart to linear construction project, a huge diagram would repeat n times in scheduling linear and repetitive project. And the bar chart is unable to indicate progress rate and actual location.

2.7.2 Cyclogram

The shortcomings of the Gantt Chart prompted the creation of a more sophisticated tool that incorporates the shortcomings of the Gantt Chart[22]. The Cyclogram was created to address technological and spatial issues. The vertical axis shows the percent completion as a function of time. It is mostly used to display project plans for infrastructure projects such as highway construction[22]. In such cases, cross-sections are represented on the vertical axis.

2.7.3 Network Planning Techniques

The increasing complexity of projects necessitated the development of a more sophisticated method of displaying project plans. As a result, network planning techniques were created. In 1959, the techniques evolved alongside modern project management.[22].

2.7.3.1 Critical Path Method

According to the project management institute[14], The critical path method is a technique for estimating the minimum project duration and determining the amount of scheduling flexibility on the logical network paths within the schedule model. By performing a forward and backward pass analysis through the schedule network, this technique calculates the early start, early finish, late start, and late finish dates for all activities without regard for any resource constraints. The Critical Path is the longest path through the project, and it determines how long the project will take. Events are represented by circles in a CPM network, while activities are represented by arrows[22]. They are sometimes referred to as Activity-on-the-arrow diagrams.

Events represent the completion and commencement of activities directed to and from them. The numbers in the nodes represent the events' early and late occurrences. The red line also represents the project's critical path[22]. Assert that the CPM is capable of storing previously created logic, allowing for simple changes to the original plan. The CPM has been successfully implemented on a number of projects[25]. Noted that the success was not only peculiar to the construction industry, but project management in other disciplines. In summary, [25]concluded that Today‘s construction manager who ignores the use of critical path methods is ignoring a useful and practical management tool.

2.7.3.2 Program Evaluation and Review Technique (PERT)

The Program Evaluation and Review Technique (PERT) functions similarly to the CPM and evolved around the same time, in the late 1950s. However, unlike the CPM, the task durations are determined stochastically[22]. Today, as in the past, project managers and planners have been preoccupied with PERT[26]. Academics argue that uncertainties abound on projects and that is the major advantage of the PERT, and also the difference between the PERT and CPM – details of PERT are not known with certainty. In PERT the duration of the project is assumed to have a beta probability distribution given by the formula below:

$$Beta\ Distribution\ (PERT): E\ = \frac{O+4M+P}{6}$$

Where

- O= the Optimistic duration ,M= the Most likely duration P= the Pessimistic duration

2.7.3.3 Advantages of Network Scheduling Method

When comparing bar charts with networks, three advantages over bar charts[18]:

- Network show logic, the relationships among the activities. Bar charts do not
- Networks can better represent large and complicated projects.
- Networks can estimate, or predict, the completion date of the project, or other dates, on the basis of mathematical calculations of the CPM

2.7.3.4 Limitation of Network Scheduling Method

Network scheduling, unlike bar charts, is not time scaled. To understand the CPM, practitioners must be trained. According to the authors' experience, the presentation of CPM is not as acceptable for field workers as the bar chart. Furthermore, resource information cannot be loaded into CPM. Some scheduling software vendors attempted to exploit the time-scaled feature of bar charts and impose it on networks, which some people referred to as time-scaled logic diagrams. However, there is evidence that contractors do not use networks in highly repetitive jobs because they believe that high repetition will reduce the chances of successful network scheduling and control[18]. For example, the network method complicates repetitive projects such as high-rise building construction. The inability of CPM-based techniques to model repetitive projects has been widely criticized in the literature[18].

The first issue is the network's sheer size. In a repetitive project with n units, the network designed for one unit must be repeated n times and linked to the others, resulting in a massive network that is difficult to manage. This may cause communication issues among members of the construction management team. The second issue is that the CPM algorithm is designed primarily for project duration optimization rather than adequately dealing with the unique resource constraints of repetitive projects. The CPM algorithm lacks the ability to ensure a smooth flow of crews from unit to unit with no conflict and no downtime for workers or equipment. This causes hiring and procurement issues in the flow of labor and material during construction[27].

For repetitive work, such as work on floors in a high-rise project or work on sections in an underground pipe line or utility line project, a new format was developed. The use

of basic CPM on a pipe line or utility line was laborious; the input for work on a typical section was duplicative and tedious. Furthermore, once the schedule reached the typical section, basic arithmetic could be used to predict a result without the use of a computer. This implied that there were alternatives to network presentation for graphing the result; this realization resulted in the development of some methods for use in linear and repetitive projects. One of them is the line of balance (LOB) method, which employs a is one of them using a unit network to portray repetitive

2.7.4 4-D CAD Visualization Techniques

Conventional project planning techniques such as CPM, PERT, Gantt chart, and so on are disadvantageous in terms of adequate communication of the modern manager's conceptual planning. [28]. Additionally, relating information through these conventional techniques is more difficult and mistake prone. The result is that some problems remain inherent and elude the project planning stage. This phenomenon explains why variations or changes are common place in construction[28]. Most of these elusive problems could be detected during the planning stages if project information could be visualized. The theory of Visualization techniques in project planning and scheduling in construction evolved from this principle. This section goes over the various visualization techniques used in project planning and scheduling. The fact that the benefits cut across the board is especially important in the 4-D CAD Visualization Techniques. Designers and builders can communicate using design and construction information, which improves collaboration and communication between the two parties[29]. In Contrast to the conventional techniques, users can also use the 4-D CAD to assess the cost, health and safety issues, or allocation of resources even before the completion of the facility. Below are the under listed types of 4-D CAD Visualization techniques.

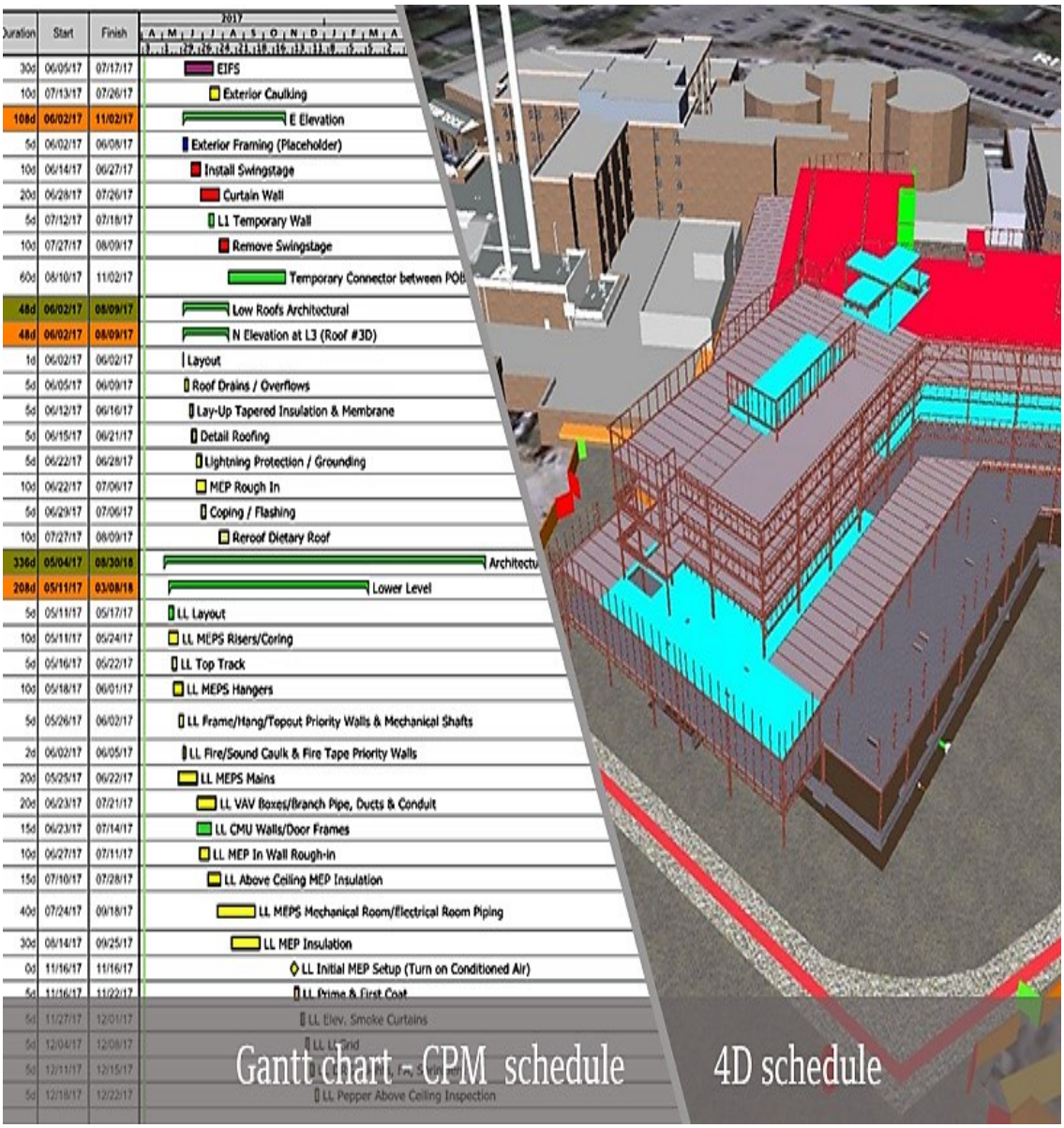

Figure 2.7.4 4-D CAD Visualization Techniques

(Source:https://www.united-bim.com/wp content/uploads/2020/10/CPM_4DSchedule.-1.jpg)

Jacobus Technologies developed the technology that resulted in the software. The 4-D CAD combines 3D construction graphics with schedule data from Primavera or Microsoft Project. According to [30], The data from these packages is merged using OLE2 (Object linking and embedding) Automation, which dynamically links schedule data. Any change to the schedule is immediately reflected and thus visualized in the 4D environment, which is a unique feature of the tool. Perhaps the most significant disadvantage is the inability to automatically link or connect tasks to 3D objects [30].

2.7.4.1 Smart Plant Review –Intergraph Incorporated

Smart Plant Review evolved from the Schedule Simulator. The tool includes a Schedule Review engine, which allows for 4D simulation by connecting tasks (project schedule information) to 3D CAD. Though it performs functions similar to the schedule simulator, it also allows for the automatic connection of tasks and 3D objects.[30].

2.7.4.2 FourDviz – Balfour Technology

The display of objects in virtual reality allows the creation of visual scenes. As a result, a real-time environment is created that the user can manipulate through any direction of the visual scene [30].

2.7.4.3 Common Point 4 D

The Center for Integrated Facility Engineering at Stanford University in the United States created this tool. The project was completed in 1998. Because the authors compare this tool to conventional tools, the limitations of conventional planning and scheduling tools may have prompted this work. [31]. This tool, as in the tools aforementioned, also relies on AutoCAD; specifically 3D IFC complaint models[30]. Tasks are manually linked to 3D CAD objects, just like in the Schedule Simulator. However, one distinguishing feature of the software is the ability to manually group objects and attach them to one or more tasks[30].

2.7.5 Line of Balance (LOB)

The line of balance (LOB) method was developed by the US Navy during WWII for the programming and control of both repetitive and non-repetitive projects. It was invented by the Good Year Company in the early 1940s[18]. The typical unit network is a feature shared by LOB techniques. A high-rise building or a repetitive housing project are examples of construction projects that fall into this category[32]. A high rise building construction project's process sequence may include form erection, steel installation, concrete placement, form removal, curtain wall installation, and glazing. The activity production curves are plotted as a function of time. The slope of a process can be used to calculate its production rate. The horizontal distance between two consecutive production curves at a given location indicates the time buffer. The criticality is defined as the difference between the total number of production quantities

delivered and the LOB quantity at any given time. The negative criticality indicates that actual progress is slower than predicted. A quantity-time diagram is the LOB. It focuses on the required completion of quantities. Linear construction projects frequently involve repetitive processes with varying production rates. This phenomenon of production rate imbalance has the potential to harm project performance by resulting in work stoppages, inefficient use of allocated resources, and excessive costs. Because of different production rates and insufficient lag between process start times, production rate imbalance occurs when the production curves of leading processes intersect the curves of following processes.

The main advantage of the LOB methodology is that it provides information on production rate and duration in the form of an easily interpreted graphic format. The LOB plot for a linear construction project is simple to create, can show what is wrong with the project's progress at a glance, and can detect potential future bottlenecks. Although LOB methodology can be used to help with the planning and control of any type of project, it is best suited for use on repetitive projects rather than non-repetitive projects. One limitation of the LOB methodology is that it assumes linear production rates. Due to the stochastic nature of construction processes, the assumption that production rates of construction projects and processes are linear may be erroneous. Additionally, the objective of many planning techniques based on the LOB concept is to reduce project duration with little regard for project cost[18].

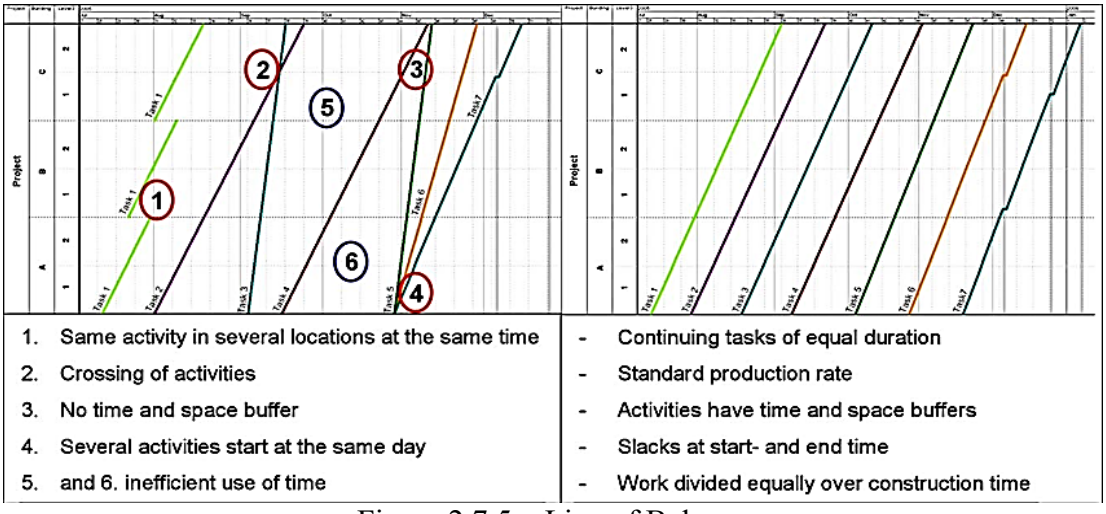

Figure 2.7.5 Line of Balance

(Source: - https://www.researchgate.net/figure/Examples-of-Line-of-Balance-diagrams-Locations-are-represented-on-the-Y-axis-and-project_fig1_223193942

Benefits and limitations of LOB

2.8 Challenges of Time Scheduling In Building Projects

The challenges that impede the successful integration of construction planning and scheduling techniques.

2.8.1 Complexity of the Tools

The complexity of the planning and scheduling tools is an impediment to successful planning and scheduling tool integration. Many authors have extensively researched this problem, and it is evident in any identified challenges studies conducted around the world. For instance, [33]observed the difficulty students especially beginners faced in the use of similar construction planning tools. This barrier is not peculiar to the class alone, it transcends to sites. The difficulty in entering data and the time required to handle data are two consequences of tool complexity[34].

2.8.2 Unable to take into account spatial planning

Existing project planning and scheduling tools do not account for the spatial requirements of construction sites[35]. As a result, [30]argued that these planning and scheduling tools are considered one-dimensional. In research, integration of site-related practices of planning and scheduling has received little attention over a decade of development, this field is still in its beginning stages. This evolution resulted in a heavy reliance on professionals' intuition and personal experience.

2.8.3 Technological Challenges

Interoperability is required to fully reap the benefits of construction planning and scheduling tools [36]. The smooth exchange of information across all disciplines is referred to as interoperability. However, the construction industry is fragmented and isolated. [37] Impede this integration and inconsequence such incompatibility aggravate the adoption of modern construction planning and scheduling tools including 4D CAD. The conventional nature of the road industry makes it more difficult to implement these practices.

