Sudan University of Science and Technology

College of Graduate Studies

Evaluation of the Application of Modern Management Systems in the Construction Industry in Sudan

تقييم تطبيق نظم الإدارة الحديثة في صناعة البناء والتشييد في السودان

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of M.Sc. in Civil Engineering (Construction Management)

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بسم الله الرحمن الرحيم

(تَبَارَكَ ٱلَّذِى نَزَّلَ ٱلْفُرْقَانَ عَلَى عَبْدِهِ لِيَكُونَ

لِلْعَالَمِينَ نَذِيراً)

صدق الله العظيم

سورة الفرقان: الاية: 1

Dedicate

To my beloved Mother
To spirit of my wonderful Father
To dear Brothers
To my loyal Friends

Acknowledgment

I am extremely grateful to **Almighty, Allah** who bestowed me the understanding and perseverance to make this accomplishment possible.

I would like to express my heartfelt gratitude and admiration to my direct supervisor ***DR. ISAM ABBAKAR ISHAG*** for his steady help, guidance,and endless support. In addition, he has been endowing me with hisconstructive observations at every stage of this research.

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Abstract

Modern construction management received more interest in the construction industry of our times due to the increased size of the projects and overlapping jurisdictions and tasks in addition intense competition. This study aims to identify the measure the application of management techniques construction sites in the state of Khartoum.

Information was collected from a group of construction companies and a group of engineers and managers locations within the state of Khartoum using the questionnaire system to obtain the necessary data for the study where total sample size of 60 people.

The results of the study concluded that the application of modern management of methods (the amount of information available on the project and coordination with other departments in the implementation of organization projects the possibility of the institution providing the means for technical services and equipment from laptops and accessories action plans take care of the work plan to improve production to improve productivity the application of computer programs in project management and human resource management materials management time management project management contract management resources management project scope purchases of risk management of the project management interest owners manage the project partners (Clint - contractor - Consultant) professional management Per desirable projects implementation) was good either building at the site control / quality management between acceptable and either good cost control, management and equipment and management Machinery and encourage team spirit and teamwork among the staff it was acceptable.

The study also indicated that the application of safety management in Sudan is very weak.

The study also indicated that more negative on the non-application of modern management methods in project management in Sudan effects are slow work and not organized conflicting information and lack of accuracy. Conflicting information and lack of accuracy weak productive length of the implementation of projects and increase cost plans failed.

المستخلص

تلقى إدارة التشييد الحديثة إهتماماً زائداً فى صناعة التشييد فى وقتنا الحالى نظراً لزيادة حجم المشاريع وتداخل الإختصاصات والمهام بلإضافة للمنافسة الشديدة .
تهدف هذه الدراسة الى التعرف على قياس مدى تطبيق أساليب الإدارة الحديثة فى مواقع التشييد في ولاية الخرطوم .
تم جمع المعلومات من مجموعة من شركات التشييد ومجموعة من مهندسي ومدراء المواقع داخل ولاية الخرطوم بإستخدام نظام الاستبانة للحصول على البيانات اللازمة للدراسة حيث بلغ حجم العينة 60 شخصاً.

خلصت الدراسة أن تطبيق أساليب الإدارة الحديثة المتمثلة فى (كمية المعلومات المتاحةعلى المشاريع و التنسيق مع الإدارات الأخرى في تنفيذمشاريع المنظمة ـــ إمكانية المؤسسة توفيروسائلا لخدماتالفنية والمعدات من أجهزة الكمبيوترالمحمولة والإكسسورات ـــ خطط عمل لتحسين الإنتاجية ـــ رعاية العمل تخطط لتحسين الإنتاج ـــتطبيق برامج الكمبيوترفي إدارةالمشاريع ـــ إدارةالمواد ـــ إدارةالمواردالبشرية ـــ إدارة زمن المشروع ـــ إدارةالعقود ـــ إدارةالموارد ـــ إدارةنطاقالمشروع ـــ إدارةالمخاطر ـــ إدارةالمشترياتالمشروع ـــ إدارة اصحاب المصلحة ـــ شركاء المشروع (مالك- مقاول - استشارى) ـــ ادارة محترفة لكل المشاريع المرغوب تنفيذها) كان جيد اما بناءالتحكم فى الموقع / إدارةالجودة بين مقبول وجيد اما مراقبة التكاليف والإدارة و المعدات وإدارة الآلات و تشجيع روح الفريق والعمل الجماعي بين الموظفين كان مقبول .

وخلصت الدراسة ايضا أن أكثر الأثار السالبة على عدم تطبيق أساليب الادارة الحديثة فى إدارة المشاريع فى السودان هى بطء العمل وعدم تنظيمه تضارب المعلومات وعدم دقتها . تضارب المعلومات وعدم دقتها ضعف الانتاجية طول فترة تنفيذ المشاريع وزيادة التكلفة فشل الخطط .

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Introduction

CHAPTER ONE

1.1INTRODUCTION

Modern construction management are suggested to deal more effectively with increasing importance of management in the construction sites in the present day because of the nature of the current projects of the increase in the size and overlapping in the disciplines and functions and powers in addition to the intense competition and complexity in terms off indignant the multiplicity of systems and options available for the implementation of these projects.

The management of construction projects requires knowledge of modern management as well as an understanding of the design and construction process. Construction projects have a specific set of objectives and constraints such as a required time frame for completion. While the relevant technology, institutional arrangements or processes will differ, the management of such projects has much in common with the management of similar types of projects in other specialty or technology domains such as aerospace, pharmaceutical and energy developments (Muller and Turner, 2007).Construction Project management is the art of directing and coordinating human and material resources throughout the life of a construction project by using modern construction management techniques to achieve predetermined objectives of scope, cost, time, quality and participation satisfaction (Idoro and Patunola – Ajayi, 2009). By contrast, the general management of business and industrial corporations assumes a broader outlook with greater continuity of operations. Nevertheless, there are sufficient similarities as well as differences between the two so that modern management techniques developed for general management may be adapted for project management.

Excellence in Project Management is achieved through a structured process that includes multiple phases:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing.

Of the main reasons for the failure of projects is either that there is an error in the planning or an error in execution.

There is a widespread belief to the name of "failure" as the project is called, which is not complete, and this belief is wrong!

The project is considered as a failure in one of the following cases:

If delayed delivery date

If a budget overrun

If there is an amendment to the project outputs

If the bad quality

If you did not obtain customer satisfaction

If you do not achieve its objectives

Here comes the PMI Project Management Institute and sets a standard global methodology Standard and foundations seeking to follow up the success of their projects and their implementation during the specified

timer (Time), and within budget (Budget), without change to the scope of work required (Scope).

This methodology is summarized in the development of 42 administrative process that ensures maximum setting types and Triangle for the quality of distributed during the project period (start-up period, planning, implementation, monitoring and control and close the project), these processes surrounding the management of the following aspects:

Project Integration Management Integration Management

Project Scope Management Scope Management

Project management time Time Management

Project management costs Cost Management

Project Quality Management Quality Management

Human Resources Management Project Human Resource Management

Telecom Project Management Communication Management

Project Risk Management Risk Management

Purchases of project management Procurements Management

Apart from that the testimony of the PMP is considered the second most powerful Vocational globally, but it will earn you the skills and extensive experience, and proficiency of these skills Appointed to understand the main role in the leadership of any project regardless of the nature, size and will deal with most of the things around you in a different way when they were considered anything in your life is a project in itself.

A working knowledge of general management and familiarity with the special knowledge domain related to the project are indispensable. Supporting disciplines such as computer science and decision science may also play an important role. In fact, modern management practices and various special knowledge domains have absorbed various techniques or tools which were once identified only with the supporting disciplines.(Arnaboldi et.al, 2004). For example, computer- based information systems and decision support systems are now common-place tools for general management. Similarly, many operations research techniques such as linear programming and network analysis are now widely used in many knowledge or application domains.

Construction project management encompasses a set of objectives which may be accomplished by implementing a series of operations subject to resource constraints. There are potential conflicts between the stated objectives with regard to scope, cost, time and quality, and the constraints imposed on human material and financial resources. (Idoro and Patunola – Ajayi, 2009) These conflicts should be resolved at the onset of a project by making the necessary tradeoffs or creating new alternatives.

Construction is the only sector of economic, which appears twice in the national accounts presented according to the United Nations recommendations. It is one of the eleven sectors of analysis of Gross Domestic Product (GDP) at the factor cost by industrial origin; but construction is also a component of fixed capital formation in the composition of Gross Domestic Capital Formation (GDCF) by the type of assets. Finally, construction appears as a separate entry in labor statistics reported by the International Labor Organization."

Construction is an important industry due to the variety of demand for the essentials project in the life of any nation, which the industry must satisfy:

- The demand for housing construction;
- The demand for building construction such as commercial, social uses etc;
- The demand for heavy engineering construction;
- The demand for industrial construction including factories etc.

1.2Statement of Research Problem :

number of development projects by government and private sector companies have created opportunities for construction companies to get infrastructural projects like road reconstruction, housing projects, bridge building, construction of drainage, dams rural electrification, city expansion and beautification projects among others have been on the increase in sudan, Against this background, with more capital investment in the construction industry in sudan because the nation is at the developing stage, there is a need to investigate modern construction management techniques in use among contracting firms or organization As a basis for the completion of engineering projects with high quality and time and cost less .

1.3 Research Questions:

From the above information, the research question generated which this study provides answers to are:

1- What modern management appropriate to the challenges facing the construction industry and how to apply the techniques that are

available and what are the recurrence mistakes which must prevent their occurrence and recurrence.

2- What are the techniques necessary to carry out the project management phases of the construction and application this techniques and work to achieve the goals, according to estimates of the required quality and specifications agreed upon, which invite ably will satisfy all parties, the projects successor all.

1.4 Research Significance:

Identification procedures and modern management methods and professional and follow the curriculum provides the ability to meet the challenges in the construction industry in Sudan and the completion of engineering projects with high efficiency, quality and less of time and cost

1.5 Limitation of Study

The dissertation covers the Assessment of modern Construction Management application in the Sudan Construction Industry taking Khartoum State as the case study area.

The essay is however limited to the following:

• Financial constraints

• Time constraints and weak productivity.

• Lack of access to some information needed for the project work.

1.6 Research objectives

The study specific objectives are to:

A measurement application of modern construction management techniques to reduce mistakes in the construction industry in Sudan

A- identify and assess construction management techniques in the construction industry in Sudan

B- identify and assess factors affecting the construction management techniques in Sudan

C- examine the impact of construction management techniques on construction cost, time and quality in Sudan

1.7 Research Hypothesis:

1. If modern management in engineering organizations have not been applied, whether in the public or private sector deficiencies will happen in the construction of the administrative system in the current implementation of engineering projects in Sudan

2. If there is no comprehensive knowledge of modern management techniques and by those working in the construction industry in Sudan will be repeated mistakes and thus engineering projects the failure

Chapter (2)

Literature Review

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter describes the review of relevant literatures that are related to this study. Among issues addressed by the chapter include the understanding of the term "Construction Project Management", Construction Management Techniques and Tools, Construction Managers among others. This review provides a holistic situation and approach to management techniques applicable in construction industry.

2.2 Construction Project Management

Construction project management according to Opara, (1986) is the overall planning, co-ordination and control of a project from inception to completion aimed at meeting a client's requirements in order to produce a functionally and financially viable project that will be completely feasible. Construction Project Management is that which applies to the construction sector (Lewis J.P (2007). The most common responsibilities of a Construction Manager according to The Construction Management Association of America (CMAA) fall under the following seven (7) categories: Project Management Planning, Cost Management, Time Management, Quality Management, Contract Administration, Safety Management and CM Professional Practice which includes specific activities like defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities and developing communication protocols and identifying elements of project design and construction likely to give rise to disputes and claims.Arnaboldi et.al, 2004)

A project manager is a professional in the field of project management having the responsibility of planning, execution and closing of any project, typically relating to construction industry, architecture e.t.c (Muller and Turner, 2007)

Project Management according to PMBOK (2004) is application of knowledge, skills, tools and techniques to project activities to achieve project requirements. Project management is accomplished through the application and integration of the project management processes of initiating, planning, monitoring, controlling and closing. (Wysocki and Lewis, 2001).

PMBOK (2004) identifies nine knowledge areas that Construction Project Managers should be familiar with in order to be considered professionals. These are as follows:

2.2.1 Construction Project Integration Management

Project integration management ensures that the project is properly planned, executed and controlled, including the exercise of formal project change control. As the term applies, every activity must be co-ordinate or integrated with every other one in order to achieve the desired project outcomes. (Muller and Turner, 2007)

2.2.2 Construction Project Scope Management

Changes to project scope are often the factors that "kill" a project. Scope management includes authorizing the job, developing a scope management that will define the boundaries of the project, sub-dividing the work into manageable components with deliverables, verifying that the amount of work planned has been achieved and specifying scope change control procedures.(Muller and Turner, 2007)

2.2.3 Construction Project Time Management

Time management implies personal efforts to manage one's time. For Construction projects, it refers to developing a schedule that can be met, then controlling work to ensure that this happens. Project Time Management in construction can be called schedule management (Patel 2008)

This is however a powerful technique, particularly for white collar, supervisory and management personnel

Time management involves minimization of wasteful elements of person's administrative work. Lack of efficient and efficient time management leads to:

- Interruptions by drop-in visitors (without appointment)
- Attending lengthy and unnecessary meetings that accomplish very little
- Inability to say "no" for some tasks
- Procrastination and lack of decisiveness
- Inability to delegate work
- Taking on much more than can be handled
- Lack of responsibility and authority to do certain jobs
- Delayed, inaccurate or inadequate information
- Taking orders from too many people
- Handling too many "crisis" situations
- Lack of organization of tasks by priority or target dates
- Lack of determination to complete tasks assigned
- Lack of organization on and around desk
- Unnecessary socialization
- Poor filling system

- Making unnecessary trips to people, departments, copy machines etc.
- Excessive conversation time
- Too many rescheduling of meeting, personal engagements etc.

