EFFECT OF PROJECT TIME CONTROL ON THE DELIVERY OF THE AYI-MENSAH HOUSING PROJECT BY KRANE CONSTRUCTION

By

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and behalf, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgement is made in the thesis.

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ABSTRACT

This research selected the Ayi Mensah Housing project to review the time control practices on the project and objectives included examining the time control practices, identifying challenges with their implementation and proposing best practices for project time control. The literature review unearthed relevant past research on the subject matter and formed the bases for the research instrument that was targeted at staff members working on the Ayi Mensah Housing project for data collection. A descriptive research design was adopted, and also applied a mixed method approach towards data collection and analysis. Based on the analysis of the data collected, in line with the literature findings, it was concluded that time control practices on the Ayi Mensah Housing project were in line with recommendations for industry and practice, including definition of activities, sequencing, estimation of resources and duration and finally scheduling. The selection of tools used for time control purposes were also in line with industry specifications, including most common ones such as Precedence Network Diagrams, Critical Path Network, Templates and Critical Path Analysis. The research also concluded that computer software were heavily relied on for project scheduling, and included the use of Microsoft Project and Microsoft Excel. In terms of the identified challenges to implementing time control practices, it was concluded that the most significant for the Ayi Mensah Housing project included scope changes, improper risk analysis and management, impossible deadlines, estimating task duration and assigning resources. Best practices identified for successful time control was for the strengthening of the existing practices, such as the use of standardized templates, precedence and critical networks and adequate allocation for risk. It was also recommended that project managers build their capacity, commit resources and time to planning and companies adopt time control policies.

Key words: **Time control, project management**

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LIST OF ABBREVIATIONS

CIOB	Chartered Institute of Builders
EPSRC	Engineering and Physical Sciences Research Council
FF	Finish to Finish
FS	Finish to Start
GDP	Gross Domestic Product
LOB	Line of Balance
PDM	Precedence Diagram Method
PERT	Project Evaluation and Review Technique
PMBOK	Project Management Book of Knowledge
PMI	Project Management Institute
SF	Start to Finish
SS	Start to Start
WBS	Work Breakdown Structure

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DEDICATION

This project work is dedicated to my family, Ms Charity Agbenyegah, Mr Sebbastian Adika, and Mrs Anthea Aforkor Okle for their enormous support and prayers and all my loved ones who have provided support in diverse ways throughout the course of my study.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

According to Anaman and Amponsah (2014) the construction industry within any country represents a very important sector for driving growth and development, in part due to it being an engine for providing infrastructure, a significant element of development, but as well, also due to its contributions towards the Gross Domestic Product (GDP). GDP contribution from the construction industry in Ghana has averaged about GHS2745.12 million annually, from 2006 to 2019, and reached its all-time high of GHS3587.37 million in the third quarter of 2018 (Anaman & Amponsah, 2014). This has represented between 14.5% and 14.9% of GDP annually, according to the Oxford Business Group (2017). As an employer, the Oxford Business Group (2017) estimates that annually the construction sector in Ghana employs up to three hundred thousand Ghanaians, with an expectation of significant growth in the future (Ghana Statistical Service, 2018).

This therefore paints a picture of how significant the construction sector in Ghana is to national development, though it has still been challenged in several areas, with one of such being the inability to deliver projects according to time schedules. Delays and challenges of time management on construction have become a global phenomenon, where projects regularly are unable to meet the time schedules, and the resultant time overruns leading to cost overruns, disputes and litigation (Odeh and Battaineh, 2012). It therefore becomes imperative that there be efficient project time management for successful project delivery and higher productivity levels.

The Chartered Institute of Building (2013) conducted a research to determine how time management and time control practices were applied within the construction industry, as well as the level of training and understanding that existed among professionals in the industry with regards to the application of time control tools. The findings made were significant, and included the fact that time management practices on construction projects were generally poor while training and education on the application of time controls in the industry was not abreast with the pace of technological developments. CIOB (2013) also concluded from its research that there were very few projects actually applied modern project time control techniques. Another research was conducted by Ahmed et al (2013) which also concluded that delays occur in almost all construction projects, though the difference only exists with the level and magnitude that occurs, while research by EL-Razek et al (2015) also found that in most cases, there is no singularity of mind or agreement among construction professionals about the factors that contribute to delays on construction projects.

According to the Project Management Book of Knowledge (2017) definition, project time management involves all processes that ensure that there is a timely delivery of the project to the client. To achieve successful time management on a project the relevant activities need to be defined, as well the expected sequence for undertaking each activity also outlined. From that point the project team can determine the necessary resources needed for each activity and estimate the duration so that a complete project schedule can be developed and controlled. The planning and scheduling functions of project time management require experience and expertise, as noted by Chamoun (2016) because no two projects can have the same schedule, no matter how similar they may be. In most cases, a single project manager can often plan and schedule all activities on a smaller

scale project, but with larger scale specifications, an entire professional project team may be required to undertake the planning and scheduling function (Chamoun, 2016).

1.2 PROBLEM STATEMENT

Time management forms a significant aspect of project management within the construction industry, but the challenge still remains that on most projects, there is a difficulty in meeting time schedules set out for completion. Without proper time management, many problems will occur such as extension of time or time overrun (Marsouk et al., 2018). Some of the researchers describe time overrun as delay and some of them describe that the time overrun is an effect from the construction delay, no matter what it was described, time overrun become the most general problem in construction industry worldwide (Singh, 2014). Time overrun occur when the actual progress of a construction project is slower than the planned schedule. Delay or time overrun will affect all parties involved in the project. It will affect the profits which would be obtained if the project can be completed on the schedule (Faradi and El-Sayegh, 2016). But due to the time overrun, contractors had to spend more money on labor, plant and may lose the opportunity to get the next project. Hence, effective time management is very important and crucial to achieve successful completion of construction projects (Sambasivan and Soon, 2017).

The challenges of project time management are further compounded with the size increase in the projects. Due to the number of project teams and resources that are relied on for completing large scale projects, it often becomes the case that any time delay will have a ripple effect on several other aspects of the project. Project teams need to coordinate all their efforts on the project to ensure that time schedules are met, and it is important that the right tools are used to achieve this.

The Ayi Mensah Housing Project is a joint Ghanaian – US venture to build 218 houses at Ayi Mensah, which is located at the foothills of Aburi Mountains. The project was envisioned to build a community around a significant park and garden walks linking residents to the central garden. The housing units would be carefully crafted with security, amenities and conveniences of modern living. Considering the significant size of such a housing development it will be important to determine what tools are used to ensure the project time management and measure the efficiency of these tools, with the expectation of developing a time management model that will ensure greater efficiency.

1.3 RESEARCH QUESTIONS

To draw conclusions on the problem set out, the following questions needed to be answered;

i. What are the project time management practices adopted on the Ayi Mensah Housing Project?
ii. What are the challenges with the adopted project time management practices on the Ayi Mensah Housing Project
iii. What are the best practices for project time management for the Ayi Mensah Housing Project?

1.4 AIM OF THE RESEARCH

The aim of this research is to assess the project time management practices that have been adopted for use on the Ayi Mensah Housing Project.

1.5 OBJECTIVES OF THE RESEARCH

To achieve the research aim of the research the following objectives were advanced:

i. To examine the project time management practices adopted on the Ayi Mensah Housing Project
ii. To identify challenges with the time control practices on the delivery of the Ayi Mensah Housing project
iii. To propose the best practices of project time management for the Ayi Mensah Housing Project

1.6 SIGNIFICANCE OF THE RESEARCH

As identified earlier, time control and project schedule management challenges exist within the Ghanaian construction industry, and therefore it remains important that best practices for time control on any project, regardless of size, can be determined and adopted within the construction industry. Therefore, the findings to be made in this research will be significant for the following;

i. Project managers may adopt the findings to be made towards improving on timeliness of project delivery, so that there can be a net impact on productivity levels to be achieved on their projects too.
ii. Companies may adopt the findings from this research towards the development of training and policy manuals and standards of performance across all projects that they will engage in.
iii. The construction professional bodies may also apply the findings towards developing standards of practice for project time control for training among members so they can adopt these towards improved time control and increased productivity.

iv. The government agencies which engage private contractors on construction projects may adopt these conclusions from this research as the best practices required for all contractors to adopt towards delivering of governmental projects in a timely manner.

v. The conclusions from this research may also add to existing knowledge of project time control in the construction industry.

1.7 SCOPE OF THE RESEARCH

The purpose of the scope was to set the limits for the research, and in this case, it will first be defined by the objectives set out in this research. The research would begin with a thorough examination of the time control practices employed on the Ayi Mensah housing project, and then identify the effects of the time control practices and on the project delivery, before developing a model for best practices of time control on the project. Time control practices to be examined will be those standardized for the Ayi-Mensah project, and not just a one-off application. The Ayi Mensah project was specifically selected for this research because of the diversity of the housing project as well as the number of multiple houses being built, which will provide ample data on time control for successful delivery. The Ayi Mensah housing project was also selected due to its proximity to the researcher.

1.8 RESEARCH METHODOLOGY

The research applied a mixed approach that relied on both quantitative and qualitative strategies for collecting and analysing data. The researcher relied on collection of qualitative data through observations and interview of the sampled population for the research, while quantitative data was collected using structured and close ended

questionnaires. Interpretation and analysis of the data was done using descriptive statistics to present it in an easily understandable format, and mean score ranking and correlation analysis applied towards the quantitative data. Data analysis was carried out using SPSS 24. Both managers and staff members of Krane Construction Ltd were targeted for this research using the questionnaire, and the census sampling was used to determine the sample size to participate in the research.

1.9 ORGANIZATION OF THE RESEARCH

The research was presented in five distinct chapters as follows;

Chapter one provided an introduction to the whole research by giving a background and stating the problem, aim, objectives and research questions. The chapter also provided the significance, scope and brief methodology for the research.

Chapter two covered the literature review, where previously published works related to the current work were also laid out to provide a theoretical and conceptual basis for the research.

Chapter three provided greater details on the methodology applied, including the research design and strategy, sources of data, research instrument, population, sampling and the data analysis method.

Chapter four of this research went into details on the analysis of the data and discussions to help in drawing the necessary conclusions.

Chapter five culminated the whole research by providing a summary of the findings, conclusion and recommendations, as well as directions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The literature review provides detailed definitions on key terms related project time control, and then covers previous related studies on the application of project time control tools in the construction industry. Through this the works relating to the stated objectives of the study will also be reviewed to provide an understanding and draw conclusions from them. This will provide the theoretical foundations upon which the research will be built.

2.2 DEFINITION OF KEY TERMS

2.2.1 Project Time Control

According to the Project Management Book of Knowledge (2013) Project Time Control (PTC) refers to an aspect of overall project management that deals with how projects can meet the timelines that have been set and be delivered according to the schedule set out. Project Time Control however is not just made up of one singular activity but is inclusive of several different activities that all add up towards the meeting of project schedules. Activities that fall under the Project Time Control framework include

- **Activity Definition**– This is often the first point of any Project Time Control framework, and it is at this point that the various activities that need to be undertaken for a whole project to be completed are identified and defined.
- **Activity Sequencin**g– This stage follows the definition of the activities and here, the project manager determines how all the various activities will be carried out in a logical manner to ensure successful completion. Sequencing requires

significant experience from the project managers who must have clear understanding of the project.

- **Resource Estimation**– Once the sequence of activities has been completed the next step is to estimate the resources that will be required for the completion of each. For construction projects this could be either the materials, labour or plant component of resources that will be required for completion. Again this requires an experienced manager to undertake it.
- **Duration Estimation** – This is another significant aspect of the Project Time Control framework because this is where the time durations for each of the activities are determined. This is significant because accurate determination of durations goes a long way towards ensuring that time control is done efficiently.
- **Schedule Development**- The project schedule presents in a logical format how the various activities in the project tie into each other, with considerations for resources to be used, durations, dependencies and potential risk elements towards the execution of the project. The schedule gives a clear picture of the overall project to anyone who views it, and allows for manipulation to ensure that schedules are met.
- **Schedule Control**– Manipulation and interventions carried out on the project schedule to ensure that timelines are met is referred to as schedule control. However, schedule control is dependent on all the above activities being carried out first.

2.3 PROJECT TIME CONTROL PROCESSES

According to the Project Management Institute (PMI, 2016) the processes which are associated with project time control include the following;

2.3.1 Defining Activities

As already indicated above, the first step in the time control framework is the definition of activities, and this can be carried out with various tools and techniques which may be available to the project team. Some of the most common methods for this defining activities include:

2.3.1.1 Decomposition

Srinivasan (2018) defines project decomposition as the breaking down of project activities into smaller and much easier managed tasks, often in a structure such as the Work Breakdown Structure (WBS). The purpose of decomposition is to ensure that each smaller task can be easily identifiable in the overall project execution framework, so they can be tackled easily. The process of decomposition involves the following:

- Collect all relevant data on major project deliverables and identify all the tasks associated with it
- Develop the project WBS from the major project deliverables
- Once the WBS is started, decompose these major deliverables into smaller tasks
- Each item in the WBS must have a unique identifying code which will illustrate whether the level of decomposition that has taken place is enough

2.3.1.2 Rolling wave planning

Another method that is applied towards activity definition is the Rolling Wave Planning, and as the name suggests, the project manager plans the project as it is underway. The project manager is able to make plans and changes to plans as the project unfolds, or iteratively. In essence, with this form of planning the project manager can plan and re-plan as the activities unfold, and can refine the plan eventually to make execution much

smoother. Rolling Wave Planning requires experience to undertake, since the manager needs to be able to envision how the project will be pan out in the first few months so that planning will unfold according to the expectations (Sharma, 2013).

2.3.1.3 Templates

Project planning templates are an important resource for planning because they allow for an easier determination of the activities by following a pre-determined plan. However, this is not also a straightforward process since the project manager needs to have a good understanding of how his project fits into the template, while also being able to undertake any necessary manipulations to define the activities to suit the timelines desired (Yousuf et al, 2014).

2.3.1.4 Expert judgment

Project managers with extensive experience in defining project activities can also rely on this experience to develop activities for the present project with ease. This is because experience on any project is an invaluable resource and having project managers with a good understanding and expert knowledge of the requirements can ease the planning process significantly (Callahan et al., 2012).

2.3.2 Sequence Activities

As already defined also, sequencing of the project activities involves laying them out in a logical and easily understandable manner that shows the connection from one activity till the other until the whole project is completed. There are several tools that are used for activity sequencing and these include the following (PMP, 2012):

2.3.2.1 Precedence diagramming method (PDM)

Precedence Diagramming Method is a sub-function of the Critical Path Method (CPM) which allows for the sequencing of activities in a project based on the connections that exist among them, in terms of their start and completion. PDM remains a very popular tool for activity sequencing because of its ease of use, and also for allowing a clear representation of the connections that exist between various activities, so that manipulations can be carried out easily and the effect of other activities clearly seen (Baker, 2014).