2.8.4 High Computer Illiteracy Rate (High Skill is required)

The ability to develop accurate and realistic construction plans and schedules using visualization tools is important [38]. Modern construction planning and scheduling

techniques necessitate extensive tool manipulation knowledge. Most professionals in Ghana's construction industry are unfamiliar with modern construction tools, in part because computers have not been fully integrated into the curriculum. Furthermore, there are few reference materials on the subject.

2.8.5 Fragmented Nature of Construction Industry

Today, as in the past, major conflicts plague construction projects, causing delays and cost overruns in the majority of cases. According to[37], the fragmented nature of the construction industry is a contributing factor. Despite the fact that this industry characteristic is shared by all countries, there have been attempts to successfully integrate collaboration in the developed economies' construction industries. This has accelerated the adoption of numerous sophisticated planning and scheduling techniques. Surprisingly, the developing-country industry is still grappling with issues of collaboration and fragmentation. According to [37], technology alone will not be able to solve the industry's widespread problem. Collaboration is required for the implementation of these techniques.

2.8.6 Traditional Tools Forces Minds Visualizations

The heavy reliance on mind modeling poses a greater challenge with traditional planning and scheduling tools [38]. Although cognitive processes and intuition are essential in construction site coordination, situations such as complexity and multiple interconnected factors limit human cognitive, reflective, and analytical abilities [38]. Pervasive cost and time overruns, the ―90% syndrome among others are some of the highlights of the disadvantages of mental visualization[39]. To address this, construction planning and scheduling software evolved. Those working in Ghana's construction industry, on the other hand, have been the problem rather than the solution. The reason for this is that the industry relies on one-dimensional tools such as Gantt charts, etc. [30], which forces mental visualization.

2.8.7 Cost Of Modern Planning and Scheduling Tools (Cost Of Software)

Upgrades to software and hardware are regarded as significant impediments to planning and scheduling techniques, particularly for SMEs[40]. [41]discovered that significant resources are expended on the implementation of these techniques in the form of stringent training requirements, which can be time-consuming in some cases.

2.9 Improvement Methods of Time Scheduling In Construction Projects

To complete a construction projects within time need the best time scheduling and modern management system.

project scheduling in the Nigeria construction industry, where the findings revealed the use of a qualified and certified professional in managing project schedule and the use of a scientific approach rather than a rule of thumb in estimating for labor and materials requirement, as this will improve the performance of project scheduling in the Nigeria construction industry and contribute to the optimal utilization of resources in project delivery, as this will improve the performance of project scheduling in the Nigeria construction industry and contribute to the optimal utilization of resources in project delivery[42]. In the Malaysian construction industry, schedule performance methods are used in construction projects. They discovered that proper work planning, committed leadership and management, close monitoring, sending clear and complete messages to workers to ensure effective communication, and hiring skilled workers were suggested methods for improving schedule performance[23].

Effective planning and scheduling, detailed preparation of the contract, design documents, and drawings, the owner's commitment to pay the contractor on time, a clear definition of each party's responsibilities, the availability of labor and equipment needed for the project, and on-time delivery of required materials were all critical factors in completing construction projects on time[43].

The reliability and quality of detailed schedules, the effectiveness of managerial support for motivational and training programs, the ability to quickly re-plan and recover from unexpected changes in the baseline schedule, In scheduling, well-documented inputs, milestones, and deliverables, focusing on a holistic approach rather than the completion of individual activities, The cost-effectiveness of accelerating and reworking schedules and their activities was ranked as one of the scheduling improvement mechanisms[44].

Adequate communication among all project participants, the availability of resources (funds, machinery, materials, etc.) as planned throughout the project, the project manager's understanding of the scope of work, project managers with similar project

experience, regular schedule and budget updates, and regular monitoring and feedback by the owner were all methods of improving project schedule performance[45].

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study area

The study area selected for this study was Jimma Zone, Region of Oromia Ethiopia. Jimma is named for the former Kingdom of Jimma, which was absorbed into the former province of Kaffa in 1932. Highest point in this zone is Mount Maigudo (2,386 m).

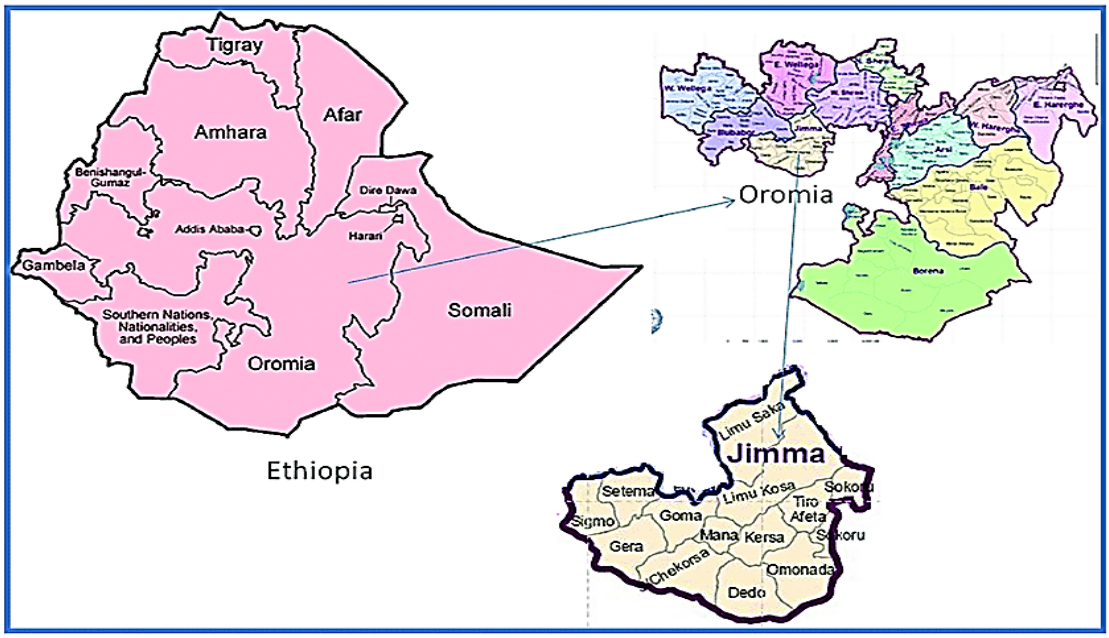

Figure 3.1 Map of Jimma zone, Ethiopia

(Source: The Map of Jimma zone, Oromia Regional State. Note: Adapted from Copyright ©2019 Belew S, Suleman S, Mohammed T, et al. Quality of fixed dose artemether/lumefantrine products in Jimma Zone, Ethiopia. Malar J.2019; 18:236. Doi: 10.1186/s12936-019-2872-1. 9)

3.2 Research Type

There are many different types of research papers depending on purpose, goal, and approach. A descriptive survey design was used in the methodology in order to gather, assess, and present the data for this study. Descriptive research comprises a variety of surveys and fact-finding questions. Thus, the design was preferred to identify and analyze the existing practice.

The researcher's goal is to describe the current practice of effective time scheduling and the challenges of time scheduling in the building construction of Jimma Zone. In this

study, a mixed method approach was adopted because opinions, personal judgments, views, and attitudes cannot be transformed into specific numbers and figures, so they were analyzed through the qualitative method. To analyze the current practice of time scheduling and rank the critical challenges, a quantitative approach was used. The mixed methods approach tries to combine the benefits of both quantitative and qualitative approaches.

3.3 Research Design

Research design is the arrangement of conditions for collection and analysis of data in a manner that aims of combining relevance to the research purpose with economy in procedure[46]. The research design employed in this study was descriptive survey design in order to collect, analyze and present the data. Several actions were taken to conduct this study. First, the problem was identified through preliminary literature analysis and the researchers' previous experience with construction projects. after Literature Review interview was conduct with some professional to support questionaries' response and questionaries' also distributed ,after distributed questionaries' returned data was analyzed final the research was conclude and some recommendation was forwarded from researcher.

3.4 Study Variable

3.4.1 Dependent Variable

- ✓ The current effective time scheduling of building construction in Jimma zone.

In this contexts there are many incorporated independent variables but the following are the most considered.

3.4.2 Independent

- ✓ Current practice of time scheduling
- ✓ Tools and techniques of time scheduling and scheduling
- ✓ Technology used for time

3.5 Target Population

In this study, the target population was professionals working building construction projects in Jimma zone such as contractors, consultants and clients.

3.6 Sampling Technique

The objective of sampling is to provide a practical means of enabling the data collection and processing components of research to be carried out while ensuring that the sample provides a good representation of the population[47]. [48] Indicated that the sample should be free from bias. Otherwise, the type of selected sample will greatly affect the reliability of subsequent generalization. Sampling strategies are categorized into main groups, namely probability and non-probability sampling[48]. Non-Probability sampling was used for this study.

From Non-Probability, purposive Consecutive sampling technique were used to select sample of respondents from entire population in the study area. Purposive sampling is a sampling technique in which the researcher uses his or her own judgment when selecting members of the population to participate in the study. It also depends on personal judgment when establishing criteria to answer research questions or accomplish the objectives. Consecutive sampling to address all accessible subjects as part of the sample because all subjects that are available that makes the sample a better representation of the entire population.

To reach the study's goal, the established criteria by researchers to select the sample of population is the professionals who have responsibility to develop time schedule and to manage the developed schedule during implementation of time schedule. Based on criteria project manager was selected because he/she have responsibility to manage schedule next Engineer was select because Engineer have reasonability to develop Schedule, next Contractor because Contractor have responsibility to implement developed schedule and site Engineer was selected because he/she have responsibility to evaluate actual schedule within planned schedule.

3.7 Data Collection and Analysis Methods

3.7.1 Data collection Methods

In this study, the data collection process used both primary and secondary data sources. Interviews and questionnaires were used to collect the primary data, and books, journals, theses, and other articles in published materials were used as secondary sources. The mixed use of these data types is from the standpoint that insufficiency and incompleteness will be minimized.

a) Questionnaire

Questionnaire provides first-hand information for the subject matter of a research as it is focused on issues which further serves as a survey to understand the main concerns and attitudes of respondents towards the problems. Based on the study's goals and the knowledge gathered during the literature research, a questionnaire was created. In this study, questionnaires were distributed to a selected sample of respondents, involving building construction in Jimma zone.

Questionnaires was formulated as closed-ended questions mostly and facilitate or taking place for "if other____" question as open-ended, Its Respondents can respond in their own words, in as much or as little detail as they want. Closed questions offer responders a set of predefined responses from which to choose. So it's comprise of both. Structured Open-ended and closed-ended to collect data, questionnaires were distributed.

Part I: General Information of the company: to identify the company profile and respondents profile.

Part II: the current practices of time effective scheduling in building construction in Jimma Zone.

Part III: scheduling tools and techniques using for effective time scheduling on building construction projects in Jimma Zone.

Part IV: the challenges faced on Effective time scheduling process on building construction projects in Jimma Zone.

b) Interview

A subject and an interviewer are conducting a research interview. Professionals conduct the interviews and keep an eye on the conversation as the interviewee responds to the questions, including some of my colleagues who have engineering degrees as well as myself or the researcher. When in-depth information on people's opinions, thoughts, experiences, and feelings is required, interviews are an effective strategy. The interview can help the researcher to judge the spontaneity of the respondent as well Semi-structural open-ended interviews were conducted with each professional to support questionaries' responses.

c) Secondary data sources

Based on the identified variables from questionnaire, interview and data from secondary sources was collected in order to confirm the reliability of information. These secondary sources provide a general understanding of the subject area by presenting a wide range of ideas in the field which help to supplement other specific information obtained from the primary data sources. Secondary data was obtained from organizations reports, schedules and contractual documents, in addition it obtained from thesis, journals, books and different articles in published documents.

3.7.2 Data analysis methods

The research was dependent on qualitative and quantitative types of data. To present the data the researcher were demonstrated the finding of the case study with simple graphics analysis, percentages, and describe finding by supporting personal interviews and observations. Statistical analysis of data is conducted by the researcher using a systematic process known as quantitative data analysis.

In order to analyze the questionnaire, descriptive statistics were used. The data analyzed included the biographic information gathered through the questionnaire, and this information explained the characteristics of the research respondents in relation to their training, years of experience, and position within the organization. In order to comprehend the pattern of how the respondents perceived the key research topics, descriptive statistical methods were also used to examine the research questions. To analysis the qualitative data from interview thematic analysis was adopted and the themes were the research questions. For the second and third objectives, the collected data through questionnaire was analyzed using relative importance index (RII)

$$\text{Relative Important Index} = \frac{\sum W}{AN} = \frac{5n_{5+}4n_{4+}3n_{3+}\ 2n_{2+}1n_{1}}{5N}$$

Where,

- W= is the total weight given to each attributes by the respondents from 1 to 5 n1= number of respondents' for very low, n=2 number of respondents for low n3= number of respondents for average n=4 number of respondents for high n=5 number of respondents for very high
- N= is the total number or respondent in the sample and A= is the highest weight on the Likert scale[49].

Table 3.7.2 Classification of RII

Scale	Level of Significance	RII
1	Very low	$0.0 \leq RII \leq 0.2$
2	Low	$0.2 < RII \leq 0.4$
3	Average	$0.4 < RII \leq 0.6$
4	High	$0.6 < RII \leq 0.8$
5	Very high	$0.8 < RII \leq 1.0$

3.8 Reliability and Validity of Data

Closed-ended questionnaires and semi-structured interviews, were constructed to generate a valid and comparable answer, so the validity of the research was considered. Reliability in quantitative research is the output consistency of an indicator. It implies that the parameters of the indicator's instrument do not affect the information provided by indicators[49].

Moreover, a pilot survey was once undertaken to see if the research instrument had reached the proper degree of quality in terms of its consistency and steadiness. This was once completed by means of the use of a convenience sample of professionals in Jimma Zone Building construction projects experts. Before the questionnaires have been administered, eight soft copies of the questionnaires have been presented to four consultant and four contractor to validate the contents therein, making sure that the sentences are clear and precise. Questions then amended based on the comment collected from those who participated in the pilot study.

To ensure the validity of the questionnaire, Spearman tests were conducted. Spearman's correlation coefficient is a statistical measure of the strength of a monotonic relationship between paired data. In a sample, it is denoted by and is using rs design constrained as follows[50].

$$-1 \leq r_s \leq 1$$

And its interpretation is comparable to that of Pearsons, e.g. the nearer rs is to +1 the greater the monotonic relationship or positive correlation means that as one variable increases, the other variable also tends to increase. A negative correlation signifies that as one variable increases, the other tends to decrease. Values close to -1 or +1 represent stronger relationships than values closer to zero.

Correlation is an impact size and so we can verbally describe the strength of the correlation the use of the following information for the absolute value of rs

Spearman's correlation coefficient value

.00-.19	"very weak"
.20-.39	"weak"
.40-.59	"moderate"
.60-.79	"strong"
.80-1.0	"very strong"

Finally, it was assured that the questionnaire was valid and appropriate enough to measure what designed to measure.

The reliability of the dataobtained from the questionnaire survey was then tested via the Cronbach's Alpha method[51]. This was achieved by using SPSS Statistics Software (version 25) to compute the Cronbach's Alpha, while the reliability coefficient was determined to show the internal consistency of the datausing.

$$\textbf{Cronbach's alpha, } \alpha = \frac{K}{K-1}\left[1 - \frac{\sum Vi^2}{Vx^2}\right]$$

Where K, represents the number of items; V_i represents the variance of scores on each item; and, Vx represents the variance of the observed total test scores

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 OVERVIEW

The aim of this research is to assess effective time scheduling on building construction projects: its practice and challenges in the case of Jimma zone According To Objectives of The Study, The Current practices of time scheduling in building construction of Jimma Zone was assessed and also, tools and techniques used for effective time scheduling for building construction in Jimma Zone ware assessed. Finally, the critical challenges of effective time scheduling for building construction in Jimma Zone was identified.