(Stukenbruck & Zomorrodian, 1987)

All these does not encourage and will never improve productivity level in construction industry because time the say is money. Efficient use of time during construction however will always improve human productivity level in a construction industry. It is too often ignored, particularly by management people who preach productivity to their subordinates.

To minimize these "time-wasters", time management applies simple, common-sensible but very effective programming rules to very item of work, one of which is: "never handle same task twice". (Stukenbruck & Zomorrodian, 1987)

Employees are given freedom in determining their hours of work. The schedule of the time series can be given as:

- Core time (hours when all employees must be at work)
- Flexible time (hours when employees can vary their time of arrival and departure) Compressed Work Week:

Working for same number of hours but for fewer days / week

- 08 hours 05 days
- 10 hours 04 days

This time schedule series is a concept of time management knowing when to work, the time allocated in hours for each tasks to be

done and the relaxation period to cool down heels. (Stukenbruck & Zomorrodian, 1987)

2.2.4 Construction Project Cost Management

This involves estimating the cost of resources, including people, equipment, materials and such things as travel and other support details. Costs are budgeted and tracked to keep the project within the budget. (Patel, 2008)

2.2.5 Construction Project Quality Management

As commented by Pinto (2005), one cause of project failure is that quality is overlooked or sacrificed so that a tight deadline can be met. It is not very helpful to complete a project on time, only to discover that the thing delivered won't work properly. Quality Management included both quality assurance (planning to meet quality requirements) and quality control (steps taken to monitor results to see if they conform to requirements).

2.2.6 Construction Project Human Resource Management

Managing human resources is often overlooked in construction projects. It involves identifying the people needed to do the job, defining their roles, responsibilities and reporting relationships, acquiring those people and then managing them as the project is executed.(White & Fortune, 2002)

2.2.7 Construction Project Communications Management

Communication management involves planning, executing and controlling the acquisition and dissemination of all information relevant to the needs of all project stakeholders. This information will include project status, accomplishments events that may affect other stakeholders or projects and so on. (White & Fortune, 2002).

2.2.8 Construction Project Risk Management

Risk Management is the systematic process of identifying, quantifying, analyzing and responding to project risk. It includes maximizing the profitability and consequences of positive events and minimizing the profitability and consequences of adverse events to project objectives. This is an extremely important aspect of project management that is sometimes overlooked by novice project managers.(White & Fortune, 2002)

2.2.9 Construction Project Procurement Management

Procurement of necessary goods and services for the project is the logistics aspects of managing a job. It involves deciding what must be procured, issuing request for bids or quotations, selecting vendors, administering contracts and closing them when the job is finished.

2.3 Functions of Construction Management

The functions of project management for construction generally include the following:

1. Specification of project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants.
2. Maximization of efficient resource utilization through procurement of labor, materials and equipment according to the prescribed schedule and plan.
3. Implementation of various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.
4. Development of effective communications and mechanisms for resolving conflicts among the various participants.

According to Adedeji (1989), Construction planning is a fundamental and challenging activity in the management and execution of construction projects. It involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a crit
ical task in the management of construction, even if the plan is not written or otherwise formally recorded. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project. For example, the extent to which sub-contractors will be used on a project is often determined during construction planning.

2.4The Role of Construction Project Managers

A construction project's execution is planned and controlled by the project manager. The project manager is assigned by the Agency or the contractor (Westland, 2003). The project manager must have adequate authority to exercise the responsibility of forming and managing a team for support of the project. The project manager must have prior experience managing similar projects in the past. If an Agency cannot commit such an individual with adequate time and resources, the Agency is well advised to outsource project management services for management of the project. The project manager may be tasked with management of multiple projects that may require assignment of additional project managers for support. In such cases the project manager is taking on the role of project manager activities without a project manager. It shows the multiple interactions an Agency faces without a project manager to manage the work activities involved in

delivering a new capital asset(Westland, 2003). Project management organization is structured with the assignment of a project manager to manage project work activities. (White and Fortune, 2002)

2.5Construction Management Techniques and Tools

Different techniques and tools are used in managing projects for a describable outcome. Some of these techniques are Work Breakdown Structure, Gantt Charts, prince , Project Networks
(Critical path Networks and Programmer Evaluation and Review Techniques), Project Sensitivity Analysis, Cost Benefit Analysis, Graphical Evaluation and Review Technique(GERT) and Construction Project Software.

2.5.1 Work Breakdown Structure (WBS)

deals with breaking down of the project into manageable individual components din a hierarchical structure. Such a structure defines tasks that can be completed independently of other tasks, facilitating resource allocation, assignment of responsibilities and measurement and control of project. Wysocki (2009) also observed that it is a veritable tool for defining work packages and developing and tracking the cost and schedule for the project. Work Breakdown Structure (WBS) provides a common framework for the natural development of the overall planning and control of a project and it is the basis for dividing work into definable increment from which the Statement of Work can be developed and technical, schedule cost and labour hour reporting can be established. (Abbasi & Al- Mharmah, 2000)

2.5.2 Gantt chart

is a useful construction technique for planning and scheduling projects. It shows graphical representation of the duration of the duration of tasks against progression of time. It was developed by Henry Gantt in 1915 purposely for monitoring projects progression and tracki8ng. Gantt charts

have become a common technique for representing the phases and activities of a project Work Breakdown Structure (WBS) sop they can be understood by a wide audience all over the world (Wysocki, 2009). The Gantt chart is a popular type of bar chart that illustrates a project schedule. Gantt charts illustrate the start and finish dates of the activities and summary elements of a project. Activities and summary elements comprise the work breakdown structure of the project. Some Gantt charts also show the dependency (i.e. precedence network) relationships between activities. Henry Laurence Gantt (1861-1919) was a mechanical engineer, industry advisor and management consultant. He developed first examples of Gantt charts in 1910. Gantt charts were used as a visual tool to illustrate the start and finish dates of the terminal elements and summary elements of a project. Accepted as a commonplace project management tool today, it was an innovation of world-wide importance at that time. Gantt charts were used in large construction projects like the Hoover Dam started in 1931, and the USA interstate highway system started in 1956. In the 1980s, personal computers eased the creation and editing of elaborate Gantt charts, and they have since been developed from simple linked bar charts into network (or precedence) diagrams and are widely used for planning and scheduling projects. The Gantt chart is the most widely used of the techniques; perceived by the Construction Industry as being the easiest and most recognizable form of programming.

The Current Application of these Methods:

Today, the Gantt chart is accepted as a commonplace project management tool. This method, via the numerous desktop computer applications that are available, is primarily used by construction project managers and project planners in the management of projects. It is popular because it allows you to estimate how long a construction project should take, lays

out the order in which tasks need to be carried out, helps manage dependencies between tasks, determines the resources needed, monitors progress and helps to see how remedial action may bring the project back on course.

2.5.3 The Line of Balance (LOB)

technique was originated by the Goodyear Company in the early 1940's and was developed by the U.S. Navy in the early 1950's for the programming and control of both repetitive and non-repetitive construction projects. LOB was first applied to industrial manufacturing and production control, where the objective was to attain or evaluate a production line flow rate of finished products. The basic concepts of LOB have since been applied in the construction industry as a planning and scheduling method. Several attempts either to modify the basic LOB technique or to develop variations named differently have also been made (Examples, to name a few include: velocity diagrams, the construction planning technique, the vertical production method, the linear scheduling method, time space scheduling method, and repetitive project model). Lines of Balance diagram are techniques used in the construction industry to illustrate the planned sequence of work and to allow adjustments due to changed circumstances. There are potentially very few projects where a LOB diagram cannot be used and be of benefit. As seen above though, for more complex projects this perhaps may only be at a summarized level. Generally, for all main works and main subcontractors, it will assist in the management of both the subcontractor and the project. The diagrams are usually much easier to read than a detailed Gantt chart, making it a good tool for reporting purposes and for illustrating the inter-relationship between different activities. The LOB method is not simple though when dealing with a construction project that is broken down into a large number of activities that are bound by numerous and complicated

relationships and other constraints. The ensuing diagram is not as effective and can prove more complicated to read than the traditional Gantt chart.

2.5.4 Network Analysis

methods are very popular in larger projects but present complications in projects of repetitive nature such as high-rise building construction. Critical Path Method (CPM) based techniques have been criticized for their inability to model repetitive projects. The first problem is the sheer size of the network. In repetitive projects of n units, the network prepared for one unit has to be repeated n times and linked to each other; this results in a huge network that is difficult to manage. This may cause difficulties in communication among the members of the construction management team and difficulties in foreseeing the likely effect of delays. The second problem is that the Critical Path Method of analysis used in network analysis is designed primarily for optimizing project duration rather than adequately dealing with the special resource constraints of repetitive projects. Indeed, the critical path method has no capability to assure a smooth procession of labour teams from unit to unit with no conflict and no idle time for workers and equipment. This leads to hiring and procurement problems in the flow of labour and material during construction.

2.5.5 Prince 2

which connotes Project In Controlled Environment 2 is a process based method for effective project management. It is a de fact standard used extensively by the UK government and is widely recognized in the private and public sector, both in the UK and internationally. Its features include focus on business justification, division of project into manageable and controllable stages, flexible in application at a level appropriate to the project management team. PRINCE 2 basically

describes product based planning, change control technique and quality review technique.

2.5.6 Project Sensitivity Analysis

determines which variable have the most potential to affect project. Variables include task duration, success rate and costs, risks, lags between predecessors and successors, project duration, total project cost and so on. It is also useful in decision making under uncertainty and risk (Abbasi & Al- Mharmah, 2000)

2.5.7 Cost Benefit Analysis (CBA)

is one of the most widely accepted and applied methods for project appraisal for large scale infrastructure in the public and private sector. CBA is a prescriptive technique that provides guidance on the criteria to take account in decision making, ensuring that the net aggregate benefits to society outweigh net aggregate cost (Patel, 2008)

2.5.8 Graphical Evaluation and Review Technique (GERT)

is a network analysis technique used in construction project management that allows probabilistic treatment of both network logic and activity duration estimates. It is a useful management tool for planning, coordinating and controlling complex projects (Westland, 2003). The key objective of GERT is to evaluate on the basis of the network logic and estimated duration of the activity and derive inference about some activities that may not be performed. GERT can be used with a complimentary network analysis evaluation of activities (path) has the least amount of scheduling flexibility and therefore will most likely determine when the project can be completed. (Muller & Turner, 2007).

2.5.9 Programming Evaluation and Review Technique (PERT*)*

is an event-and-probability based network analysis system generally used in projects where activities and t heir durations are difficult to define. PERT is often used in large programme where the project involves

numerous organizations at widely different locations. (Abbasi & Al-Mharmah, 2000) An alternative to CPM is the PERT project planning model, which allows a range of durations to be specified for each activity. In Program evaluation and review technique (PERT), complex projects require a series of activities, some of which must be performed sequentially and others that can be performed in parallel with other activities. This collection of series and parallel tasks can be modeled as a network. While CPM is easy to understand and use, it does not consider the time variations that can have a great impact on the completion time of a complex project. The Program Evaluation and Review Technique (PERT) is a network model that allows for randomness in activity completion times. PERT was developed in the late 1950's for the U.S. Navy's Polaris project having thousands of contractors. It has the potential to reduce both the time and cost required to complete a project. (Pinto, 2007). The Network Diagram In a project, an activity is a task that must be performed and an event is a milestone marking the completion of one or more activities. Before an activity can begin, all of its predecessor activities must be completed. Project network models represent activities and milestones by arcs and nodes. PERT originally was an activity on arc network, in which the activities are represented on the lines and milestones on the nodes. Over time, some people began to use PERT as an activity on node network. The PERT chart may have multiple pages with many sub-tasks.

2.5.9.1 Steps in the PERT Planning Process

PERT planning involves the following steps:

1. Identify the specific activities and milestones.
2. Determine the proper sequence of the activities.
3. Construct a network diagram.
4. Estimate the time required for each activity.

5. Determine the critical path.

6. Update the PERT chart as the project progresses.

1. Identify Activities and Milestones: The activities are the tasks required to complete the project. The milestones are the events marking the beginning and end of one or more activities. It is helpful to list the tasks in a table that in later steps can be expanded to include information on sequence and duration.

2. Determine Activity Sequence: This step may be combined with the activity identification step since the activity sequence is evident for some tasks. Other tasks may require more analysis to determine the exact order in which they must be performed.

3. Construct the Network Diagram: Using the activity sequence information, a network diagram can be drawn showing the sequence of the serial and parallel activities. For the original activity-on-arc model, the activities are depicted by arrowed lines and milestones are depicted by circles or "bubbles". If done manually, several drafts may be required to correctly portray the relationships among activities. Software packages simplify this step by automatically converting tabular activity information into a network diagram.