2.3.2.2 Determination of Dependency

Conventional knowledge on dependencies in activity sequencing has identified four main types which can determine how implementation and tracking of the various activities can be carried out, and they include

- FS – Finish to Start dependency
- FF – Finish to Finish dependency
- SS – Start to Start dependency
- SF – Start to Finish dependency

2.3.2.3 Application of leads and lags

Leads and lags represent relationships that exist between activities in a sequencing framework, where leads denote a situation where a successive activity starts before its predecessor is complete, while a lag also denotes a situation where a successive activity cannot start immediately after its predecessor is complete, but must allow for a delay (Sharma, 2013).

2.3.2.4 Scheduling templates

Templates provide a standardized format for the drawing up of a project schedule by inputting the necessary data and making relevant adjustments and manipulations to an existing format. The schedule template can either represent all or a part of the project schedule, depending on the requirements of the project or the stage it has reached.

2.3.3 Estimating resources for activities

Estimating of activity resources is a close function to cost estimation, as this allows for a determination of the project resources required either for the entire project, or on a stage by stage basis (PMP, 2012). Estimation of the activity resources can be done using the following tools / methods

- Application of experience or expert judgement
- Application of alternate analysis
- Relying on published estimating data
- Application of the Bottom-up method
- Use of project management software

2.3.4 Estimating duration of activities

This activity basically requires the project manager to make a determination on the amount of time that each activity will require to be completed, and this can be done through the work effort and resource input method (PMP, 2012).

2.3.4.1 Project Evaluation and Review Technique (PERT)

The Programme Evaluation and Review Technique is a project management tool that basically analyses and presents the various activities needed for the completion of a

project. It was first introduced by the United States Navy in 1958 for scheduling and its main advantage is the analysis of time allocation towards the completion of a project. Time performance estimation is at the core of PERT, and allows for developing probabilities for timelines (Liberatore et al., 2013).

2.3.5 Develop Schedule

The schedule keeps the project team informed about the progress of works in real terms, by providing the data on the works that have been completed, the current stage of the works being done and the remainder of works to be completed. The project schedule does not remain static and must always be reviewed as the works are ongoing (McGraw and Leonougrakis, 2016). It continues to develop as the project moves forward, changes arise, risks come and go, and new risks are identified. The schedule essentially transforms the project from a vision to a time-based plan. Tools and Techniques used are:

2.3.5.1 Schedule Network Analysis:

This is a graphic representation of the project's activities, the time it takes to complete them, and the sequence in which they must be done. Project management software is typically used to create these analyses – Gantt charts and PERT Charts are common formats.

2.3.5.2 Critical Path Analysis

This is the process of looking at all of the activities that must be completed, and calculating the "best line" – or critical path – to take so that you will complete the project in the minimum amount of time.

2.3.5.3 Schedule Compression

This tool helps shorten the total duration of a project by decreasing the time allocated for certain activities.

2.3.5.4 “What if” scenario analysis

This method compares and measures the effects of different scenarios on a project.

2.3.5.5 Resource levelling

Here, you rearrange the sequence of activities to address the possibility of unavailable resources, and to make sure that excessive demand is not put on resources at any point in time.

2.3.5.6 Critical chain method

This also addresses resource availability. You plan activities using their latest possible start and finish dates. This adds extra time between activities, which you can then use to manage work disruptions.

2.3.5.7 Risk multipliers

Risk is inevitable, so you need to prepare for its impact. Adding extra time to high-risk activities is one strategy. Another is to add a time multiplier to certain tasks or certain resources to offset overly optimistic time estimation.

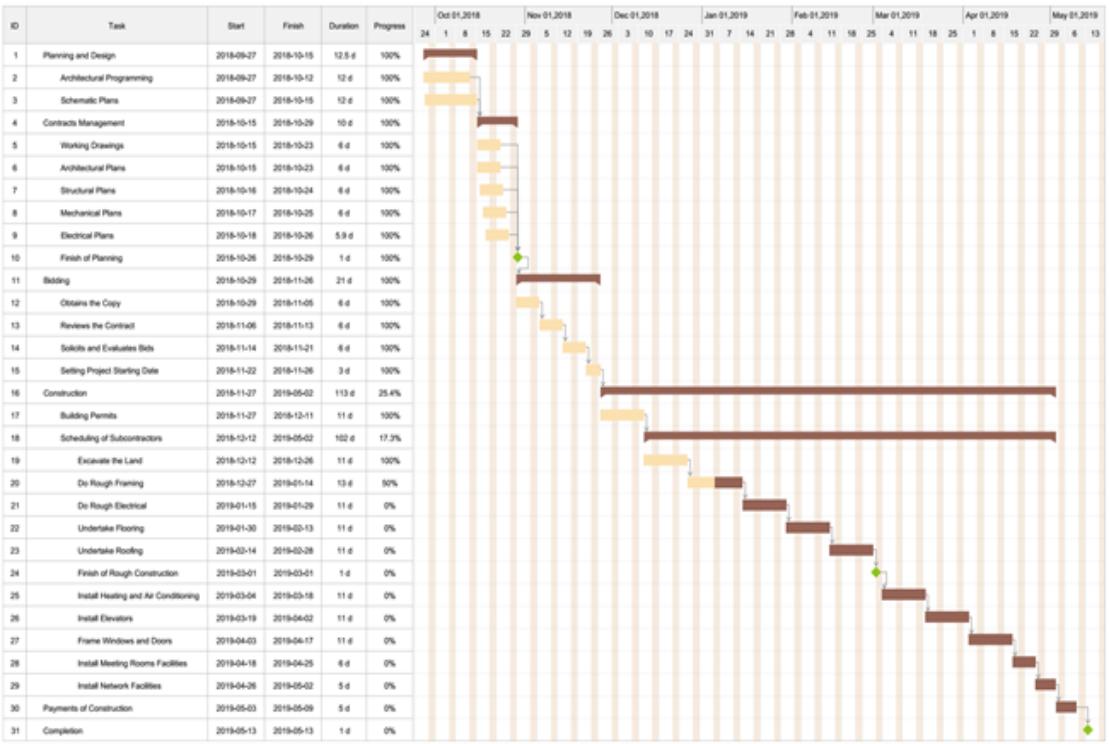
2.4 PROJECT TIME CONTROL TOOLS

Several project time control tools exist that are commonly used on construction sites, and each of them has different functions which aim to manage the time to completion and

delivery of any project. Selection of a particular time control tool is dependent on several factors, such as size of the project, number of tasks required for completing different activities on the project, time allocation towards the project and each activity, level of technology available for use on the project and amount of data available. However, it is dependent on the project team to identify the most suitable tool for use on each project, and some of these tools include:

2.4.1 Gantt Bar Chart

The Gantt bar chart is one of the most common and basic scheduling tools, and it is often baked in most project management software as a standard feature. Gantt bar charts give a clear graphical representation of the project schedule, with resources and durations clearly stated. The chart allows for dependencies to be represented as well, and it is easy to prepare, with an easy learning curve (Smith, 2012). The Gantt chart shows the effective use of resources based on the representation of activities, with their constraints and key milestones noted.



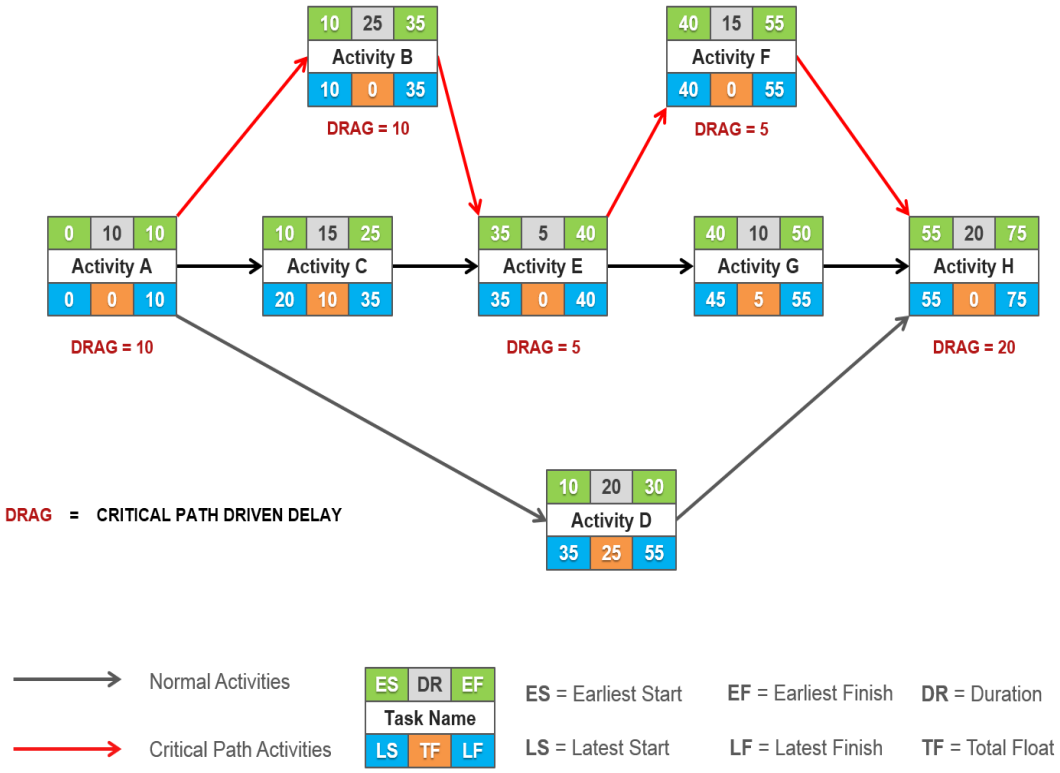
ID	Task	Start	Finish	Duration	Progress
1	Planning and Design	2018-09-27	2018-10-15	12.5 d	100%
2	Architectural Programming	2018-09-27	2018-10-12	12 d	100%
3	Schematic Plans	2018-09-27	2018-10-15	12 d	100%
4	Contracts Management	2018-10-15	2018-10-29	10 d	100%
5	Working Drawings	2018-10-15	2018-10-23	6 d	100%
6	Architectural Plans	2018-10-15	2018-10-23	6 d	100%
7	Structural Plans	2018-10-16	2018-10-24	6 d	100%
8	Mechanical Plans	2018-10-17	2018-10-25	6 d	100%
9	Electrical Plans	2018-10-18	2018-10-26	5.9 d	100%
10	Finish of Planning	2018-10-26	2018-10-29	1 d	100%
11	Bidding	2018-10-29	2018-11-26	21 d	100%
12	Obtains the Copy	2018-10-29	2018-11-05	6 d	100%
13	Reviews the Contract	2018-11-06	2018-11-13	6 d	100%
14	Solicits and Evaluates Bids	2018-11-14	2018-11-21	6 d	100%
15	Setting Project Starting Date	2018-11-22	2018-11-26	3 d	100%
16	Construction	2018-11-27	2019-05-02	113 d	25.4%
17	Building Permits	2018-11-27	2018-12-11	11 d	100%
18	Scheduling of Subcontractors	2018-12-12	2019-05-02	102 d	17.3%
19	Excavate the Land	2018-12-12	2018-12-26	11 d	100%
20	Do Rough Framing	2018-12-27	2019-01-14	13 d	50%
21	Do Rough Electrical	2019-01-15	2019-01-29	11 d	0%
22	Undertake Flooring	2019-01-30	2019-02-13	11 d	0%
23	Undertake Roofing	2019-02-14	2019-02-28	11 d	0%
24	Finish of Rough Construction	2019-03-01	2019-03-01	1 d	0%
25	Install Heating and Air Conditioning	2019-03-04	2019-03-18	11 d	0%
26	Install Elevators	2019-03-19	2019-04-02	11 d	0%
27	Frame Windows and Doors	2019-04-03	2019-04-17	11 d	0%
28	Install Meeting Rooms Facilities	2019-04-18	2019-04-25	6 d	0%
29	Install Network Facilities	2019-04-26	2019-05-02	5 d	0%
30	Payments of Construction	2019-05-03	2019-05-09	5 d	0%
31	Completion	2019-05-13	2019-05-13	1 d	0%

(Source: Kienapple, 2019)

Fig. 2.1 Sample Gantt chart for construction works

2.4.2 Critical Path Networks

This applies algorithms in a practical sense towards scheduling of activities, and incorporates the precedence diagram framework within it as well. The purpose of the critical path is to identify the longest stretch of activities which show dependencies and then measure the time for completing those (Lu and Abouzik, 2013). It calculates the longest path needed for a logical end point to end the project by identifying the most critical activities for completing the project.



(Source: Lu and Abouzik, 2013)

Fig. 2.2 Sample critical path network for construction project

2.4.3 Milestone Date Programming Techniques

This technique has its focus on the project milestones in the project management framework, and it determines how these milestones can be reached with the durations and resources available. The milestone data programming technique is modelled along the line of the critical path, and its focus is that all milestones be met at all cost (Yang and Loannou, 2014). That means that there is significant manipulation of resources and durations in this technique.