4.2 Questionaries' respondent rate

Table 4.2 Respondent rates

no	Respondent category	questionaries' distributed	response collected	Response collected rate (%)
1	Project managers	7	5	10%
2	Office Engineers	20	17	34%
3	Project Supervisor	8	7	14%
4	site Engineers	15	11	22%
5	total	50	40	80%

4.3 General Information

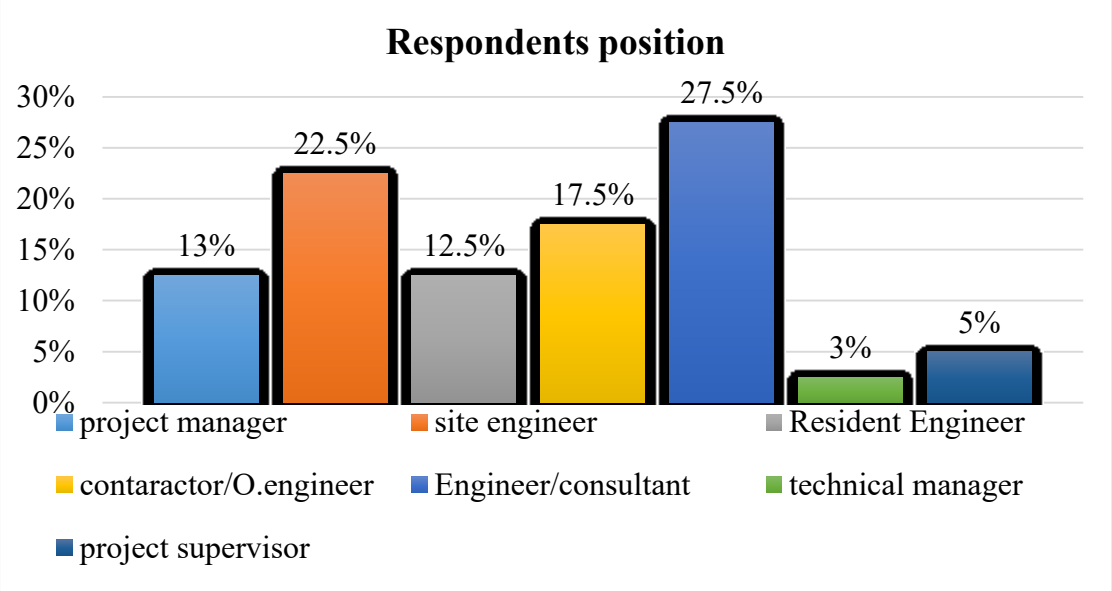

Figure 4.3.1 Respondents' position

Figure 4.3 shows that majority of respondents position are Engineer/consultant (28%), next 22% of respondents are site engineer, 18% are contractors, 13% are project managers and residents engineer, 5% are project supervisor and 3% are technical manager. The main reason of asking the position of respondents can help the researcher to identify how they can use time schedule on their position.

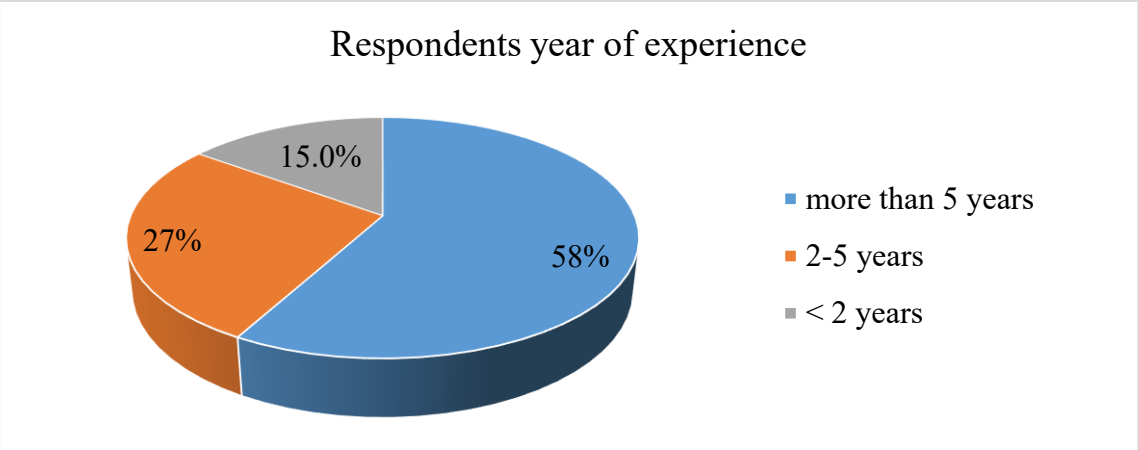

Figure 4.3.2 Years of respondent's experience

Figure 4.3.2 shows that, majority of respondents are working in their company more than 5 years (58%), also some of them are working in the company between 2-5 years and few of them are working in their company less 2 years. Asking respondents their experience can help researcher to balance their experience within their time scheduling practice how much they can update themselves time scheduling practice per year.

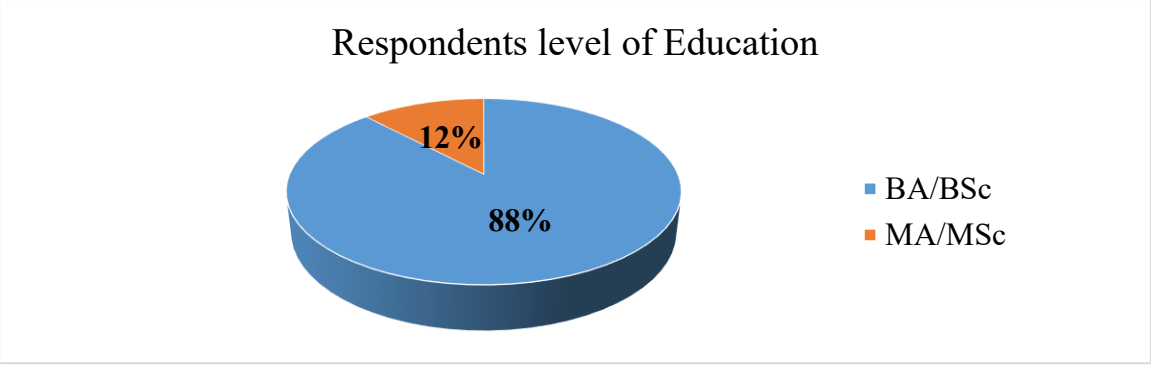

Figure 4.3.3 Respondent's level of Education

Figure 4.3.3 shows that, majority of respondent's level of education is BA/BSc (88%) and only 12% respondents are on MA/MSc level. Asking respondent's level of education can help researcher to identify how much they can practice effectively time of scheduling in their organization by their level of Education.

4.4 The current practices of time scheduling

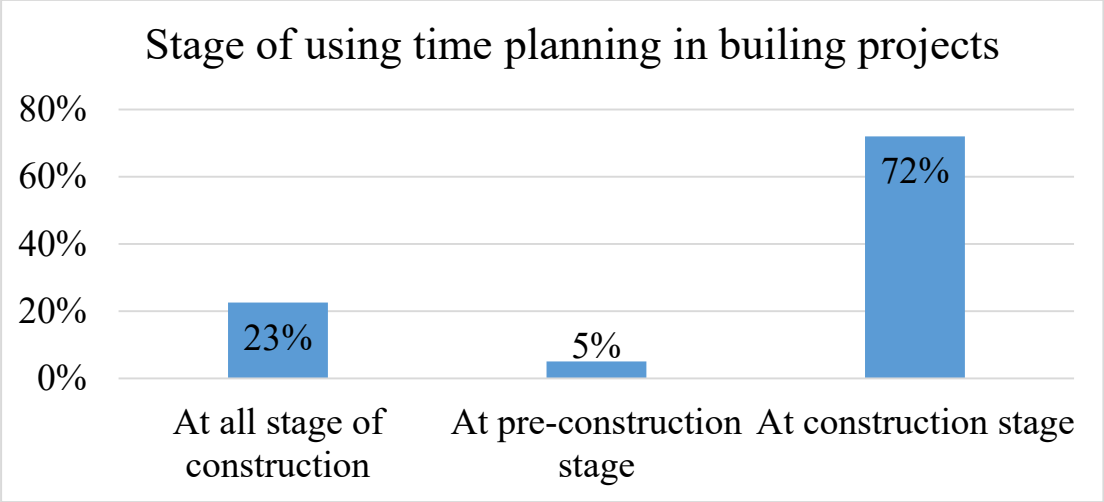

Figure 4.4.1 Usage of time planning in building projects

Figure 4.4.1 shows that majority of them are using time planning at construction stage (72%) the result from interview also show that majority of construction parties using scheduling during applying on the land to identify the relationship and sequence of activity this can help them to do activity parallel and to prepare construction materials early. also 23% of them are using time planning at all stage of building projects life cycles and 5% of them are using time planning at pre-construction stage from interview results especially general construction company using time planning from pre-construction stage because they prepare design by them self at this time there design time.

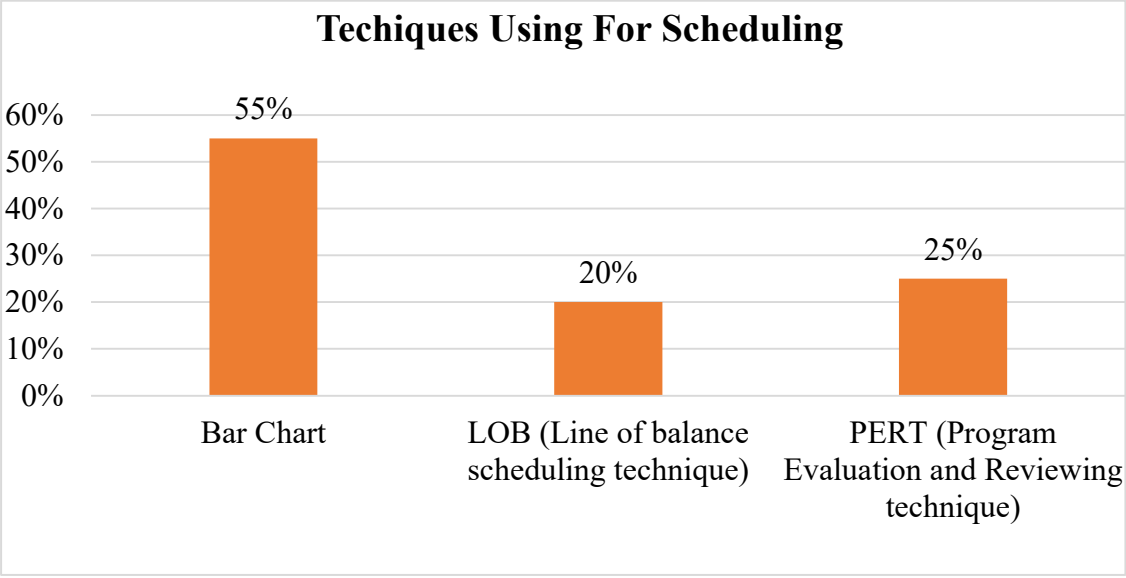

Figure 4.4.2 Tools using for time scheduling

Figure 4.4.2 shows that majority of them using bar chart techniques to schedule project time (55%) next to bar chart interview result support this results because it show that majority of time scheduler using bar chart because it is easy to develop also they have some awareness rather than other techniques. However 25% of them are using PERT (Program Evaluation and Reviewing technique) and 20% are using LOB (Line of balance scheduling technique).

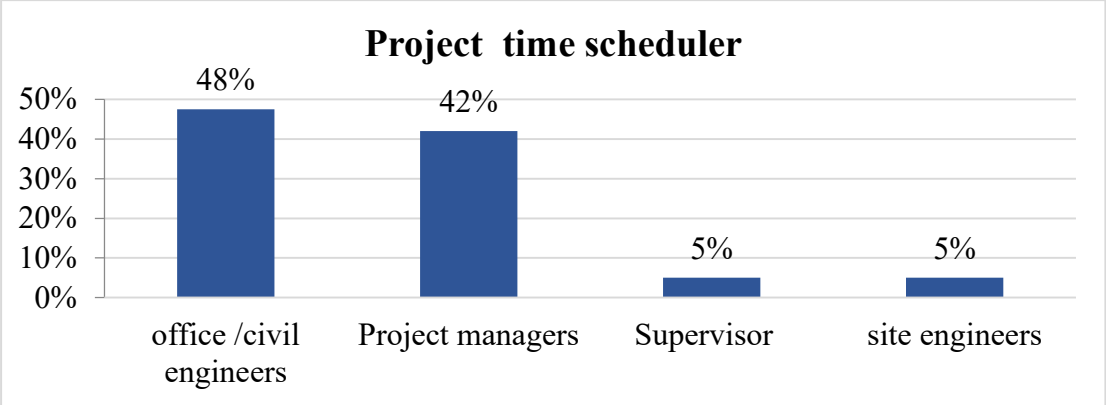

Figure 4.4.3 Project time scheduler

Figure 4.4.3 shows that in majority of company time scheduling is preparing by office/Civil Engineer (48%), also interview result show that civil engineer can prepare detail drawing specification so. time scheduling preparing form detail drawing this easy for civil Engineer. also 42% of respondent results show that project time scheduling is preparing by project managers especially in general construction company the time planning is preparing by project manager starting from pre-construction stage and 5% of respondents show that project time scheduling is preparing by supervisor and contractors.

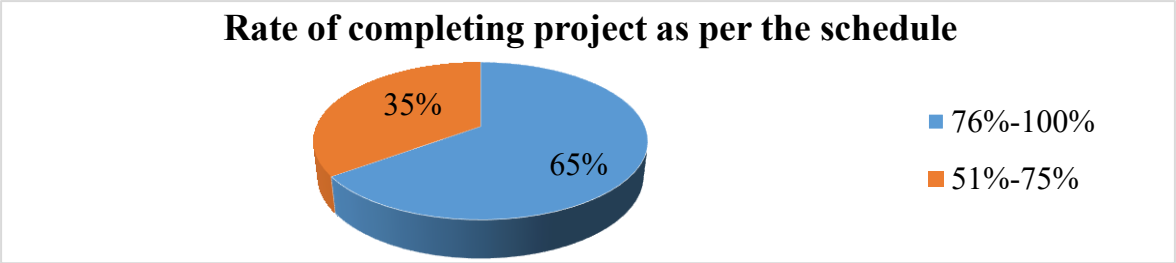

Figure 4.4.4 Rate of completing project as per schedule

Figure 4.4.4 shows that, 65% of construction companies was completing their projects between 76%-100% .All constructions cannot be complete 100% as per scheduling because of lack of effective time scheduling management and some unexpected

problem occur during construction. And 35% of the contractors complete their projects between 51%-75%. Big/complex projects are exposed to delay because less time to scheduling for project. It's far from actual execution.

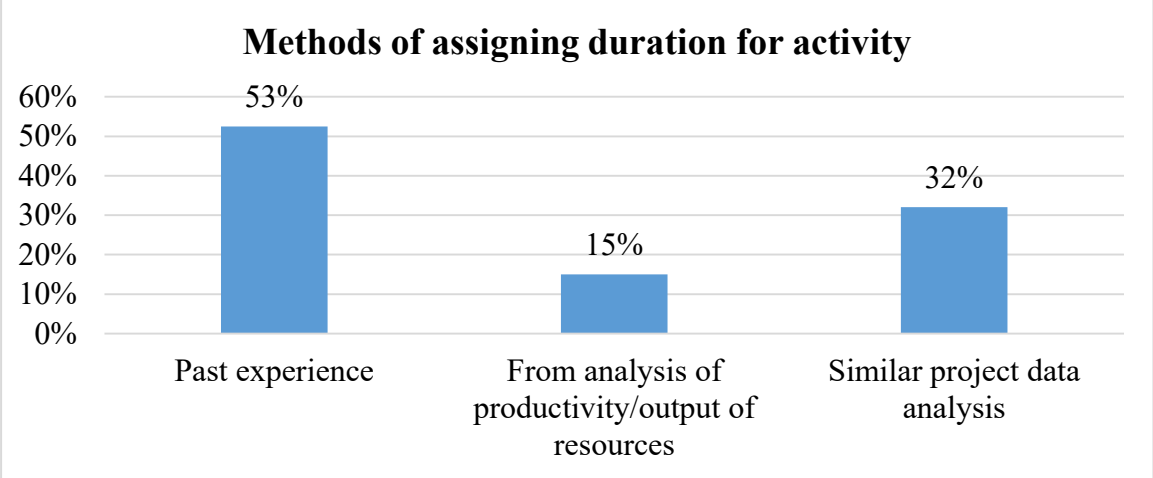

Figure 4.4.5 Methods of assigning duration for activity

Figure 4.4.5 shows that, majority of construction company using past experience to assign duration for each activity (53%) in addition to this results from interview show that to fix the duration each activity majority of professionals using past experience to considering output of labor and machine as input of scheduling. however 32% of respondents results show that they are using similar project data analysis to assign the duration of activity by taking complete project and by comparing projects and 15% of respondents results show that they using analyzed productivity/ output of resources to assign the duration for each activity.

