بسم الله الرحمن الرحيم

Sudan University of Science & Technology
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The Effect of Cost Management in Construction Projects' Planning in Sudan

تأثير إدارة التكاليف في تخطيط مشاريع التشييد في السودان

A thesis Submitted In Partial Fulfillment of the Requirement for The Master sciences (M.sc) in Civil Engineering (Construction Management)

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قال تعالى:

{اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ
خَلَقَ الإِنسَانَ مِنْ عَلَقٍ* اقْرَأْ وَرَبُّكَ الأَكْرَمُ* الَّذِي عَلَّمَ بِالْقَلَمِ * عَلَّمَ الإِنسَانَ مَا لَمْ يَعْلَمْ}

صدق الله العظيم

سورة العلق، الآيات 1 – 5

DEDICATION

Specially dedicated to my mom's soul.

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Nobody has been more important to me in the pursuit of this Master than the members of my family. I would like to thank my father, mother in low and my sisters whose love and guidance are with me in whatever I pursue. They are the ultimate role models. Most importantly, I wish to thank my loving and supportive Husband, Mutaz, and my two wonderful children, Jury, and Muzzamil, who provide unending inspiration, also my colleagues Nada and Eman who had a great role in encouraging me to continue and succeed.

ABSTRACT

The construction industry in Sudan is an important sector due to its enormous contribution to the country's economic development. This in terms of employment opportunities and attraction of Foreign Direct Investments which grossly contributes to the country's GDP. However due to the geographical, political, social and financial situation of the country, many construction projects are prone to delay, cost overrun or unsatisfactory quality, these three functions form the core of Project Management, on the other hand, this is what planned by every manager and project engineer. The cost management function maintains its important focus at every stage throughout the life cycle of a project.

In listing the reasons for the success of a project, the management of cost is the most important as all project aspects affect this function. The main aim of this Research is to find out and to understand the role of the cost management on delayed delivery of projects, the increase in project budgeting and non-matching specification on delivery and to develop approaches to avoid these problems. The methodology is by using a questionnaire forms based on the data and information collected through the theoretical review.

The results obtained indicate that most of the construction projects in Sudan have no completed planning and costing system, at same time disputes are occurring in the construction projects in Sudan in a significant way, due to the lack of awareness in planning and costing system, and consequently database in cost system is completely ignored.

The Awareness of cost management stages in construction projects in Sudan is very poor that's why the main reason for not reaching project goals (profit, duration and quality), which are planned in advance. it is found that the cost management of any construction project has a direct effect on the implementation of the project planning, and they are linked and complementary to each other, and to ensure the increase in the success rate of construction projects in Sudan.

The relationship between cost management and planning must be maintained by giving an extra attention to the development of integrated costing and planning system, and apply it in all projects no matter the size or the budget or the type of project, and this system should be monitoring periodically throughout all of the project stages until the project handover phase.

We found in our survey the following:

- Most of the construction projects in Sudan have no completed planning and costing system.
- The main reason for not reaching project goals (profit, duration and quality), which are planned in advance, is not to implement an integrated cost management system.
- The primary cost is very important on the majority of construction projects in Sudan and is very reliable.
- Following the steps of cost management carefully leads to successful outputs.

مستخلص

تعتبر صناعة التشييد في السودان قطاعًا مهمًا نظرًا لمساهمتها الهائلة في التنمية الاقتصادية للبلاد. هذا من حيث فرص العمل وجذب الاستثمارات الأجنبية المباشرة التي تساهم بشكل كبير في الناتج المحلي الإجمالي للبلاد. ولكن نظرا للوضع الجغرافي والسياسي والاجتماعي والمالي للبلاد ، فإن العديد من مشاريع البناء عرضة للتأخير أو تجاوز التكلفة أو الجودة غير المرضية ، هذه العوامل الثلاث تشكل جوهر إدارة المشاريع ، من ناحية أخرى ، هذا ما يهدف له كل مدير ومهندس مشروع. تتميز وظيفة إدارة التكاليف بتواجدها المهم في كل مرحلة طوال دورة حياة المشروع.

عند سرد أسباب نجاح المشروع ، تعتبر إدارة التكلفة هي الأكثر أهمية حيث تؤثر على جميع جوانب المشروع. إن الهدف الرئيسي من هذا البحث هو اكتشاف وفهم دور إدارة التكاليف في تأخر تسليم المشاريع ، والزيادة في وضع ميزانية المشروع والمواصفات غير المطابقة للتسليم ، وتطوير مناهج لتجنب هذه المشاكل. إن المنهجيه المستخدمه في هذا البحث هي عن طريق استخدام نموذج استبيان على أساس البيانات والمعلومات التي تم جمعها من خلال المراجعة النظرية.

تشير النتائج التي تم الحصول عليها إلى أن معظم مشاريع التشييد في السودان ليس لديها نظام تخطيط وتكلفه كامل ، في الوقت نفسه يتكررحدوث الخلافات في مشاريع التشييد في السودان بشكل كبير ، بسبب نقص الوعي بالتخطيط ونظام التكلفة و بالتالي يتم تجاهل قاعدة البيانات في نظام التكلفة تماما.

إن الوعي بمراحل إدارة التكاليف (ما قبل البناء ، وأثناء البناء ، و مرحلة ما بعد البناء) في مشاريع التشييد في السودان ضعيف للغاية إن السبب الرئيسي لعدم الوصول إلى أهداف المشروع (الربح والمدة والجودة) ، والتي تم التخطيط لها مسبقا هو عدم تنفيذ نظام متكامل لإدارة التكاليف. أيضا وجدنا أن إدارة تكلفة أي مشروع تشييد لها تأثير مباشر على تنفيذ تخطيط المشروع ، وأن التخطيط و إدارة التكلفه مرتبطان ومتكاملان مع بعضها البعض ، ولضمان الزيادة في معدل نجاح مشاريع البناء في السودان .

يجب الحفاظ على العلاقة بين إدارة التكاليف والتخطيط من خلال إيلاء اهتمام أكبر لتطوير نظام متكامل للتكاليف والتخطيط ، وتطبيقه في جميع المشاريع بغض النظر عن حجم أو ميزانية أو نوع المشروع ، ويجب مراقبة هذا النظام بشكل دوري في جميع مراحل المشروع حتى مرحلة تسليم المشروع.

توصلنا من خلال بحثنا إلى الأتي :

- معظم مشاريع البناء في السودان ليس لديها نظام تخطيط وتقدير مكتمل.
- السبب الرئيسي لعدم تحقيق أهداف المشروع (الربح والمدة والجودة) التي تم التخطيط لها مسبقًا ، هو عدم تطبيق نظام متكامل لإدارة التكاليف.
- التكلفة الأولية مهمة جدا في غالبية مشاريع البناء في السودان ويمكن الاعتماد عليها.
- اتباع خطوات إدارة التكلفة بعناية يؤدي إلى مخرجات ناجحة

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List of Symbols /Abbreviations:

1- **(CMs)**…….. Construction Managers.

2- **(CM**)……... Construction Manager.

3- **(CMAA)**……. Construction Management Association of America.

4- **(CMAR)**……...The Construction Manager At-Risk.