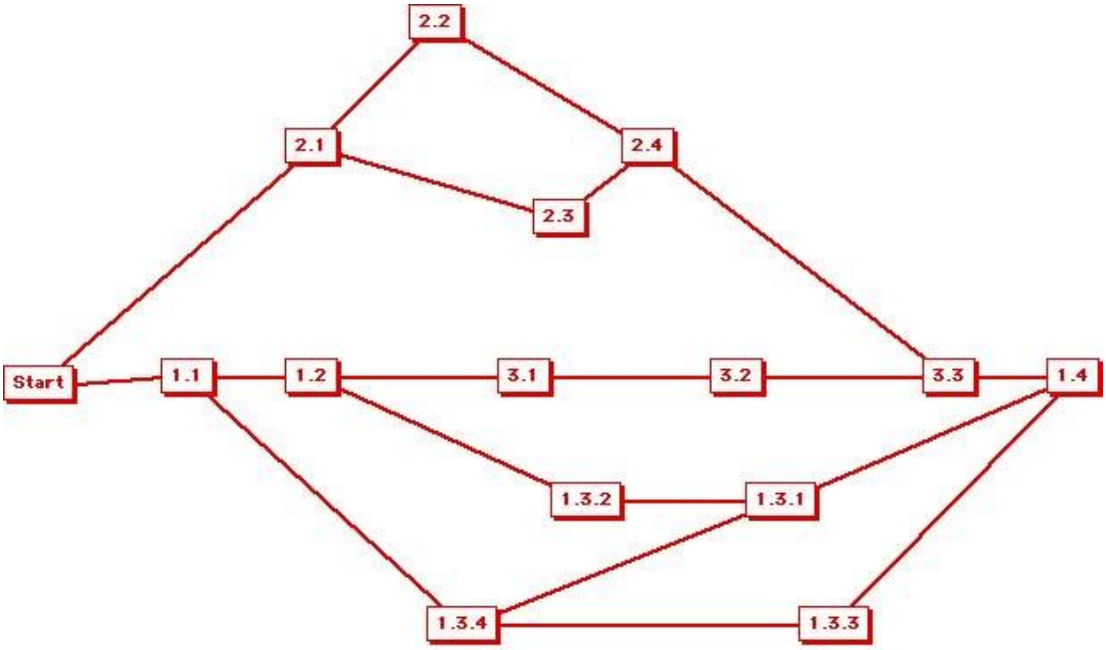


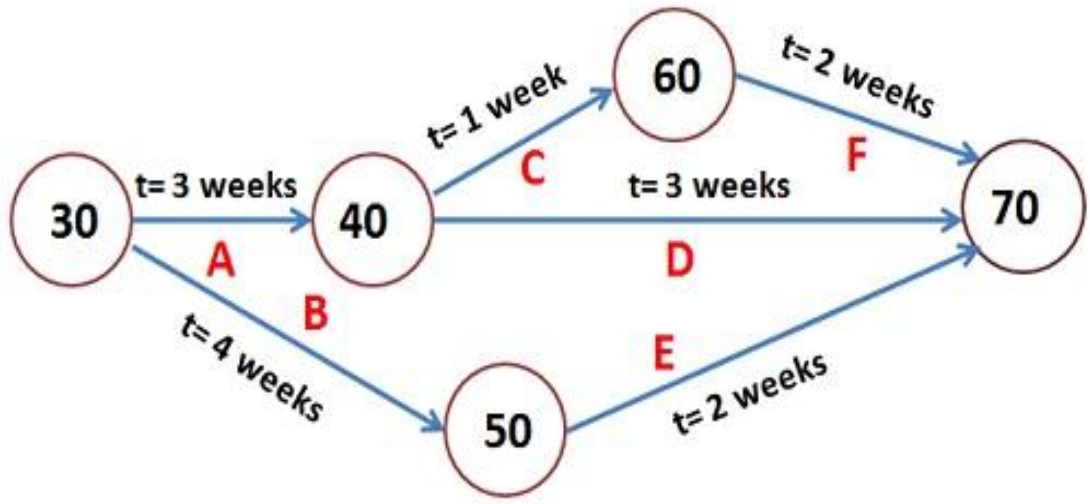
Exhibit 8. Arrow Diagram for Establishment of Prenatal Health Care Clinic

(Source: Yang and Loannou, 2014)

Fig. 2.3 Sample milestone date programming chart

2.4.4 Programme Evaluation and Review Technique

The Programme Evaluation and Review Technique is a project management tool that basically analyses and presents the various activities needed for the completion of a project. It was first introduced by the United States Navy in 1958 for scheduling and its main advantage is the analysis of time allocation towards the completion of a project (Mahamid, 2011). Time performance estimation is at the core of PERT, and allows for developing probabilities for timelines.

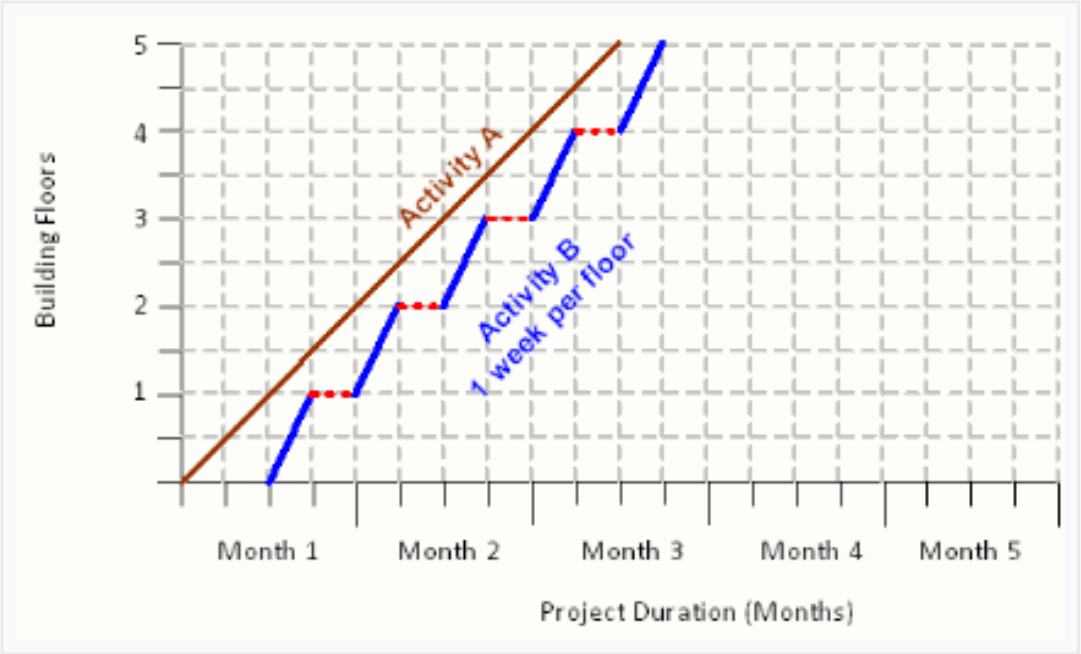


(Source: Mahamid, 2011)

Fig. 2.4 Sample Programme Evaluation and Review Technique

2.4.5 Elementary Trend Analysis / Line of Balance Method

Kurt (2014) defined the Line-of-Balance as a scheduling tool which determines a balance of activities in a linear manner, thereby ensuring that activities maintain a continuous and consecutive approach. Though it normally follows a linear pattern the line-of-balance can also be used for analysis of interrelated patterns in a project schedule, such as on a construction project where there are several related activities.

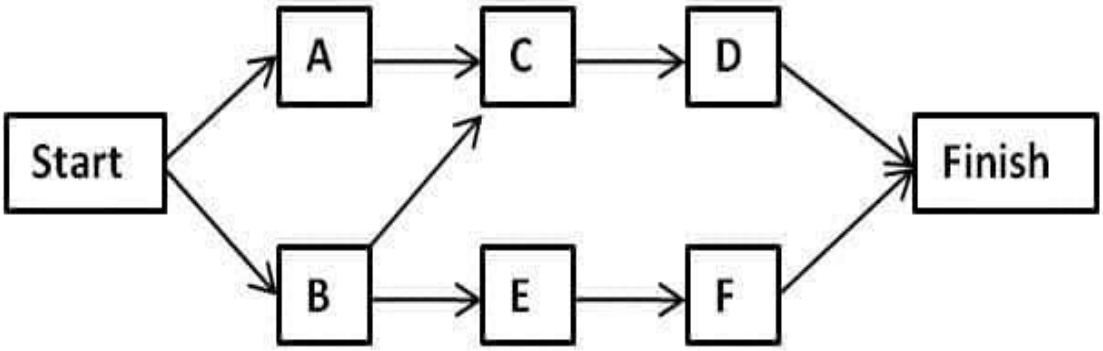


(Source: Kurt, 2014)

Fig. 2.5 Elementary Trend Analysis / Line of Balance Method

2.4.6 Precedence Diagram Method

The Precedence Network Diagram is a very popular scheduling tool among construction professionals because of the ease of adding the various defined activities and manipulating them based on their dependencies. The ease of use of this tools means that the project managers can basically determine which activities either need to be completed before another starts, or which need to start before another one does (Mantel et al., 2011).



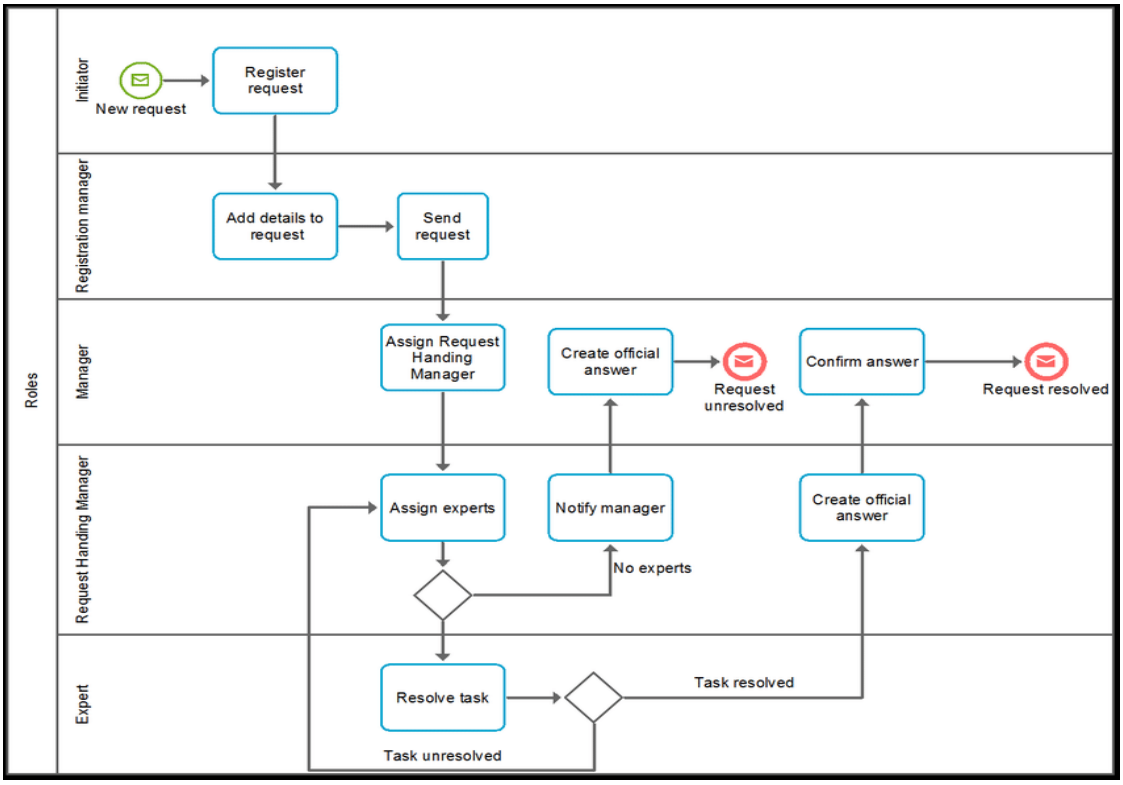
Precedence Diagram Method (PDM)

(Source: Mantel et al., 2011)

Fig. 2.6 Sample Precedence Network Diagram

2.4.7 Simulation

Simulation is a tool for project scheduling that requires that the project manager be very knowledgeable about how it works. This tool is very appropriate for duration definition and planning, and it relies on two important tools, namely the Process Interaction and Activity Scanning. Simulation allows the project manager to test how various activities in the schedule relate to each other and the result will determine the confirmation or otherwise (Takim and Akintoye, 2012).



(Source: Takim and Akintoye, 2012)

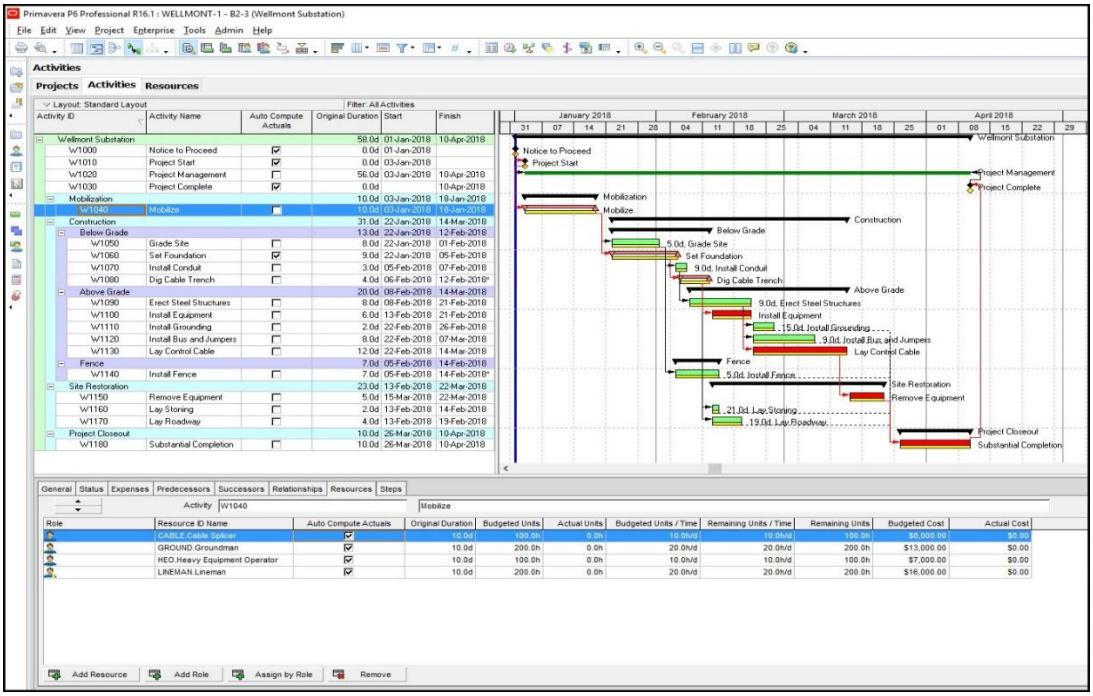
Fig. 2.7 Process Interaction Diagram

2.5 PROJECT TIME MANAGEMENT APPLICATIONS FOR COMPUTERS

In the present day, most time control tools have been adapted into various computer software which make the input and analysis of data more seamless and easier, so that results can be achieved earlier. These software have been adopted on most construction projects, and regardless of size, are able to compute vast amounts of data and represent the time control tools in an easy to read and interpret format. Most of such software do not require users to have extensive background knowledge on time scheduling and control for projects, as most have tutorials and guides that can make use easier. Some of the most common computer applications include;

2.5.1 Primavera Project Planner

Primavera Project Planner is very popular in the United States for project planning, and it is often used for very large projects which require significant allocation of resources for completion. Primavera functions very much like Microsoft Project, and provides clear overviews of the project along with resources and durations, dependencies and tools for managing the time, budget and other resources (Bryan, 2016). Primavera is also able to generate reports in the form of numerical or statistical data, PERT, Gantt and bar charts.