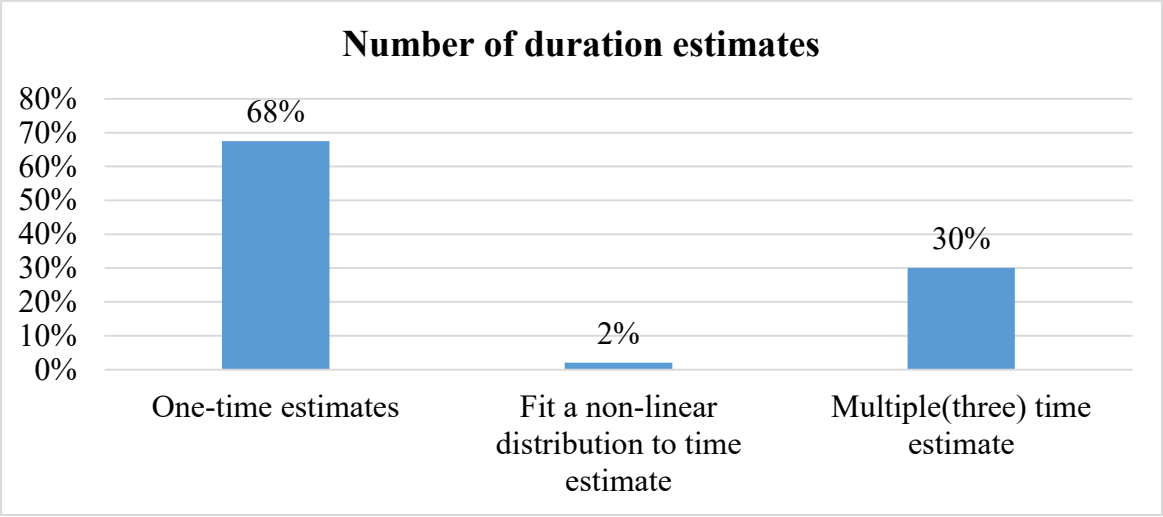

Figure 4.4.6 Number of time schedule estimates

Figure 4.4.6 shows that, majority of construction project time schedule is one time estimates (68%), 30% of respondents results show that project time scheduling is three time estimates and 2% of respondents results show that project time scheduling is fit a non-linear distribution to time estimates.

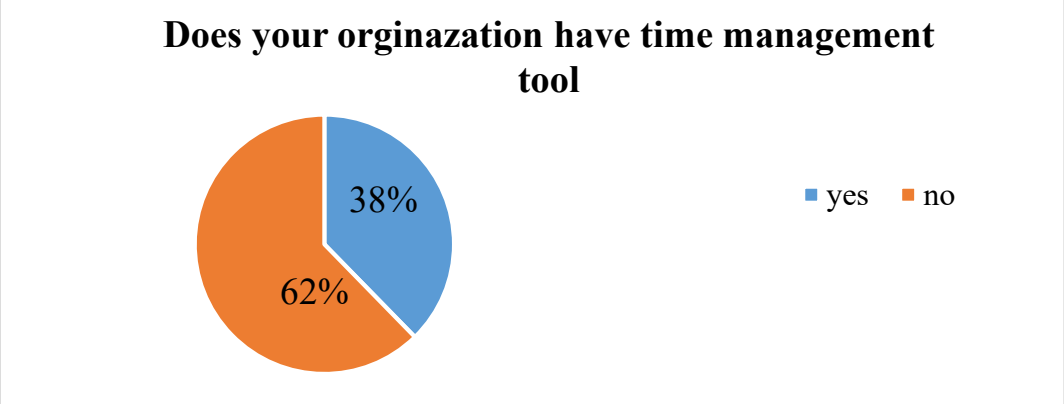

Figure 4.4.7 Existence of time management tool

Figure 4.4.7 shows that majority of construction projects hasn't time management tools (62%) interview results show that majority of construction company in Jimma Zone have not planned time management strategy. However only 38% have time management plan and prepared guideline how project scheduling can be managed.

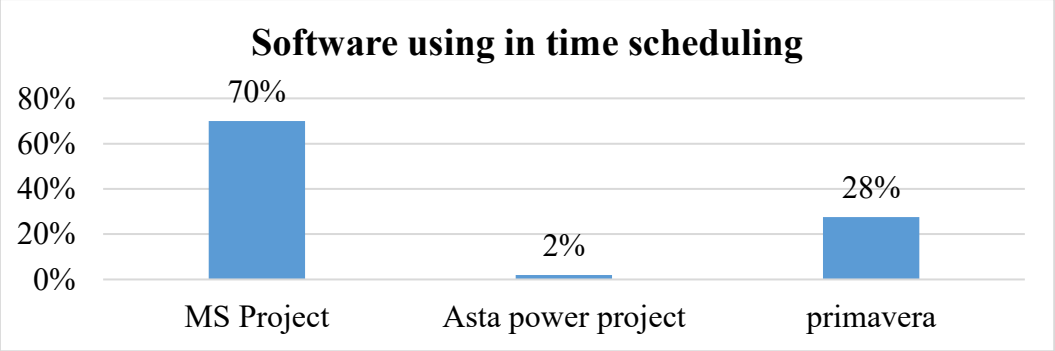

Figure 4.4.8 Software using time scheduling

Figure 4.4.8 shows that majority of construction project using MS project for time scheduling (70%) form interview results the reason why they using more MS project software is lack of skilled person majority of construction have only a person who have MS project skill this influence them to only using MS project software. but, 28% of respondents results show that weather they are using primavera software a for project time scheduling and very few construction using Asta power Project for project time scheduling.

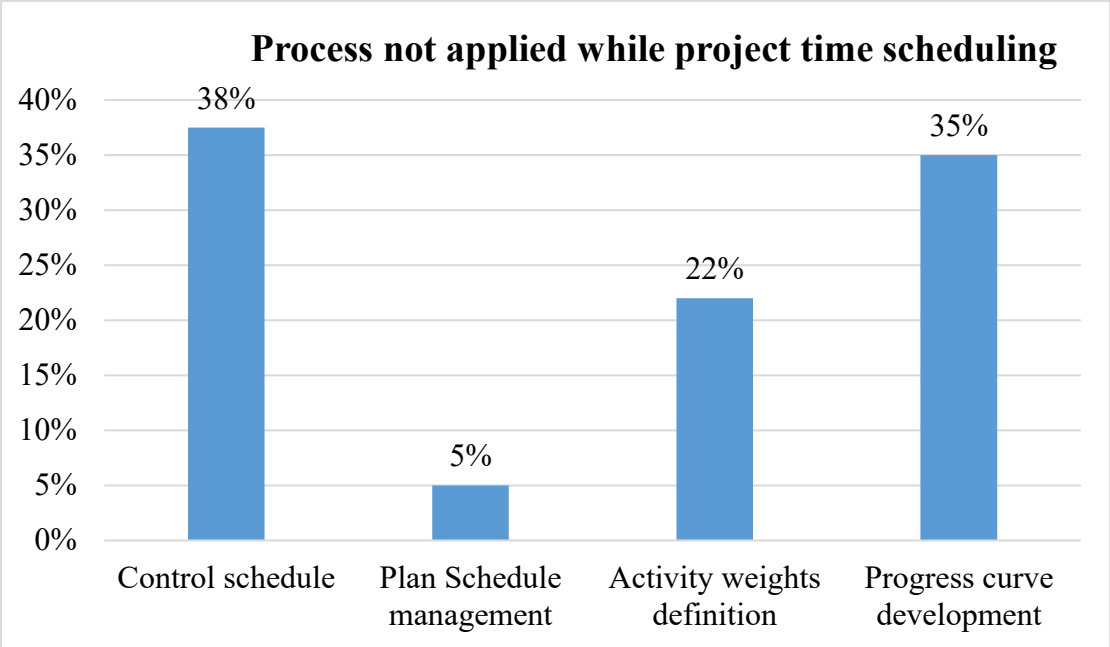

Figure 4.4.9 Process that not applied while project time scheduling

Figure 4.4.9 shows that, in project time management some process should applied to ensure the timely completion of project however, in majority of construction company that assessed by this study control schedule process is not applied (38%), next 35% of respondents results show that progress curve development process is not adopted, the 3rd process that not applied is activity weights definition and the 4th is plan schedule management process. Those activity use to evaluate the progress of time scheduling but, in majority of Construction Company it is not applied according to interview results the reason why it is not applied is lack of awareness the advantage of those method of evaluation.

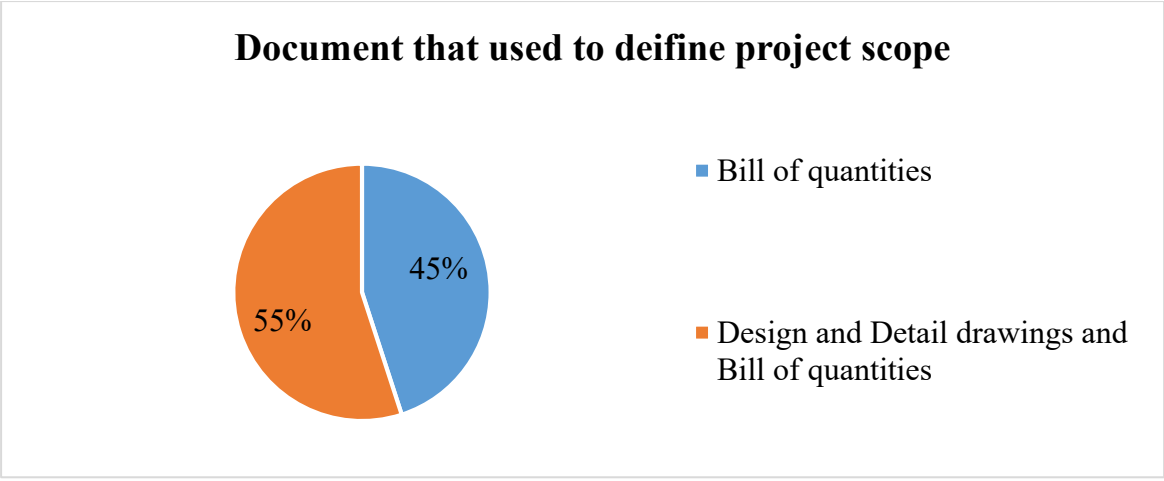

Figure 4.4.10 Document using to define the scope of project

Figure 4.4.10 shows that, majority of building Construction Company in Jimma zone is using design, detail drawing and bill of quantity to define project scope to prepare work break down structure and 45% of them are using only Bill of quantity document to define the scope the projects.

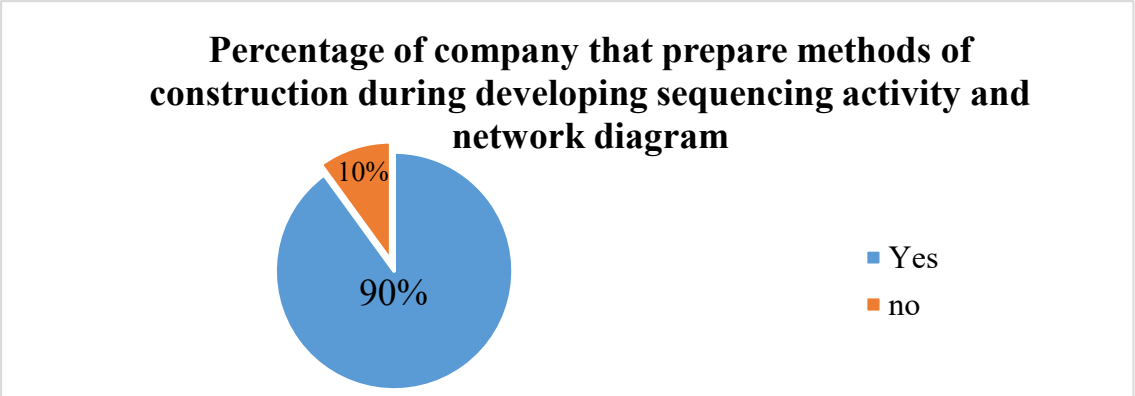

Figure 4.4.11 Percentage of organization preparing methods of construction

Figure 4.4.11 show that majority of building Construction Company in Jimma zone is preparing methods of construction to develop the sequence of activity and network diagram. However 10% of Construction Company didn't prepare methods of construction to develop the sequence of activity and network diagram.

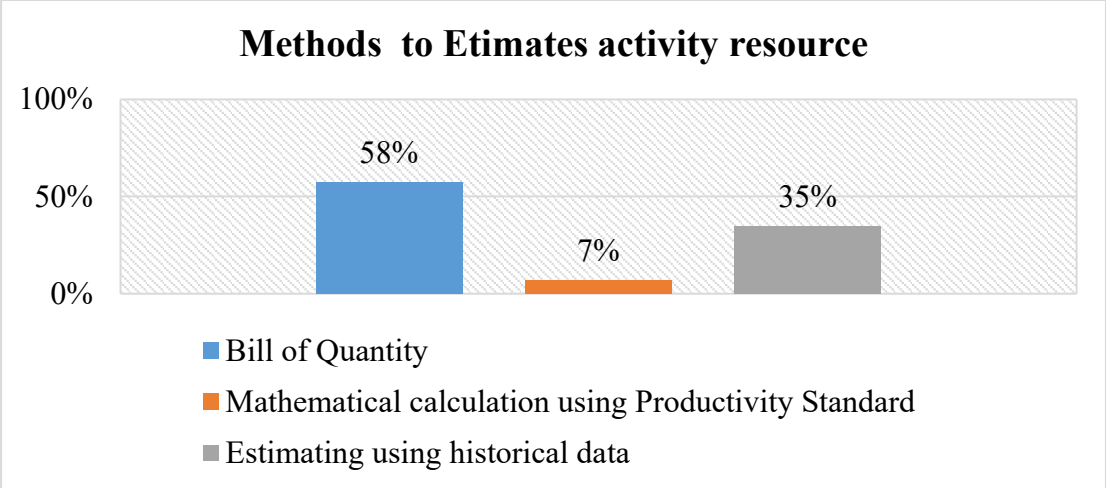

Figure 4.4.12 Methods using to estimate activity resource

Figure 4.4.12 shows that, Bill of quantity is the method that using by majority of Jimma zone building construction company. Also estimating using historical data is the second method using in Jimma zone building construction organization and 7% of organization is using mathematical calculation using productivity standard to estimate activity resources.

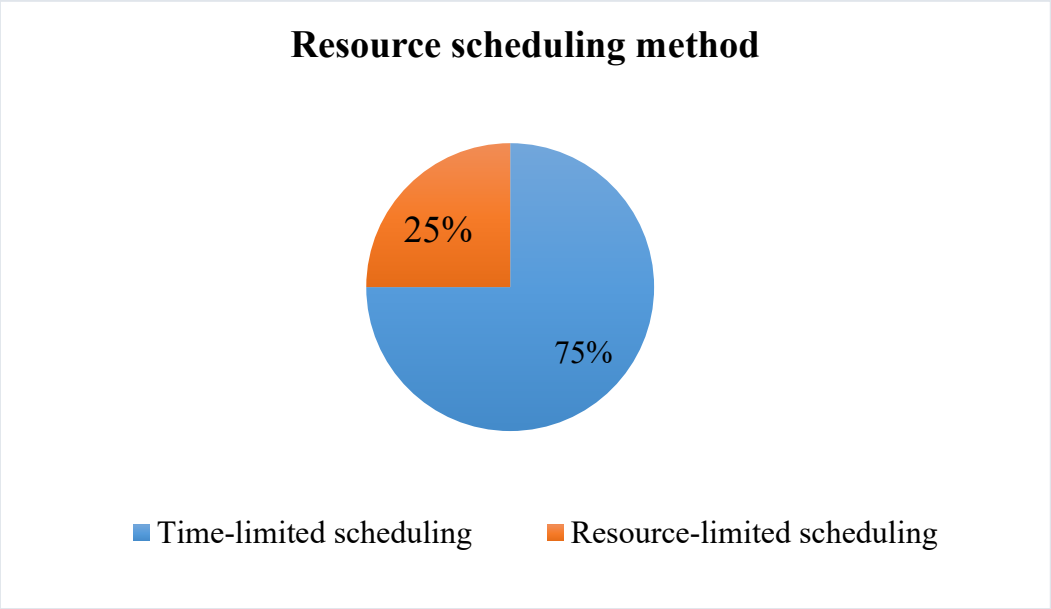

Figure 4.4.13 Resource scheduling method

Figure 4.4.13 shows that, majority (75%) of Jimma zone building Construction Company adopted time limited scheduling to resource scheduling but, result show that 25% adopted resource-limed scheduling.