5- **(CII)**…… The Construction Industry Institute.

6- **(ROI)**……Return On Investment.

7- **(PLC)**……...Project Life Cycle.

8- **(AACE)**……American Association of Cost Engineers

List of Appendices

1- The Questionnaire Form

Chapter One

Introduction

Chapter One.

1 **Introduction:**

Cost Management is one of the primary functions of Project Managers. When integrated with the scope/quality of the project and time management, these three functions form the core of Project Management, on the other hand, this is what planned by every manager and project engineer. The cost management function maintains its important focus at every stage throughout the life cycle of a project. In listing the reasons for the success of a project, the management of cost is the most important as all project aspects affect this function. What counts for the owner is the "bottom line."

1.1 **Research Components:**

1.1.1 Research Scope:

The scope of this research emphasizes the significance of sound management and cost planning from the beginning of the project undertaking in order to facilitate the proper establishment for conducting and systemizing the project costs. Also, the determination of the major obstacles that affect the management and scheduling of construction costs and to suggest solutions through demonstrating the roles of the parties involved in the project.

According to the preliminary information, data, questionnaires, and exploratory readings that will be collected about this matter.

1.1.2 Research problem:

From the experience and observation of the researcher there are many problems arising from unmanaged costing and their side effects since the initial stage of the project till the project hand over. These problems always lead to project overrun in term of cost, scope and time deviations.

1.1.3 Objectives of the study:-

The objectives of this research comprises of the following:

- To know the factors that affect the planning in the constructions projects in Sudan
- To understand the Methods used in cost management in construction projects

in Sudan.

- To understand the relationship between cost management and effective planning in constructions projects in Sudan.
- To assess the applications of the cost management's in construction projects.
- To study the cost management's techniques in construction projects.

1.1.4 Importance of the study:-

The importance of this study is to understand the role of the cost management on delayed delivery of projects, the increase in project budgeting and non-matching specification on delivery and to develop approaches to avoid these problems.

1.1.5 Research questions:-

The questions raised from the research problem could be summarized as follows:

- What are the factors that affect planning in construction projects in Sudan?
- How could cost management be applied in construction projects in Sudan?
- What is the relationship between cost management and the effective planning in constructions projects in Sudan?
- What are the techniques of the cost management's usually used in construction projects?

1.1.6 Research Methodology:-

In order to meet the aims of this research, a scientific methodology is pursued in :-

- Review of many relevant local and international references such as (books, journals, researches, paper and etc.) that are directly relevant to the research, and aided by reports and articles from the internet from websites of engineering facilities of relevancy, this represent the secondary data

- primary data is formal using open questionnaire and the regular closed questionnaire forms based on the data and information collected through the theoretical review and the open questionnaire to conclude and examine some concepts concerning the actual management status of cost planning. This research depending on the questionnaire must be workable. Thus, it be possible to define the major obstacles that affect the process of construction cost management and planning; also, to suggest an appropriate plan for cost management and planning using a method or criteria in projects management and planning to reach the project goal.

1.1.7 Research Limits:

In fact, there is a critical need to limit and determine the proper fundamentals of cost conduct and planning according to a sound clear system, taking into account what is applied and followed during our research time limit in order to assess these procedures and improve them as much as possible in our specific locational limit.

- Locational limit in Sudan.
- Timelimit2018-2019

Chapter Two

Literature Review

Chapter Two.

2 **Literature Review:**

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.

2.1 **Planning and Project management:-**

A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical 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. (Hendrickson, 2008)

In developing a construction plan, it is common to adopt a primary emphasis on either cost control or on schedule control as illustrated in Fig. 2-1. Some projects are primarily divided into expense categories with associated costs. In these cases, construction planning is cost or expense oriented. Within the categories of expenditure, a distinction is made between costs incurred directly in the performance of an activity and indirectly for the accomplishment of the project. For example, borrowing expenses for project financing and overhead items are commonly treated as indirect costs. For other projects, scheduling of work activities over time is critical and is emphasized in the planning process. In this case, the planner insures that the proper precedence among activities is maintained and that efficient scheduling of the available resources prevails. Traditional scheduling procedures emphasize the maintenance of task precedencies (resulting in critical path scheduling procedures) or efficient use of resources over time (resulting in job shop scheduling procedures). Finally, most complex projects require consideration of cost and scheduling over time, so that planning, monitoring and record keeping must consider both dimensions.

In these cases, the integration of schedule and budget information is a major concern. (Hendrickson, 2008)

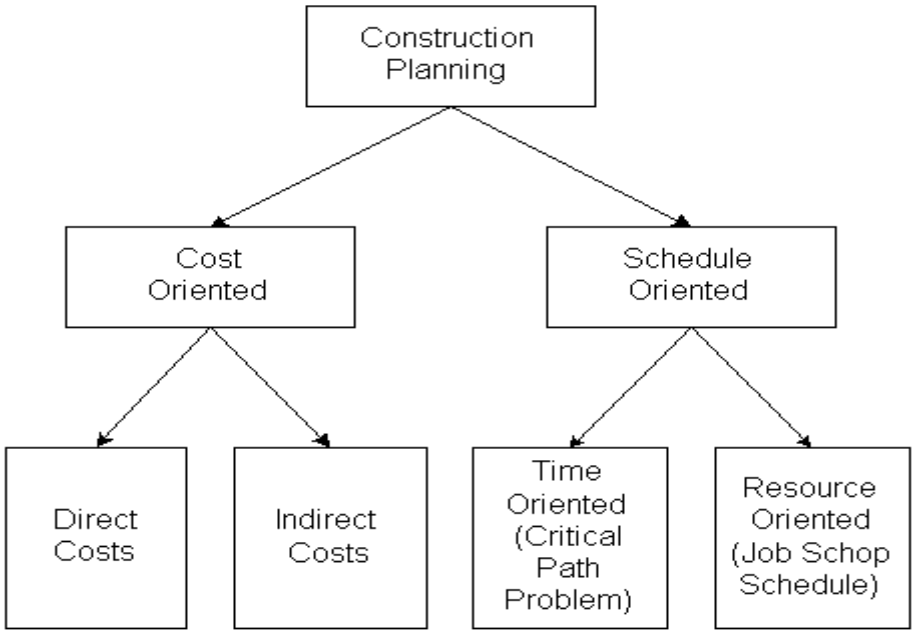

Figure 2.1 Alternative Emphases in Construction planning. (Hendrickson, 2008)

2.2 **Project Cost Management:-**

Project Cost Management includes the processes required to ensure that the project is completed within the approved budget. Figure 2–1 provides an overview of the following major processes: ((PMBOKGuide), 2000)

2.3 **Project cost Management Processes:-**

- **Resource Planning**—determining what resources (people, equipment, materials)
- and what quantities of each should be used to perform project activities.
- **Cost Estimating**—developing an approximation (estimate) of the costs of the resources needed to complete project activities.
- **Cost Budgeting**—allocating the overall cost estimates to individual work items.
- **Cost Control**—controlling changes to the project budget.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project. Each process generally occurs at least once in every project phase. Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may

overlap and interact in ways not detailed here. Project cost management is primarily concerned with the cost of the resources needed to complete project activities. However, project cost management should also consider the effect of project decisions on the cost of using the project product. For example, limiting the number of design reviews may reduce the cost of the project at the expense of an increase in the customer's operating costs. This broader view of project cost management is often called life-cycle costing. In many application areas predicting and analyzing the prospective financial performance of the project product is done outside the project. In others (e.g., capital facilities projects), project cost management also includes this work. ((PMBOKGuide), 2000)