4. Estimate Activity Times: Weeks are a commonly used unit of time for activity completion, but any consistent unit of time can be used.

A distinguishing feature of PERT is its ability to deal with uncertainty in activity completion times.

For each activity, the model usually includes three time estimates:

• Optimistic time - generally the shortest time in which the activity can be completed. It is common practice to specify optimistic times to be three standard deviations from the mean so that there is approximately a 1% chance that the activity will be completed within the optimistic time.

• Most likely time - the completion time having the highest probability. Note that this time is different from the expected time.

• Pessimistic time - the longest time that an activity might require. Three standard deviations from the mean are commonly used for the pessimistic time. PERT assumes a beta probability distribution for the time estimates. For a beta distribution, the expected time for each activity can be approximated using the following weighted average: Expected time = Optimistic + 4 x Most likely + Pessimistic) / 6 This expected time may be displayed on the network diagram. To calculate the variance for each activity completion time, if three standard deviation times were selected for the optimistic and pessimistic times, then there are six standard deviations between them, so the variance is given by: [(Pessimistic - Optimistic) / 6]2

The variance in the project completion time can be calculated by summing the variances in the completion times of the activities in the critical path. Given this variance, one can calculate the probability that the project will be completed by a certain date assuming a normal probability distribution for the critical path. The normal distribution assumption holds if the number of activities in the path is large enough for the central limit theorem to be applied. Make adjustments in the PERT chart as the project progresses. As the project unfolds, the estimated times can be replaced with actual times. In cases where there are delays, additional resources may be needed to stay on schedule and the PERT chart may be modified to reflect the new situation.

2.5.9.2 Benefits of PERT

PERT is useful because it provides the following information: • Expected project completion time.

• Probability of completion before a specified date. • The critical path activities that directly impact the completion time.

• The activities that have slack time and that can lend resources to critical path activities. • Activity start and end dates.

2.5.9.3 Limitations of PERT

The following are some of PERT's weaknesses:

• The activity time estimates are somewhat subjective and depend on judgement. In cases where there is little experience in performing an activity, the numbers may be only a guess. In other cases, if the person or group performing the activity estimates the time there may be bias in the estimate.

• Even if the activity times are well-estimated, PERT assumes a beta distribution for these time estimates, but the actual distribution may be different.

• Even if the beta distribution assumption holds, PERT assumes that the probability distribution of the project completion time is the same as that of the critical path. Because other paths can become the critical path if their associated activities are delayed, PERT consistently underestimates the expected project completion time. The underestimation of the project completion time due to alternate paths becoming critical is perhaps the most serious of these issues. To overcome this limitation, Monte Carlo simulations can be performed on the network to eliminate this optimistic bias in the expected project completion time.

2.5.10 Lean construction Management Technique:

Managing construction under Lean is different from typical contemporary practice because it has a clear set of objectives for the delivery process, is aimed at maximizing performance for the customer at the construction project level, designs concurrently product and process, and applies production control throughout the life of the project. By contrast, the current form of production management in construction is derived from the same activity centered approach found in mass

production and project management.(Arnabodi, Azzone, & Savoldelhi, 2004) It aims to optimize the project activity by activity; assuming customer value has been identified in design. Production is managed throughout a project by first breaking the project into pieces, i.e. design and construction, then putting those pieces in a logical sequence, estimating the time and resources required to complete each activity and therefore the project. Each piece or activity is further decomposed until it is contracted out or assigned to a task leader, foreman or squad boss. Control is conceived as monitoring each contract or activity against its schedule and budget projections (Arnabodi, Azzone, & Savoldelhi, 2004). These projections are rolled up to project level reports. If reliable workflow was a consequence of stopping the line rather than a stated objective. Activities or chains along the critical path fall behind, efforts are made to reduce cost and duration of the offending activity or changing the sequence of work. If these steps do not solve the problem, it is often necessary to trade cost for schedule by working out of the best sequence to make progress. The focus on activities conceals the waste generated between continuing activities by the unpredictable release of work and the arrival of needed resources.

Simply put, current forms of production and construction project management focus on activities and ignore flow and value considerations (Koskela 1992, Koskela and Huovila 1997). Managing the combined effect of dependence and variation is a first concern in lean production.

2.5.11 Just In Time Method(JIT)

The acronym JIT has been highly visible since the late 1980's, as manufacturing attempted to meet competitive challenges by adopting newly emerging management theories and techniques. Manufacturing JIT is a method of pulling work forward from one process to the next "just-in-time"; i.e. when the successor process needs it, ultimately producing

throughput. One benefit of manufacturing JIT is reducing work-in-process inventory, and thus working capital. An even greater benefit is reducing production cycle times, since materials spend less time sitting in queues waiting to be processed (Arnabodi, Azzone, & Savoldelhi, 2004)However, the greatest benefit of manufacturing JIT is forcing reduction in flow variation, thus contributing to continuous, ongoing improvement. Can this approach be applied to construction?

Construction JIT: JIT is a technique developed by Taichi Ohno and his fellow workers at Toyota. Ohno's fundamental purpose was to change production's directives from estimates of demand to actual demand--a purpose originally rooted in the absence of a mass market and the need to produce small lots of many product varieties. In assembly line production systems managed by lean production concepts, the directives for production are provided by means of kanban from downstream processes. This system insures that whatever is produced is throughput, i.e. is needed for the production of an order. The application of JIT to construction differs substantially from its application to manufacturing because construction and manufacturing are different types of production, and because of the greater complexity and uncertainty of construction. The extent and significance of uncertainty in construction has been adequately addressed in earlier papers but a moment's reflection supports the view that construction is complex. The number of parts, relative lack of standardization, and the multiple participants and constraining factors easily make the construction of an automobile factory more difficult than the production of an automobile in that factory. When this complexity is joined with economic pressures to minimize time and cost, that uncertainty results is not surprising. But is construction really a different type of production than manufacturing, or simply a more complex and uncertain version of manufacturing itself? What kind of production is

construction? Construction according to Akpan and Chizea (2002) is the final component in manufacturing's product development process. Construction is complete before manufacturing's production begins. Consequently, it is misleading to conceive construction as analogous to factory production (although some aspects of construction fit better in that analogy; i.e. fabrication). Construction is best conceived as a product development process, extending from product design through process design to facility (the manufacturing process tool) construction, the end result of which is readiness for manufacturing(Akpan and Chizea, 2002). Admittedly, this is a best fit in the case of industrial construction, and becomes less plausible as we move toward the cookie cutter end of the industry spectrum, e.g. manufactured housing. There seems to be a gray zone between manufacturing and construction, where the work looks like construction because final assembly is done where the facility is to be used, but looks like manufacturing because all that remains of the process is to match production output with sales. This gray zone is obviously ripe for industrialization and mechanization, which ultimately pushes it over into the camp of manufacturing. The proper business of construction is completing product and process design. Once that is done, it is but a matter of time before wit and invention capture mere assembly for manufacturing. Uncertainty is a necessary component in construction conceived as a product development process. The very purpose of the process is to surface and resolve trade-offs between means and ends, all the way from product design through facility construction. The management of projects so conceived is the proper terrain for lean construction concepts and techniques. So, construction is a different type of production than manufacturing, and has greater uncertainty and flow variation. (Akpan and Chizea 2002).

2.5.12 Monte Carlo Technique

Monte Carlo simulation, or probability simulation, is a technique used to understand the impact of risk and uncertainty in financial, project management, cost, and other forecasting models. How It Works: In a Monte Carlo simulation, a random value is selected for each of the tasks, based on the range of estimates. The model is calculated based on this random value. The result of the model is recorded, and the process is repeated. A typical Monte Carlo simulation calculates the model hundreds or thousands of times, each time using different randomly-selected values. When the simulation is complete, we have a large number of results from the model, each based on random input values. These results are used to describe the likelihood, or probability, of reaching various results in the model.

2.5.13. Critical Path Method (CPM):-

In 1957, DuPont developed a construction project management technique designed to address the challenge of shutting down chemical plants for maintenance and then restarting the plants once the maintenance had been completed. Given the complexity of the process, they developed the Critical Path Method (CPM) for managing such projects.

The most widely used scheduling technique in Construction Project Management is the critical path method. (CPM) for scheduling, often referred to ascritical path scheduling. (Arnabodi, Azzone, & Savoldelhi, 2004).

This method calculates the minimum completion time for a project along with the possible start and finishes times for the project activities. Indeed, many texts and managers regard critical path scheduling as the only usable and practical scheduling procedure. Computer programs and algorithms for critical path scheduling are widely available and can efficiently handle projects with thousands of activities.

The critical path represents the set or sequence of predecessor/successor activities which will take the longest time to complete. The duration of the critical path is the sum of the activities' durations along the path. Thus, the critical paths can be defined as the longest possible path through the "network" of project activities. The duration of the critical path represents the minimum time required to complete a project.(Arnabodi, Azzone, & Savoldelhi, 2004). Any delays along the critical path would imply that additional time would be required to complete the project. There may be more than one critical path among all the project activities, so completion of the entire project could be delayed by delaying activities along any one of the critical paths. For example, a project consisting of two activities performed in parallel that each requires three days would have each activity critical for a completion in three days. Formally, critical path scheduling assumes that a project has been divided into activities of fixed duration and well defined predecessor relationships. A predecessor relationship implies that one activity must come before another in the schedule. No resource constraints other than those implied by precedence relationships are recognized in the simplest form of critical path scheduling. To use critical path scheduling in practice, construction planners often represent aresource constraint by a precedence relation. Aconstraint is simply a restriction on the options available to a manager, and are source constraint is a constraint deriving from the limited availability of some resource of equipment, material, space or labor. For example, one of two activities requiring the same piece of equipment might be arbitrarily assumed to precede the other activity. This artificial precedence constraint insures that the two activities requiring the same resource will not be scheduled at the same time. Also, most critical path scheduling algorithms impose restrictions on the generality of the activity relationships or network geometries

which are used. In essence, these restrictions imply that the construction plan can be represented by anetwork plan in which activities appear as nodes in a network.

CPM provides the following benefits:

• Provides a graphical view of the project.

• Predicts the time required to complete the project.

• Shows which activities are critical to maintaining the schedule and which are not. CPM models the activities and events of a project as a network. Activities are depicted as nodes on the network and events that signify the beginning or ending of activities are depicted as arcs or lines between the nodes. (Arnabodi, Azzone, & Savoldelhi, 2004).

The following is an example of a CPM network diagram: CPM Diagram Steps in CPM Project Planning

1. Specify the Individual Activities: From the work breakdown structure; a listing can be made of all the activities in the project. This listing can be used as the basis for adding sequence and duration information in later steps.

2. Determine the Sequence of the Activities: Some activities are dependent on the completion of others. A listing of the immediate predecessors of each activity is useful for constructing the CPM network diagram.

3. Draw the Network Diagram: Once the activities and their sequencing have been defined, the CPM diagram can be drawn. CPM originally was developed as an activity on node (AON) network, but some project planners prefer to specify the activities on the arcs.

4. Estimate Activity Completion Time: The time required to complete each activity can be estimated using past experience or the estimates of knowledgeable persons. CPM is a deterministic model that does not take

into account variation in the completion time, so only one number is used for an activity's time estimate.

5. Identify the Critical Path: The critical path is the longest-duration path through the network. The significance of the critical path is that the activities that lie on it cannot be delayed without delaying the project. Because of its impact on the entire project, critical path analysis is an important aspect of project planning.

The critical path can be identified by determining the following four parameters for each activity:

• **ES - earliest start time:** the earliest time at which the activity can start given that its precedent activities must be completed first.

• **EF - earliest finish time:** equal to the earliest start time for the activity plus the time required for completing the activity.

• **LF - latest finish time:** the latest time at which the activity can be completed without delaying the project.

• **LS - latest start time:** equal to the latest finish time minus the time required to complete the activity. The slack time for an activity is the time between its earliest and latest start time, or between its earliest and latest finish time. Slack is the amount of time that an activity can be delayed past its earliest start or earliest finish without delaying the project. The critical path is the path through the project network in which none of the activities have slack, that is, the path for which ES=LS and EF=LF for all activities in the path. A delay in the critical path delays the project. Similarly, to accelerate the project it is necessary to reduce the total time required for the activities in the critical path.

6. Update CPM Diagram: As the project progresses, the actual task completion times will be known and the network diagram can be updated to include this information. A new critical path may emerge, and

structural changes may be made in the network if project requirements change.

(Arnabodi, Azzone, & Savoldelhi, 2004).

2.5.13.1CPM Limitations

CPM was developed for complex but fairly routine projects with minimal uncertainty in the project completion times. For less routine projects there is more uncertainty in the completion times, and this uncertainty limits the usefulness of the deterministic CPM model.

2.6Construction Project Management Phases

Project management phases otherwise known as project lifecycle refers to the stages in a project's development. Project life cycle is important because it demonstrates the logic that governs a project. It also helps in developing plans for carrying out the project. (Pinto, 2007) identified four distinct project life cycle phases which are:

Conceptualization: According to Pinto (2007) refers to the development of the initial goal and technical specification for a project. The scope of work is determined, necessary resources (people, money, material and machine) identified and important organizational contributions to stakeholders signed on. Also feasibility study is conducted at this stage to investigate whether the project can be continued or not.