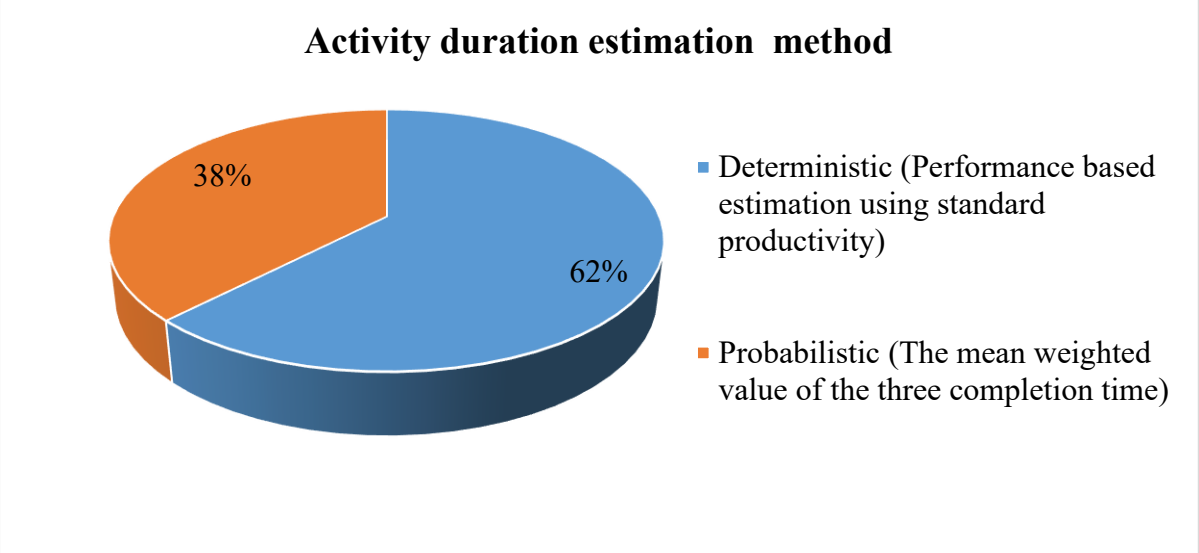

Figure 4.4.14 Activity duration estimation method

Figure 4.4.14 shows that, majority (62%) of Jimma zone building construction organization adopt Deterministic(performance based estimation using standard productivity) to estimate the duration of each activity however 38% of building construction company adopt probabilistic(the mean weighed value of the three completion time).

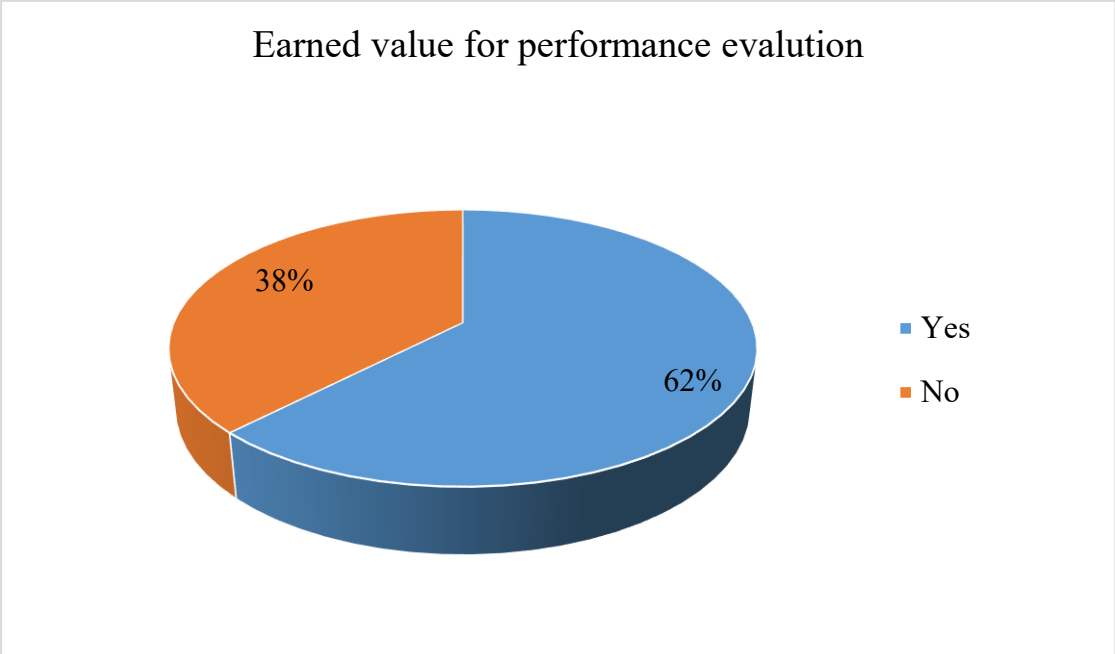

Figure 4.4.15 Percentage of using Earned Value for performance Evaluation

Figure 4.4.15 shows that, 62% of building Construction Company in Jimma zone applying Earned value to evaluate the performance of project on time management however, 38% didn't applied to evaluate the performance of the project.

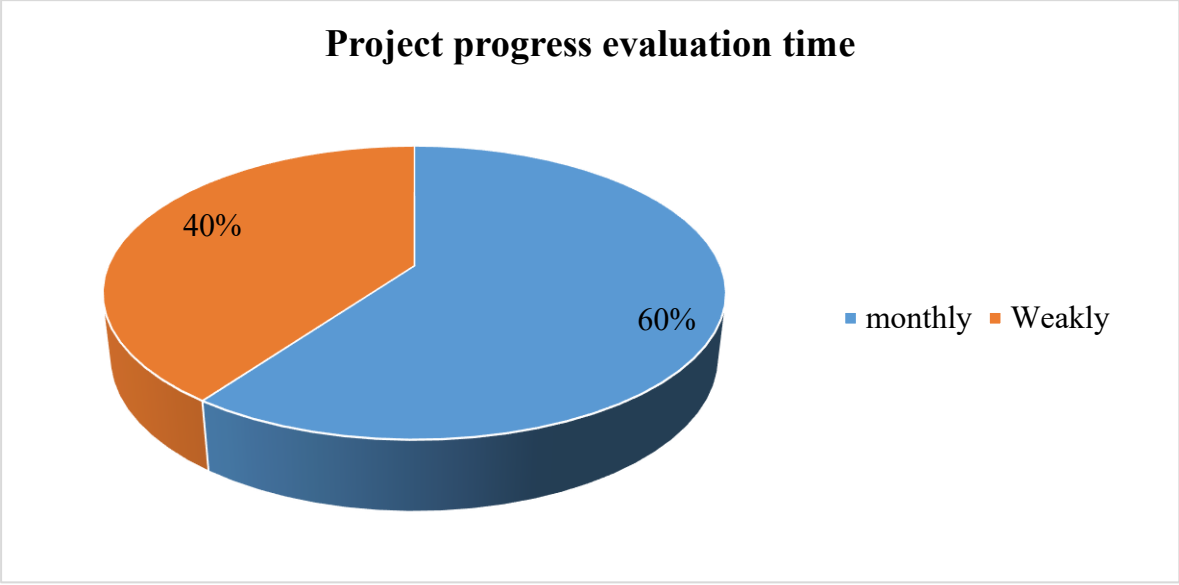

Figure 4.4.16 Project progress evaluation time

Figure 4.4.16 shows that, majority of building construction in Jimma Zone evaluate project progress per weak (60%) however, 40 % of building construction are evaluate project progress per month.

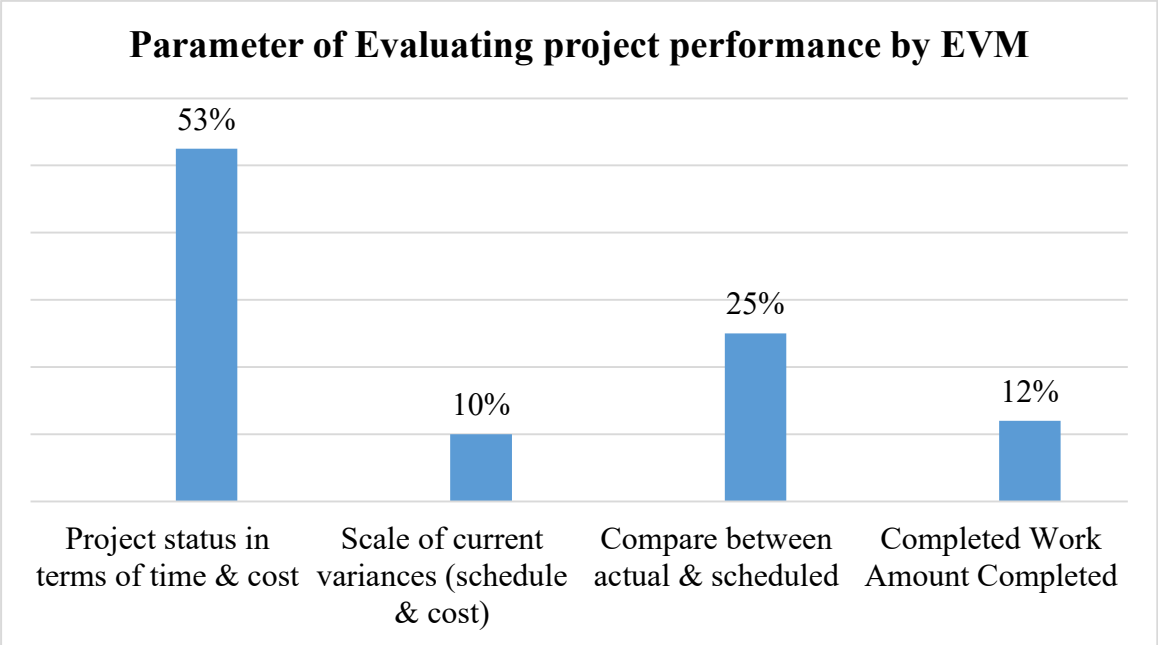

Figure 4.4.17 Parameter of evaluating project performance by EVM

Figure 4.4.17 shows that, majority of building construction in Jimma zone are evaluating project status in terms of time and cost by EVM (53%), next 25% compare between actual and scheduled by using EVM method. Also by EVM method 12% are evaluate completed work amount and 10% are evaluating scale of current variance (schedule and cost).

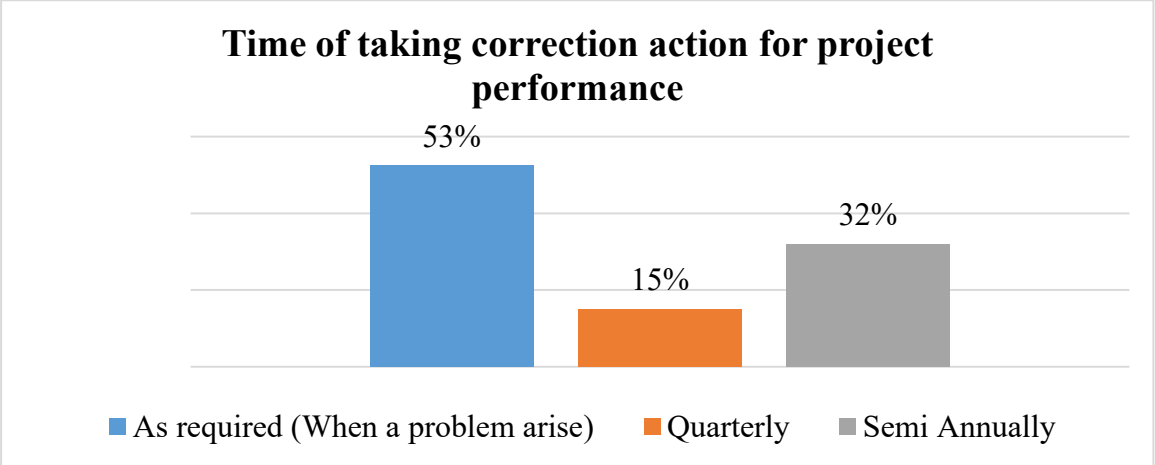

Figure 4.4.18 Frequency of correction action time for project performance

Figure 4.4.18 shows that the majority of Jimma zone Construction Company are taking correction for project success is as required time (when a problem arise)(53%), 32% of construction company also taking correction action semiannually and 15% are taking correction action quarterly.

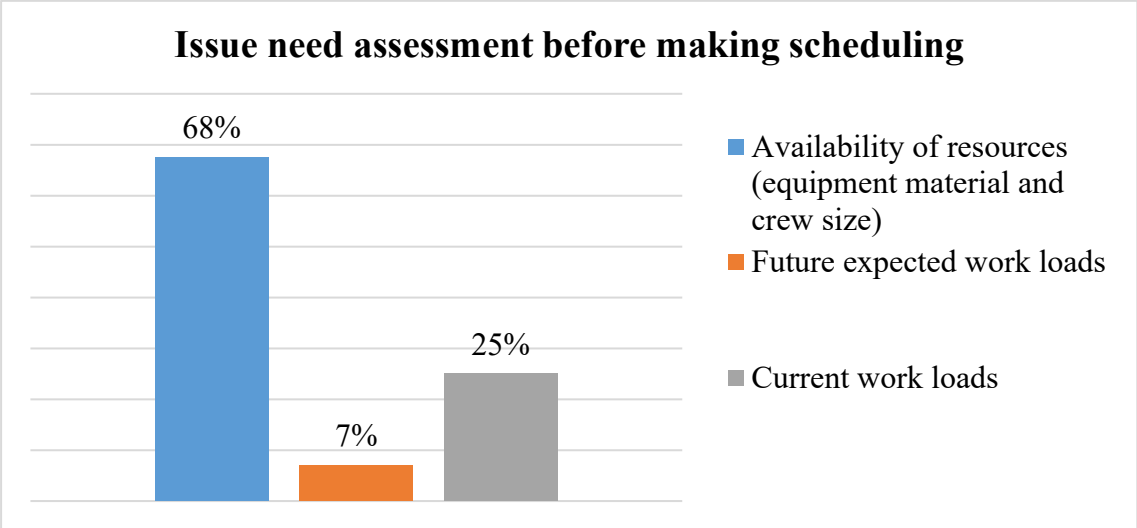

Figure 4.4.19 Issues need assessment before making scheduling

Figure 4.4.19 shows that, availability of resources (equipment material and crew size) 68% of the companies are assessing before making scheduling by majority of Jimma zone building construction, however 25% of Construction Company in Jimma zone are assessing current work load before making scheduling and 7% are assessing future expected work load before making scheduling.