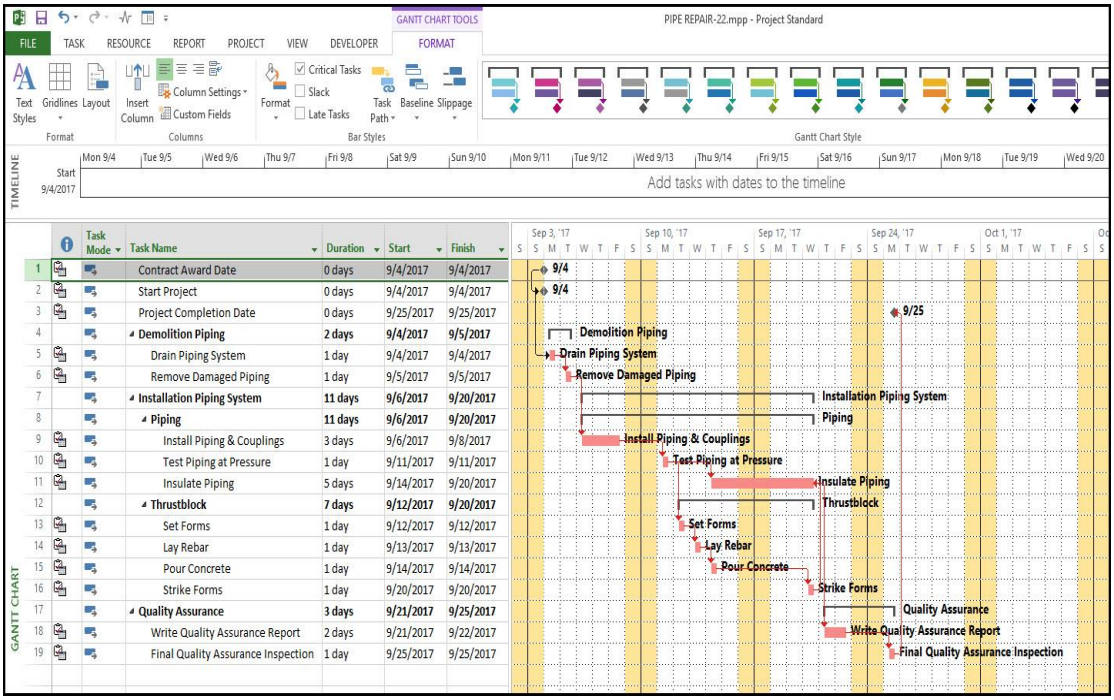
(Source: Bryan, 2016)

Fig. 2.8 Oracle Primavera P6

2.5.2 Microsoft Project

Microsoft Project remains the standard for project management software on the market now due to its sophistication and functionality. Microsoft Project can be relied on entirely for all planning, estimation, resource allocation and scheduling as well as its

manipulation for completing a project successfully. Microsoft Project also has in-built templates that can make the scheduling process easier and has graphical representations of the schedules with resources identified (Bryan, 2016). It is a versatile tool that can be used automatically for scheduling, or manually manipulated for more desirable results.



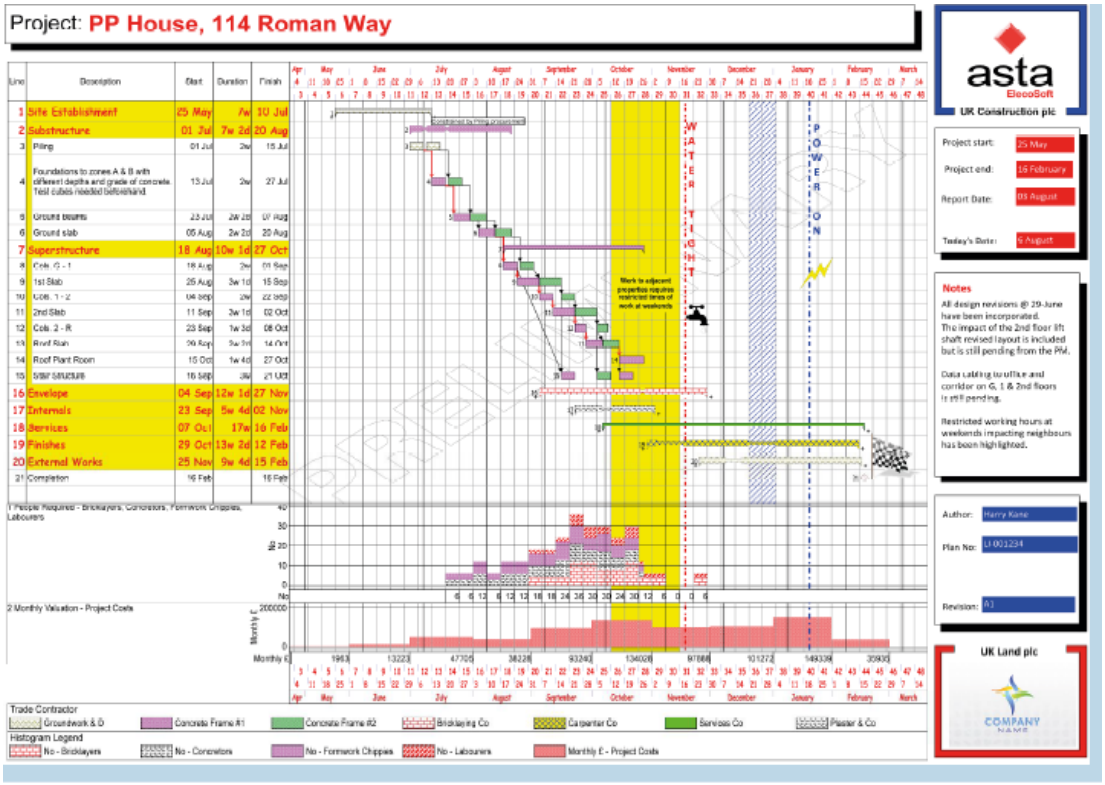
(Source: Bryan, 2016)

Fig. 2.9 Microsoft Project 2016

2.5.3 Asta Power Project

This is a relatively less used project planning software that allows managers to undertake planning and scheduling much as they would do with other more sophisticated software. The functionality of Asta Power is relatively good when compared to other software, and is useful for activity duration planning right down to the hours, minutes and seconds, as well as calendaring to produce the project schedule (Kent, 2017). Asta Power also allows

for the use of tools such as hammocks and multiple links in the Precedence Diagramming Method.



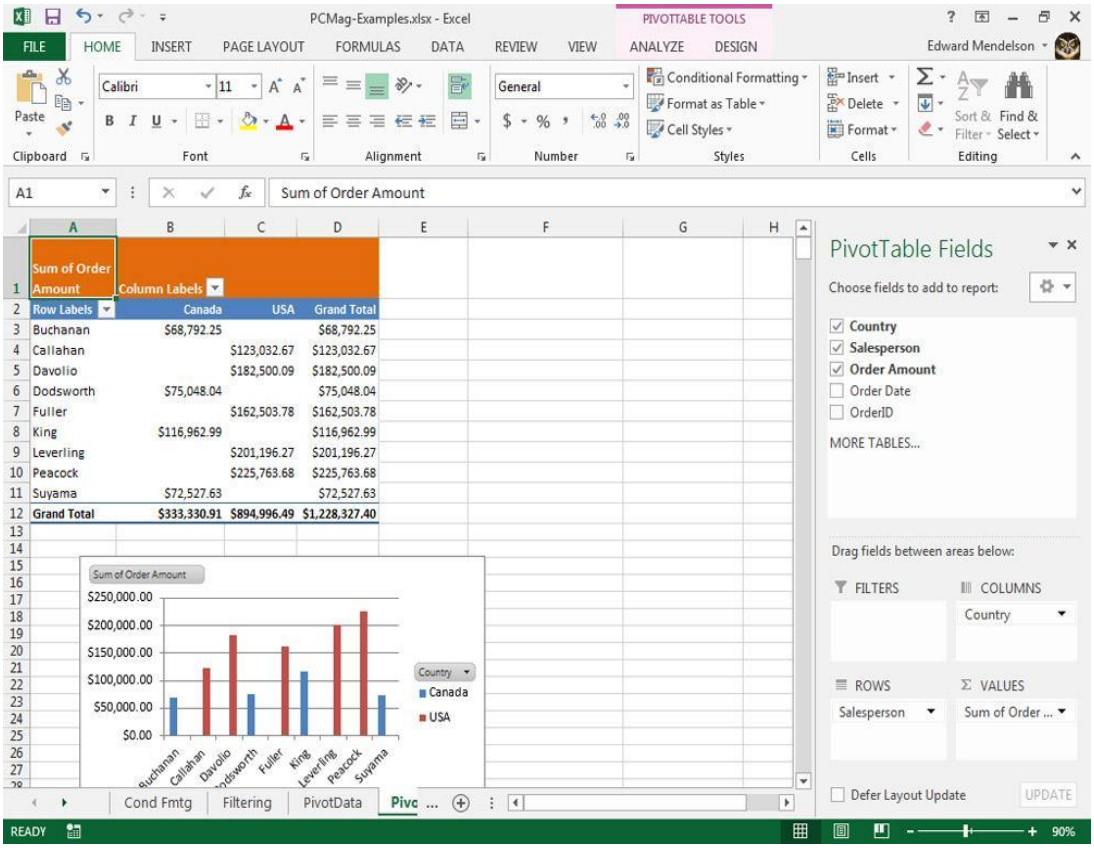
(Source: Kent, 2017)

Fig. 2.10 Asta Power Project Planner

2.5.4 Microsoft Excel

Microsoft Excel has remained a very popular project planning tool, though not comparable to its more specialized sibling, Microsoft Project. However, with each update to this software Microsoft has increased its capabilities at scheduling, calculations of duration and resources for project activities and even graphing and mapping out of the schedule for easier understanding. Microsoft Excel is the most popular and easy to use tool for project planning for most organization, since it does not have a sharp learning curve, and managers can learn to use it while on the job (Microsoft, 2016). Microsoft

Excel provide formulas for easy analysis of the data input into it for project scheduling and estimation, though it still is limited in functionality.



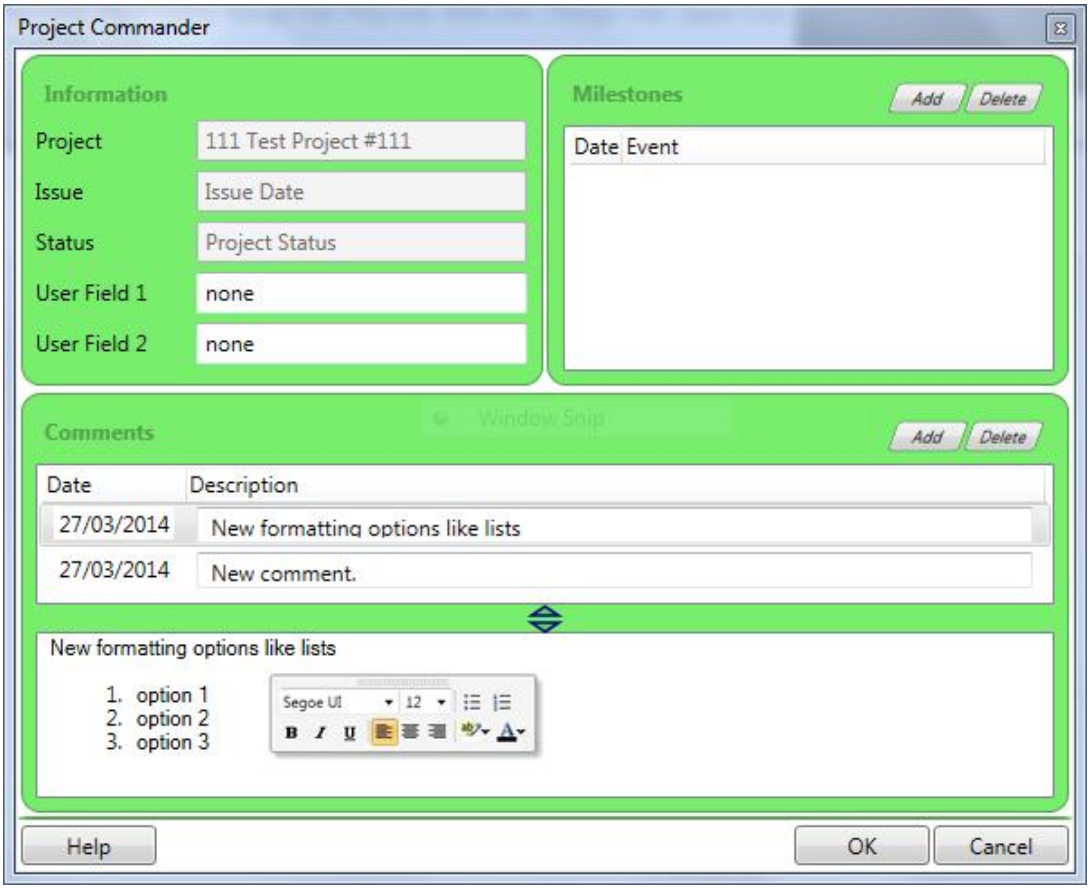
(Source: Microsoft, 2016)

Fig. 2.11 Microsoft Excel 2016

2.5.5 Project Commander

This is a project scheduling software that has remained very popular in the United Kingdom for smaller companies without the budgets to acquire the more sophisticated computer software. Project Commander has remained popular because of its simplicity of use in scheduling, resource allocation and time estimation, as well as the ease of customization for each individual project (Cooke, 2014). It is not versatile as software

such as Microsoft Project, but for a low budget project that needs scheduling software, Project Commander can get the job done.