Planning: Is the stage in construction in which detailed specifications, schematic, schedules and other plans are developed and steps necessary to meet the project's objectives are put in place. At this stage, the individual pieces of the project called work packages are broken down, individual assignment made and the process for completion clearly delineated (Muller & Turner, 2007). Project schedule, the actual work and the estimated cost of completion are also identified. Anything that might pose a threat to the successful completion of the project is also identified at this stage. Finally all the project stakeholders must be identified at this stage

of the project so as to establish a communication plan that describes information needed and the delivery method to be used to keep stakeholders informed (Patel, 2008).

Execution: Execution phase with actual performance of the work of the project. Progress is continuously monitored and appropriate adjustments are made and variances recorded so as to maintain the original project plan. The project manager uses this information to maintain control over the direction of the project by measuring the performance of the project activities comparing the results with the project plan and takes corrective actions as needed (Westland, 2003).

Termination: This occurs when the completed project is transferred to the customer, project documentation is handed over to the business, suppliers' contracts terminated, project resources released and the project closure communicated to all Stakeholder.

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2.7critical Barriers / Problems Of Implementing Effective

Construction Management:

- Family-controlled industry
- Monopolistic market, in some segments, some high competitive
- Erratic inflow of orders
- Lack of productivity and quality culture
- Shortage of funds low level codification
- Automation -not encouraged
- Low priority of market and commercial activities
- Poor after service
- Complicated government policy, rules and regulations
- Poor infrastructure support/road transport

Chapter (3)

Research methodology

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter is a review of the various approaches to data collection and analysis adopted in conducting this research; it explains the type of research strategy adopted the mode of data collection and the methodology used in carrying out this research. The study focuses on the assessment of construction management techniques in construction industry in Sudan in Khartoum state as a case study.

3.2 Research Strategy

Research strategy is defined as the way in which research objectives can be questioned. The type of research adopted for this research is the qualitative research. The purpose for its adoption being the nature of the research, due to the subjective nature of the qualitative approach to research. It emphasizes meanings, experiences e.t.c. The information that was gathered under this research is was two forms; exploratory and attitudinal.

The exploratory research dealt with the area of this research in which I had limited knowledge, it helped in showing how much the average Sudanese tertiary institutions students have entrepreneurial orientation and mindset in their daily academic endeavors.

Attitudinal research as used in this research was used to evaluate the views and opinions of the respondents as regards assessment of construction management techniques.

3.3 Research design

The research can be described systematic and organized effort to investigate the specific and to provide a solution to this problem is a result is adding new knowledge and working to develop theories according to the existing knowledge of the methodology and correct and reliable

The research design employed in this study is descriptive statistics. Exposition is made on the sources of data, method of data collection,

sampling and sampling techniques, research instrument and data analysis method used.

3.4 Research Population

The study population for this study shall comprise the construction professionals who are in active practices in the study area. The professionals include Architects, Quantity Surveyors, Engineers, Builders e.t.c Information about the professionals were obtained from the register of their various professional bodies to find out the list of those registered with their professional bodies. The list forms the basis for consultation and selection of sample for this study.

3.5 Sample Frame

A sample is a specimen or part of a whole (population) which is drawn to show what the rest is like . For this research, a sample was drawn from a population and adequate measure was taken to ensure that the characteristics of the sample are the same as its population as a whole.

3.6 Sample Size

The sample size for a study is the representation of the population to be studied. The sample size for this study was obtained from the register of their various professional bodies.

3.7 Sampling Technique

For this research, a purposive sampling of the participants in the selected area was conducted. Purposive sampling technique by distributes questionnaire at his/ her convenience or as come in contact. The sample consists of professionals in diverse field of construction- Architects, Quantity Surveyors, Builders, Engineers e.t.c

A total of sixty questionnaires were administered and sixty were retrieved. The retrieved questionnaires were used for analysis.

3.8 Data Collection Instrument

The instruments for the collection of data are the various modes available to extract data and information from respondents. As a result of the nature of the study, the instrument for data collection used for the study was questionnaire. The basic elements of all questionnaires are the questions; therefore, a careful thorough planning was required in the construction of the questions

(a) Identification of the first thought question; this is a form of precipitate from the objectives and the literature review. It forms the backbone upon which the questionnaire is constructed and at this stage; quite a number of questions were generated though the order and wording was not of consideration.

(b) Formulation of the final questions; at this stage the questions from the initial stage were fine-tuned and divided into two different sections to aid the respondents and also to facilitate easy analysis. The first section identifies the demographic information about the respondents. These include their academic and professional qualifications, years of work experience in service and other relevant information.

The questions contained in the questionnaire consists basically of factual questions which are required to gather facts related to the background of the individual respondents, their academic levels and their perception construction management techniques. The other questions which require some level of objectivity for its assessment.

The questionnaire approach was adopted because the purpose of this research is clear enough to be explained in a few paragraph and the respondents can make adequate contribution without ambiguity.

Also as the questionnaire approach has the advantage of a wide coverage, wide consultation on the part of the respondent it is best suited for this research.

In order to guard against some of the disadvantages associated with the questionnaire approach, which include lack of control over respondent, ambiguity in the structure of the questions, fatigue due to excessive inflow of questionnaire to increase the reliability of the data and information gathered through the questionnaire approach

3.9 Approach / Procedure for Data Collection

The approach adopted for carrying out this research was employed due to the nature of the investigation and the type of data and information that was required and available. The approach adopted for this research is the field work (primary data collection). The field work research refers to the methods of primary data collection and in this case the practical approach used is the problem solving approach. This involved assessing the modern construction management in construction industry in Sudan .

3.10 Method of Data Analysis

The methods of analysis used in this research were selected due to the type of data available for the analysis and the objectives of the research. Most of the questions were qualitative; hence the descriptive method of analysis is best suited for the analysis. Such methods include the frequency distribution; percentages, tabulations, charts. e.t.c. Likert scales rating was used with interval 5 to 1 where 1 represents the least ranking and 5 represents the highest ranking which addressed issues on the objectives of this study. The scale includes very high, high, moderate, low and very low.

Chapter (4)

Result And Data Analysis

CHAPTER FOUR

ANALYSIS OF DATA AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the analysis and results of the data collected. It also explains the method of measurement used, method of coding and the type of analyses carries out. From these analyses, different conclusions are made as regards the assessment of construction management techniques in the construction industry in sudan.

4.2 Levels of Measurement

Measurement is the procedure in which a researcher assigns numerals (numbers or other symbols) to empirical properties (variables) according to rules (Naoum, 1999). In order to select the most appropriate method of analysis, the appropriate level of measurement must be used.

Statistical package for social sciences The nominal scale was used to assign variables into different classification and also to assign variables based on their properties and the spss measuring the ordinal variables can be arranged so that the variable values so given every indication that he can be arranged values and accurately determine the differences (excellent, very good, good, acceptable, poor)

4.3 Analysis and Presentation of Result

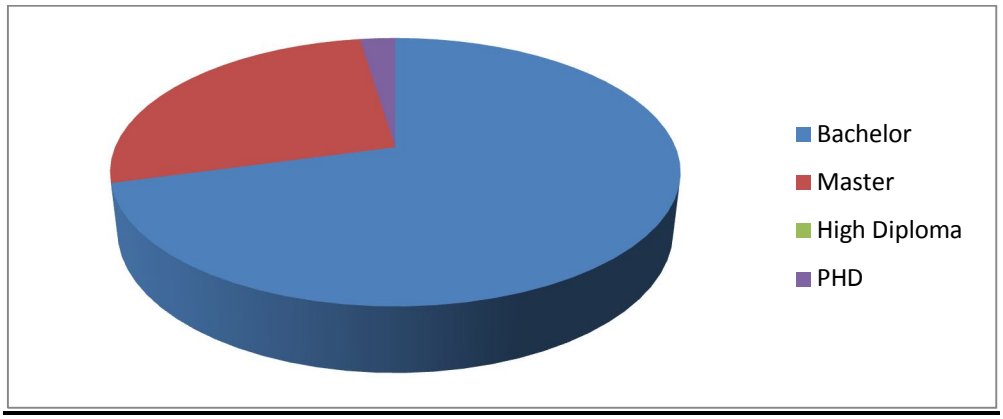
The descriptive method of data analysis is employed for this research. The method of analysis will follow the structure set out in the questionnaire in order to achieve the objectives of the research

Table(4 - 1) :

Section 1 :personal information:

The following table shows frequencies and percentages of Qualifications:

options	Frequency	Percentage
Bachelor	58	70.7
Master	22	26.8
High Diploma	0	0
PHD	2	2.4
Total	98	%100

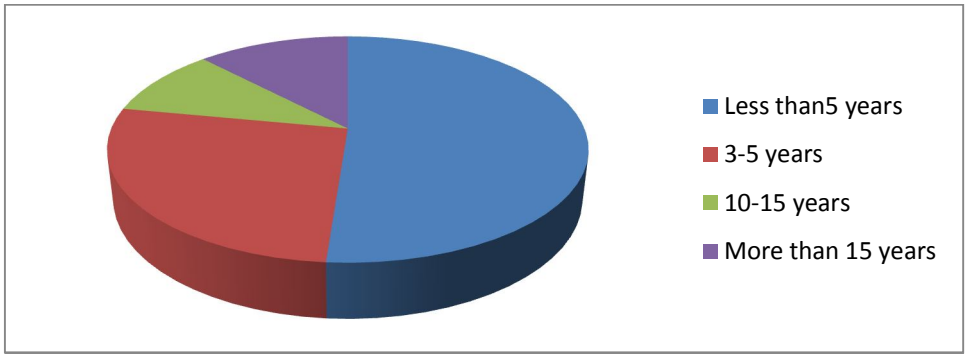


Figure(4 - 1) : The figure above show result of Qualifications

Table (4 - 2)

The following table shows frequencies and percentages of Experience :

options	Frequency	Percentage
Less than5 years	42	51.2
3-5 years	22	26.8
10-15 years	8	9.8
More than 15 years	10	12.2
Total	82	%100

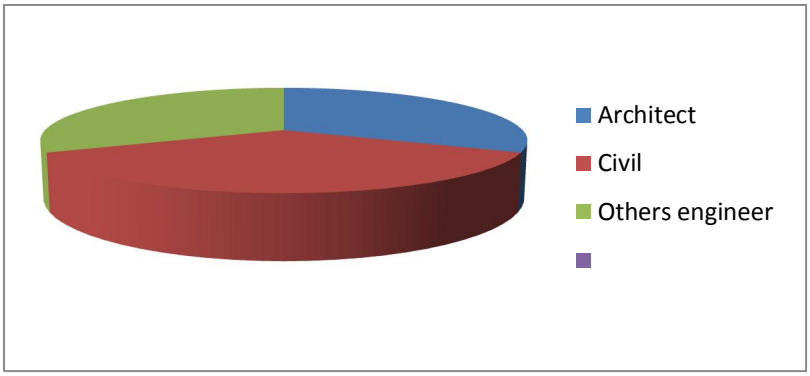


Figure(4 - 2) : The figure above show resultof Experience

Table (4 - 3)

The following table shows frequencies and percentages of Specialization :

options	Frequency	Percentage
Architect	26	31.7
Civil	30	36.6
Others engineer	26	31.7
Total	82	%100

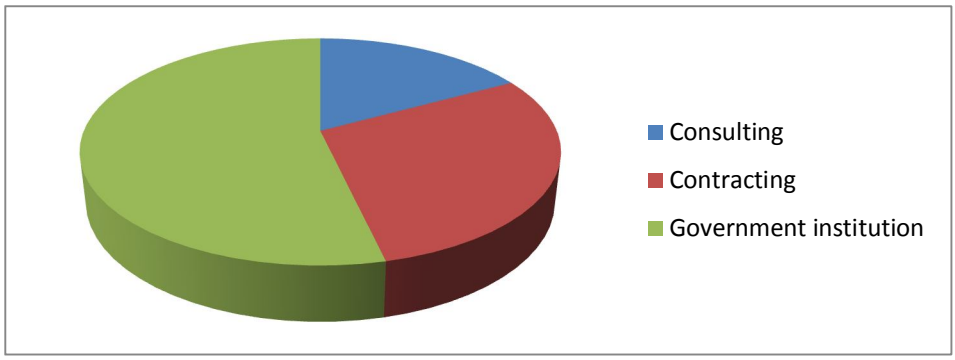


Figure(4 - 3) : The figure above show result of Specialization

Table(4 - 4) :

The following table shows frequencies and percentages of Type of Business:

options	Frequency	Percentage
Consulting	14	17.1
Contracting	24	29.3
Government institution	44	53.7
Total	82	%100



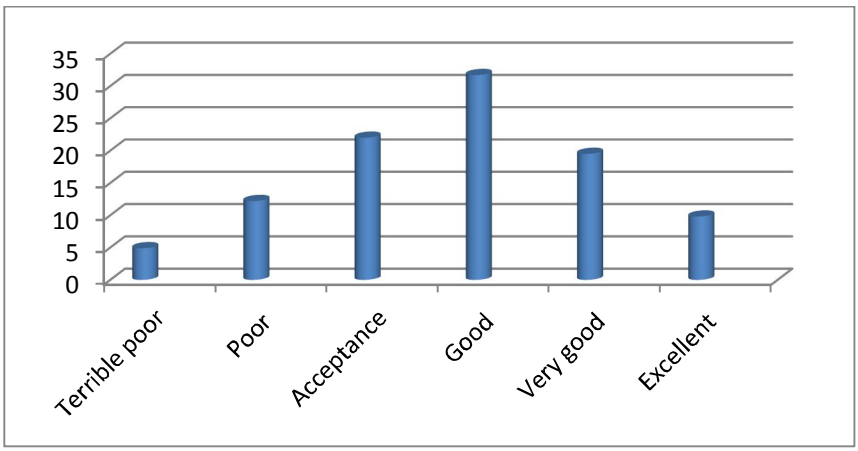
Figure(4 - 4) : The figure above show result of Type of Business:

Table(4 - 5):

Section 2:

(1)The following table shows frequencies and percentages of degree of clarity and objectives of the projects in the organization

options	Frequency	Percentage
Terrible poor	4	4.9
Poor	10	12.2
Acceptance	18	22.0
Good	26	31.7
Very good	16	19.5
Excellent	8	9.8
Total	82	100%

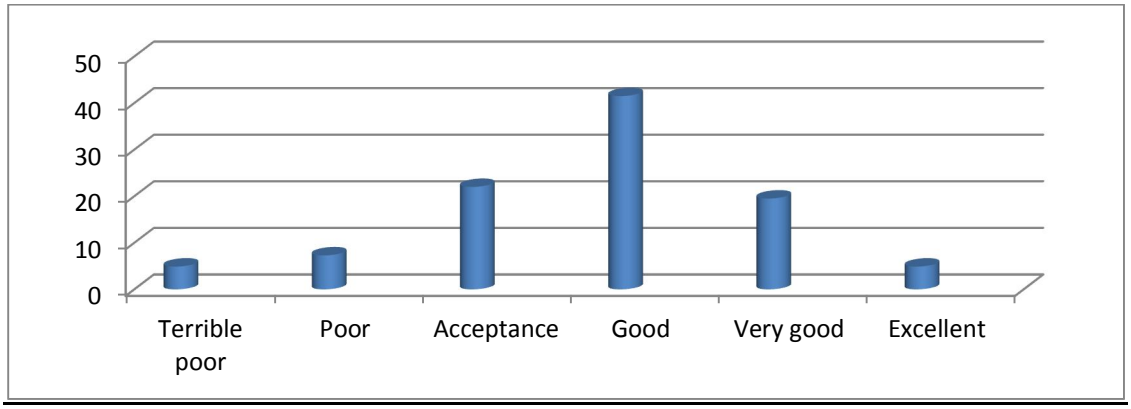


Figure(4 - 5) : The figure above show result of type of degree of clarity and objectives of the projects in the organization

Table(4 - 6) :

(2)The following table shows frequencies and percentages of The amount of information available on the projects :

options	Frequency	Percentage
Terrible poor	4	4.9
Poor	6	7.3
Acceptance	18	22.0
Good	34	41.5
Very good	16	19.5
Excellent	4	4.9
Total	82	100%



Figure(4 - 6) : The figure above show result of The amount of information available on the projects

Table(4 - 7):

(3)The following table shows frequencies and percentages of Coordination with other departments on the implementation of the projects the organization :

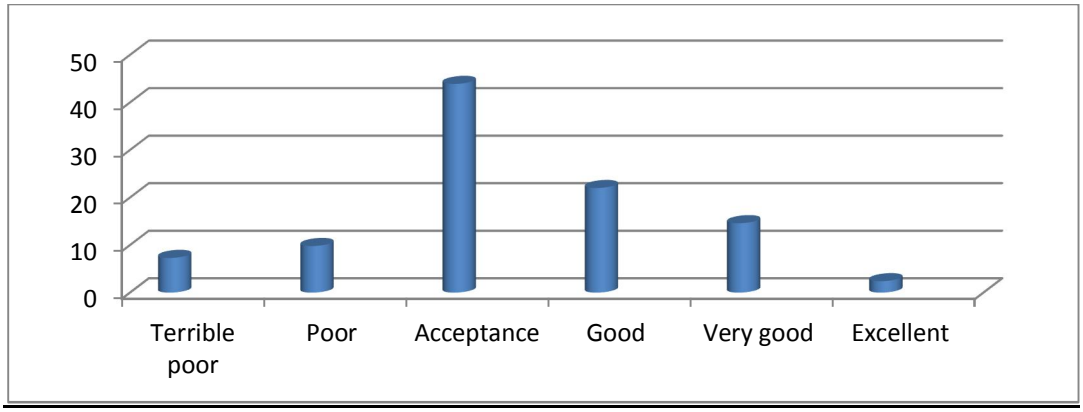
options	Frequency	percentage
Terrible poor	6	7.3
Poor	12	14.6
Acceptance	18	22.0
Good	28	34.1
Very good	16	19.5
Excellent	2	2.4
Total	82	100%

Figure(4 - 7) : The figure above show result of Coordination with other departments on the implementation of the projects the organization

Table(4 - 8):

(4)The following table shows frequencies and percentages of The extent Authority to focus attention on the elements of modern project management urged staff to implement projects :

options	Frequency	Percentage
Terrible poor	6	7.3
Poor	8	9.8
Acceptance	36	43.9
Good	18	22.0
Very good	12	14.6
Excellent	2	2.4
Total	82	100%



Figure(4 - 8) : The figure above show result of The extent Authority to focus attention on the elements of modern project management urged staff to implement projects

Table(4 - 9)

(5)The following table shows frequencies and percentages of The possibility of the institution providing the means for technical services and equipment from Computers Lap tops and accessories :

options	Frequency	Percentage
Terrible poor	6	7.3
Poor	10	12.2
Acceptance	16	19.5
Good	24	29.3
Very good	18	22.0
Excellent	8	9.8
Total	82	100%

Figure(4 - 9) : The figure above show result of The possibility of the institution providing the means for technical services and equipment from Computers Lap tops and accessories

Table(4 - 10):

(6)The following table shows frequencies and percentages of Encourage team spirit and teamwork among staff :

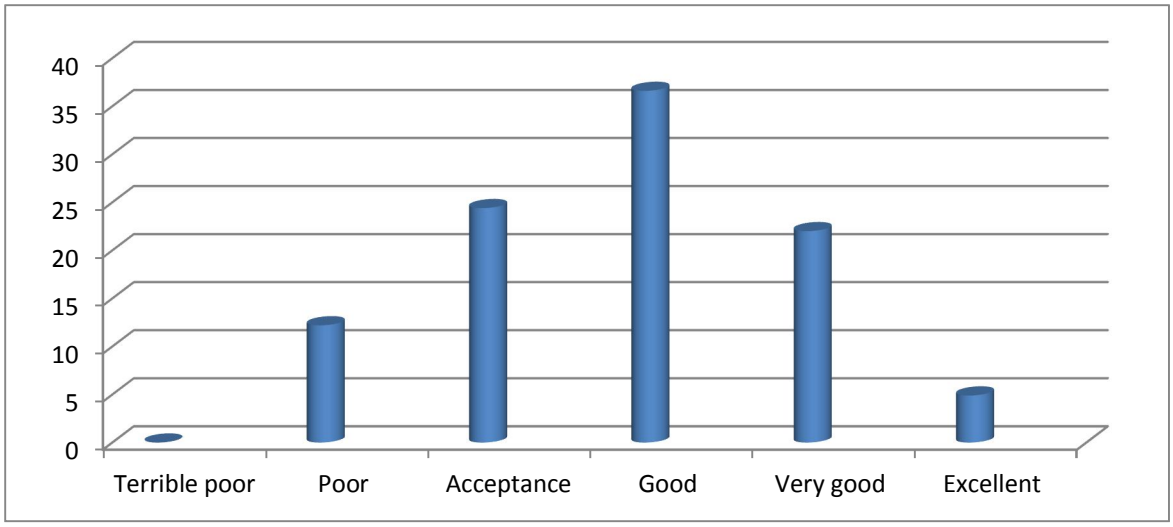
options	Frequency	percentage
Terrible poor	4	4.9
Poor	6	7.3
Acceptance	26	31.7
Good	22	26.8
Very good	16	19.5
Excellent	8	9.8
Total	82	100%

Figure(4 - 10) : The figure above show result of Encourage team spirit and teamwork among staff

Table(4 - 11):

(7)The following table shows frequencies and percentages of plans of action to improve productivity :

options	Frequency	percentage
Terrible poor	0	0
Poor	10	12.2
Acceptance	20	24.4
Good	30	36.6
Very good	18	22.0
Excellent	4	4.9
Total	98	100%



Figure(4 - 11) : The figure above show result plans of action to improve productivity

Table(4 - 12):

(8)The following table shows frequencies and percentages of institution takes care of the work plans to improve production :

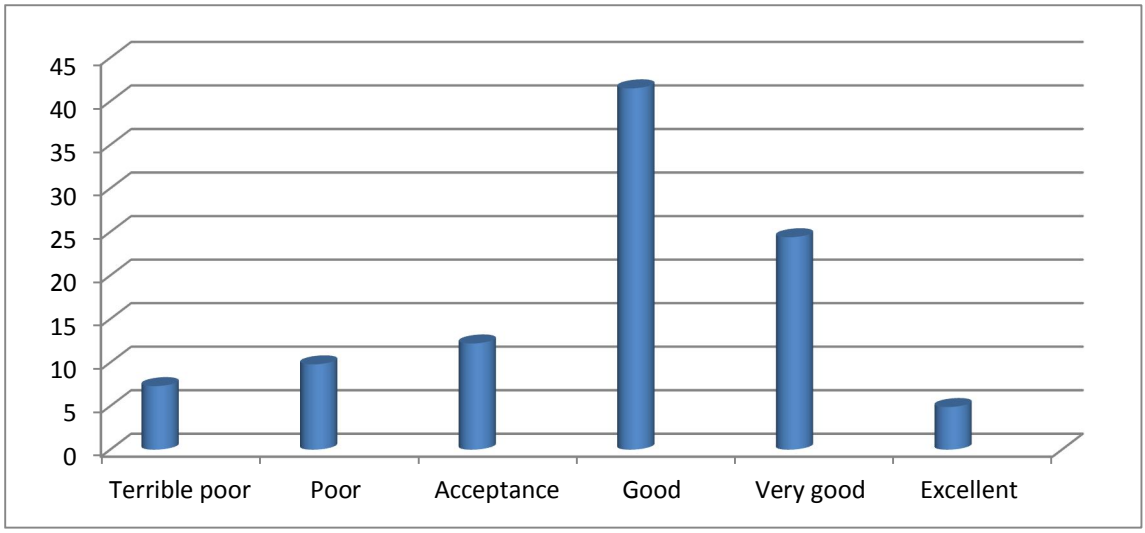
options	Frequency	Percentage
Terrible poor	4	4.9
Poor	12	14.6
Acceptance	16	19.5
Good	30	36.6
Very good	20	24.4
Excellent	0	0
Total	82	100%

Figure(4 - 12) : The figure above show resultof institution takes care of the work plans to improve production

Table(4 - 13):

(9)The following table shows frequencies and percentages of Is the institution applied computer programs in the management of projects :

options	Frequency	percentage
Terrible poor	6	7.3
Poor	8	9.8
Acceptance	10	12.2
Good	34	41.5
Very good	20	24.4
Excellent	4	4.9
Total	82	100%

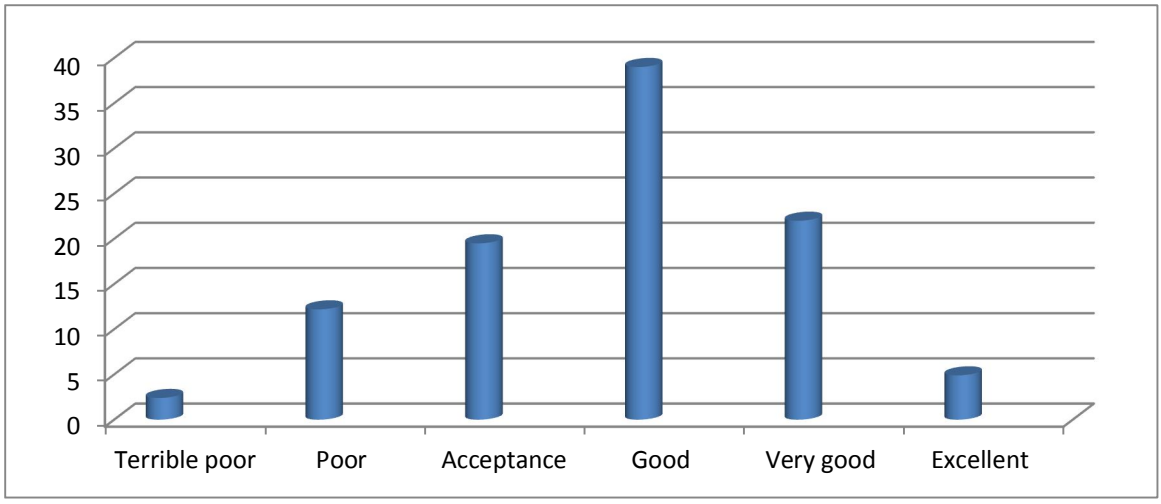


Figure(4 - 13) : The figure above show resultof the institution applied computer programs in the management of projects

Table(4 - 14):