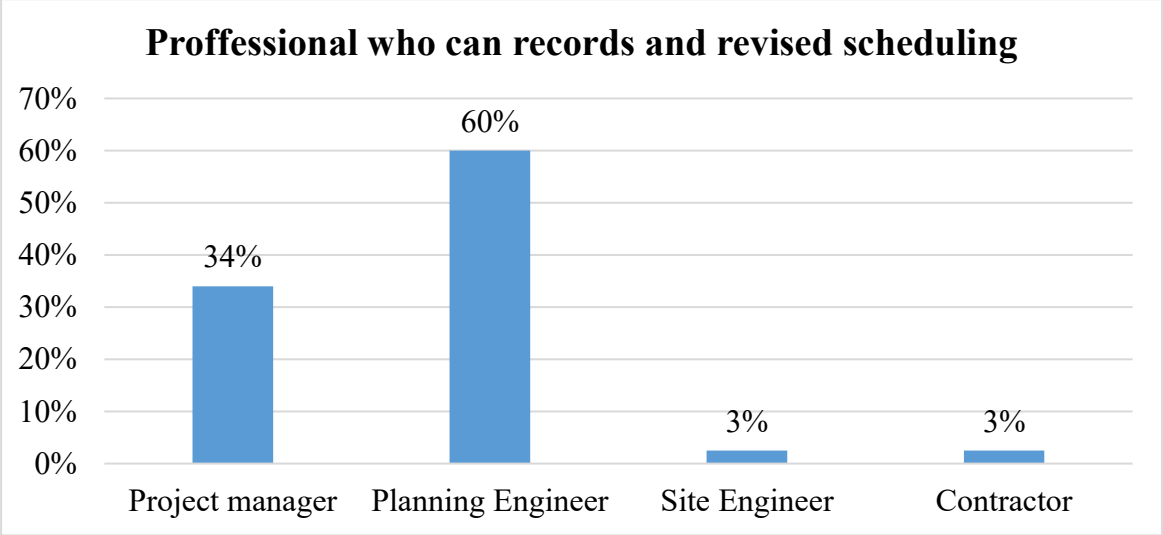

Figure 4.4.20 Professional who can records and revised scheduling

Figure 4.4.20 shows that, in majority of building construction in Jimma zone schedule record and revised by planning Engineer (60%), next to planning Engineer project manager is record and revised scheduling in building construction (34%) also in few construction company schedule is record and revised by site Engineer and contractor (3%).

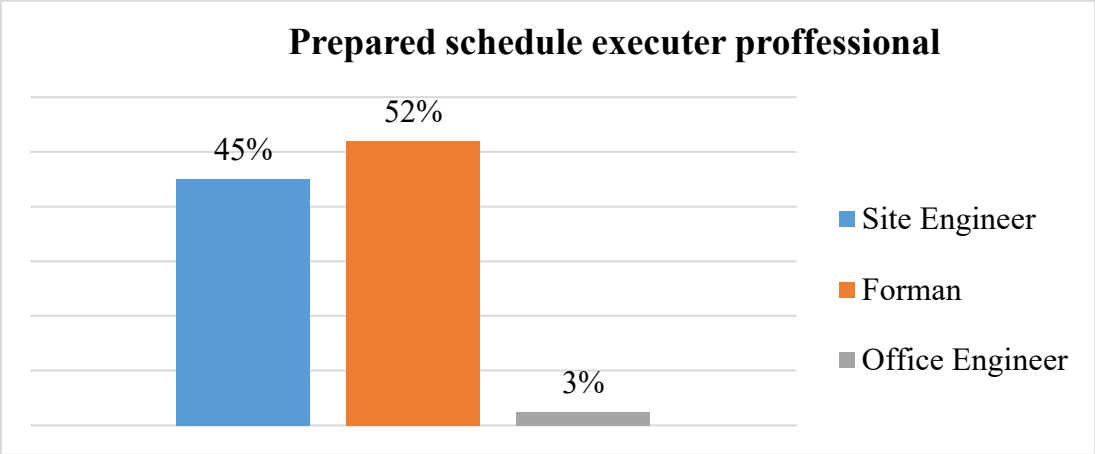

Figure 4.4.21 Schedule executor professional

Figure 4.4.21 shows that, in majority of building construction in Jimma zone prepared schedule is executing by Forman (52%), next to for man site Engineer is schedule executer in some building construction company (45%) and results show that, only in 3% of building construction company office Engineer can execute prepared schedule.

4.5 Scheduling Improvement Parameters

Table 4.5 Schedule improvement parameter

Scheduling Improvement Parameters	mean value	RII	RII and Mean Ranking	Level of Significance
Establishing the schedule management process	4.33	0.865	1	Very High
Adopting time schedule Management methodologies	3.95	0.79	5	High
Creating a well-planned project schedule	4.33	0.865	1	Very High
Assigning competent Project Manager & team	4.05	0.81	3	Very High
Understanding stakeholders needs Fully	3.90	0.78	6	High
Applying appropriate scheduling software	4.13	0.825	2	Very High
Preparing detailed specification for individual action	4.03	0.805	4	Very High
Completing design details preparation	3.93	0.785	6	high

Providing Training on project management	3.70	0.74	8	High
Establishing coordination system between the parties	3.80	0.76	7	High

Table 4.5 shows that, from schedule improvement parameter establishing the schedule management process to accomplish any activity step by step and creating a well-planned project schedule is the (RII=0.865) is the most scheduling improvement parameter in Jimma zone building projects in terms of the level of significance. Furthermore from scheduling improvement parameter applying appropriate scheduling software to reduce human error (RII=0.825), assigning competent project manager and team (RII=0.81), preparing detail specification for individual action (RII=0.805) and Adopting time schedule Management methodologies (RII=0.79) are ranked second, third, fourth and fifth positions respectively.

Besides, Completing design details preparation and Understanding stakeholders needs fully (RII=0.785), Establishing coordination system between the parties (RII=0.76) and Providing Training on project management (RII=0.74) are sixth, seventh and eighth position respectively.

Generally, when we come to discussion on the current practices of time scheduling on building construction in Jimma Zone. The results analyzed on the current practice of time scheduling is show that, majority of the building construction company using time planning at construction stage rather than pre-construction. Time scheduling Tools using in majority of Construction Company is bar chart but, this show that modern scheduling techniques no more adopted. In majority of construction company project time scheduler is civil Engineer next to that project managers however the project time schedule should have understandable by all stakeholders for project success but, if it is prepared and managed by project manager it have more advantage for project performance. The building construction company in Jimma zone is not complete as per schedule majority are complete between 76%-100% of planned scheduled this show that the project is delay. The duration of activity is assign by using past experience and in some construction company by using similar project data. Using past experience is good but, it is difficult to assign duration for current modern machine intensive projects. Majority of Construction Company in Jimma zone have not time scheduling

management tools this exposed the project for reworks and delay so, reworks and delay is the risk for project.

70% of building Construction Company using MS project software for time scheduling this show that they are very late on using new technology. There is many modern technology which develop improved time scheduling using of advance technology can make them competent within other modern construction company. Some necessary process that must for time scheduling but, not applied in Jimma zone building construction are control schedule, progress curve development those help us to evaluate project time progress easily. So, we can say the project time progress in Jimma Zone building construction is not evaluated properly. Majority of building Construction Company in Jimma zone is preparing methods of construction to develop the sequence of activity and network diagram. This can help to keep and manage total duration of project and to adjust parallel activity. Majority of construction project in Jimma Zone using BOQ method to estimate activity resource. BOQ using time scheduler to get all resource to assign for each activity. BOQ method is good method than using historical data. Deterministic (performance based estimation using standard productivity) to estimate the duration of each activity more adopted in Jimma Zone Building Construction Company. Majority of construction project progress in Jimma zone Evaluate the project progress per weak this show that they active on following the project progress. But, 40% of the construction company is evaluate per month this may not give chance to take correction action fast. In majority of construction project in Jimma Zone correction action was taken as required (only if problem raised) this can expand the chance of cumulating problem. Cumulating problem may difficult to correct in short time so, it may effect on total Duration of project.

In majority of construction company project time scheduling is executing by Forman next by site Engineer. This is good for project success because the role of Forman and site Engineer on applying design on land is very high. They are close to site works than other professionals. The most scheduling improvement parameters in building construction of Jimma Zone are establishing the schedule management process, Creating a well-planned project schedule, Applying appropriate scheduling software and Assigning competent Project Manager & team this practice can help them to

develop effective time scheduling and improve project time scheduling management system.

4.6 Scheduling Tools and Techniques For Effective Time Scheduling

Table 4.6 Construction planning and scheduling techniques

Scheduling Techniques	Mean Value	RII	RII and Mean Ranking	Level of significance
Traditional Planning Techniques	3.93	0.785	4	High
Gantt Chart	4.08	0.815	2	Very High
Cyclogram	2.93	0.585	6	Average
Network Planning Techniques	4.10	0.82	1	Very High
Critical Path Method	4.03	0.805	3	Very High
Program Evaluation and Review Technique (PERT)	3.55	0.71	5	High
Precedence Diagramming Method	2.33	0.465	8	Average
4-D CAD Visualization Techniques	2.28	0.455	9	Average
Schedule Simulator	2.25	0.45	10	Average
Smart Plant Review –Intergraph Incorporated	2.45	0.49	7	Average
Four Dviz – Balfour Technology	1.88	0.375	13	Low
Common Point 4 D	1.95	0.39	12	Low
Visual Project Scheduler	1.95	0.39	12	Low
Project Navigator 2000 – Virtual STEP	2.00	0.4	11	Low

Table 4.6 results shows that, Network planning techniques (RII=0.82) the most ranked technique for effective rime scheduling in Jimma zone building construction project in terms of the level of significance. Furthermore, Gantt Chart (RII=0.815), Critical Path Method (RII=0.805), Traditional Planning Techniques (RII=0.785), Program

Evaluation and Review techniques (PERT) (RII=0.71) and Cyclogram (RII=0.585) are ranked second, third, fourth, fifth and sixth position respectively.

Smart Plant Review –Intergraph Incorporated (RII=0.49), Precedence Diagramming Method (RII=0.465), 4-D CAD Visualization Techniques (RII=0.455), Schedule Simulator (RII=0.45) are the average ranked techniques in terms of the level of significance and ranked seventh, eighth, ninth and tenth position respectively.

Project Navigator 2000 – Virtual STEP(RII=0.4), Common Point 4 D and Visual Project Scheduler (RII=0.39) and Four Dviz – Balfour Technology(RII=0.375) are the low level ranked techniques in terms of the significance level and ranked eleventh, twelve's and thirteenth position respectively.

When we come to discussion for scheduling tools and techniques using for effective time scheduling on Building construction in Jimma Zone, the results show that the most tools and techniques using at Very High and High level in terms of the level of significance in Jimma Zone building Construction projects are.

- ✓ Network Planning Techniques
- ✓ Gantt Chart
- ✓ Critical Path Method
- ✓ Traditional Planning Techniques
- ✓ Program Evaluation and Review

The above tools and techniques are old techniques on the world. there are different modern technology for project time scheduling like 4D- CAD scheduling, Four Dviz – Balfour Technology and etc. but, those technology is not adopted more in Jimma Zone Building construction company this means they are late from the world construction company.

4.7 The challenges faced on Effective Time scheduling process

Table 4.7 Challenges of effective time scheduling

Challenges of effective time scheduling	mean value	RII	RII and Mean Rank	Level of significance
Complexity of the tools	3.60	0.72	10	High
Unable to take into account spatial planning	3.35	0.67	18	High
Technological challenges	3.85	0.77	5	High
High computer illiteracy rate (High Skill is required)	3.54	0.71	13	High
Cost of Modern planning and scheduling tools (Cost of Software)	3.85	0.77	5	High
Lack of Guidance for schedule development	3.83	0.765	6	High
Lack of Communication and coordination problem with involving parties	3.88	0.775	4	High
Lack of Continuous WBS readjustments to incorporate strategy changes	3.63	0.725	9	High
Poor project scheduling practice	3.45	0.69	15	High
Deciding to share critical resources across several projects (Over committed resources)	3.57	0.71	12	High
Inappropriate project organization structures	3.63	0.725	9	High
Incomplete design information	3.73	0.745	8	High
Poor understanding about construction works program	3.57	0.71	12	High
Low level of project management knowledge	3.60	0.72	10	High
Lack of Project management software application	4.08	0.82	1	Very High
Lack of effective leadership	3.63	0.725	9	High
Insufficient support from project stakeholders in the development of plans and schedules	3.85	0.77	5	High

Poor decision making regarding activity criticality	3.80	0.76	7	High
Lack of education and training in planning and scheduling	3.80	0.76	7	High
Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)	3.23	0.645	21	High
Absence of schedule contingency	3.83	0.765	6	High
Trivial control and reporting system between management levels	3.58	0.715	11	High
Absence of resource constrained scheduling for dealing with uncertainty problems	3.13	0.625	22	High
Lack of Well documented inputs, milestones and deliverables in scheduling	3.40	0.68	17	High
Lack of Professional team in managing scheduled activities, deviations and corrective actions	3.55	0.71	12	High
Lack of Cost-efficiency in accelerating and reworking schedules and their activities	3.45	0.69	15	High
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget	3.88	0.775	4	High
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule	3.98	0.795	2	High
Lack of Effective tracking of in progress schedule deviations	3.43	0.685	16	High
Availability of alternate planning methods to overcome shortcomings with existing methods	3.50	0.7	14	High
Maintaining schedule quality control by excluding unintended operational behavior	2.98	0.595	20	High

Lack of Effectively resource levelling in scheduling	3.95	0.79	3	High
Lack of Efficiency managerial support for motivational and training programmers	3.25	0.65	19	High

The results of analysis of the challenges faced by building construction projects in Jimma zone when practicing effecting time scheduling is present in table 4.8. as perceived by the respondents, table 4.4 revealed that lack of project management software application (RII= 0.82) is the most ranked challenge faced by Jimma Zone building construction projects in terms of the level of significance. Furthermore, Lack of fast tracking re-planning and recovery from unexpected changes in baseline schedule (RII=0.795), Lack of Effectively resource levelling in scheduling (RII=0.79), Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget (RII=0.775) and Lack of Communication and coordination problem with involving parties (RII=0.775) are ranked second, third, fourth respectively. Also interview results show that, because of skill person shortage on scheduling. Lack of fast tracking re-planning and unexpected change is occurring. Because of poor information flow and weak relationship between parties. The communication between them and awareness of about time scheduling of each professional is very low. It means there is no more Information sharing practices on time scheduling.

Technology challenges (RII=0.77), Lack of Guidance for schedule development, Absence of schedule contingency (RII=0.765), Poor decision making regarding activity criticality, Lack of education and training in planning and scheduling (RII=0.76), Incomplete design information (RII=0.745), Lack of Continuous WBS readjustments to incorporate strategy changes (RII=0.725) and Lack of effective leadership (RII=0.725) are ranked fifth, sixth, seventh, eighth and ninth respectively.

Some interview results which support fifth, sixth, eighth and ninth results show that, there is no prepared Guidelines for scheduling, the confidence of time scheduler on deciding each of activity duration is very weak also scheduler have not sufficient training on preparing scheduling the other results from interviews is there no enough information for each of structure design.

Low level of project management knowledge (RII=0.72), Complexity of tools (RII=0.72), Trivial control and reporting system between management levels (RII=0.715), Deciding to share critical resources across several projects (Over committed resources)(RII=0.71), Lack of Professional team in managing scheduled activities, deviations and corrective actions(RII=0.71), Poor understanding about construction works program(RII=0.71), High computer illiteracy rate (High Skill is required)(0.71) and Availability of alternate planning methods to overcome shortcomings with existing methods(RII=0.7) are ranked tenth, eleventh, twelve's, thirteenth and fourteenth respectively. Additional results from interview on tenth, eleventh, twelve's, thirteenth and fourteenth rank show that, scheduler have not detail knowledge on time scheduling and time scheduling management system between top and low level is very poor. The correction action is only during problem raising, also, scheduler and schedule executer computer skills is very weak. Majority of project scheduler are not creativity they can't develop project schedule by different methods without adopted one.

Lack of Cost-efficiency in accelerating and reworking schedules and their activities (RII=0.69), Poor project scheduling practice (RII=0.69), Lack of Effective tracking of in progress schedule deviations (RII=0.685), Lack of Well documented inputs, milestones and deliverables in scheduling (RII=0.68), Unable to take into account spatial planning (RII=0.67), Lack of Efficiency managerial support for motivational and training programmers (RII=0.65), Maintaining schedule quality control by excluding unintended operational behavior(RII=0.595), Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)(RII=0.645) and Absence of resource constrained scheduling for dealing with uncertainty problems(RII=0.625) are ranked fifteenth, sixteenth, seventeenth, eighteenth, twentieth, twenty one and twenty two respectively.

When we came to discussion on the challenges faced on Effective Time scheduling process on building construction projects In Jimma Zone.

Results show that the critical challenges of faced on effective time scheduling in Jimma Zone building construction company are.