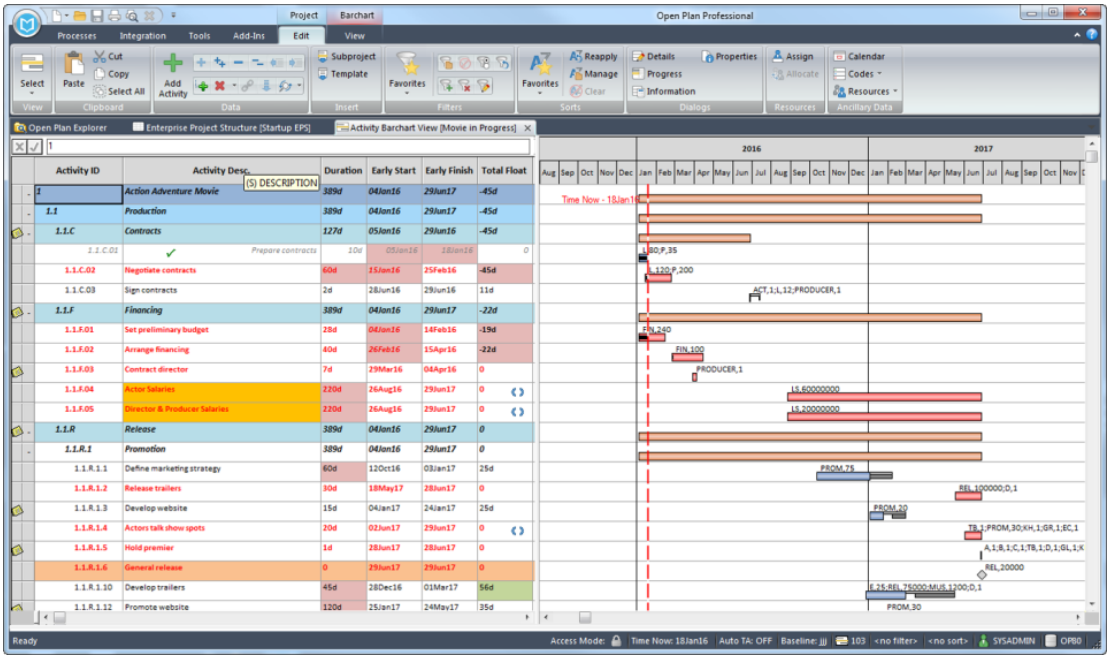
(Source: Cooke, 2014)

Fig. 2.12 Project Commander Professional

2.5.7 Deltek Open Plan

Deltek Open plan is an open source project planning software that allows project managers to be able to plan a project on a budget. Though it is not as sophisticated as more recognisable tools such as Microsoft Project and Primavera, it however is also efficient at tasks such as performance analysis, project prioritization, resource allocation and the modelling of the project plan (Cooke, 2014). Deltek Open plan however is not as

widely used as other more conventional software, and remains mostly used by smaller companies without the resources to acquire more conventional software.



(Source: Cooke, 2014)

Fig. 2.13 Deltek Open Plan

2.6 CHALLENGES WITH PROJECT TIME CONTROL

Challenges arising out of time control on a project often lead to delays, which impact on the successful delivery of the project. Previous research have shown that delays on a construction project often lead to other challenges, often related to higher costs for both the owner and contractor, lost revenues for the owner and litigation. However, it is important to fully understand the challenges that arise with regards to time control on a project so that best practices can be recommended.

2.6.1 Undefined Goals

The first step in project scheduling and time control is with the definition of the project goals, and when this is not properly done, it can often lead to challenges of determining time duration and scheduling. Project goals are defined at the planning stage and it often lies with the project manager and overall project team to align their knowledge and experiences with similar projects to define project goals clearly. There must be no ambiguity in the determination of the project goals, and they must be as realistic as possible so that time estimation and resource allocation can also be carried out successfully (Leeds, 2016).

2.6.2 Scope Changes

Scope changes often occur on most projects, either due to changes required by the client or contractor, or the unfeasibility of the original plan. However, scope changes also bring along changes to activities, time allocation and scheduling. Where scope changes are not adequately analysed and necessary changes made to the time schedule, it can lead to time control challenges on the project, and invariably affect the ability to successfully delivery the project to time. It is important firstly that scope changes be limited on the project as much as possible, and where they are to be made, that the project team make adequate allowance in the project schedule to incorporate these scope changes (O'Berry, 2015).

2.6.3 Inadequately skilled personnel

Time control on any project, regardless of size, requires necessary knowledge and experience to be able to adequately undertake. This is because construction projects comprise of many different activities which either occur simultaneously or have linkages with each other, and ensuring that all these activities are undertaken according to their

schedules requires experience (Zaki et al., 2012). Added to this are uncertainties and risk elements which may arise and also cause some level of confusion with activities and their completion. Where time control is left in the hands of unskilled personnel, it often can lead to disruptions in the construction processes or poorly planned and executed time controls on the project (Zaki et al., 2012).

2.6.4 Estimating task duration

Estimating task duration can be achieved through different techniques, either using expert opinions or other mathematical calculations to achieve the duration for each activity on the project (Roseke, 2016). Though mathematical formulas can derive various durations, expert opinions, often derived from working on other projects, comes into play. Where activity duration is not calculated correctly for the project, it will invariably lead to poor time control, and corrective measures for mistakes done in activity duration estimation may lead to more delays and later completion of project (Roseke, 2016).

2.6.5 Improper Risk Analysis and Management

Risk elements are unforeseeable, regardless of how much preparation is made towards mitigating them. However, the potential for risk elements to greatly affect a project can be minimized with the relevant risk analysis and management tools (Rafferty, 2014). Putting proper risk management measures in place will ensure that risks which can potentially affect time schedules for the project can be eliminated completely or minimized in terms of their impact. However, this is dependent on adequate steps taken by a competent planning team and adequate risk management techniques implemented by a similarly skilled project team during execution (Rafferty, 2014).

2.6.6 Assigning resources

Resource allocation must be done in the most effective and economical manner, since resources are scarce. However, inability to properly allocate resources to activities in the schedule means that time controls will be challenged, where allocation of time needs to be made to restore the proper balance of resources for the project (Kurzawska, 2017). For example, where allocation of number of bags of cement to substructure works is not done properly, and there is a shortage, the time controls will have to be adjusted to make room for reallocation of bags of cement to that activity, and this will then affect all other activities that come after it, compounding time control problems. This again therefore falls to a competent project management team to carry out resource allocation properly to ensure that firstly, there is correct and effective allocation of resources, and also that there is room for any potential risk elements that may arise in that regard (Kurzawska, 2017).

2.6.7 Poor communication management

Project communication management is an important factor towards effective time control on any project, and in the present age where technological advancements have made it possible for project team members to communicate and collaborate on projects without being physically present at the same location, communication challenges should not have arisen (Goubau, 2018). However, the construction industry continues to be plagued by communication challenges, often caused by poor responsiveness among project team members, inability to collaborate effectively among project team members and lack of an effective platform where project stakeholders and team members can effectively communicate and share project information. All three problems therefore lead to poor

information management among the project team, which invariably affects time controls on the project (Goubau, 2018).

2.6.8 Impossible deadlines

Deadlines are familiar in project management, as they are set by the project team and client, and affect the development of the project schedule to meet the deadlines. Deadlines may be set for individual activities in the project, with the project teams working to meet these, in the overall plan of completing the whole project on time (Tripathi, 2016). However, where impossible deadlines are set by either the client or the project manager, it can put undue pressure on the team to deliver, and this can leave them prone to mistakes and risks which will affect time controls. Deadlines must be as realistic as possible, and be in line with activity duration estimations which are standard within the construction industry. It is however also normal that in some situations the client may require the project to be delivered much faster, and in such a case, time controls must be as realistic and reasonable as possible, so that impossible targets will be set and the project team unable to reach them (Tripathi, 2016).

2.6.9 Lack of stakeholder engagement

Stakeholder engagement is essentially about managing the relationships that exist between the project team and the various interested parties in the project. Such relationships can either be positive or negative towards the delivery of the project, and is all dependent on the manner the project manager and project team handle it (Rathenam, 2017). Stakeholders may put undue pressure on the project team for faster completion, where they are fully appraised on the nature of the works and how it must be carried out, with their full cooperation guaranteed. Improper stakeholder engagement can also lead

to frequent stoppages of work for them to be appraised, or resultant scope changes that are pushed by stakeholders. All these will invariably affect time controls that are implemented on the project (Rathenam, 2017).

CHAPTER THREE

LITERATURE REVIEW

3.1 INTRODUCTION

According to the definition provided by the Webster's Dictionary (2018) research methodology can be defined as the method, or in a broader sense the collection of methods that may be applicable within a certain framework towards achieving the desired results. This affirms a definition which was put forward by Kallet (2014) which stated that in the quest to achieve the relevant conclusions in a research problem there needs to be a certain reasoning regarding the procedures which will be employed towards collecting and analysing data.

3.2 RESEARCH DESIGN

According to a definition provided in the Merriam Webster Dictionary (2018) the research design basically provides an outline that details how the research will take place, and covers features of the research such as the nature of data to be collected and method of analysis. A research design is important to the process it gives meaning to all the steps that need to be taken to ensure that the researcher is able to reach credible conclusions for their research (DeVaus, 2016). Mauz (2013) determined that there are six primary research designs, and this may include the correlational, descriptive, explanatory, experimental, semi-experimental and meta-analytic. Selection depends on the conclusions that are being sought and how best the researcher believes these can be drawn. Each design has its own advantages and disadvantages and special use cases, and for this particular research the descriptive design will be used. This research design is selected because, as identified by Yin (2011), it is based on the observations of a prevailing situation and drawing conclusions from it. The descriptive research design

also allows for the collection of data using survey methods and analysis using statistical and mathematical calculations.

3.3 RESEARCH STRATEGY

In research there often needs to be a logical progression to determine how conclusions will be drawn, and Jenny (2014) notes that this is basically the research strategy. The strategy allows the researcher to determine point by point how various aspects of the research will be carried with the view to delivering credible conclusions. The research strategy is important to the researcher because it helps to eliminate any potential drawbacks to achieving a logical progression of the research. Kenyon (2015) identified two research strategies, namely the quantitative and qualitative, and each has its own strengths and weaknesses and use cases. Using the quantitative approach there can be a collection of vast amounts of statistical data and analysis to draw conclusions from the numerical values.

3.4 RESEARCH DATA

The University of Leicester (2019) defined research data as collected, observed or created for the purposes of analysis to produce original research results. Tedds (2016) of the University of Leicester noted that there are different spectrums of data which include;

i. Raw unprocessed data
ii. Research ready processed data
iii. Published output dataset
iv. Published catalogue representations

These categories are broadly summarized by the EPSRC (2011) as the primary and secondary data. Primary data is often collected directly from source by the researcher and unprocessed, and can either be quantitative or qualitative. Secondary data on the

other hand is already processed or published data that forms the theoretical basis for a research. This research will therefore apply both the primary and secondary data sources to draw conclusions.

3.5 RESEARCH INSTRUMENTS

The research instruments relied on for collecting data were of the quantitative and qualitative variety, and were defined as follows:

3.5.1 Quantitative Instrument

This formed the primary data collection instrument and was in the form of a questionnaire presented to study respondents. The questionnaire was selected because according to Fray (2014) it is an economical means for collecting data from a large population, since the same questions can be asked of all members of that population.

The questionnaire was structured as follows:

i. Section A – Demographic characteristics of respondents
ii. Section B – Examination of project time management practices adopted on Ayi Mensah Project
iii. Section C – Assessment of time management practices adopted on Ayi Mensah Project
iv. Section D – Proposals on best practices for project time management

3.5.2 Qualitative Data Gathering and Procedure

The research also relied on qualitative data which was derived from the observation of the time control practices which were in use on the Ayi Mensah Housing Project and make determinations of how efficient they were in their application.

3.6 POPULATION OF THE STUDY

Grooves et al, (2013) defined population simply as individuals or items with similar defining characteristics. This research targeted the Ayi Mensah Housing Project, which construction works was being undertaken by Krane Construction Ghana. Since the entire permanent contractor's staff population working on the particular project was thirty-seven (37) and easily accessible on the site, and five (5) staff members for the project consultant and five (5) for the client, they formed the entire population for the research. Thus the total population targeted for the research was 47 permanent professionals working on the project.

3.7 SAMPLE SIZE AND SAMPLING TECHNIQUE

According to Burns and Groove (2011) it becomes important to determine a sample from a research population where it is impossible for the entire population to be targeted for a research. Sampling ensures that an economically reachable population is selected from the entire population. Different techniques are applicable towards sampling, and it is all dependent on different factors. In the case where the research population is relatively small, then the Census Sampling method is applied. The element of researcher bias can be eliminated by targeting the entire population. Considering the permanents number of professionals on the project was 47, they formed the entire sample targeted for the research work.

3.8 DATA ANALYSIS

Data analysis and presentation was done in a way to ensure clarity of the data as well as easy interpretation and drawing of conclusions. Demographic data collected was presented using descriptive tools, namely, tally tables and graphs. Data on the time

management tools and practices were also presented using descriptive statistics and mean score indexing to show significance of each practice.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

With the analysis of the data completed it would allow for an in-depth discussion of the results in relation to the set aim and objectives. The research targeted all 37 permanent staff members of Krane Construction Ghana, as well as five staff members representing the client and five also representing the consulting team on the project, making a total of 47 respondents. However, only 45 successfully completed and returned their questionnaires, representing 96% of the population.

4.2 DEMOGRAPHIC DATA ON RESPONDENTS

The first section of the questionnaire captured the demographic characteristics of the respondents, and the purpose of this was to ensure that those participating in the research not only had knowledge of the time control practices that were used specifically on the Ayi Mensah Housing project, but as well, had the relevant education, skill set and experience within the construction industry. Tables 4.1 to 4.9 summarize the demographic data on the respondents.

4.2.1 Highest education of respondent

The respondents, in this first question, were required to state the level of education that they had received, and this data was considered important because it would allow for an assessment the level of understanding and experience that they would have towards providing responses to the questionnaire. The data is summarized in table 4.1.

Table 4.1 Highest education of respondent

Qualifications	Tally	Percentage
PhD	0	0
Masters degree	21	46.7
Bachelors degree	24	53.3
Higher National Diploma	0	0
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.2 Respondents' job description in construction industry

The respondents were next required to indicate the job designation that they had on the Ayi Mensah Housing project and this was not only to confirm that they actually worked on the project, but also to determine the level of experience and knowledge they had gathered from working on the project. The data is summarized in table 4.2.

Table 4.2 Respondents' job description in construction industry

Job description	Tally	Percentage
Architect	2	4
Quantity surveyor	7	16
Engineer	18	40
Project Manager	10	22
Supervisor	8	18
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.3 Length of time working in the construction industry

This next section related to the experience and knowledge built up by the respondents from working in the construction industry, and this determination was to be made by reviewing the number of years that they had worked in the industry. The theory in this case was that respondents would've gathered more experience and knowledge from working longer in the industry. The data is summarized in table 4.3.

Table 4.3 Length of time working in the construction industry

Length of time	Tally	Percentage
Less than a year	0	0
1 – 5 years	7	16
6 – 10 years	8	18
11 – 15 years	13	29
16 – 20 years	11	24
Above 20 years	6	13
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.4 Number of housing projects worked on

In keeping up with the level of experience gathered this next section required the respondents to state how many construction projects that they had actually worked on. This also followed the same theory that respondents who had worked on more housing projects would be expected to have more knowledge and experience. The data is summarized in table 4.4.

Table 4.4 Number of housing projects worked on

Range of Houses	Tally	Percentage
1 – 5 projects	0	0
6 – 10 projects	19	42
11 – 15 projects	24	53
16 – 20 projects	1	2.5
21 – 25 projects	1	2.5
Over 25 projects	0	0
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.5 Time spent on current project

Respondents were required here to indicate how long exactly they had spent working on the Ayi Mensah Housing project, and this requirement was needed to also provide some

greater assurance that the respondents had spent significant time on the project and collected enough knowledge on the time control practices. The data is summarized in table 4.5.