(10)The following table shows frequencies and percentages of Materials Management :

options	Frequency	percentage
Terrible poor	2	2.4
Poor	10	12.2
Acceptance	16	19.5
Good	32	39.0
Very good	18	22.0
Excellent	4	4.9
Total	82	100%

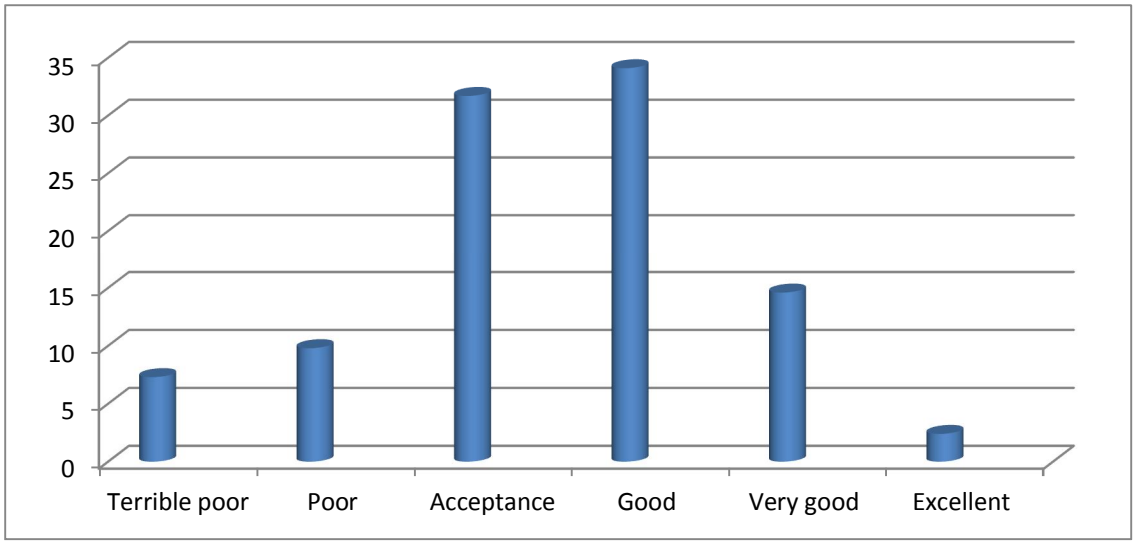


Figure(4 - 14) : The figure above show result of Materials Management

Table(4 - 15):

(11)The following table shows frequencies and percentages of Human Resource Management :

Options	Frequency	percentage
Terrible poor	6	7.3
Poor	8	9.8
Acceptance	26	31.7
Good	28	34.1
Very good	12	14.6
Excellent	2	2.4
Total	82	100%

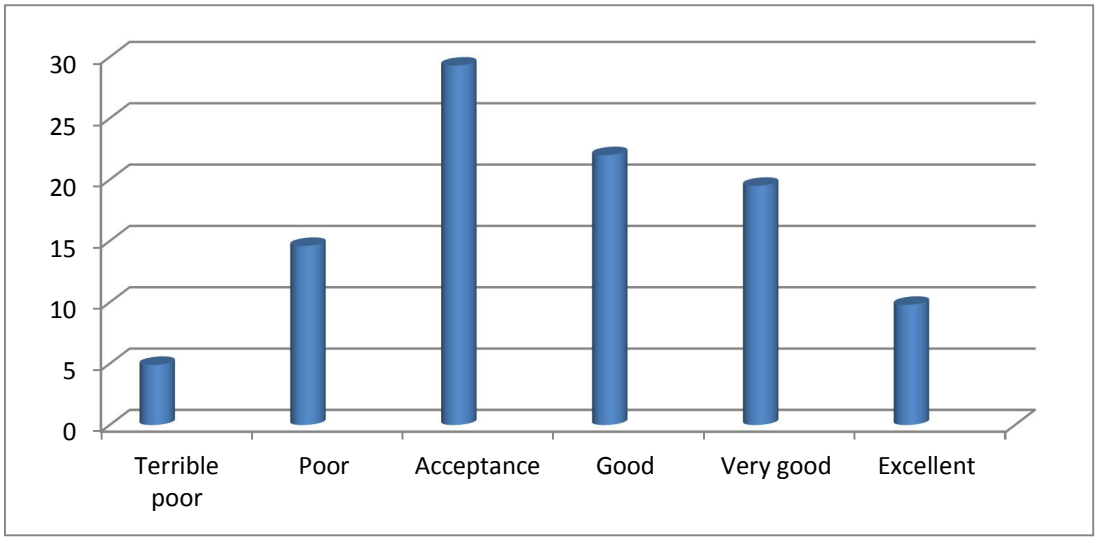


Figure(4 - 15) : The figure above show resultof Human Resource Management

Table(4 - 16):

(12)The following table shows frequencies and percentages of Cost Management :

options	Frequency	percentage
Terrible poor	4	4.9
Poor	12	14.6
Acceptance	24	29.3
Good	18	22.0
Very good	16	19.5
Excellent	8	9.8
Total	82	100%



Figure(4 - 16) : The figure above show result of Cost Management

Table(4 - 17):

(13)The following table shows frequencies and percentages of Construction Quality Management :

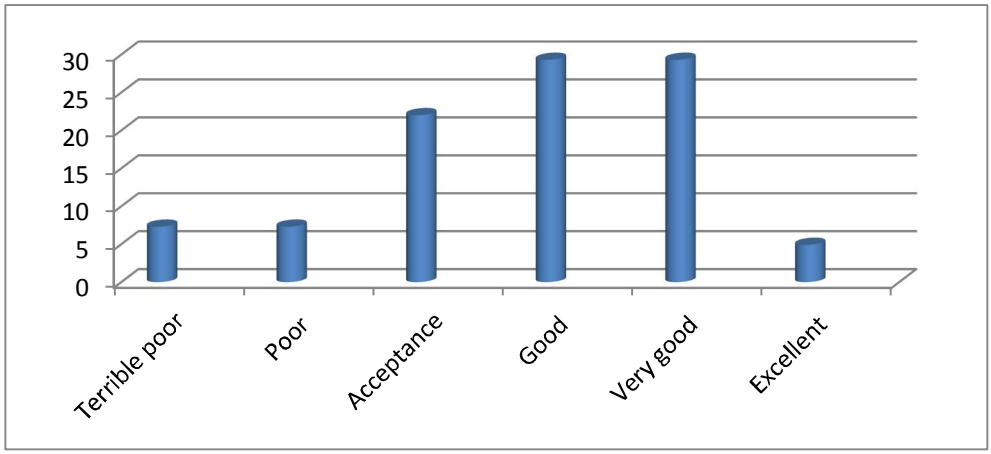
options	Frequency	percentage
Terrible poor	2	2.4
Poor	12	14.6
Acceptance	22	26.8
Good	16	19.5
Very good	24	29.3
Excellent	6	7.3
Total	82	100%

Figure(4 - 17) : The figure above show result of Construction Quality Management

Table(4 - 18):

(14)The following table shows frequencies and percentages of Project planning and Scheduling :

options	Frequency	Percentage
Terrible poor	6	7.3
Poor	6	7.3
Acceptance	18	22.0
Good	24	29.3
Very good	24	29.3
Excellent	4	4.9
Total	82	100%

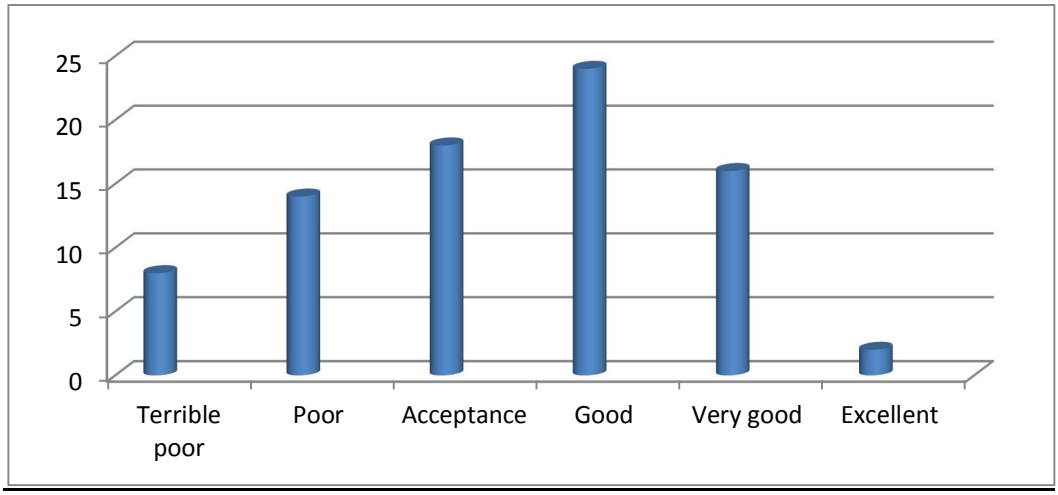


Figure(4 - 18) : The figure above show result of Project planning and Scheduling

Table(4 - 19):

(15)The following table shows frequencies and percentages of Time Management :

options	Frequency	percentage
Terrible poor	18	8
Poor	14	14
Acceptance	16	18
Good	14	24
Very good	14	16
Excellent	6	2
Total	82	82

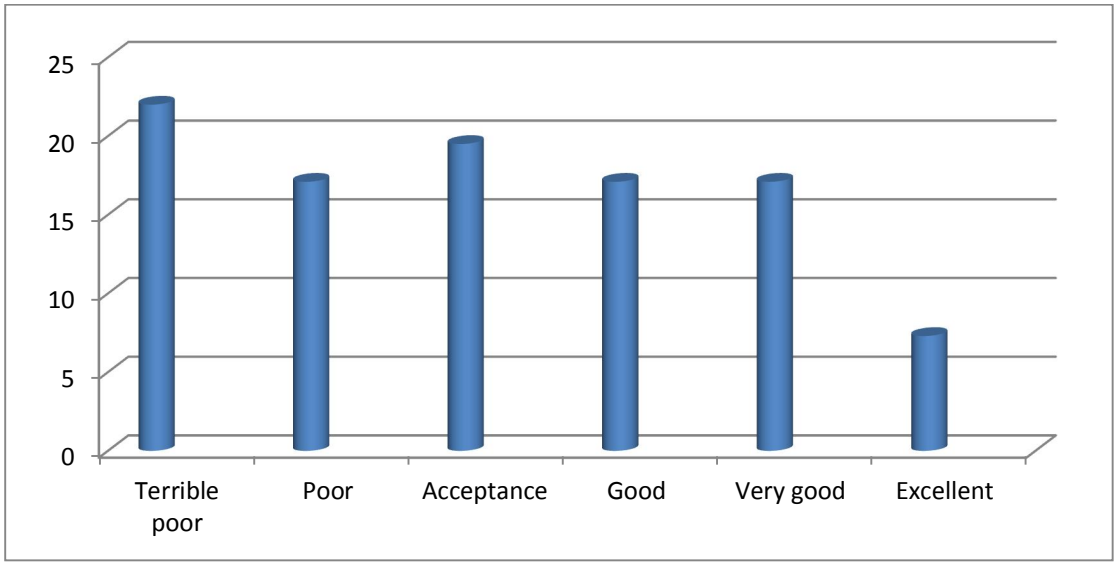


Figure(4 - 19) : The figure above show result of Time Management

Table(4 - 20):

(16)The following table shows frequencies and percentages of Safety Management:

options	Frequency	Percentage
Terrible poor	18	22.0
Poor	14	17.1
Acceptance	16	19.5
Good	14	17.1
Very good	14	17.1
Excellent	6	7.3
Total	82	100%

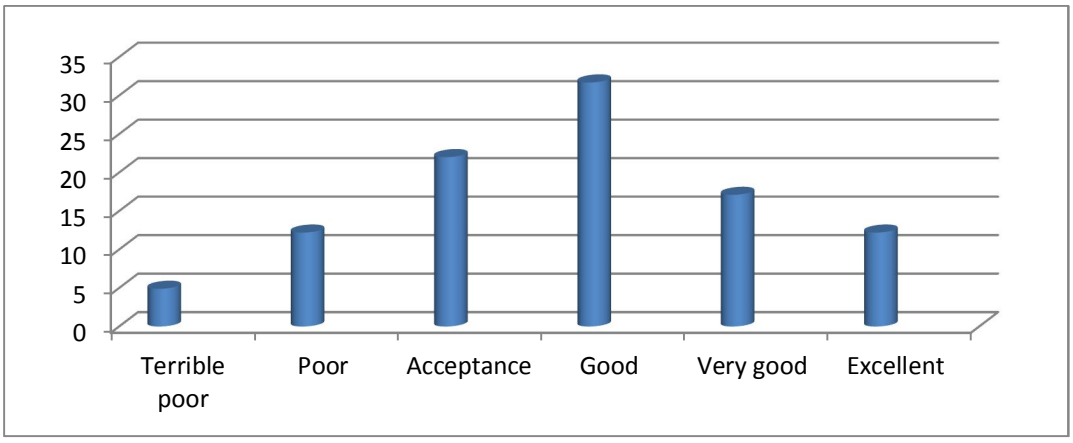


Figure(4 - 20) : The figure above show resultof Safety Management

Table(4 - 21):