When such predictions and analysis are included, project cost management will include additional processes and numerous general management techniques such as return on investment discounted cash flow, payback analysis, and others. Project cost management should consider the information needs of the project stakeholders—different stakeholders may measure project costs in different ways and at different times. For example, the cost of a procurement item may be measured when committed, ordered, delivered, incurred, or recorded for accounting purposes. When project costs are used as a component of a reward and recognition system controllable and uncontrollable costs should be estimated and budgeted separately to ensure that rewards reflect actual performance. ((PMBOKGuide), 2000)

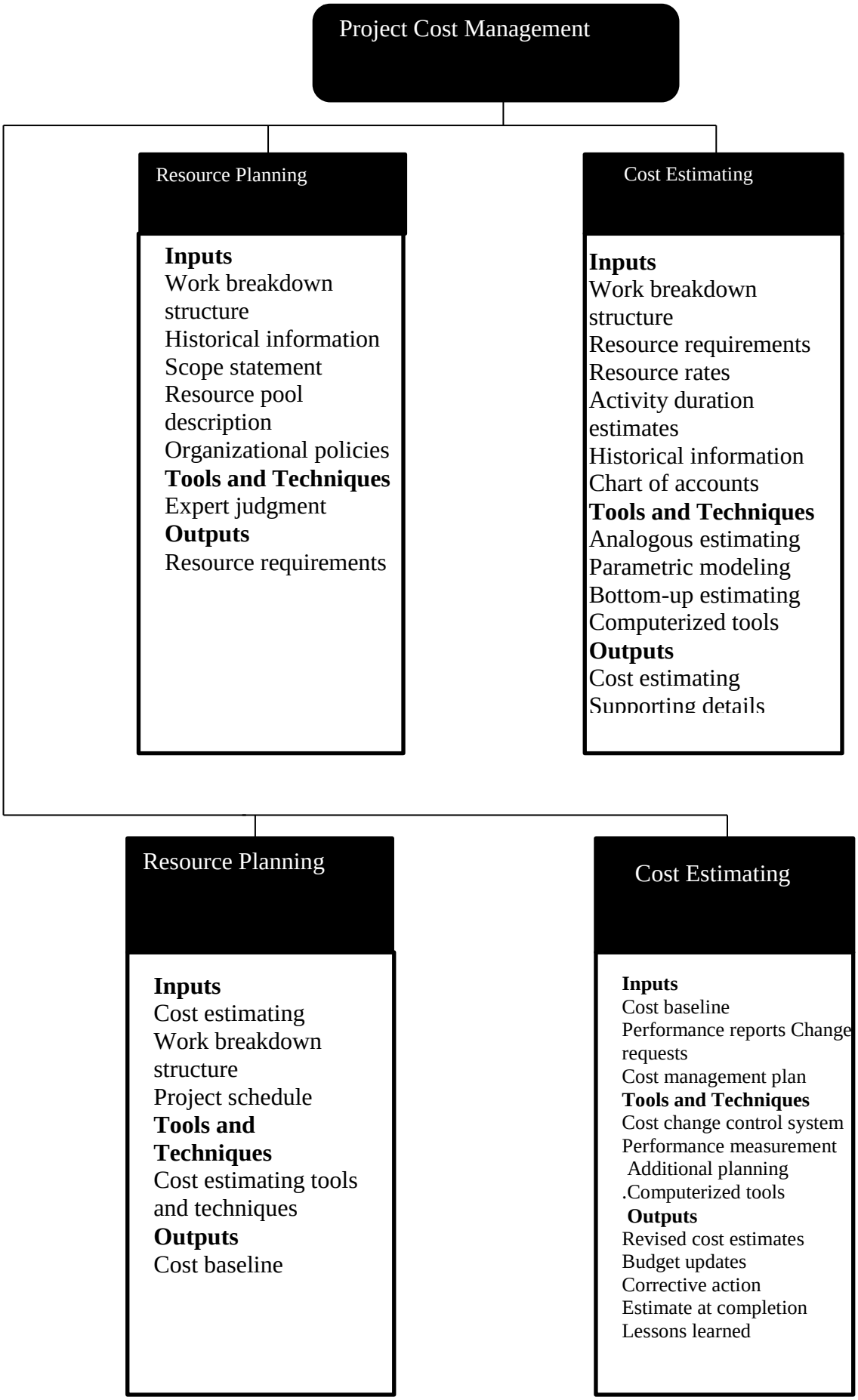

Figure 2.2 Project Cost Management Overview ((PMBOKGuide), 2000)

The term “construction management” can be defined as the process of professional management applied to the planning, design, and construction of a project from inception to completion for the purposes of controlling time, scope, cost, and quality. Under CMAA’s definition, construction management refers to the application of integrated systems and procedures, by a team of professionals, for the purposes of meeting the owner’s project goals (Cost Management Guidelines. (CMAA, 2018))

One of the goals for the majority of project owners is to deliver the completed project within the budget established for that project. This requires that the CM and others on the project team develop, implement, and operate through a process and procedures intended to establish realistic cost projections at the outset of the project and monitor and analyze those costs throughout the pre-design, design, procurement, construction, and the post-construction phases of the project. Some of the procedures developed by the CM should relate to controlling cost, or minimizing cost growth, through these five project phases. These Guidelines are organized to reflect the various phases of a project. Subsequent sections are organized for project phases as follows: (CMAA, 2018)

2.4 **Project cost management phases**

- **Pre-design phase**
  - Project and construction budget
  - Cost management system
  - Estimating
  - Cost compliance monitoring
- **Design phase**
  - Design phase cost management
- **Construction phase**
  - Construction phase cost management
  - Cost control
- **Post-construction phase**
  - Project closeout

2.5 **CM’s Role in Cost Management**

George J. Ritz refers to the cost management plan as the “project money plan” in

Total Construction Project Management. He states that the project money plan was the financial forecast for the project and notes that it establishes the basis for the control of both project cost and cash flow. The CM, with a background in cost estimating, budgeting, cost control, payment processing, and changes management, etc. is in the ideal position to develop the cost management plan for the project. (CMAA, 2018)

2.6 **Team Responsibilities & Management Structure**

A project management team can be organized in many forms. Whatever the structure of the project team, all communications, especially those concerning cost or time, must include the CM. The CM is still responsible for cost management regardless of how communications are routed, either through the CM or copied to the CM. Ideally, communication protocols, roles, and responsibilities are documented in the overall project management plan. Because project cost is so easily influenced, both positively and negatively, the CM must be involved in all project meetings. As the project's cost manager, the CM must be kept informed of all discussions and all decisions related to project time, cost, scope, etc. The owner must give the CM the responsibility and the authority to gain access to all information, to monitor all project costs, and to raise a red flag whenever there are potential or actual budget variances. (CMAA, 2018)