Table 4.5 Time spent on current project

	Tally	Percentage
Less than a 6 months	0	0
6 months – 1 year	3	7
1 year – 2 years	15	33
Above 2 years	29	60
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.6 Level of awareness of project time control for construction projects

This question on awareness of project time control spoke to the core of what was being sought in this research, and it was to determine from the respondents what knowledge or level of awareness they had about time controls, on the Ayi Mensah Housing project. Determination of this would assure that the respondents had adequate knowledge to proceed to the subsequent sections of the questionnaire. The data is summarized in table 4.6.

Table 4.6 Level of awareness of project time control for construction projects

Awareness	Tally	Percentage
YES	45	45
NO	0	0
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.7 Awareness of project time control / management practices employed on Ayi Mensah Housing Project

Respondents showed in table 4.6 above that they were very well aware of the concept of time controls in the construction industry, and more specifically for the Ayi Mensah Housing project, so this next section was to determine from them if they were aware of the specific time control practices that were employed for the Ayi Mensah Housing project. The data is summarized in table 4.7.

Table 4.7 Awareness of project time control / management practices employed on Ayi Mensah Housing Project

Awareness	Tally	Percentage
YES	36	80
NO	9	20
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.2.8 Belief that project time control has an impact on successful project delivery

Respondents had to indicate in this final section their belief or otherwise that project time control could impact the successful delivery of the housing project. Though this belief was relative, it would still give some assurance that the respondents held a view on how time controls could impact any construction project. The data is summarized in table 4.8.

Table 4.8 Belief that project time control has an impact on successful project delivery

Awareness	Number	Percentage
YES	45	100
NO	0	0
TOTAL	**45**	**100**

Data Source: Researcher Field Survey, 2019

4.3 SUMMARY OF DEMOGRAPHIC DATA

The demographic data provided greater confidence in the sampled population participating in the research and to assure that the responses being provided were accurate and reflected realities based on their knowledge and experience of time control practices on the Ayi Mensah Housing project.

The level of education achieved by the respondents was the first factor considered under the demographic characteristics and though there is no straightforward measure for level of education, Conelly (2016) notes that its analysis should be based on how high the respondents have achieved. The data from these respondents showed that they had indeed achieved high levels of education and thus could be relied on to understand and provide data for the research. Therefore, from the data, it can be seen that 46.7% of the respondents had a postgraduate qualification while 53.3% had an undergraduate qualification.

The demographic data also showed that all respondents held job descriptions on the Ayi Mensah Housing project, and therefore gave them direct knowledge of the time control practices on the project.

The demographic data also required respondents to state their length of time in the construction industry, and though this was to give an understanding of how much

knowledge and experience they could have gathered, Dovan (2017) also noted that this is not a straightforward measure, but should only be taken on how high it was. Table 4.3 showed that about 84% of the respondents had worked within the construction industry over five years, and also 58% of the respondents indicated that they had worked on more than ten housing projects, as evidenced in table 4.4. The remaining 42% of the respondents had also worked on between 5 to 10 housing projects as well. Majority of the respondents (93%) indicated that they had worked on the current project at least a year or more.

With regards to the awareness of what time control / management practices are, all respondents (100%) indicated that there were aware of the concept, though only 80% of the respondents expressed knowledge of the specific time control practices that were applied on the Ayi Mensah Housing project. However, there was a general consensus among the respondents that time control practices had an impact on the successful delivery of a construction project. Therefore with the demographic characteristics of the respondents presented above, it is possible that all participate in the subsequent questions as they have proven their knowledge and skill set, as well as level of experience of the time control practices employed on the Ayi Mensah Housing project.

4.4 EXAMINING THE PROJECT TIME CONTROL PRACTICES ADOPTED ON THE AYI MENSAH HOUSING PROJECT

The first stated objective of this research was to examine the project time control practices that were employed on the Ayi Mensah Housing project. In the presentation of the demographic characteristics the respondents had indicated awareness of time control practices which were employed on the project, therefore this section relied on past research on some project time control practices which are standard within the project

management sphere and these were presented to the respondents. The objective was divided into three sections, with the first part requiring the respondents to identify the specific time control practices that were used on the project, while the second section required the respondents to identify the specific time control tools that the project managers relied on for time control on the project. The final section of this objective was dedicated to the identification of the specific project scheduling software that were also employed for time control purposes on the project. All sections relied on 5-point Likert scales to gauge the degree to which the respondents attached significance to the practices and tools on the Ayi Mensah Housing Project. Tables 4.9 and 4.10 provide the details on the time control practices on the project.

Table 4.9 Mean scores on the time management practices adopted on the Ayi Mensah Housing Project

	N	Mean	Std. Deviation	Std. Error Mean
Defining activities				
Decomposition	45	2.01	1.024	0.102
Rolling wave planning	45	1.69	1.114	0.111
Templates	45	3.87	0.947	0.095
Expert judgement	45	3.93	0.868	0.087
Average of Averages		**2.88**		
Sequence activities				
Precedence Diagram Method	45	4.02	0.689	0.069
Dependence determination	45	3.77	0.897	0.089
Applying leads and lags	45	3.81	0.857	0.086
Schedule network templates	45	3.95	0.798	0.079
Average of Averages		**3.89**		
Estimate activity resources				
Expert judgment	45	3.82	0.886	0.089
Alternatives analysis.	45	2.41	1.048	0.105
Published estimating data.	45	3.79	0.863	0.086
Bottom-up estimating	45	2.68	1.063	0.106
Project management software.	45	4.07	0.601	0.060
Average of Averages		**3.35**		
Estimate activity duration				
Expert judgment	45	3.74	0.947	0.095
Analogous estimating	45	3.80	0.835	0.084
Parametric estimating	45	1.97	1.117	0.112
Three-Points estimating	45	1.68	1.126	0.113
Project Evaluation and Review Technique (PERT)	45	2.47	1.087	0.109
Reserve analysis	45	2.04	1.108	0.111
Average of Averages		**2.62**		
Develop Schedule				
Schedule Network Analysis:	45	4.03	0.634	0.063
Critical Path Analysis	45	4.11	0.587	0.059
Schedule Compression	45	3.77	0.927	0.093
“What if” scenario analysis	45	1.87	1.086	0.109
Resource levelling	45	2.37	0.998	0.099
Critical chain method	45	3.80	0.817	0.082
Risk multipliers	45	1.79	1.147	0.115
Average of Averages		**3.11**		

Data Source: Researcher Field Survey, 2019

Table 4.10 Ranking of the Mean scores on the time management practices adopted on the Ayi Mensah Housing Project

FACTOR	MEAN SCORE	RANKING
Defining activities		
Expert judgement	3.93	1
Templates	3.87	2
Decomposition	2.01	3
Rolling wave planning	1.69	4
Sequence activities		
Precedence Diagram Method	4.02	1
Schedule network templates	3.95	2
Applying leads and lags	3.81	3
Dependence determination	3.77	4
Estimate activity resources		
Project management software.	4.07	1
Expert judgment	3.82	2
Published estimating data.	3.79	3
Bottom-up estimating	2.68	4
Alternatives analysis.	2.41	5
Estimate activity duration		
Analogous estimating	3.80	1
Expert judgment	3.74	2
Project Evaluation and Review Technique (PERT)	2.47	3
Reserve analysis	2.04	4
Parametric estimating	1.97	5
Three-Points estimating	1.68	6
Develop Schedule		
Critical Path Analysis	4.11	1
Schedule Network Analysis:	4.03	2
Critical chain method	3.80	3
Schedule Compression	3.77	4
Resource levelling	2.37	5
“What if” scenario analysis	1.87	6
Risk multipliers	1.79	7

Data Source: Researcher Field Survey, 2019

Table 4.9 gives the results of the mean score analysis of the time control practices employed on the Ayi Mensah Housing project and table 4.10 below gives the ranking of the mean scores to determine the most significant factors. The 5-point Likert scale

provided a means for respondents to show the degree to which they agreed or disagreed with any factors. Analysis of the data provided mean scores which would be ranked from the highest to the lowest. However, to determine which factors would be considered significant to the research and which would not, the midpoint of 3.00 would be the differentiator. Any mean scores above this midpoint would be considered significant while mean score below this midpoint would be discarded. Five key areas of time control practices, as proposed by the Project Management Book of Knowledge (2017) were presented to the respondents in this section, and under each key practice, the various sub-practices were to be ranked according to the 5-point significance scale.

The first practice identified by the PMBOK (2017) was the definition of activities and Sharma (2013) as well as PMP (2012) identified four key methods associated with this practice, which included the use of expert judgement, templates, decomposition and rolling wave planning. However, respondents only considered expert judgement and the use of templates as relevant time control practices used on the Ayi Mensah Housing project. As noted by Sharma (2013) expert judgement is critical in the construction industry because project teams rely on the experience and skills built and developed over years of working on similar, or even different projects, and this informs how they make decisions on defining activities for execution. Templates also play a significant role, as they provide a standardized basis which the project team can just fill in with the necessary information to develop the definition of their activities for the project. Though decomposition and rolling wave planning also offer relevant guidance in the definition of activities (PMP, 2012), they were not practices associated with the Ayi Mensah Housing project.

With the activities defined, the next practice identified by the PMBOK (2017) was the sequencing of these defined activities, and under this as well, four key practices for undertaking this were identified, and the responses show that all four key practices were associated with the delivery of the Ayi Mensah Housing project. Baker (2014) and Sharma (2013) identified these practices, and the most ranking them according to their significance to the project, the highest was the precedence diagramming method for activity sequencing, which is one of the most popular methods available. Precedence diagramming method (PDM) is used in the Critical Path Methodology (CPM) for constructing the project schedule network diagram. The precedence diagramming method allows for sequencing activities for projects that are made up of a significant number of individual activities. The method, as described by Baker (2014) allows for the determination of activity associations, and determine which need to be completed before next activities begin, thereby creating a chain of activities that can be easily followed. The next ranked method was schedule network template, and this allowed for the expedited preparation of the activity sequences using either all or some of the activities identified (PMP, 2012). Application of leads and lags was also identified by the respondents, as proposed by Sharma (2013), and in explaining its significance, lead refers to a relationship whereby the successor activity begins before the predecessor activity has completed. The lag also refers to a relationship whereby the successor activity cannot start right after the end of its predecessor's. Finally, the dependence determination method was also identified by the respondents, and dependencies of the activities on each other determine the route that the implementation can track during the project execution phase, it includes four types of dependencies or logical relationships.

The next practice identified by the respondents, as proposed by the PMBOK (2017) was the estimation of activity resources, and though five methods were proposed by (PMP, 2012), only three of them were identified as associated with the Ayi Mensah Housing project, and these included the use of project management software, expert judgement and using published estimating data. Project management software have become very popular in planning and executing purposes of projects due to their versatility in undertaking various activities that would normally have been undertaken by hand and would've required significant time and effort, and as well, their ability to process large volumes of data. Several different project management software exist, as identified by Duffy (2019) exist, though each have their individual functionalities and strengths. The respondents as well were given the opportunity to identify which project management software were used on the Ayi Mensah Housing project as part of achieving the objective. However the respondents next indicated that expert judgement also was relied on in the estimation of activity resources, and as already noted by Sharma (2013) the experience and knowledge built up from working on different projects informs the planning and execution of new projects. Finally, the respondents also noted that estimating of activity resources was also achieved on the Ayi Mensah Housing project by relying on published estimating data, which often came from the Quantity Surveying journal published by the Ghana Institution of Surveyor GhIS) commodity / material prices published by retailers and manufacturers.

Upon completion of the activity resources estimation, the next step in the cost control process was the estimation of activity duration, the respondents on the Ayi Mensah Housing project indicated that two main methods were relied on, which included analogous estimating and expert judgement. As explained by the Line Management Institute of Training (2012) analogous duration estimating means using the actual

duration of a previous, similar schedule activity as the basis for estimating the duration of a future schedule activity. This also is closely associated with expert judgement, which has featured prominently in the time control practices that are used on the Ayi Mensah Housing project. Expert judgement takes experiences and skills gained from previous projects to make activity duration estimates for current projects.

The final element in the project time control practices was the development of the schedules, and under this four elements of project scheduling were identified as associated with the Ayi Mensah Housing project. The highest ranked of the lot was the Critical Path Analysis (CPA), which is a project management technique that requires mapping out every key task that is necessary to complete a project. It includes identifying the amount of time necessary to finish each activity and the dependencies of each activity on any others. Also known as the critical path method, CPA is used to set a realistic deadline for a project and to track its progress along the way. Critical path analysis identifies the sequence of crucial and interdependent steps that comprise a work plan from start to finish. It also identifies non-critical tasks. These may also be important, but if they hit an unexpected snag they will not hold up any other tasks and thus jeopardize the execution of the entire project. The concept of a critical path recognizes that completion of some tasks in a project is dependent on the completion of other tasks.

The next identified scheduling method was the schedule network analysis which is a strategy that is commonly used in project management and consists of visualising the different project tasks and making connections between them in the project management plan. For making a final schedule, a schedule network analysis is finished utilizing a draft schedule.

Critical chain is an alternative to critical path analysis. Main features that distinguish critical chain from critical path are:

i. Implicit use of resource dependencies: Implicit means that they are not included in the project network, but must be identified by looking at the resource requirements.

- Lack of search for an optimum solution—a suitable solution is enough because:
- As far as is known, there is no analytical method for finding an absolute optimum

ii. The inherent uncertainty in estimates is much greater than the difference between the optimum and near-optimum.

iii. Iii Monitoring project progress and health by monitoring the consumption rate of the buffers rather than individual task performance to schedule.

Schedule compression refers to a series of techniques used to shorten the duration of a project without compromising the result. Common schedule compression techniques include crashing, fast-tracking and resource reallocation. The goal of schedule compression to shorten the project without amending the project scope, according to the schedule constraints, required time and other objectives. Any compression must be done in the critical path activities.

With the identification of the time control practices employed on the Ayi Mensah Housing project completed the next step in achieving this objective was to identify the significant time control tools that were also relied on for successful delivery of the project. These represented the project scheduling tools that where relied on for planning and executing purposes for the project and allowed the project team to make determinations on project durations and how to properly manage it. The literature was relied on to identify some of these time control tools and these were presented to the study respondents to rank on a 5-point Likert scale to show the significance of each to

the Ayi Mensah Housing project. Tables 4.11 and 4.12 give the details and summary respectively of the analysis of the data collected from the respondents.