(17)The following table shows frequencies and percentages of Contract Administration :

options	Frequency	percentage
Terrible poor	4	4.9
Poor	10	12.2
Acceptance	18	22.0
Good	26	31.7
Very good	14	17.1
Excellent	10	12.2
Total	82	100%

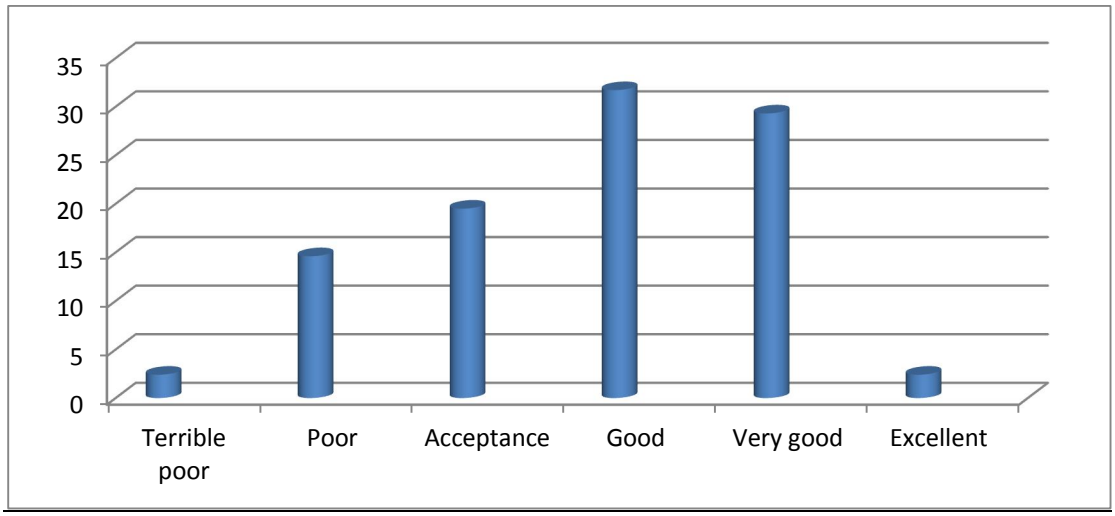


Figure(4 - 21) : The figure above show result of Contract Administration

Table(4 - 22):

(18)The following table shows frequencies and percentages of Resources Management :

options	Frequency	percentage
Terrible poor	2	2.4
Poor	12	14.6
Acceptance	16	19.5
Good	26	31.7
Very good	24	29.3
Excellent	2	2.4
Total	82	100%

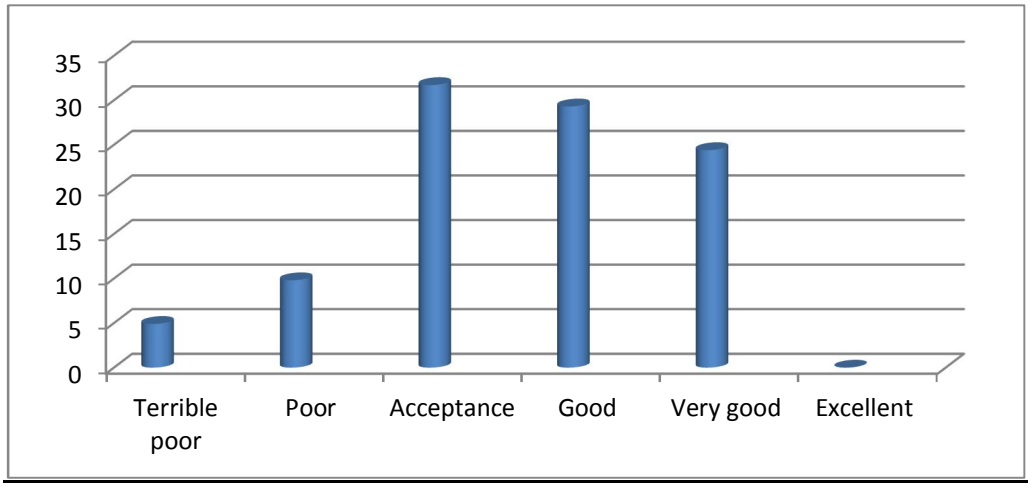


Figure(4 - 22) : The figure above show result of Resources Management

Table(4 - 23):

(19)The following table shows frequencies and percentages of Equipment and Machines Management :

options	Frequency	percentage
Terrible poor	4	4.9
Poor	8	9.8
Acceptance	26	31.7
Good	24	29.3
Very good	20	24.4
Excellent	0	0
Total	82	100%

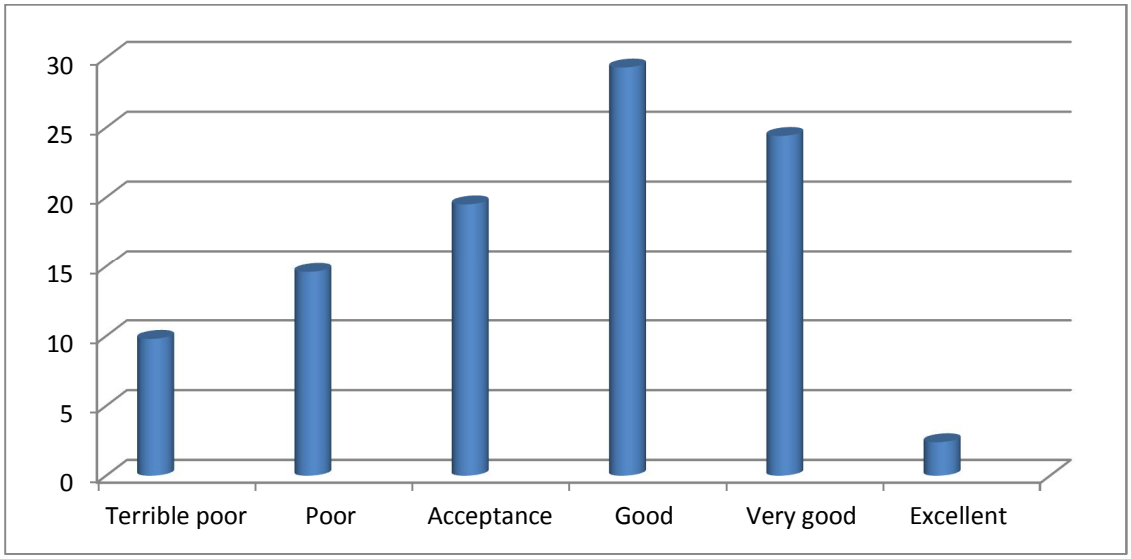


Figure(4 - 23) : The figure above show result of Equipment and Machines Management

Table(4 - 24):

(20)The following table shows frequencies and percentages of Project Scope Management :

options	Frequency	percentage
Terrible poor	8	9.8
Poor	12	14.6
Acceptance	16	19.5
Good	24	29.3
Very good	20	24.4
Excellent	2	2.4
Total	82	100%

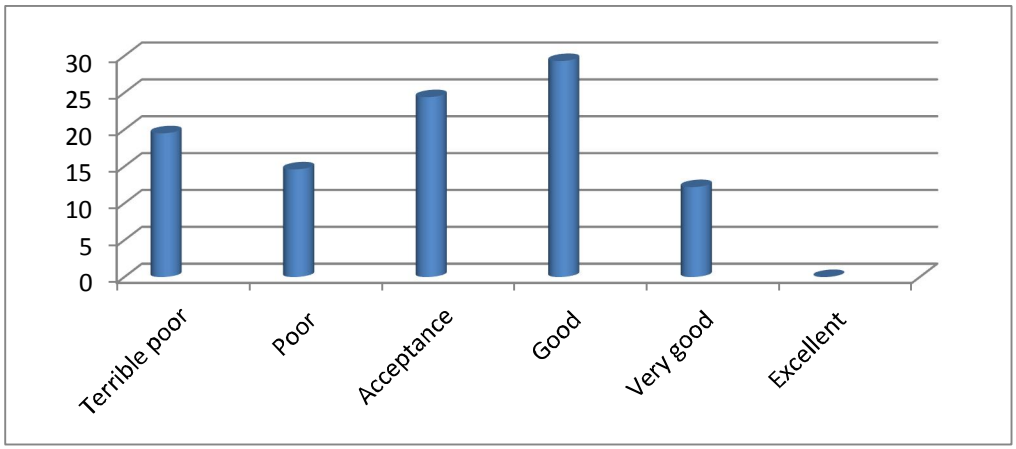


Figure(4 - 24) : The figure above show result of Project Scope Management

Table(4 - 25):

(21)The following table shows frequencies and percentages of Risk Management :

options	Frequency	percentage
Terrible poor	16	19.5
Poor	12	14.6
Acceptance	20	24.4
Good	24	29.3
Very good	10	12.2
Excellent	0	0
Total	82	100%



Figure(4 - 25) : The figure above show result of Risk Management

Table(4 - 26):

(22)The following table shows frequencies and percentages of Project Procurement Management :

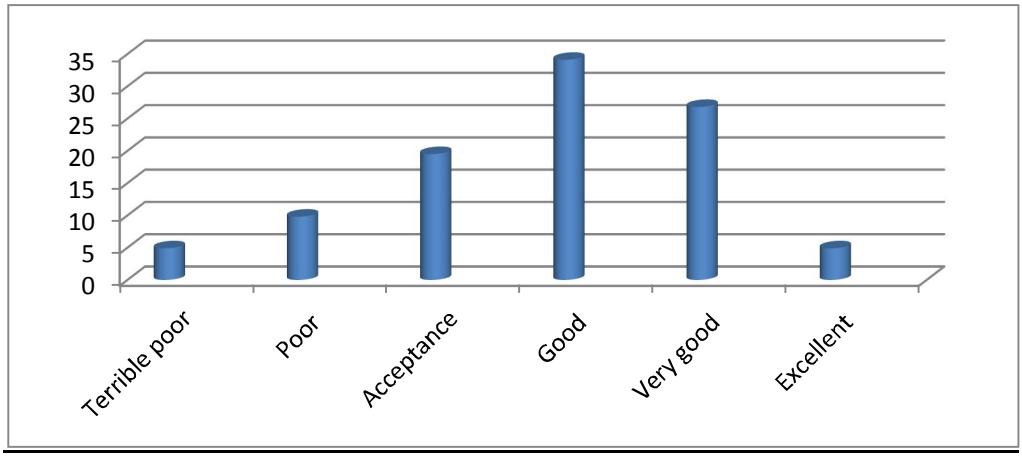
options	Frequency	percentage
Terrible poor	4	4.9
Poor	12	14.6
Acceptance	20	24.4
Good	26	31.7
Very good	16	19.5
Excellent	4	4.9
Total	82	100%

Figure(4 - 26) : The figure above show result of Project Procurement Management

Table(4 - 27):

(23)The following table shows frequencies and percentages of Stakeholder Management :

options	Frequency	percentage
Terrible poor	4	4.9
Poor	8	9.8
Acceptance	16	19.5
Good	28	34.1
Very good	22	26.8
Excellent	4	4.9
Total	82	100%



Figure(4 - 27) : The figure above show result Stakeholder Management

Table(4 - 28):

(24)The following table shows frequencies and percentages of Professional Management :

options	Frequency	percentage
Terrible poor	6	7.3
Poor	16	19.5
Acceptance	18	22.0
Good	24	29.3
Very good	16	19.5
Excellent	2	2.4
Total	82	100%

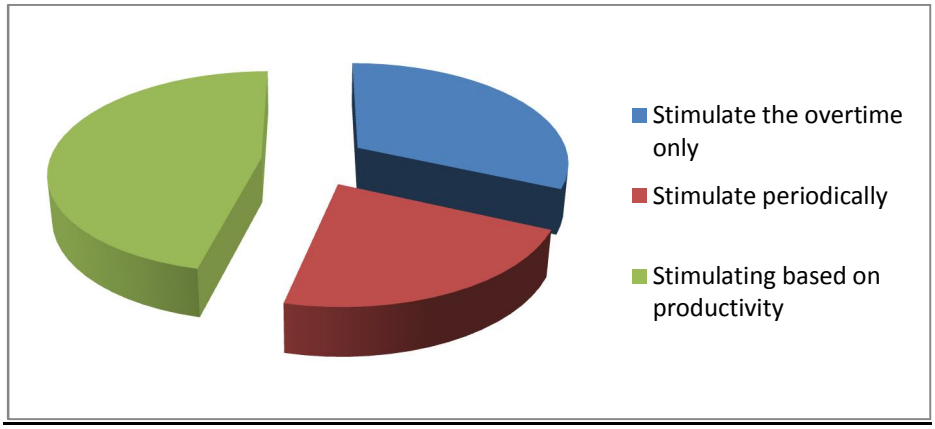
Figure(4 - 28) : The figure above show result of Professional Management

Table(4 - 29):

Section 3 :

The following table shows frequencies and percentages of How is motivating employees :

options	Frequency	percentage
Stimulate the overtime only	31.7	31.7
Stimulate periodically	22.0	22.0
Stimulating based on productivity	46.3	46.3
Total	82	100%