- ✓ Lack of Project management software application
- ✓ Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule
- ✓ Lack of Effectively resource levelling in scheduling
- ✓ Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget
- ✓ Technological challenges
- ✓ Cost of Modern planning and scheduling tools (Cost of Software)

The above critical challenges are need immediate solution to solve the problem that effect on project by time scheduling problem.

4.8 Data reliability test

With the use of Table 4.2, the internal consistency of feedbacks from the respondents was measured based on range of the Cronbach coefficient obtained[52]. Furthermore, the Cronbach's Alpha reliability test result obtained for feedbacks on 10 scheduling Improvement parameter, 15 scheduling tools and techniques and 33 challenges of effective time scheduling. The Cronbach's Alpha values results are 0.528, 0.729 and 0.892 respectively. Meaning that the internal consistency of the feedbacks for scheduling Improvement parameter is satisfactory, for scheduling tools and techniques the feedback internal consistency is good and for challenges of effective time scheduling the internal consistency is Excellent.

Table 4.8.1 internal consistency of Cronbach's Alpha

S/N	Cronbach's alpha, α	Internal consistency
1	$\alpha \geq 0.8$	Excellent
2	$0.8 > \alpha \geq 0.7$	Good
3	$0.7 > \alpha \geq 0.5$	Satisfactory
4	$\alpha < 0.5$	Poor

Table 4.8.2 Chronbach's Alpha coefficient

	number of Items(N)	Chronbach's Alpha
scheduling improvement parameter	10	0.528
scheduling techniques	15	0.729
challenges of effective time scheduling	33	0.892

Form correlation analysis Spearman (rho) test results also show that each of variable have positive correlated.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

There are different building construction projects in Jimma Zone. Majority of those projects cannot complete on time as per scheduling, the main reason project delay in Jimma zone is Lack of Project management software application and Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule. This study assessed the effective time scheduling on building construction project, current practice of time scheduling, tools and techniques for time scheduling and challenges face on effective time scheduling process in Jimma Zone building projects.

From this study, the following conclusions was drawn:

Based on the results gained the current practices of time scheduling in Jimma Zone building construction is show that, 72% of building construction company in Jimma Zone are using time planning at construction stage, they can complete project between 76%-100% of planned scheduling it means the project cannot completed as per schedule and 70% of construction company in Jimma zone using MS project software for time scheduling this is old technology so, they are late from the world modern construction company on time scheduling. Establishing the schedule management process to accomplish any activity step by step and creating a well-planned project schedule (RII=0.865), parameter applying appropriate scheduling software (RII=0.825), assigning competent project manager and team (RII=0.81) are the most scheduling improvement parameter in Jimma Zone Building projects.

The most tools and techniques used by Jimma Zone building Construction Company for time scheduling are, Network Planning Techniques(RII=0.82), Gantt Chart (RII=0.815), Critical Path Method (RII=0.805), The most critical challenges of faced on effective time scheduling in Jimma Zone building construction company are, lack of project management software application (RII= 0.82), Lack of fast tracking re-planning and recovery from unexpected changes in baseline schedule (RII=0.795), Lack of Effectively resource levelling in scheduling (RII=0.79).

5.2 Recommendations

Based on the finding of the research the following recommendation are forwarded:

- Clients or client representative should evaluate prepared schedule before construction stage at planning stage to enhance their decision on each project task duration and sequence to avoid schedule overrun.
- Consultant should practice modern technology like 4D-scheduling to avoid lack of information flow between stakeholders on project scheduling to reduce change orders, request from contractors for extension time and to create different scheduling option.
- Contractor should build his capacity on overall project management system including application of software's through a capacity building programs and by updating him/her self within new technology. Also contractor should supplying material, equipment's and manpower before scheduling time for each project this make him to use his/her time effectively.
- All project schedule executer stakeholders should take full training on project time schedule to success project without time overrun.
- All construction company should update their project time planning from traditional to modern project time planning by developing time schedule using MS project software and integrating within BIM technology to improve project following progress systems.

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APPENDICES

Appendix A: Questionnaires

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

Questionnaire paper

Dear Respondent.

This questionnaire is prepared for a research purpose at Jimma University "Assessment on Effective Time Scheduling Practice and Challenges on Building Construction Projects in Jimma Zone" therefore, your response is very important for success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, you are kindly requested to give your response depend on question. Your response is kept in confidential and you are not required to write your name.

Email: fuadjemal533@gmail.com

Part I: General Information

1. What is your position? ----------

2. Number of years you have been working in the organization

   A. <2 years B. 2-5 years C. More than 5 years

3. The highest level of education you have accomplished

   A. Diploma B. BA/BSc C.MA/MSc D. PHD

   Another……

Part II: the current practices of time scheduling on building construction projects in Jimma Zone

4. At what stage do you/your company use time planning?

   A. At pre-construction stage B. At construction stage

   C. At post construction stage D. At all stage of construction

5. Which type of planning technique do you/your company use?

   A. Bar Chart B. LOB (Line of balance scheduling technique)

   C. CPM D. PERT (Program Evaluation and Reviewing technique)

   If other specify…….

6. Who prepares time plans in your company?

   A. Office engineers /Civil engineers B. Site engineers

   C. Project managers D. Architect

   If others; please mention…….

7. If efficiency is to measure the ratio of the scheduled completion to the completion; how do you rate the efficiency of your company in completing the project as per the schedule?

   A. 0%-15% B. 16%-50%

   C. 51%-75% D. 76%-100%

   E. >100%

8. Assigning duration to single work step or activity is believed to be one problem area in time Planning. How do you/your company assign duration to activities?

   A. Past experience B. Similar project data analysis

   C. From analysis of productivity/output of resources

If combination of the above, please identify……

9. How many duration estimates do you/ your company assign to a given activity?
   A. One-time estimates
   B. Multiple(three) time estimate
   C. Fit a non-linear distribution to time estimate

   If others……

10. Does your organization have time management tools to predict unanticipated time overruns at the early stage of building construction?

    Yes ☐ No ☐

    If yes, can you shortly brief in the space provided? (Pleas if possible attach it with the questionnaire _____

11. Which scheduling software does your company use?
    A. MS Project B. Primavera
    C. Asta power project D. Project commander

    If other, please specify……..

12. In Project Time Management the following processes is widely accepted to ensure timely completion of projects. As per your experience which part of processes is not applied while project scheduling?
    A. Plan Schedule management B. Define Activities
    C. Sequencing Activities D. Estimate Activity Resources
    E. Estimate Activity Duration F. Develop Schedule with software
    G. Activity weights definition H. Progress curve development
    I. Control schedule

13. Which document do you use to define project scope, work breakdown structure and creation of project deliverables?

    A. Design and Detail drawings B. Condition of contract & Technical Specifications
    C. Bill of quantities D. Performance Standards

    If Others (Please Specify) _____

14. While the developments of sequencing activities and Network diagram do you prepare the Method of construction/ statement?
    A. Yes B. No,

    Why? (Please specify)…….

15. In your practice, which methods are used to estimate Activity Resources?

A. Mathematical calculation using Productivity Standard
B. Estimating using Historical data
C. Bill of Quantity

Other (Please specify) _____

16. Which Resource scheduling methods do you adopt?

A. Time-limited scheduling B. Resource-limited scheduling

17. Which method do you adopt to estimate activity duration?

A. Deterministic (Performance based estimation using standard productivity)
B. Probabilistic (The mean weighted value of the three completion time)

Other (Please specify) _____

18. Do you apply earned value method for performance evaluation?

A. Yes B. No

19. Do you develop a Progress Curve (S curve) for performance evaluation?

A. Yes B. No,

20. Project progress is evaluated at a certain interval. Which time interval do you use for evaluation?

A. Weekly B. Monthly

Other (Please specify) _____

21. Project performance is evaluated commonly with the Earned Value Method (EVM)).

What parameter do you evaluate with EVM?

A. Project's status in terms of time & cost,
B. Compare between actual & scheduled
C. Scale of current variances (schedule & cost)
D. Performance Index (schedule & cost)
E. Completed Work Amount Completed

Other (Please specify) _____

22. How frequent do you take the necessary corrective actions taken during performance failure?

A. Quarterly B. Semi Annually C. Annually D. As required (When a problem arise)

23. Before preparing a schedule do you make assessment on (please select from the following)

A. Availability of resources (equipment material and crew size)

B. Current workloads C. Future expected work loads

24. Who has responsibility for recording and distributing the master & revised schedules?

A. Project manager C. Site Engineer

B. Planning Engineer D. Contractor/Office engineer

C. Consultant

Other……

25. Who is exercise the work schedule document last circulation level in your project/practice?

A. Forman B. Site Engineer

C. Office Engineer D. Supply and chain manager

Other……

26. Please indicate your level of agreement with the following statements by ticking (√) the answer that best corresponds to your feeling on which parameter you are using for preparing effective time schedule . Use the scale: 1= never 2=very Low 3=Low 4=high 5= Very High

Scheduling Improvement Parameters	5	4	3	2	1
Establishing the schedule management process					
Adopting time schedule Management methodologies					
Creating a well-planned project schedule					
Assigning competent Project Manager & team					
Understanding stakeholders needs Fully					
Applying appropriate scheduling software					
Preparing detailed specification for individual action					
Completing design details preparation					
Providing Training on project management					
Establishing coordination system between the parties					

Part III: scheduling tools and techniques using for effective time scheduling on building construction projects in Jimma Zone

27. Please indicate your level of agreement with the following statements by ticking (√) the answer that best corresponds to your feeling on the usage of the following construction planning and scheduling techniques on Building construction.

Techniques	Always	Often	Some times	Rarely	Never
	5	4	3	2	1
Traditional Planning Techniques					
Gantt Chart					
Cyclogram					
Network Planning Techniques					
Critical Path Method					
Program Evaluation and Review Technique (PERT)					
Precedence Diagramming Method					
4-D CAD Visualization Techniques					
Schedule Simulator					
Smart Plant Review –Intergraph Incorporated					
Four Dviz – Balfour Technology					
Common Point 4 D					
Visual Project Scheduler					
Project Navigator 2000 – Virtual STEP					

If Others……

Part III: the challenges faced on Effective time scheduling process on building construction projects in Jimma Zone

Please indicate your level of agreement with the following statements by ticking (√) the answer that best corresponds to your feeling on challenges faced in organization during building construction time scheduling. Use the scale: 1= never 2=very Low 3=Low 4=high 5= Very High

Challenges of effective time scheduling	**5**	**4**	**3**	**2**	**1**
Complexity of the tools					
Unable to take into account spatial planning					
Technological challenges					
High computer illiteracy rate (High Skill is required)					
Cost of Modern planning and scheduling tools (Cost of Software)					
Lack of Guidance for schedule development					
Lack of Communication and coordination problem with involving parties					
Lack of Continuous WBS readjustments to incorporate strategy changes					
Poor project scheduling practice					
Deciding to share critical resources across several projects (Over committed resources)					
Inappropriate project organization structures					
Incomplete design information					
Poor understanding about construction works program					
Low level of project management knowledge					
Lack of Project management software application					
Lack of effective leadership					
Insufficient support from project stakeholders in the development of plans and schedules					
Poor decision making regarding activity criticality					
Lack of education and training in planning and scheduling					

Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)					
Absence of schedule contingency					
Trivial control and reporting system between management levels					
Absence of resource constrained scheduling for dealing with uncertainty problems					
Lack of Well documented inputs, milestones and deliverables in scheduling					
Lack of Professional team in managing scheduled activities, deviations and corrective actions					
Lack of Cost-efficiency in accelerating and reworking schedules and their activities					
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget					
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule					
Lack of Effective tracking of in progress schedule deviations					
Availability of alternate planning methods to overcome shortcomings with existing methods					
Maintaining schedule quality control by excluding unintended operational behavior					
Lack of Effectively resource levelling in scheduling					
Lack of Efficiency managerial support for motivational and training programmers					

Interview

Dear interviewee, the purpose of this interview is to collect data only for the research work entitled "to assess the current effective time scheduling, practices and challenges of time scheduling in the case of Jimma Zone on building construction projects".

The focus of this study is to study as how time is managed in construction projects, taking Jimma Zone building construction as cases. As a professional with vast experience taking part in Jimma Zone building construction. I request you to kindly give you answers and opinions for the following questions. I assure you that this study is solely intended for academic purposes and confidentiality of your response is guaranteed.

Part I: General Information

1. Roles of interviewee…….
2. Relevant work Experience (in years)……..
3. Educational qualification……

Part II: time scheduling practices in building construction

4. Who involved in the schedule preparation?

   A. Office engineers B. Project supervisor C. Site engineers
   D. Project managers E. Architect

5. Describe a project you involved in
   - Project actual duration: _____
   - Project status: _____
   - Project planned duration: _____

6. Is there standard time management techniques/methods (such as Bar chart, Critical Path Method (CPM), PERT, LOB or Other) in place for this project? If your answer is yes, could you list?

   A. YES ☐ B. NO ☐

If your answer is yes, could you mention which one? …… ……

7. Who is responsible for revise your schedule?

   A. Office engineers B. Civil engineers C. Site engineers
   D. Project managers E. Architect

If other_____

8. Do you prepare method of construction while activity & resource estimation?

☐ ☐

A, YES B, NO

9. Do you have a regular meeting on progress evaluation?

A, YES ☐ B, NO ☐

10. What kind of action take for schedule improvement?

……

11. Do you use scheduling software (such as Microsoft project, Asta power project, Primavera, Project commander or others) in this project? If your answer is yes, could you mention which one?

A, YES ☐ B, NO ☐

If your answer is yes, could you mention which one? …… ……

12. Do you instruct/advise the Engineer/Consultant to prepare different levels of work programmes such as master work programme, summary and detail work programmes?

A, YES ☐ B, NO ☐

If your answer is yes, could you mention which one? …… ……

Part III: Tools and Techniques of time scheduling

13. Which technique you using for time scheduling in your project? Why?

A, MS Project B, Excel spreadsheets C, Primavera

Other (Please specify) _____

Part IV: Challenges of effective time scheduling

14. What are the challenges you faced during preparation of time schedule in your company?

……

……

Appendix B: project manager response on scheduling improvement methods

Scheduling Improvement Parameters	1	2	3	4	5
Establishing the schedule management process	0	0	0	4	1
Adopting time schedule Management methodologies	0	0	0	5	0
Creating a well-planned project schedule	0	0	0	3	2
Assigning competent Project Manager & team	0	0	2	0	3
Understanding stakeholders needs Fully	0	0	2	1	2
Applying appropriate scheduling software	0	0	0	3	2
Preparing detailed specification for individual action	0	0	1	0	4
Completing design details preparation	0	0	1	2	2
Providing Training on project management	0	0	2	3	0
Establishing coordination system between the parties	0	0	2	2	1

Appendix C: Engineer Response on scheduling Improvement Methods

Scheduling Improvement Parameters	1	2	3	4	5
Establishing the schedule management process	0	0	1	10	6
Adopting time schedule Management methodologies	0	0	2	12	3
Creating a well-planned project schedule	0	0	2	8	7
Assigning competent Project Manager & team	0	0	3	12	2
Understanding stakeholders needs Fully	0	0	4	11	2
Applying appropriate scheduling software	0	0	2	9	6
Preparing detailed specification for individual action	0	0	2	12	3
Completing design details preparation	0	0	5	8	4
Providing Training on project management	0	0	10	6	1
Establishing coordination system between the parties	0	0	7	8	2

Appendix D: Site Engineer Response on scheduling Improvement Methods

Scheduling Improvement Parameters	1	2	3	4	5
Establishing the schedule management process	0	0	1	4	6
Adopting time schedule Management methodologies	0	0	3	7	1
Creating a well-planned project schedule	0	0	0	6	5
Assigning competent Project Manager & team	0	0	3	5	3
Understanding stakeholders needs Fully	0	0	3	7	1
Applying appropriate scheduling software	0	0	2	7	2
Preparing detailed specification for individual action	0	1	1	6	3
Completing design details preparation	0	0	4	5	2
Providing Training on project management	0	1	3	5	2
Establishing coordination system between the parties	0	1	4	4	2