Table 4.11 Mean scores on the time control tools adopted on the Ayi Mensah Housing Project

	N	Mean	Std. Deviation	Std. Error Mean
Gantt Bar Chart	45	4.12	.639	0.064
Critical Path Networks	45	4.06	.678	0.068
Milestone Date Programming Techniques	45	2.56	1.039	0.104
Programme Evaluation and Review Technique	45	2.45	1.061	0.106
Elementary Trend Analysis / Line of Balance Method	45	1.68	1.053	0.105
Precedence Network Diagram	45	3.94	.827	0.083
Simulation	45	1.44	1.101	0.110

Data Source: Researcher Field Survey, 2019

Table 4.12 Ranking of the Mean scores on the time control tools adopted on the Ayi Mensah Housing Project

FACTOR	MEAN SCORE	RANKING
Gantt Bar Chart	4.12	1
Critical Path Networks	4.06	2
Precedence Network Diagram	3.94	3
Milestone Date Programming Techniques	2.56	4
Programme Evaluation and Review Technique	2.45	5
Elementary Trend Analysis / Line of Balance Method	1.68	6
Simulation	1.44	7

Data Source: Researcher Field Survey, 2019

Tables 4.11 and 4.12 give the details and summary of ranking respectively of the analysis of responses on the time control tools employed on the Ayi Mensah Housing project, and this forms the second part of the achievement of the first objective in this research. The

time control tools were identified in the literature and presented to respondents to rank on a 5-point significance scale. The 5-point Likert scale provided a means for respondents to show the degree to which they agreed or disagreed with any factors. Analysis of the data provided mean scores which would be ranked from the highest to the lowest. However, to determine which factors would be considered significant to the research and which would not, the midpoint of 3.00 would be the differentiator. Any mean scores above this midpoint would be considered significant while mean score below this midpoint would be discarded.

From the summary table it can be seen that only three out of the presented tools were identified by respondents as being used on the Ayi Mensah Housing Project, and these were the Gantt Bar chart, Critical Path Networks and Precedence Network Diagram. The Gantt bar chart is one of the most common and basic scheduling tools, and it is often baked in most project management software as a standard feature. Gantt bar charts give a clear graphical representation of the project schedule, with resources and durations clearly stated. The chart allows for dependencies to be represented as well, and it is easy to prepare, with an easy learning curve. The Gantt charge shows the effective use of resources based on the representation of activities, with their constraints and key milestones noted. This applies algorithms in a practical sense towards scheduling of activities, and incorporates the precedence diagram framework within it as well. The purpose of the critical path is to identify the longest stretch of activities which show dependencies and then measure the time for completing those. It calculates the longest path needed for a logical end point to end the project by identifying the most critical activities for completing the project.

The Precedence Network Diagram is a very popular scheduling tool among construction professionals because of the ease of adding the various defined activities and manipulating them based on their dependencies. The ease of use of this tools means that the project managers can basically determine which activities either need to be completed before another starts, or which need to start before another one does.

The final determination to be made under this objective was to identify the specific project scheduling computer software that were used on the Ayi Mensah Housing project, and this determination was also important because of the current age of information technology where most companies rely on computer applications to maximize their efficiency and effectiveness at completing tasks. The most common project scheduling computer software were identified and presented to the study respondents to rank on a 5-point scale to show the level of association with the Ayi Mensah Housing project. Tables 4.13 and 4.14 provide further details on the responses received, and shall conclude on the first objective set out for this research.

Table 4.13 Mean scores on the project scheduling software adopted on the Ayi Mensah Housing Project

	N	Mean	Std. Deviation	Std. Error Mean
Primavera Project Planner	45	1.39	1.117	0.112
Microsoft Project	45	4.26	.639	0.064
Asta Power Project	45	1.65	1.062	0.106
Microsoft Excel	45	4.11	.677	0.068
Project Commander	45	1.47	1.103	0.110
Deltek Open Plan	45	1.28	1.127	0.113

Data Source: Researcher Field Survey, 2019

Table 4.14 Ranking of the Mean scores on the project scheduling software adopted on the Ayi Mensah Housing Project

SOFTWARE	MEAN SCORE	RANKING
Microsoft Project	4.26	1
Microsoft Excel	4.11	2
Asta Power Project	1.65	3
Project Commander	1.47	4
Primavera Project Planner	1.39	5
Deltek Open Plan	1.28	6

Data Source: Researcher Field Survey, 2019

Tables 4.13 and 4.14 give the details and summary of ranking respectively of the analysis of responses on the project scheduling software employed on the Ayi Mensah Housing project, and this forms the third part of the achievement of the first objective in this research. The 5-point Likert scale provided a means for respondents to show the degree to which they agreed or disagreed with any factors. Analysis of the data provided mean scores which would be ranked from the highest to the lowest. However, to determine which factors would be considered significant to the research and which would not, the midpoint of 3.00 would be the differentiator. Any mean scores above this midpoint would be considered significant while mean score below this midpoint would be discarded.

The summary from table 4.14 shows that only two of the computer software were actively used for project scheduling on the Ayi Mensah Housing project and these two incidentally are also the most popular software used for project management in most countries. Microsoft Project remains the standard for project management software on the market now due to its sophistication and functionality. Microsoft Project can be relied on entirely for all planning, estimation, resource allocation and scheduling as well as its manipulation for completing a project successfully. Microsoft Project also has in-built templates that can make the scheduling process easier and has graphical representations

of the schedules with resources identified. It is a versatile tool that can be used automatically for scheduling, or manually manipulated for more desirable results.

Microsoft Excel has remained a very popular project planning tool, though not comparable to its more specialized sibling, Microsoft Project. However, with each update to this software Microsoft has increased its capabilities at scheduling, calculations of duration and resources for project activities and even graphing and mapping out of the schedule for easier understanding. Microsoft Excel is the most popular and easy to use tool for project planning for most organization, since it does not have a sharp learning curve, and managers can learn to use it while on the job. Microsoft Excel provide formulas for easy analysis of the data input into it for project scheduling and estimation, though it still is limited in functionality.

4.5 IDENTIFYING CHALLENGES ASSOCIATED WITH THE TIME CONTROL PRACTICES ON THE DELIVERY OF THE AYI MENSAH HOUSING PROJECT

The second objective of this research was to identify challenges that arose on the Ayi Mensah Housing project with regards to the implementation of time controls on the project. The first objective above had successfully identified the time control practices, tool and also the computer software that were used on the project and it was important to see if challenges with application or implementation of any of these arose. It must however be noted that, as identified by Kean (2016), it is often difficult to get accurate data on challenges which exist in a company when respondents are workers or managers in the same company, due to the element of bias that may exist. This is because participants may not wish to make known to the public any possible challenges that may exist within their companies, for fear of repercussions or backlash. Therefore the data

provided below by the respondents may not represent the full picture and must therefore be taken in that context. Tables 4.15 and 4.16 provide details on the data collected.

Table 4.15 Mean scores on the challenges with the project time control practices adopted on the Ayi Mensah Housing Project

	N	Mean	Std. Deviation	Std. Error Mean
Undefined Goals	45	2.78	.968	0.097
Scope Changes	45	3.87	.812	0.081
Inadequately skilled personnel	45	2.41	1.069	0.107
Estimating task duration	45	3.50	.833	0.083
Improper Risk Analysis and Management	45	3.70	.827	0.083
Assigning resources	45	3.28	.904	0.090
Poor communication management	45	2.37	1.009	0.101
Impossible deadlines	45	3.69	.885	0.089
Lack of stakeholder engagement	45	2.48	1.055	0.106

Data Source: Researcher Field Survey, 2019

Table 4.16 Ranking of the Mean scores on the challenges with the project time control practices adopted on the Ayi Mensah Housing Project

CHALLENGES	MEAN SCORE	RANKING
Scope Changes	3.87	1
Improper Risk Analysis and Management	3.70	2
Impossible deadlines	3.69	3
Estimating task duration	3.50	4
Assigning resources	3.28	5
Undefined Goals	2.78	6
Lack of stakeholder engagement	2.48	7
Inadequately skilled personnel	2.41	8
Poor communication management	2.37	9

Data Source: Researcher Field Survey, 2019

Tables 4.1.5 and 4.16 give the details and summary of ranking respectively of the analysis of responses on the challenges with time control practices on the Ayi Mensah Housing project. The challenges with the time control practices were identified in the literature

and presented to respondents to rank on a 5-point negativity scale. The 5-point Likert scale provided a means for respondents to show the degree to which they agreed or disagreed with any factors. Analysis of the data provided mean scores which would be ranked from the highest to the lowest. However, to determine which factors would be considered significant to the research and which would not, the midpoint of 3.00 would be the differentiator. Any mean scores above this midpoint would be considered significant while mean score below this midpoint would be discarded.

From the nine possible challenges that were presented to the respondents, five out of that total were identified as actually having a negative impact on the implementation of the time control practices on the Ayi Mensah Housing project.

The first challenge for time control implementation on the project was related to scope changes, which often occur on most projects, either due to changes required by the client or contractor, or the unfeasibility of the original plan. However scope changes also bring along changes to activities, time allocation and scheduling (Rodriguez, 2018). Where scope changes are not adequately analysed and necessary changes made to the time schedule, it can lead to time control challenges on the project, and invariably affect the ability to successfully delivery the project to time (O'Berry, 2015).

Next ranked by the respondents was the Risk element, which are unforeseeable, regardless of how much preparation is made towards mitigating them. However, the potential for risk elements to greatly affect a project can be minimized with the relevant risk analysis and management tools. Putting proper risk management measures in place will ensure that risks which can potentially affect time schedules for the project can be eliminated completely or minimized in terms of their impact (Rafferty, 2014).

Respondents next identified challenges with deadlines, which are familiar in project management, as they are set by the project team and client, and affect the development of the project schedule to meet the deadlines (Tripathi, 2016). Deadlines may be set for individual activities in the project, with the project teams working to meet these, in the overall plan of completing the whole project on time. However, where impossible deadlines are set by either the client or the project manager, it can put undue pressure on the team to deliver, and this can leave them prone to mistakes and risks which will affect time controls (Tripathi, 2016).

Estimating task duration can be achieved through different techniques, either using expert opinions or other mathematical calculations to achieve the duration for each activity on the project (Roseke, 2016). Though mathematical formulas can derive various durations, expert opinions, often derived from working on other projects, comes into play. Where activity duration is not calculated correctly for the project, it will invariably lead to poor time control, and corrective measures for mistakes done in activity duration estimation may lead to more delays and later completion of project (Roseke, 2016).

Resource allocation must be done in the most effective and economical manner, since resources are scarce. However, inability to properly allocate resources to activities in the schedule means that time controls will be challenged, where allocation of time needs to be made to restore the proper balance of resources for the project (Kurzawska, 2017). For a large project such as the Ayi Mensah Housing, improper balance in resource allocation can have a ripple effect on several other buildings and lead to significant delays overall.

4.6 BEST PRACTICES OF PROJECT TIME CONTROL FOR THE AYI MENSAH HOUSING PROJECT

The final objective of the research was to identify the best practices for ensuring successful implementation of time controls on the Ayi Mensah Housing project. To achieve this, the respondents were given the opportunity to identify which of the existing time control practices and tools needed to be improved, or which new ones needed to be added on, and could effectively deal with the outlined challenges. As noted in objective two of this research, the main challenges that impacted on successful implementation of the time control practices included scope changes, improper risk analysis and management, impossible deadlines, estimating task duration and assigning resources.

Table 4.17 Project time control practices for dealing with challenges of time controls

FACTOR	MEAN SCORE	RANKING
Defining activities		
Templates	4.11	1
Sequence activities		
Precedence Diagram Method	4.02	1
Schedule network templates	3.95	2
Applying leads and lags	3.81	3
Dependence determination	3.77	4
Estimate activity resources		
Published estimating data.	4.02	3
Estimate activity duration		
Analogous estimating	3.80	1
Develop Schedule		
Critical Path Analysis	4.11	1
Critical chain method	3.80	3

Data Source: Researcher Field Survey, 2019

i. SCOPE CHANGES

Scope changes may arise either during the planning stages of a project or during implementation, and as noted by Rodriguez (2018) and O'Berry (2015) they can effectively throw a project plan into disarray and complicate existing schedules. However it is important to note that in going through the five stages of the project time control practices outlined above it is important that the existing methodology be properly strengthened. Though expert judgement and experience plays a significant role that should not be heavily relied upon since circumstances on a project are continuously revolving. Project managers can rely on templates which provide standardized planning tools, which can also take considerations from their expert judgements. Tools such as the precedence diagram method and schedule network templates offers reliable tools that, coupled with relevant experience, can properly handle scope changes. In determining the activity durations as well it is important that project managers make adequate contingency allocation to allay the impact of any risk elements that arise.

ii. IMPROPER RISK ANALYSIS AND MANAGEMENT

Risk elements need to be identified at the planning stage of the project and the relevant contingency measures and risk management protocols be put in place. Most project scheduling tools and software allow for the allocation of contingency time in the plan (Microsoft Project, Microsoft Excel) so that project risk management can be baked directly into the final plan that is made. The project sequencing (Precedence Diagram Method / Schedule network templates / Applying leads and lags / Dependence determination) and schedule development tools (Critical Path Analysis / Critical chain method) in place on the Ayi Mensah Housing project make adequate allocation for risk elements during schedule

planning, and resource allocation towards activities can also make considerations for risk management.

iii. IMPOSSIBLE DEADLINES

Dealing with impossible deadlines with the existing practices can be handled quite easily, since it will require a concerted effort from all stakeholders on the project to determine that will be a realistic deadline for each activity. Analogous estimating which is used on the Ayi Mensah Housing project allows for the determination of realistic deadlines for the project activities by relying on data from previous similar projects and making realistic determination. It is incumbent on the project managers to make realistic activity durations and predictions of deadlines, taking into consideration also allowances for

iv. ESTIMATING TASK DURATION

As with dealing with impossible deadlines on the Ayi Mensah housing project, it is also important that estimating of task durations be done accurately, and analogous estimating provides and important tool for achieving this. However, the project templates that are relied on to define the activities also provide some insights on durations for activities. In this instance however, expert judgement of the project managers will also be needed, though respondents did not indicate such. Expert judgement allows the managers to fall on recent knowledge of planning on other projects, since the respondents indicate that they have all worked on significant numbers of projects. This invaluable resource can provide an appropriate benchmark for estimating the task durations accurately.

v. ASSIGNING RESOURCES

Finally, on the challenge of assigning resources, it is important that published data relied on for the Ayi Mensah Housing project be as current as possible, with

multiple sources also contacted for verification of the price estimates. Estimators must not only have accurate data but must also be capable at developing estimates that will be relevant for the project and prove challenging when implementation begins. Allowances must also be made for the contingency or risk elements during estimation, since unforeseeable events are very rife in the construction industry and account for a lot of cost overruns.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter in the researcher provides a summary of the entire work carried out within the context of the objectives which were set out, by beginning with the findings made, then drawing conclusions and finally making recommendations for industry as well as directions for future studies.