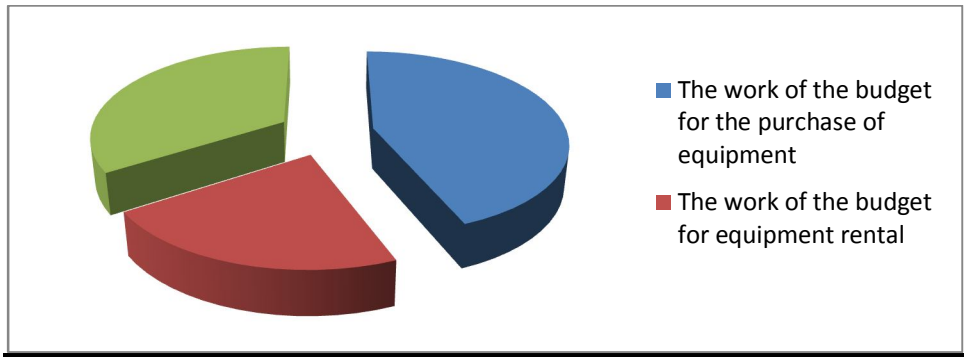


Figure(4 - 29) : The figure above show result of How is motivating employees :

Table(4 - 30):

The following table shows frequencies and percentages of How to manage the equipment :

options	Frequency	Percentage
The work of the budget for the purchase of equipment	36	43.9
The work of the budget for equipment rental	18	22.0
the rent at time of project implementation	28	34.1
Total	82	100%

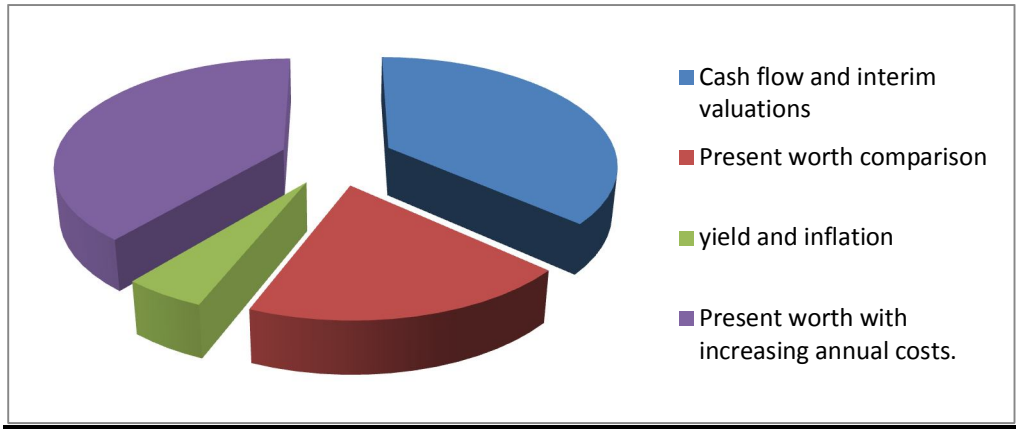


Figure(4 - 30) : The figure above show result How to manage the equipment

Table(4 - 31):

The following table shows frequencies and percentages of Monitoring and evaluation of the company's budget :

Options	Frequency	Percentage
Cash flow and interim valuations	30	36.6
Present worth comparison	16	19.5
yield and inflation	4	4.9
Present worth with increasing annual costs.	32	39.0
Total	82	100%



Figure(4 - 31) : The figure above show result of Monitoring and evaluation of the company's budget

Chapter (5)

Conclusions and Recommendations

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

Construction Management has been identified to be an important area that requires much concentration as efficient management of construction project has an adverse effect on the construction performance and productivity. for effective realization of a good value for money and constructing buildings that are cost effective, viable and feasible enough, various construction management techniques needed to be employed as evident from the result of the study carried out to various professionals in the construction field. From the study, it was obvious that the use of construction management techniques is vital as it improves individual and the construction industry especially in the study area. In the previous chapters it was established that construction projects have a specific set of objectives and constraints such as a required time frame for completion . Construction Project Management in compliance chapters one and two of this study is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, and quality and participation satisfaction.

Project management in construction encompasses a set of objectives which may be accomplished by implementing a series of operations subject to resource constraints. There are potential conflicts between the stated objectives with regard to scope, cost, time and quality, the constraints imposed on human material and financial resources. These conflicts should be resolved at the onset of a project by making the necessary tradeoffs or creating new alternatives

The Construction Project Management Institute focuses on nine distinct areas requiring construction project manager knowledge and attention:

1. Construction Project integration management to ensure that the various project elements are effectively coordinated.
2. Construction Project scope management to ensure that all the work required (and only the required work) is included.
3. Construction Project time management to provide an effective project schedule.
4. Construction Project cost management to identify needed resources and maintain budget control.
5. Construction Project quality management to ensure functional requirements are met.
6. Construction Project human resource management to development and effectively employ project personnel.
7. Construction Project communications management to ensure effective internal and external communications.
8. Construction Project risk management to analyze and mitigate potential risks.
9. Construction Project Procurement Management to obtain necessary resources from external sources. Construction planning is a fundamental and challenging activity in the management and execution of construction projects. It involves the choice of technology, the definition of work tasks, the estimation of the required resources and durations for individual tasks, and the identification of any interactions among the different work tasks. A good construction plan is the basis for developing the budget and the schedule for work.

5.2 CONCLUSION

Base on the results of the study carried out, Construction management technique is in no doubt a must use for every professionals in the construction industry.

The modern construction management used as evident from the respondent professionals in the construction field include The amount of information available on the project, coordination with other departments in the implementation of organization projects the possibility of the institution providing the means for technical services and equipment from laptops and accessories, care plans of action work plans to improve production, application of computer programs in project, management materials, management to improve productivity, Human Resources Management project, time management, contract management, resources management, scope of the project, risk management, procurement management of the project, management interest owners of the project partners (Clint - Contractor - Consultant) professional management of each desired implementation projects and lot of factors such as Size of the project, Location of the project, Type of Client Source of finance, Complexity of the project, Vitality of the materials, Poor planning, Materials storage, Cost of transportation and storage and so on constitute the factors affecting on modern construction Management application in Construction Industry in Sudan.

It is however concluded that the functions of construction project management for construction generally include the following:

1. Specification of project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants.

2. Maximization of efficient resource utilization through procurement of labor, materials and equipment according to the prescribed schedule and plan.

3. Implementation of various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.

4. Development of effective communications and mechanisms for resolving conflicts among the various participants.

Modern Construction Management application in construction industry in Sudan had a strong impact on. Planning and organization of work. Save time and effort and quality of work and increased productivity

5.3 RECOMMENDATION

Base on the findings from this research, and the results of the interview and a summary of the above, the following recommendation is given to professionals and those in charge of the construction industry in Sudan regarding the use and implementation of modern management systems for effective construction.

- should seek construction professionals to take advantage of construction management techniques such as building control at in the site and quality management , cost control, equipment management and machinery management and encourage team spirit and teamwork among employees and using the critical path method, program evaluation and

review techniques (PERT), Work Breakdown Structure , network analysis to meet the challenges in the construction industry in Sudan.

• should apply the rules of safety and health professional on all companies and institutions operating in construction industry in Sudan on good application and follow the correct methods and monitoring in order to maintain the health of workers in the construction industry.

• must engage in intensive training courses for some if not all of these technologies, as well as ensure that they are proficient in their use.

• appropriate planning must put forward to reduce waste and unexpected conditions

• quality of the materials must be used and to ensure that during the construction process in other to increase the spirit of relying on professional.

5.4 RECOMMENDATION FOR FURTHER STUDIES

The study has been made on the status of the application of modern management in the construction industry in Sudan, that applied for the better advanced somewhat in and recommended further studies by- :

•Safety Management of the most important components in the management of modern construction and is considered the first measure in the local and global competition without it is not implemented any effective construction project

•Recommendations for courses and training in applied occupational safety and health in the future, including the contribution of industry professionals, and stakeholders.

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Appendices

Questionnaire for measuring The extent the application of modern management systems in the construction industry in Sudan

Section I: Personal Information

.Consists of personal information about you, please tick {X} in front of what suits your condition

Qualification:

Bachelor..... Master .....High Diploma ..... phD .....

Experience:

Less than 5 years..... 5-10 years..... 10-15 years..... more than 15 years.....

Specialization:

Architect..... civil..... Other Engineer .....

Type of Business

Consulting..... Contracting.....Government Institutions.....

	Impact indicators	Excellen	V.Good	Good	ACCEPT	Poor	Terrible Poor
1	Degree of clarity and objectives of the projects in your organization						
2	The amount of information available on the projects						
3	Coordination with other departments on the implementation of the projects the organization						
4	The extent Authority to focus attention on the elements of modern project management urged staff to implement projects						
5	The possibility of the institution providing the means for technical services and equipment from Computers Lap tops and accessories						
6	Encourage team spirit and teamwork among staff						
7	Is plans of action to improve productivity						
8	institution takes care of the work plans to improve production						
9	Is the institution applied computer programs in the management of projects						
10	Materials Management						
11	Human Resource Management						
12	Cost Management						
13	ConstructionQuality Management						

14	Project planning and Scheduling						
15	Time Management						
16	Safety Management						
17	Contract Administration						
18	Resources Management						
19	Equipment and Machines Management						
20	Project Scope Management						
21	Risk Management						
22	Project Procurement Management						
23	Stakeholder Management						
24	Professional Management						

A-How is motivating employees of the institution:

1-Stimulate the overtime only

2-Stimulate periodically

3-Stimulating based on productivity

B-How to manage the equipment in the organization :

1-The work of the budget for the purchase of equipment

2-The work of the budget for equipment rental

3-the rent at time of project implementation

C-Monitoring and evaluation of the company's budget for

1-Cash flow and interim valuations

2-Present worth comparison

3-yield and inflation

4-Present worth with increasing annual costs.

In your Opinion:

I remember the most positives to develop a modern management system in your organization:

.....
.....
.....
.....
.....
.....

I remember the most negative aspects of the non-application of modern management systems in your organization:

.....
.....
.....
.....
.....
.....

If there is no application of modern management systems in your organization any proposals propose to apply:

.....
.....
.....
.....

استبيان لقياس مدى تطبيق نظم الإدارة الحديثة في صناعة البناء والتشييد في السودان

القسم الأول: المعلومات الشخصية

يتكون من المعلومات الشخصية عنك، يرجى وضع علامة {X} أمام ما يناسب حالتك.

المؤهل:

البكالوريوس ..... ماستر ..... دبلوم عالي ..... دكتوراه .....

الخبرة:

أقل من 5 سنوات ..... 5-10 سنوات ..... 10-15 سنة .... أكثر من 15 عاما .....

التخصص:

مدنى : .....معمارى : ..... تخصص هندسي أخر : .....

نوع المؤسسة :

استشارى : ..... مقاول : ..... مؤسسة حكومية : .....

الرقم	مؤشر اساليب الادارة الحديثة	ضعيف جدا	ضعيف	مقبول	جيد	جيد جدا	ممتاز
1	درجة وضوح أهداف المشاريع في المؤسسة الخاصة بك						
2	كمية المعلومات المتاحة على المشاريع						
3	التنسيق مع الإدارات الأخرى في تنفيذ مشاريع المنظمة						
4	هل حثت الهيئة على التركيز الاهتمام على عناصر إدارة المشاريع الحديثة الموظفين لتنفيذ المشاريع						
5	إمكانية المؤسسة توفير وسائل الخدمات الفنية والمعدات من أجهزة الكمبيوتر المحمولة والإكسسورات						
6	تشجيع روح الفريق والعمل الجماعي بين الموظفين						
7	هل هناك خطط عمل لتحسين الإنتاجية						
8	تأخذ مؤسسة رعاية العمل تخطط لتحسين الإنتاج						
9	والمؤسسة تطبق برامج الكمبيوتر في إدارة المشاريع						
10	إدارة المواد						
11	إدارة الموارد البشرية						
12	مراقبة التكاليف والإدارة						
13	بناء التحكم فى الموقع / إدارة الجودة						
14	تخطيط المشاريع وجدولة						
15	إدارة زمن المشروع						
16	إدارة السلامة						
17	إدارة العقود						
18	إدارة الموارد						
19	المعدات وإدارة الآلات						
20	إدارة نطاق المشروع						
21	إدارة المخاطر						
22	إدارة المشتريات المشروع						
23	إدارة اصحاب المصلحة وشركاء المشروع (مالك- مقاول - استشارى)						
24	ادارة محترفة لكل المشاريع المرغوب تنفيذها						

القسم الثالث : ضع علامة صاح امام الخيار المناسب على موضع مؤسستك :

كيفية تحفيز الموظفين فى المؤسسة:

1- تحفيز للعمل الإضافي فقط

2- تحفيز دوري

3- تحفيز على أساس الإنتاجية

كيفية إدارة المعدات في المنظمة:

1-عمل ميزانية لشراء المعدات

2-عمل ميزانية لتأجير المعدات

3-الإيجار في وقت تنفيذ المشروع

تتم مراقبة ميزانية الشركة حسب:

1- التدفقات النقدية والتقييمات المرحلية

2- مقارنة القيمة الحالية تقييم المرحلة

3- الانتاج والتضخم

4- القيمة الحالية مع زيادة التكاليف السنوية

القسم الرابع : فى رايك

1-أذكر أبرز إيجابيات لوضع نظام الادارة الحديثة فى مؤسستك

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2- أذكر أبرز سلبيات فى عدم تطبيق نظم الادارة الحديثة فى مؤسستك

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3- اذا لم يتم تطبيق نظم الادارة الحديثة فى مؤسستك اى مقترحات تقترح لتطبيقها

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