Appendix E: Contactor Response on scheduling Improvement Methods

Scheduling Improvement Parameters	1	2	3	4	5
Establishing the schedule management process	0	0	0	5	2
Adopting time schedule Management methodologies	0	0	2	2	3
Creating a well-planned project schedule	0	0	0	6	1
Assigning competent Project Manager & team	0	0	0	4	3
Understanding stakeholders needs Fully	0	0	1	5	1
Applying appropriate scheduling software	0	0	3	2	2
Preparing detailed specification for individual action	0	0	2	2	3
Completing design details preparation	0	0	3	2	2
Providing Training on project management	0	0	1	2	4
Establishing coordination system between the parties	0	0	2	3	2

Appendix F: Project manager Response on Time scheduling tools and techniques

Techniques	1	2	3	4	5
Traditional Planning Techniques	0	0	0	4	1
Gantt Chart	0	1	1	2	1
Cyclogram	0	2	2	1	0
Network Planning Techniques	0	0	2	2	1
Critical Path Method	0	0	1	2	2
Program Evaluation and Review	0	0	1	3	1
Technique (PERT)	0	0	2	2	1
Precedence Diagramming Method	1	1	2	1	0
4-D CAD Visualization Techniques	0	2	2	0	1
Schedule Simulator	0	3	1	0	1
Smart Plant Review –Intergraph Incorporated	1	0	3	1	0
Four Dviz – Balfour Technology	2	3	0	0	0
Common Point 4 D	1	3	0	1	0
Visual Project Scheduler	2	1	0	1	1
Project Navigator 2000 – Virtual STEP	0	1	3	1	0

Appendix G: Engineer Response on Time scheduling tools and techniques

Techniques	1	2	3	4	5
Traditional Planning Techniques	1	0	4	6	6
Gantt Chart	0	2	1	5	9
Cyclogram	2	2	5	7	1
Network Planning Techniques	0	0	3	8	6
Critical Path Method	1	0	6	4	6
Program Evaluation and Review	1	1	5	6	4
Technique (PERT)	1	2	7	7	0
Precedence Diagramming Method	7	2	5	2	1
4-D CAD Visualization Techniques	6	5	6	0	0
Schedule Simulator	5	7	4	1	0
Smart Plant Review –Intergraph Incorporated	3	5	5	4	0
Four Dviz – Balfour Technology	8	7	2	0	0
Common Point 4 D	9	6	2	0	0
Visual Project Scheduler	6	10	0	1	0
Project Navigator 2000 – Virtual STEP	9	7	1	0	0

Appendix H: Site Engineer Response on Time scheduling tools and techniques

Techniques	1	2	3	4	5
Traditional Planning Techniques	0	0	3	4	4
Gantt Chart	0	2	0	4	5
Cyclogram	2	2	6	1	0
Network Planning Techniques	0	0	3	4	4
Critical Path Method	0	0	4	2	5
Program Evaluation and Review	1	0	5	3	2
Technique (PERT)	0	0	7	1	3
Precedence Diagramming Method	4	1	3	2	1
4-D CAD Visualization Techniques	5	3	1	1	1
Schedule Simulator	2	7	0	0	2
Smart Plant Review –Intergraph Incorporated	2	5	3	0	1
Four Dviz – Balfour Technology	5	3	1	2	0
Common Point 4 D	2	5	3	1	0
Visual Project Scheduler	5	4	0	2	0
Project Navigator 2000 – Virtual STEP	3	5	2	1	0

Appendix I: Contractor Response on Time scheduling tools and techniques

Techniques	1	2	3	4	5
Traditional Planning Techniques	0	0	5	2	0
Gantt Chart	0	0	3	2	2
Cyclogram	2	0	2	2	1
Network Planning Techniques	0	0	3	0	4
Critical Path Method	0	0	0	5	2
Program Evaluation and Review	1	0	3	3	0
Technique (PERT)	1	0	3	2	1
Precedence Diagramming Method	4	0	2	1	0
4-D CAD Visualization Techniques	2	2	1	0	1
Schedule Simulator	1	3	2	1	0
Smart Plant Review –Intergraph Incorporated	2	3	2	0	0
Four Dviz – Balfour Technology	1	4	0	2	0
Common Point 4 D	3	2	0	2	0
Visual Project Scheduler	2	3	2	0	0
Project Navigator 2000 – Virtual STEP	2	1	4	0	0

Appendix J: Project manager Response on challenges of time scheduling

Challenges of effective time scheduling	1	2	3	4	5
Complexity of the tools	0	0	1	3	1
Unable to take into account spatial planning	0	0	0	4	1
Technological challenges	0	0	1	2	2
High computer illiteracy rate (High Skill is required)	0	1	2	1	1
Cost of Modern planning and scheduling tools (Cost of Software)	0	1	0	3	1
Lack of Guidance for schedule development	0	0	2	3	0
Lack of Communication and coordination problem with involving parties	0	0	3	1	1
Lack of Continuous WBS readjustments to incorporate strategy changes	0	1	1	3	0
Poor project scheduling practice	0	1	1	3	0
Deciding to share critical resources across several projects (Over committed resources)	0	1	0	4	0
Inappropriate project organization structures	0	0	0	3	2
Incomplete design information	0	0	0	5	0
Poor understanding about construction works program	0	0	1	3	1
Low level of project management knowledge	0	0	1	2	2
Lack of Project management software application	0	1	0	2	2
Lack of effective leadership	0	1	1	0	3

Insufficient support from project stakeholders in the development of plans and schedules	0	0	2	2	1
Poor decision making regarding activity criticality	0	0	0	5	0
Lack of education and training in planning and scheduling	0	0	1	4	0
Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)	0	0	2	3	0
Absence of schedule contingency	0	0	1	4	0
Trivial control and reporting system between management levels	0	0	2	3	0
Absence of resource constrained scheduling for dealing with uncertainty problems	0	2	1	2	0
Lack of Well documented inputs, milestones and deliverables in scheduling	0	0	2	2	1
Lack of Professional team in managing scheduled activities, deviations and corrective actions	0	1	2	1	1
Lack of Cost-efficiency in accelerating and reworking schedules and their activities	0	1	2	0	2
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget	0	0	1	4	0
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule	0	0	0	4	1
Lack of Effective tracking of in progress schedule deviations	0	1	1	2	1
Availability of alternate planning methods to overcome shortcomings with existing methods	0	2	1	1	1
Maintaining schedule quality control by excluding unintended operational behavior	0	1	1	3	0
Lack of Effectively resource levelling in scheduling	0	0	0	2	3
Lack of Efficiency managerial support for motivational and training programmers	0	0	1	2	2

Appendix K: Engineer Response on challenges of time scheduling

Challenges of effective time scheduling	**1**	**2**	**3**	**4**	**5**
Complexity of the tools	0	1	7	9	0
Unable to take into account spatial planning	2	0	7	8	0
Technological challenges	0	1	3	10	3
High computer illiteracy rate (High Skill is required)	1	3	2	9	2
Cost of Modern planning and scheduling tools (Cost of Software)	0	0	5	9	3
Lack of Guidance for schedule development	0	1	7	6	3
Lack of Communication and coordination problem with involving parties	0	1	7	6	3
Lack of Continuous WBS readjustments to incorporate strategy changes	0	2	5	8	2
Poor project scheduling practice	0	1	4	10	2
Deciding to share critical resources across several projects (Over committed resources)	0	2	4	8	3
Inappropriate project organization structures	0	2	5	8	2

Incomplete design information	0	1	3	10	3
Poor understanding about construction works program	0	1	7	7	2
Low level of project management knowledge	1	2	7	6	1
Lack of Project management software application	1	1	4	7	4
Lack of effective leadership	1	1	6	5	4
Insufficient support from project stakeholders in the development of plans and schedules	1	0	2	7	7
Poor decision making regarding activity criticality	0	1	2	10	4
Lack of education and training in planning and scheduling	1	0	4	8	4
Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)	1	2	7	6	1
Absence of schedule contingency	0	0	6	8	3
Trivial control and reporting system between management levels	1	0	4	10	2
Absence of resource constrained scheduling for dealing with uncertainty problems	0	7	3	5	2
Lack of Well documented inputs, milestones and deliverables in scheduling	1	1	7	8	0
Lack of Professional team in managing scheduled activities, deviations and corrective actions	1	0	6	10	0
Lack of Cost-efficiency in accelerating and reworking schedules and their activities	0	2	5	8	2
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget	0	0	1	12	4
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule	0	0	3	12	2
Lack of Effective tracking of in progress schedule deviations	0	1	6	8	2
Availability of alternate planning methods to overcome shortcomings with existing methods	0	0	9	6	2
Maintaining schedule quality control by excluding unintended operational behavior	0	4	7	6	0
Lack of Effectively resource levelling in scheduling	0	0	7	7	3
Lack of Efficiency managerial support for motivational and training programmers	0	3	7	7	0

Appendix L: site Engineer Response on challenges of time scheduling

Challenges of effective time scheduling	**1**	**2**	**3**	**4**	**5**
Complexity of the tools	0	0	7	4	0
Unable to take into account spatial planning	1	1	4	4	1
Technological challenges	0	0	5	4	2
High computer illiteracy rate (High Skill is required)	0	0	3	7	1
Cost of Modern planning and scheduling tools (Cost of Software)	0	0	0	7	4
Lack of Guidance for schedule development	0	0	2	7	2
Lack of Communication and coordination problem with involving parties	0	0	2	7	2

Lack of Continuous WBS readjustments to incorporate strategy changes	0	1	3	3	4
Poor project scheduling practice	0	3	2	5	1
Deciding to share critical resources across several projects (Over committed resources)	0	1	3	7	0
Inappropriate project organization structures	0	1	1	7	2
Incomplete design information	0	1	2	6	2
Poor understanding about construction works program	0	0	4	5	2
Low level of project management knowledge	0	0	5	3	3
Lack of Project management software application	0	0	0	5	6
Lack of effective leadership	0	1	3	6	1
Insufficient support from project stakeholders in the development of plans and schedules	1	1	2	3	4
Poor decision making regarding activity criticality	0	1	3	4	3
Lack of education and training in planning and scheduling	0	0	2	5	4
Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)	0	2	5	4	0
Absence of schedule contingency	0	0	1	7	3
Trivial control and reporting system between management levels	0	0	4	4	3
Absence of resource constrained scheduling for dealing with uncertainty problems	0	5	2	4	0
Lack of Well documented inputs, milestones and deliverables in scheduling	0	0	6	5	0
Lack of Professional team in managing scheduled activities, deviations and corrective actions	0	1	3	5	2
Lack of Cost-efficiency in accelerating and reworking schedules and their activities	0	0	5	6	0
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget	1	0	1	7	2
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule	0	0	2	4	5
Lack of Effective tracking of in progress schedule deviations	0	2	4	3	2
Availability of alternate planning methods to overcome shortcomings with existing methods	0	1	5	3	2
Maintaining schedule quality control by excluding unintended operational behavior	2	1	3	5	0
Lack of Effectively resource levelling in scheduling	0	0	2	6	3
Lack of Efficiency managerial support for motivational and training programmers	0	3	2	6	0

Appendix M: Contractor Response on challenges of time scheduling

Challenges of effective time scheduling	1	2	3	4	5
Complexity of the tools	0	0	3	2	2
Unable to take into account spatial planning	2	0	0	5	0
Technological challenges	0	2	0	3	2
High computer illiteracy rate (High Skill is required)	2	0	0	5	0
Cost of Modern planning and scheduling tools (Cost of Software)	0	2	3	2	0
Lack of Guidance for schedule development	0	0	0	6	1
Lack of Communication and coordination problem with involving parties	0	0	0	4	3
Lack of Continuous WBS readjustments to incorporate strategy changes	0	1	2	4	0
Poor project scheduling practice	2	0	3	1	1
Deciding to share critical resources across several projects (Over committed resources)	0	0	6	0	1
Inappropriate project organization structures	0	4	0	3	0
Incomplete design information	0	2	3	2	0
Poor understanding about construction works program	0	4	0	3	0
Low level of project management knowledge	0	0	3	3	1
Lack of Project management software application	0	0	3	1	3
Lack of effective leadership	0	2	0	4	1
Insufficient support from project stakeholders in the development of plans and schedules	0	2	0	4	1
Poor decision making regarding activity criticality	0	2	3	2	0
Lack of education and training in planning and scheduling	0	2	2	3	0
Incompatibility of planning methods with the project schedule's nature (i.e., complexity and size)	0	2	2	2	1
Absence of schedule contingency	0	2	2	2	1
Trivial control and reporting system between management levels	2	0	3	2	0
Absence of resource constrained scheduling for dealing with uncertainty problems	0	2	0	5	0
Lack of Well documented inputs, milestones and deliverables in scheduling	0	2	1	4	0
Lack of Professional team in managing scheduled activities, deviations and corrective actions	0	0	4	3	0
Lack of Cost-efficiency in accelerating and reworking schedules and their activities	0	0	4	3	0
Lack of Proper understanding of the interrelationship (alignment) between scope, schedule and budget	0	2	2	2	1
Lack of Fast re-planning and recovery from unexpected changes in the baseline schedule	0	2	0	5	0
Lack of Effective tracking of in progress schedule deviations	0	3	2	2	0

Availability of alternate planning methods to overcome shortcomings with existing methods	0	2	0	4	1
Maintaining schedule quality control by excluding unintended operational behavior	0	5	2	0	0
Lack of Effectively resource levelling in scheduling	0	0	4	1	2
Lack of Efficiency managerial support for motivational and training programmers	0	3	3	1	0

Appendix N: SPSS Output

Reliability on scheduling improvement parameter

Reliability Statistics

Cronbach's Alpha	N of Items
.528	10

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	35.8500	8.028	.157	.519
Q2	36.1750	7.379	.347	.470
Q3	35.8500	7.772	.240	.499
Q4	36.1000	7.374	.268	.488
Q5	36.2750	7.435	.299	.481
Q6	36.0500	8.151	.062	.548
Q7	36.1500	6.438	.548	.397
Q8	36.2500	9.731	-.304	.654
Q9	36.4500	6.408	.464	.416
Q10	36.4250	6.866	.344	.461

Reliability for scheduling techniques

Reliability Statistics

Cronbach's Alpha	N of Items
.729	15

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted

Q11	39.20	52.010	-.234	.765
Q12	39.05	50.664	-.132	.762
Q13	40.18	46.302	.147	.736
Q14	39.00	44.718	.407	.710
Q15	39.08	50.994	-.156	.760
Q16	39.55	42.921	.413	.706
Q17	39.70	46.831	.156	.732
Q18	40.75	42.603	.327	.717
Q19	40.83	38.661	.622	.677
Q20	40.80	40.933	.549	.690
Q21	40.65	43.618	.372	.711
Q22	41.23	40.640	.690	.679
Q23	41.15	42.079	.545	.694
Q24	41.15	38.079	.831	.658
Q25	41.10	42.041	.589	.691

Reliability for challenges of effective time scheduling

Reliability Statistics

Cronbach's Alpha	N of Items
.892	33

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q26	115.85	192.541	.141	.893
Q27	116.08	181.302	.455	.889
Q28	115.58	179.687	.656	.885
Q29	115.93	176.122	.652	.884
Q30	115.58	186.302	.380	.890
Q31	115.60	192.246	.146	.894
Q32	115.55	191.023	.182	.893
Q33	115.80	187.087	.316	.891
Q34	115.98	179.922	.541	.887
Q35	115.85	187.259	.347	.891
Q36	115.78	182.794	.465	.889
Q37	115.70	189.703	.234	.893
Q38	115.85	181.721	.558	.887
Q39	115.83	183.533	.447	.889
Q40	115.40	181.887	.473	.888
Q41	115.78	178.025	.588	.886
Q42	115.55	177.228	.579	.886
Q43	115.65	179.208	.680	.885

Q44	115.63	180.394	.589	.886
Q45	116.15	180.900	.592	.886
Q46	115.60	184.195	.511	.888
Q47	115.85	173.977	.797	.882
Q48	116.33	192.994	.058	.897
Q49	116.03	189.922	.238	.892
Q50	115.90	184.297	.482	.888
Q51	115.88	189.856	.239	.892
Q52	115.55	183.177	.508	.888
Q53	115.45	184.767	.518	.888
Q54	115.98	187.563	.282	.892
Q55	115.90	185.836	.364	.891
Q56	116.45	191.638	.124	.895