5.2 SUMMARY OF FINDINGS

The findings made in this research were according to the objectives which were set out and were as follows;

5.2.1 To examine the project time control practices adopted on the Ayi Mensah Housing Project

The first objective set out for this research was to examine the time control practices that were adopted and used on the Ayi Mensah Housing Project, and in a broader sense, the effectiveness of these practices. To achieve this, the objective had to consider the specific practices, tools and the computer applications which aided the time control processes on this project. Based on an analysis of data received from respondents made up of staff of the company, and discussions carried out in relation to the literature covered, it was found that managers on the Ayi Mensah Housing project followed the five-pronged approach to project time control on the project as identified in the Project Management Book of Knowledge (2017). This approach included defining activities, sequencing activities, estimating activity resources, estimating activity duration and then developing activity schedules. Though these practices aligned with conventional knowledge on project time

controls, it was however also found that not all practices identified in the literature were actually associated with the Ayi Mensah Housing Project. Templates and expert judgement played a significant role in defining activities, while precedence diagrams and schedule networks were relied on for activity sequencing. In terms of estimating resources, it was found that managers on the project relied on expert judgement, project management software and published data, while analogous estimating and expert judgement played a role in estimating activity durations. Finally, the research also found that the managers on the project used tools such as critical path analysis, schedule network, critical chain and schedule compression for scheduling. All these practices combined formed the approach for time control on the Ayi Mensah Housing project, and therefore none existed or were applied in isolation from the others.

In terms of the specific tools that were applied towards time control it was also found that gantt charts were the main ones used for scheduling and time control, though critical path networks and precedence network diagrams were also heavily relied on for scheduling and control purposes. On the computer applications front the research also found that managers on the Ayi Mensah Housing project depended on Microsoft Project and Microsoft Excel, which remain among the most popular project scheduling and time control software available on the market.

5.2.2 To identify challenges with the time control practices on the delivery of the Ayi Mensah Housing Project

With the time control practices on the Ayi Mensah Housing project examined the next step was to identify the challenges that managers faced with the implementation of the time control practices on the project. However, it was important to note that since the respondents for the project were made up of only staff and stakeholders on the project,

then identification of the prevalent challenges may not portray the real situation since the element of bias could be expected. Findings made in relation to this objective showed that the most significant challenges that were faced in relation to time control on the Ayi Mensah Housing project included scope changes, improper risk analysis and management, impossible deadlines set, estimating task durations and assigning resources. Although these challenges identified also aligned with conventional knowledge on challenges associated with time control on project sites, other challenges which were identified in the literature were not found to be associated with the Ayi Mensah Housing Project.

5.2.3 To propose the best practices of project time control for the Ayi Mensah Housing Project

The final objective thereof was to propose best practices for undertaking project time controls for the Ayi Mensah Housing project, and these were to be done with the identified practices and challenges taken into perspective. Since the project was ongoing, this objective did not seek to go outside on the identified practices from the literature, but rather, to seek out which existing practices needed to be improved or eliminated, and which ones needed to be adopted to ensure overall best practices. The list of practices were again presented to the respondent to rank those considered most significant to ensure excellent time control and eliminate challenges on the project. It was found that the existing time control practices framework on the project could be maintained since it was successful so far, however, for each stage, practices that needed improvement or to be retained were identified. It was found that templates worked best at defining activities and therefore needed to be utilized more than expert judgements, while all sequencing tools identified on the project also needed to be maintained and improved. In the

estimation of activity resources, it was found that published estimating data often presented the best option and needed retention and improvement, while analogous estimating also was the best practice for estimating activity duration. Finally, the research found that overall, the critical path and critical chain methods offered the best practices for project sequencing in the time control framework.

5.3 CONCLUSION

Based on the findings made in the research it can be concluded that project time control is a significant element of successful project delivery for the managers of the Ayi Mensah Housing project, and this is evidenced by the time control framework that exists on the project as well as the extensive tools and world class software that were employed. Based on the findings it can be concluded that the existing time control framework were deemed efficient on the project, with the five stages identified by the Project Management Institute (PMI) recommendations followed through, though it was noted that not all the practices identified by the PMI were employed for the project. This however can be attributed to personal preferences of the project managers and also the specific requirements of the project. Expert judgement remained a dominant feature of the project time control process on the Ayi Mensah Housing project, and this also is due to the vast project experience of the project team members. Other widely used practices such as project planning templates, precedence diagrams and schedule networks, and project management software also were used significantly in the time control framework. The effectiveness of each practice or tool used on the project was evidenced by the mean score validation given by each respondent, and showed that from the perspectives of the managers on the project, they worked excellently for them. With the proliferation of different computer applications for undertaking the project scheduling and time control

it was also clear that the project did not suffer from a lack of use of such, since the two most popular computer software tools were used on the project.

In determining the challenges with the implementation of the time control practices on the project, as noted earlier, the data collected from the respondents may not paint the whole picture due to the possibility of bias from the respondents who are associated with the project and may not be willing to "wash their dirty linen outside". However, conclusions were drawn from the project, and these also aligned with conventional project management practices for time control. Most significant among them were the scope changes and improper risk analysis and management. As the literature found, scope changes are often an inevitability on most projects, and they carry a certain level of risk which need proper analysis and management thereof. Failure to properly achieve this would certainly impact the implementation of any time control practices. The research was also able to conclude that other challenges, such as the setting of impossible deadlines on the project, estimating of activity duration and assigning of resources to these activities also threatened the smooth implementation of the time control framework. The research however did not draw a conclusion on how significant each challenge was in impacting the implementation of the time control practices.

With the identification of the challenges identified needed solutions, and these needed to be drawn from existing practices that were in use on the project since it was ongoing, or from others identified in the research that could also be adopted. The research did not follow the simple path of just presenting the "opposites" of the challenges as solutions, but rather, needed an approach that was familiar to the project managers and could be easily implemented. The research concluded that though expert judgement remained a relevant part of time control on the project, standardized templates and tools needed to

be strengthened, such as the use of the precedence diagrams and schedule networks in appropriate sequencing of project activities. This however did not mean that the expert judgement would be eliminated, but rather would enforce the use of the standardized tools. In this way, appropriate checks and balances could be worked into the existing tools and practices

5.4 RECOMMENDATIONS FOR INDUSTRY / PRACTICE

Overall, the research was able to draw conclusions of the objectives which were set out, however, to ensure greater effectiveness and efficiency in the implementation of time controls on the project, the following recommendations could be made;

i. Project Managers need to be abreast with current practices and trends in time control, particularly in the use of more sophisticated planning and scheduling tools, and appropriate monitoring to performance measurement of time control practices to determine their efficiency on the project.

ii. Planning remains an essential part of the overall success of project delivery, and stakeholders as well as the project team overall must commit all relevant resources and tools towards efficient planning, which can eliminate the chances of the identified challenges arising to stall time control practices.

iii. Risk elements are also an ever present part of the project management framework and it is important that the project team identifies and puts in place mitigation plans for the risks and properly manage them where they cannot be mitigated.

iv. To ensure company-wide application of the time control practices effectively, it is important that training and retraining be a central focus for the company, as well as incorporating these practices into policy manuals for all employees and

stakeholders to build a company culture of efficient time controls for future projects

5.5 SUGGESTIONS FOR FUTURE RESEARCH

One limitation on this research work was the focus on one singular project to identify the time control practices, challenges and make recommendations for best practices, and though the findings and conclusions drawn would serve this particular project well, there is no assurance of the success of applying these same conclusions and recommendations on other projects. Future research can therefore expand the focus to include more projects, either large scale or smaller size, residential or commercial, and determine if similar conclusions will be drawn. Future research can also focus more on the challenges associated with time control on construction projects and more specifically, the effect they had on successful project delivery.

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APPENDIX

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

RESEARCH QUESTIONNAIRE

EFFECT OF PROJECT TIME CONTROL ON THE DELIVERY OF THE AYI MENSAH HOUSING PROJECT BY KRANE CONSTRUCTION

Dear Sir/Madam,

This questionnaire forms part of a Master's thesis to determine the effect of project time control on the Ayi Mensah Housing Project. This questionnaire forms part of the structured field survey and it is expected that the findings of the study will help ensure better time controls for housing projects.

I would like to invite you to participate in the above project. Completion of the questionnaire is completely voluntary and returning the completed questionnaire will be considered as your consent to participate in the survey. The questionnaire will take you less than 5 minutes to complete.

I appreciate that you are already busy and that participating in this survey will be another task to add to a busy schedule, but by contributing you will be providing important information. **All data held are purely for research purposes and will be treated as strictly confidential.**

If you wish to receive feedback on the research findings, a section is provided at the end of the questionnaire for you to indicate. In the event of questions or queries, please do not hesitate to contact me. Thank you for your time and valid contribution in advance.

Yours faithfully,

……

SECTION A – DEMOGRAPHIC DATA

Please kindly tick any of the following that apply to you:

1. Educational qualification of respondent

A. PhD

B. Post Graduate (Masters)

C. Undergraduate

D. Higher National Diploma

E. Other…….

2. Job designation on the Ayi Mensah Housing Project

A. Architect

B. Quantity surveyor

C. Engineer

D. Project Manager

E. Supervisor

F. Other…….

3. Number of years working in the construction sector in Ghana?

A. Less than a year

B. 1 – 5 years

C. 6 – 10 years

D. 11 – 15 years

E. 16 – 20 years

F. Over 20 years

4. How many housing projects have you worked on?

A. 1 – 5 projects

B. 6 – 10 projects

C. 11 – 15 projects

D. 15 – 20 projects

E. 21 – 25 projects

F. Over 25 projects

5. How long have you worked on this current project?

……..

6. Are you aware of the concept of project time control / time management for construction projects?

A. YES

B. NO

7. Are you aware of the project time control / time management practices employed on this project?

A. YES

B. NO

8. Are you aware of the project time control / time management practices employed on this project?

A. YES

B. NO

9. Do you believe that project time control has an impact on the successful delivery of a project?

A. YES

B. NO

SECTION B - EXAMINE THE PROJECT TIME MANAGEMENT PRACTICES ADOPTED ON THE AYI MENSAH HOUSING PROJECT

This section of the questionnaire focuses on the time management practices adopted on the Ayi Mensah Housing Project

Please rank on a scale of 1 – 5 to show how identifiable each of the following practices is, as used on the Ayi Mensah Housing Project. The scale is 1 – Not Identifiable, 2 – Less Identifiable, 3 – Neutral, 4 – Identifiable and 5 – Very Identifiable.

Time Control Practices	1	2	3	4	5
Defining activities					
Decomposition					
Rolling wave planning					
Templates					
Expert judgement					
Sequence activities					
Precedence Diagram Method					
Dependence determination					
Applying leads and lags					
Schedule network templates					
Estimate activity resources					
Expert judgment					
Alternatives analysis.					
Published estimating data.					
Bottom-up estimating					
Project management software.					
Estimate activity duration					
Expert judgment					
Analogous estimating					
Parametric estimating					
Three-Points estimating					
Project Evaluation and Review Technique (PERT)					
Reserve analysis					
Develop Schedule					
Schedule Network Analysis:					
Critical Path Analysis					
Schedule Compression					
“What if” scenario analysis					
Resource levelling					
Critical chain method					
Risk multipliers					

This section of the questionnaire focuses on the time control tools adopted on the Ayi Mensah Housing Project

Please rank on a scale of 1 – 5 to show how identifiable each of the following tools is, as used on the Ayi Mensah Housing Project. The scale is 1 – Not Identifiable, 2 – Less Identifiable, 3 – Neutral, 4 – Identifiable and 5 – Very Identifiable.

TIME CONTROL TOOLS	**1**	**2**	**3**	**4**	**5**
Gantt Bar Chart					
Critical Path Networks					
Milestone Date Programming Techniques					
Programme Evaluation and Review Technique					
Elementary Trend Analysis / Line of Balance Method					
Precedence Network Diagram					
Simulation					

This section of the questionnaire focuses on the project scheduling software adopted on the Ayi Mensah Housing Project

Please rank on a scale of 1 – 5 to show how identifiable each of the following software is, as used on the Ayi Mensah Housing Project. The scale is 1 – Not Identifiable, 2 – Less Identifiable, 3 – Neutral, 4 – Identifiable and 5 – Very Identifiable.

PROJECT SCHEDULING SOFTWARE	1	2	3	4	5
Primavera Project Planner					
Microsoft Project					
Asta Power Project					
Microsoft Excel					
Project Commander					
Deltek Open Plan					

SECTION C - IDENTIFY CHALLENGES WITH THE TIME CONTROL PRACTICES ON THE DELIVERY OF THE AYI MENSAH HOUSING PROJECT

This section of the questionnaire is to identify the challenges with the time control practices on the delivery of the Ayi Mensah Housing Project.

Please indicate the extent to which each of these challenges affects the delivery of the project. Please use the scale: 1 – Not Significant, 2 – Less Significant, 3 – Neutral, 4 – Significant and 5 – Very Significant.

IMPACT OF CHALLENGES	1	2	3	4	5
Undefined Goals					
Scope Changes					
Inadequately skilled personnel					
Estimating task duration					
Improper Risk Analysis and Management					
Assigning resources					
Poor communication management					
Impossible deadlines					
Lack of stakeholder engagement					

SECTION D - BEST PRACTICES OF PROJECT TIME MANAGEMENT FOR THE AYI MENSAH HOUSING PROJECT

This section of the questionnaire focuses on the best practices for ensuring effective time control on the Ayi Mensah Housing Project.

Please indicate the level of improvement required on the existing time control practices and tools to see an overall improvement in time control and elimination of challenges.

Please use the scale the scale: 1 – No improvement required, 2 – Little improvement required, 3 – Neutral, 4 – Improvement required and 5 – Very Significant improvement required

	1	2	3	4	5
Defining activities					
Decomposition					
Rolling wave planning					
Templates					
Expert judgement					
Sequence activities					
Precedence Diagram Method					
Dependence determination					
Applying leads and lags					
Schedule network templates					
Estimate activity resources					
Expert judgment					
Alternatives analysis.					
Published estimating data.					
Bottom-up estimating					
Project management software.					
Estimate activity duration					
Expert judgment					
Analogous estimating					
Parametric estimating					
Three-Points estimating					
Project Evaluation and Review Technique (PERT)					
Reserve analysis					
Develop Schedule					
Schedule Network Analysis:					
Critical Path Analysis					
Schedule Compression					
“What if” scenario analysis					
Resource levelling					
Critical chain method					
Risk multipliers					

THANK YOU