2.7 **When Does Cost Management Begin?**

Cost management begins at project inception. Virtually as soon as the project owner conceives of a project, someone needs to start considering costs. Few project owners have unlimited funds. Most project owners are looking for positive return on investment (ROI), thus they need to constantly monitor project costs to determine whether they will be able to obtain their desired ROI. Early development of the cost management plan is consistent with front-end planning, a CII Best Practice. Tackling cost objectives, issues, constraints, and trade-offs early in the project leads to better project outcomes. Buy-in by all team participants is vital to the success of the cost management plan. From the project outset, all project participants must work toward project delivery within the limits of the approved cost management plan and project budget. After each party accepts the cost plan, it becomes framework within which project costs are monitored and controlled throughout the planning, design, and construction processes. Team compliance is consistent with CII's alignment Best

Practice, which defines alignment, in part, as "the condition under which appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives." CII's research has clearly demonstrated that projects with high use of alignment are much more likely to have better cost performance than those with low use of alignment. (CMAA, 2018)

2.8 **Key determinants of initial project costs**

No two infrastructure projects will cost the same amount of money no matter how similar they are. Apart from basic technical factors, the wide range of economic and institutional conditions in different Member States will itself always lead to variations. Nevertheless, the fundamental project costs are based on the actual cost of the land, materials, equipment and labor in the region where the project is being procured. These basic costs will vary depending upon a number of factors which are discussed below. **Figure 2.3** summarizes these factors.

- **The Project Specification**

The specification defines the physical attributes of a project. With a road, for example, given levels of forecast traffic will lead to specification of the required length, depth and width of the road pavement, the material to be used for surfacing, the number of lanes, bridges and junctions etc. For buildings, the required function and expected occupancy rate will lead to a specification of total floor space and floorplate size, height, internal and external appearance, floor loadings, heating and lighting requirements etc.

Generally, the more detailed the specification and the larger the project, the more expensive it will be. (European Commission Directorate General, 1998)

- **Location**

Location affects project costing via institutional factors and through geographical realities. Institutional factors can affect initial project cost estimates in a number of ways. Consents procedures in particular may be more arduous in some countries, affecting the time it will take to successfully implement a project. Allowance for the costs involved in sustaining a long public consultation exercise is an example. Where major projects are likely to be strongly opposed on environmental grounds, more cost may have to be allowed for environmental mitigation measures. (European Commission Directorate General, 1998)

In geographical terms, construction and material costs, land costs and design standards vary widely across the EU because of the varying distances from suppliers, climate and weather conditions, and general market conditions. Even within a country, variations will exist depending on whether a project is being implemented in a peripheral or central area, or in an urban or rural context. Generally, the more remote a project is, the more expensive it will be because of the cost of transporting construction materials and equipment to the site. In an urban location, land costs are usually much higher. (European Commission Directorate General, 1998)

- **Form of Procurement/Contract**

The form of procurement and contract used by the project sponsor can alter the estimated cost of a project. Cost savings may be made by means of lump sum contracts although these are usually marginal in relation to the total project costs. DBFO contracts, which seek to transfer most of the risk of cost over-run from project sponsor to contractor, may in some circumstances yield savings. (European Commission Directorate General, 1998)

- **Site Characteristics**

A site can be affected by soil and drainage conditions and access restrictions which can affect the original cost estimates. The amount of excavation, piling and foundation activities required are particularly affected by poor ground conditions. Where there is uncertainty about ground conditions, accurate project costing cannot be achieved unless a soil survey is undertaken. This may require the sinking of boreholes to obtain soil samples at different levels beneath the surface. (European Commission Directorate General, 1998)

- **New Building or Improvements**

Generally, the construction of new infrastructure is more expensive than improvements to existing infrastructure, or the refurbishment of buildings. This is primarily because the "non-building" costs such as land purchase, foundations, services provision etc. do not have to be included when simply upgrading existing structures. (European Commission Directorate General, 1998)

- **Tax Liabilities**

An organization will be liable to pay tax on its purchases. Some organizations and types of project are not liable to pay taxes, or else these can be reclaimed. Local

government projects and infrastructure for public use are examples. Some public or quasi-public sector companies, voluntary and private sector organizations can be liable and these tax costs can have a significant impact on gross construction costs. (European Commission Directorate General, 1998)

- **Timescale**

Generally, the longer a project takes, the greater the project costs will be. Project timescales are dependent on the specification of a project. Usually, the larger a project is the longer it will take to implement. This is not always the case; if substantial additional resources are used, project implementation can often be accelerated. (European Commission Directorate General, 1998)

In some cases, work on a project may take a lot longer than expected because its phasing is dependent upon other, linking projects or public finance programmers. A project which involves non-continuous phases is usually more expensive than one undertaken without interruption because of the additional costs involved in remobilizing plant and contractors. (European Commission Directorate General, 1998)

- **Inflation**

The longer the expected construction period, the more account will need to be taken of expected inflationary price increases over time. This is particularly important where a public authority's expenditure programmer is involved. Initial cost estimates will need to allow for the value that will need to be paid at the time the project actually goes ahead. (European Commission Directorate General, 1998)

Levels of inflation vary amongst Member States and can be as low as 1-2% or as high as 10% per annum. In some of the states that will accede to the EU in future, higher inflation rates may be more typical. (European Commission Directorate General, 1998)

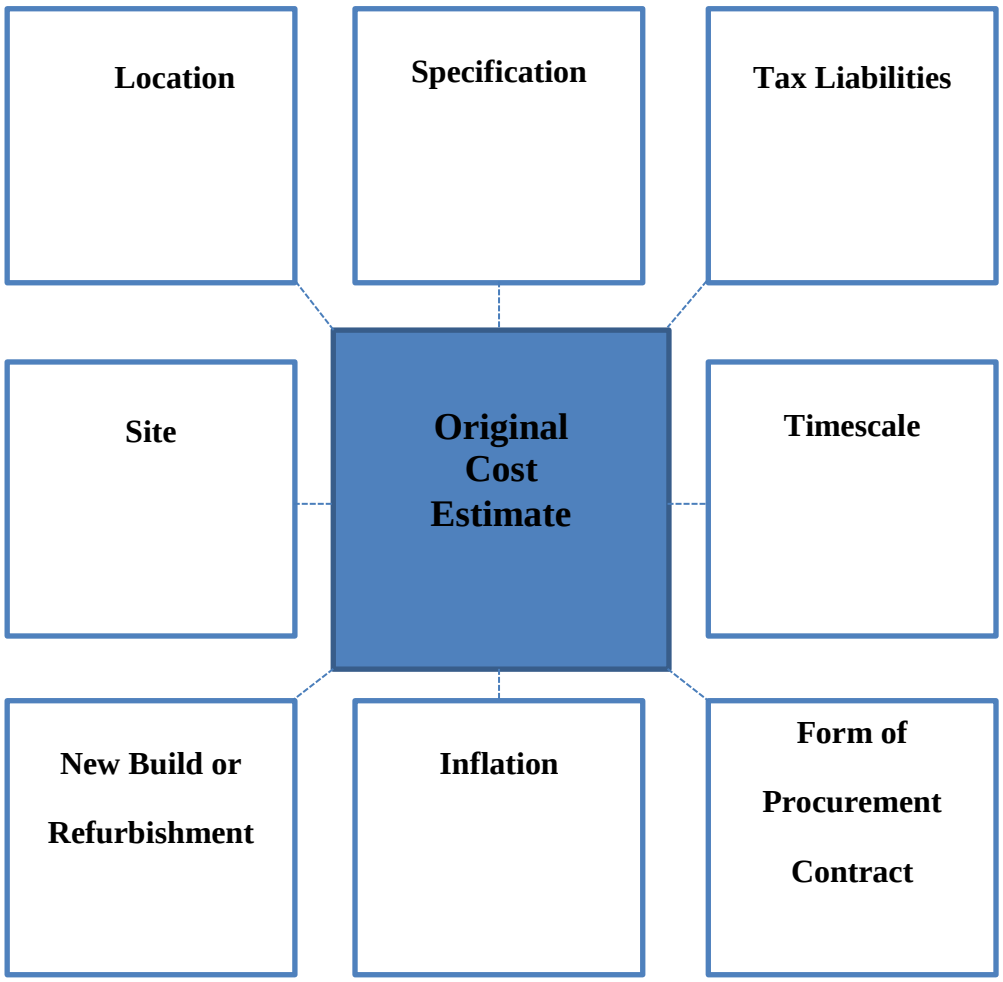

Figure 2.3 Key Determinants of Costs, (European Commission Directorate General, 1998)

2.9 **Factors Changing costs over time**

Once implementation begins, a project's costs rarely remain static. As further information becomes available the costs may be further defined. Yet, even when a cost has become firmly fixed, there are numerous factors that can lead to the cost increasing. Delays are a major factor. Whatever the reason, delays almost invariably increase budget costs. Many events may have contributed to the delay – some which could have been foreseen and others which could not. (European Commission Directorate General, 1998)

In the context of EU programmer funding, time and cost over-runs have obvious implications for the number of projects that can be funded within a programmer period, and for the scale of the outputs and impacts generated. Research carried out in the preparation of this manual has found that many ERDF projects experience a range of problems in both the pre-construction and implementation stages. These lead to projects over-running either in time or costs. As indicated above, delays generally translate into higher project costs. (European Commission Directorate General, 1998)

A key consideration in the context of EU funding is the time at which an application for funding is actually made. Applications can be made at three main points in time: (European Commission Directorate General, 1998)

- very early in the construction cycle when broad cost estimates only are available;
- on the basis of tender prices for the work to be undertaken;
- retrospective bids where the project has been completed but grant is still required.

The level of certainty about the final or outturn costs will vary for each of these three situations. Obviously, if an application comes forward very early in the project development cycle, then there is a much greater chance that the project will experience time and cost over-runs.

Figure 2.4 illustrates some of the factors that result in projects being delayed or costing more than originally planned. The Appendix to this Guide also includes case studies which illustrate how some of these factors have affected actual projects. (European Commission Directorate General, 1998)

- **Poor Project Management**

The role of the project manager or project management team is probably the most important element in containing the costs of a project. It is often true that a poor project with a good project manager will be completed satisfactorily. But even a good project, if combined with poor project management, will almost always face serious difficulties. A poor project management structure will have an impact at all stages of the construction process leading to:

· a lack of planning and coordination.
· poor communication between members of the project team and the project sponsor.
· failure to identify problems and institute necessary design and programming changes.
· a lack of control over time and cost inputs.

(European Commission Directorate General, 1998)

- **Design Changes**

A change in a project's design can arise for a number of reasons. It may be that the project sponsor wants additional elements to be included in the project or changes to existing ones. Usually, these design changes require additional time inputs from architects and engineers as well as the additional time and cost inputs from the contractor and for additional materials. (European Commission Directorate General, 1998)

- **Unexpected Ground Conditions**

Ground conditions can be assessed by a desk-based review of relevant published documentation and through the use of trial pits and borehole sampling on-site. However, the actual site conditions for the full extent of a project are not usually determined until construction begins. It is possible those difficult conditions are overlooked by the initial review or that conditions have changed due to adverse weather conditions or changes in sub-soil conditions. Unexpected sub-surface conditions can, at times, require fundamental redesign of projects at great expense. Changes in surface ground conditions can lead to problems in actually moving machinery and supplies around the site, and in undertaking excavations and laying foundations. This can also increase costs and add to the construction time required. (European Commission Directorate General, 1998)

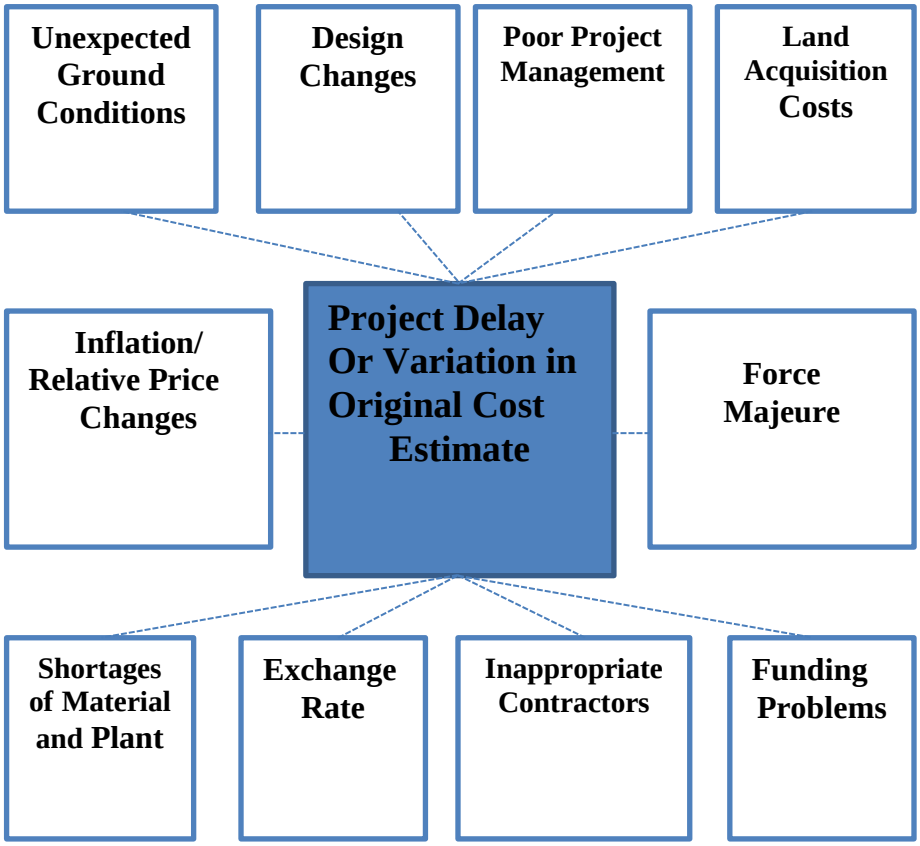

Figure 2.4 Cost Changing Factors (European Commission Directorate General, 1998)

- **Inflation:**

As noted earlier in this section inflation can act to increase the original estimates of construction costs. Inflation may have been taken into account in the original estimates, but if the rate of inflation increases above the predicted level during the construction period, then the original cost estimate will be exceeded. Obviously any other factor that delays a project will expose the project to the risk of further inflationary cost increases. Inflation may not be the only cause of price rises. Political or technological factors may affect one or more element of costs; for example, increased labor mobility between Eastern Europe and the EU, (which may occur after the accession of the Eastern states), could in future lower the labor cost element of construction projects. (European Commission Directorate General, 1998)

- **Shortages of Material and Plant**

During periods where the level of development activity is unusually high in a particular region, there may be shortages of some construction materials, construction

plant (machines and equipment used during construction) and service plant (equipment used in the operation of the infrastructure project). If this was not anticipated in the original cost estimate, delays may occur and/or the prices of these elements increase. (European Commission Directorate General, 1998)

- **Exchange Rates**

The exchange rate is particularly relevant if contracting services or other elements of the project are being purchased from other Member States or from outside the EU. If exchange rates change beyond the level predicted by the project sponsor (and the companies providing the services) then the cost of the project can increase. It can of course operate in the opposite way where the project sponsor takes advantage of a strengthening of his own currency. Of course the EU's Exchange Rate Mechanism and the Single European Currency project are designed to minimize and, eventually, eliminate such problems. (European Commission Directorate General, 1998)

- **Inappropriate Contractors**

Contractors are selected on the basis of price, experience in undertaking particular types of project and their track record in producing high quality work within budget and on time. Problems may arise where there is a high level of development activity being undertaken in a particular region and the better contractors are not available to bid for the work at that time. Alternatively, the tender review process may not have been undertaken by the personnel with the best understanding of the services required. As a consequence, firms which are not the most experienced in that field of activity are chosen, often with implications for the quality and cost of a project. (European Commission Directorate General, 1998)

Delays in project implementation and increases in costs can arise through the use of ineffective or inappropriate labor, or errors in calculating how productive the labor will be. This can happen especially when sub-contractors are used whose quality is not controlled in the main project contract. (European Commission Directorate General, 1998)

In most cases there is a trade-off between price, experience and track record but the desire to accept the lowest tender does not always lead to a project that is completed within time and budget. (European Commission Directorate General, 1998)

There are cases of contractors and sub-contractors who go into liquidation during the construction period. This can lead to significant delays and extra costs arising as the project sponsor has to re-tender the remaining work. Identifying a new contractor to complete other shortages of some construction materials, construction plant (machines and equipment used during construction) and service plant (equipment used in the operation of the infrastructure project). If this was not anticipated in the original cost estimate, delays may occur and/or the prices of these elements increase. (European Commission Directorate General, 1998)

- **Funding Problems**

The overall lack of finance to complete a project, or delays in the payment for services by the project sponsor can lead to significant problems arising. If the costs of a project have increased significantly beyond the original estimate, then work on the project may have to stop or be delayed until additional funds can be found. Funding problems can also arise if funds allocated to one project have been diverted to other projects within a programmer of development. (European Commission Directorate General, 1998)

If the payment of invoices by a project sponsor is slow, the contractor may begin to commit fewer resources to a project, and may even cease work if cash flow becomes a problem.

In some cases, even when a project is expected to be entirely profitable, project sponsors may understate the availability of local funding simply in order to maximize the level of grant. This can happen with revenue-generating projects particularly. Such practices can reduce the availability of funding for other projects. (European Commission Directorate General, 1998)

- **Land Acquisition Costs**

The land on which a project will be built is not always owned by the project sponsor. Where this is the case, local government authorities can usually compulsorily purchase the land in accordance with legal statutes. The statutes usually require that the land (and any properties on it) is valued and that compensation is paid to the owner on the basis of the valuations. Although the right to purchase and actually develop the land can be agreed relatively quickly, the amount of compensation that actually has to be paid can sometimes not be agreed until the end of the project, especially if the land owner appeals against the original valuation. The owner may

have the right to appeal and it is up to a Court to agree a fair price for the land. In many cases, this may be greater than the original forecast by the project sponsor. Inevitably, long drawn-out compensation cases will delay a project. (European Commission Directorate General, 1998)

- **Force Majeure**

This term covers a range of events which are also commonly referred to as "Acts of God". They include revolution, war, riot, extreme weather, earthquake, landslip, and fire, political and economic instability. Usually, the contractor is required to insure against such events happening. Where they do occur, they will normally lead to significant delays occurring and, consequently, cost increases. (European Commission Directorate General, 1998)

- **Other Factors**

In addition to all the categories listed above, experience shows that problems also arise from premeditated under-estimation of initial costs simply in order to obtain initial approval for a project. This can lead to major projects being approved, and started, in the knowledge that actual costs will be very much higher than the "agreed" estimate. Once started, a high profile infrastructure project is often politically difficult to stop. So, when the true costs do become apparent, it is difficult for authorities to refuse the additional funding required to complete the project. (European Commission Directorate General, 1998)

2.10 **Methods of Controlling Costs**

- **Uncertainty in project costings**

The preparation of project cost estimates is a difficult task because construction projects are subject to risks and uncertainties, particularly in the early stages when very limited information about the project is available. Yet, the cost estimates prepared at this stage are most important to the project sponsor because they often form the basis of the bid for funds.

As a project progresses, more information becomes available to allow costs to be calculated to a greater degree of accuracy, for example the ground conditions on-site or the specific types of plant or machinery that will be provided. More reliable cost estimates become available after tenders have been received from contractors.

Nevertheless, many aspects remain uncertain and normal costing practice is to include an extra element to provide "insurance" against cost over -runs. The word

"contingency" is usually used to describe this additional cost element. As was shown in Table 1 different amounts are typically allowed in different types of projects.

The contingency is typically based on a "rule of thumb" calculation, as a certain percentage of the base cost estimate or a lump sum based on the experience of the estimator. A figure of 10% of gross costs is a common allowance. This risk allowance or contingency sum is often calculated only once and is not reviewed again as the project progresses.

The main weakness of this simple approach to contingency costing is that individual risks are not separately evaluated. As a result, a contingency is often set too high for low risk projects, or too low for high risk projects. In addition, it is not always appropriate to carry a specific contingency allowance for the duration of a project since many of the risks become known and can then be eliminated. (European Commission Directorate General, 1998)

- **Risk and contingency planning**

By giving greater attention to which cost determining factors are most likely to change, and why, project sponsors should be able to develop more accurate contingency estimates. This in turn should reduce the risk of cost over-runs. Poorly managed risk affects the ability of a project to be completed within time and on budget. On the other hand, the level of risk can often be reduced if project sponsors take the time to identify, assess and manage the main factors leading to cost escalation. (European Commission Directorate General, 1998)

Although a potentially complex subject, risk management basically involves three quite simple stages:

· risk identification: what could go wrong?
· risk assessment: it is possible to quantify or at least rank any of the risks?
· risk management: what steps can be taken to mitigate or manage these risks in order to prevent cost over-runs?

Once the risks have been identified and assessed, they must be continuously monitored until the end of the project. Although careful risk assessment typically results in an increase in initial cost estimate, it usually leads to a reduction in contingency. Risk management measures are worthwhile because they lead to a more certain final project cost.

Often it is not clear what is actually contained within a project's contingency budget. As noted above, it could just be a general percentage estimate. In careful risk management the contingency allowance for larger projects should cover three main types of contingency:

- **Special risks contingency** – an allowance to cover the risks arising from higher land acquisition costs, changes in external factors such as the availability of funds, statutory requirements and force majeure. It can also cover the risk of a project sponsor changing his mind about the project specification (a fairly common occurrence!)
- **Design contingency** – an allowance for use during the technical design process to provide for the risks of changes due to design development or in estimating data.
- **Construction contingency** – an allowance for use during the construction process to provide for the risk of changes due to site conditions or as a result of changed construction methods or poor performance by contractors or sub-contractors.

The use of a better specified contingency will only be effective if suitable project control procedures are in place to control all aspects of project performance. Project control procedures should be organized and managed by the project manager. They should provide essential, coherent management information so that the project sponsor and project manager can react to changing circumstances. (European Commission Directorate General, 1998)

- **Project management**

Improved contingency planning can never be a substitute for good project management.

The essential elements of good project management are:

- **Cost control:** managing the design and construction processes to achieve best value for money and ensuring that the final cost does not exceed the budget.
- **Time control:** managing the design and construction processes so that the project is completed on or before the agreed completion date.
- **Quality control:** ensuring that the quality and performance of the completed project meets the project sponsor's original objectives.
- **Change control:** ensuring that any changes that are necessary are achieved within the approved budget, that they represent good value for money and that

authorization to proceed has been obtained from the project sponsor.
(European Commission Directorate General, 1998)

2.11 **An Approach to Cost Appraisal and Monitoring**

- **Project interrogation**

The purpose of this section is to provide desk officers with a set of questions to ask and issues to consider when appraising project applications or when monitoring ongoing major project claims. It should be used in conjunction with the existing appraisal systems for ERDF funds and the regulations of the Programmed in question. The various issues are based upon the preceding sections of the Guide which have identified the main factors that can lead to time and cost over-runs. The appraisal questions suggested here are not designed to ensure that all projects will be implemented without any problems. They are to assist the desk officer to explore the factors that can contribute to an ill-conceived project being approved and to understand why an existing project is requesting additional grant during the implementation stage.

In most cases, the initial project submission should address all of the relevant issues and satisfy the desk officer regarding the validity of cost estimates. It is also important that all sections of the application form are completed, particularly those in relation to costs. Where there are gaps in the cost details provided, it is often not clear whether the cost heading is not relevant to the particular project, or has perhaps been combined with some other cost, or even that the sponsor has simply failed to insert the relevant figure. Interrogation may be necessary to establish the actual position. The desk officer should raise any queries with the project sponsor or refer the project to appropriate specialists if the issue cannot be resolved, the project development cycle into six stages. For each stage, parallel groups of project interrogation questions are also included. These groups of questions are discussed in the following text as “Risk Issues”. Some questions are relevant at more than one stage. When interrogating a project, desk officers should first establish the stage of development of a project and then use the relevant questions.

The project cycle stages shows how risk (of cost and time over-run), decreases as project progresses.

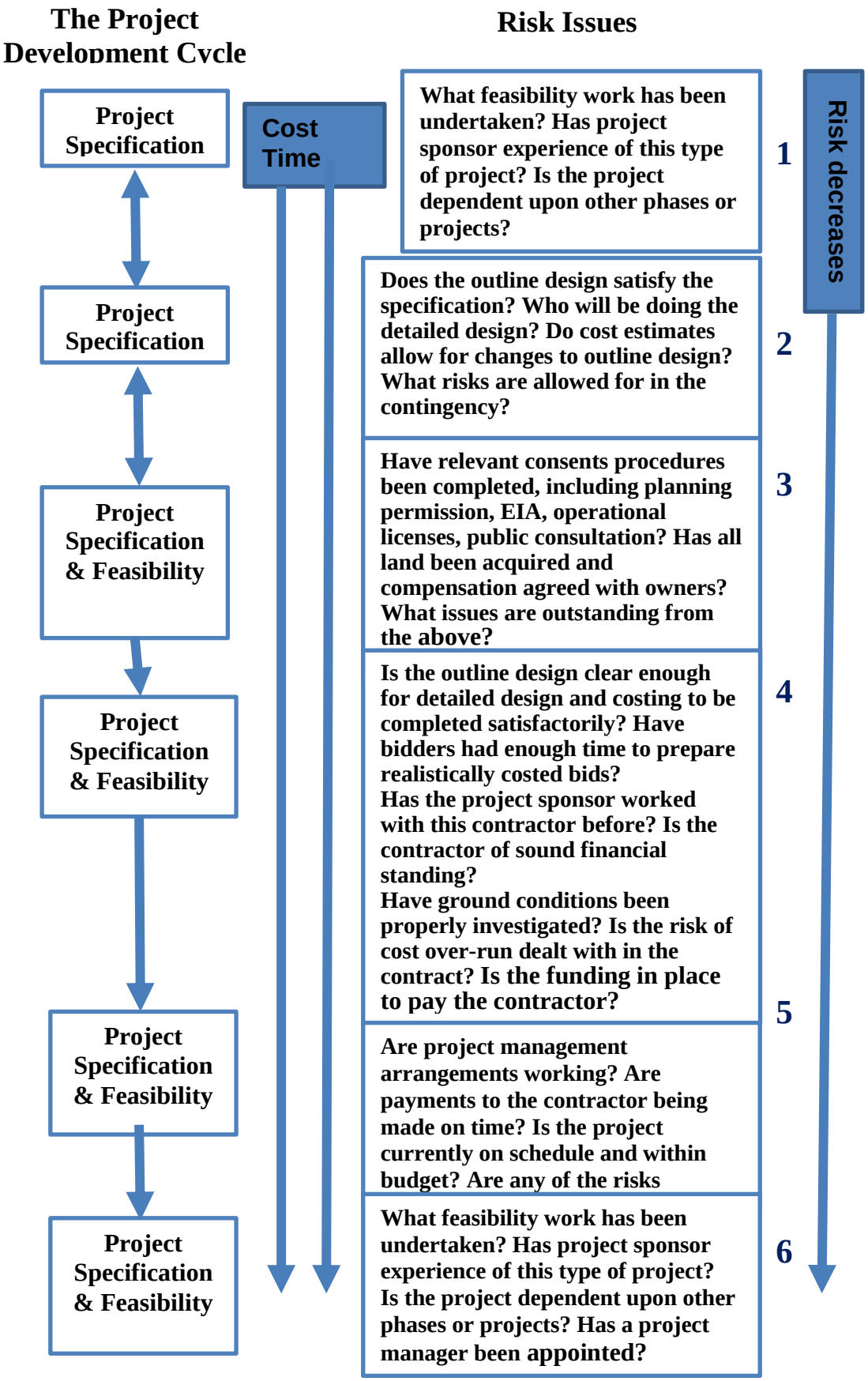

Figure 2.5 the project cycle stages showing how risk of cost and time over-run, decreases as project progresses. (European Commission Directorate General, 1998)

- **Risk Issue 1: Project Specification & Feasibility**

The key issues concerning the project's specification and feasibility relate to whether there is a need for the project and whether a budget cost (the maximum cost a sponsor will wish to pay for the project) has been identified by the sponsor. It would also be appropriate at this stage to check if a Cost Benefit Analysis has been undertaken and a project manager with proven experience appointed.

The project description should not be technically complex. The project's objectives should be clear, consistent throughout the submission, and achievable. Simple questions should be asked such as:

- Where is the project being undertaken?
- What exactly does the project comprise?
- Why is the project being undertaken – what is the demand?
- What previous phases have been undertaken and what phases are not included in the application (including costs)?
- Is this project directly dependent upon any other projects?
- Who is undertaking the project and over what time period?

(European Commission Directorate General, 1998)

- **Risk Issue 2: Outline Design**

At the outline design stage, the key issues are whether the size of the project matches the identified needs, or whether it is over-designed. It is important to establish how much more design work will be required and what role the contractor will have in this process. If cost estimates are based on outline designs only, then the potential for costs to change is greater than if they had been finalized.

For large projects it would also be appropriate for a Risk Assessment Study to have been undertaken by this stage. This would show that the project sponsor was aware that specific risks existed which could affect project costs. This would form the basis for the calculation of the contingency budget. It should be possible for the appraiser to establish how the contingency was calculated and what risks it covered.

(European Commission Directorate General, 1998)

- **Risk Issue 3: Consents and Land Acquisition**

The appraiser should be aware of what stage the project sponsor has reached with regard to consents and land acquisition. A project can experience considerable delays which may affect costs if the appropriate planning, environmental and other consent

procedures have not been adhered to.

As regards land acquisition it is important that the appraiser is aware of whether all claims have been settled or if there are any appeals over compensation. If appeals have not been settled then there is a high probability that any original land acquisition costs will be an underestimate.

(European Commission Directorate General, 1998)

- **Risk Issue 4: Detailed Design**

At the detailed design stage, the procurement of contractors to undertake the construction work can take place. In some cases, appointment of contractors may precede the detailed design stage. The form of contract and the respective roles of project sponsor and contractor in bearing risk for the ultimate project cost, are matters that desk officers should inquire about, especially where there appears to be uncertainty in this area. It is also important to establish that procurement regulations have been followed and that the contractor has relevant expertise and experience. Desk officers should check whether ground investigations have been undertaken. If these have not been done, then the risk of cost over-run increases and the contingency should reflect this. (European Commission Directorate General, 1998)

- **Risk Issue 5: Project Construction**

During the construction phase, there needs to be a project management structure in place which allows frequent reporting of progress to be made between the contractor and the project sponsor. Most of the time and cost over-run factors that can occur, do so during the construction phase. The appraiser must therefore establish that the main risks taken into account in the contingency calculation are being managed on site. (European Commission Directorate General, 1998)

- **Risk Issue 6: Handover of Project**

The project sponsor should state when the project is scheduled to end. It should be clear whether the project will be complete and fully operational once the ERDF grant has been used, or whether further phases have to be implemented. (European Commission Directorate General, 1998)

2.12 **The Budgeting:**

2.12.1 Conceptual Budgeting Methods:-

One of the biggest challenges during the pre-design phase is gaining a thorough understanding of the project definition. The project stakeholders need to arrive at a rough agreement concerning the definition of the project before a conceptual estimate can be made and a preliminary budget established. Some examples of such agreements as follow:

• Hospitals—number of beds

• Manufacturing facilities—number of units produced per day or week

• Water and wastewater facilities—million gallons per day processed

• Office buildings—square footage

• Power plants—megawatt capacity

• Process plants – process capacity

• Dams—cubic yards of fill or concrete

Once the definition of work has been agreed upon, factors such as project location, project time frame, etc., must be considered into the calculation in order to generate a conceptual budget. A conceptual budget is, therefore, based on an estimate of the cost of the project's concept. Such estimates have been referred to as conceptual estimates, preliminary estimates, indicative estimates, feasibility estimates, order of magnitude estimates, and economic study methods for performing conceptual estimates. Estimating techniques at the conceptual stage may include:

• **Analogous Estimating** (top down estimating)—Uses actual Costs of similar past projects as a basis for estimating the cost of a current Project. Analogous estimating is an approach that uses a combination of historical information and expert judgment in a comparison process where judgment will need to be applied to adjust for different project Location, local conditions, site constraints, project timing, etc. considered as a "top-down" approach that is generally not as accurate as other estimating techniques.

• **Parametric Modeling**—uses known project characteristics (parameters) in a mathematical equation to arrive at current project costs. Square footage cost, per bed cost, megawatt cost, etc. may all be used in parametric modeling to arrive at a conceptual estimate.

• **Bottom Up Estimating**—Uses cost estimation of individual project components and then sums the total of the project component estimates. For example, in a wastewater treatment plant, the estimator may be able to independently estimate the

component costs for primary clarifiers and extended aeration basins on a million gallon per day basis, and then factor in costs for headworks and screening, yard piping and electrical, disinfection facilities, and discharge piping. Having arrived at a conceptual estimate for each component of the system, the estimator can sum the component costs to arrive at a conceptual cost. There are other conceptual budgeting techniques available to estimators, but these are the most commonly used. (CMAA, 2018)

2.12.2 Integrating the Owner's Conceptual Budget

Once the conceptual estimate has been completed and provided to the project owner, the CM must obtain approval from the owner. The CM and other team members must also agree to the conceptual budget once approved by the owner. Assuming agreement by all parties can be achieved, the owner must adopt the estimate as their conceptual budget. This is a critical point in the life of a project. Based on the conceptual estimate, owners must run their own economic analyses to determine whether or not the project moves forward. ROI calculations, economic forecasts, business models, etc. can all be employed by the owner to determine if the project should proceed. Occasionally, external factors demand that the project move forward regardless of economic modeling. For example, the owner may have received a court order to upgrade a wastewater treatment facility, expand a jail or prison, or add air pollution control equipment to an existing manufacturing process. Or an owner may be faced with a rapidly increasing school population. In such cases, compliance with statutes, governmental regulations, or the needs of the public will generally override typical business processes.

The first question requiring an answer at this point is, "How much will this project cost?" The other question the owner must answer at this point is the fundamental question of, "Can I afford this project?" Early in the project the owner must determine how much money is available or can be raised to support this project. The conceptual budget should also be integrated with other elements of the project plan, especially risk management and time management, and the potential contingency costs associated with these risks. Refer to the Risk Management Guidelines for a more detailed discussion of risk management approaches and techniques. Risk management techniques can be helpful in developing appropriate contingencies for inclusion in budgets and estimates. This helps to reinforce the holistic view of the project and the

interdependence of cost, schedule, scope, and quality. (CMAA, 2018)

2.12.3 Cost Analysis

During the pre-design phase of the project, the owner may request that the designer develop conceptual design alternatives based on different site locations and/or other project schemes. The CM should prepare conceptual cost estimates for these projects alternatives for review by the owner and the designer. When different project sites are being considered, it is important to fully recognize the cost differentials for items such as site utilities, site access, soil conditions, topography, location, market conditions, labor availability, etc. The owner may also request other studies with cost and budget implications such as, lifecycle cost studies, energy studies, preliminary cash flow analyses, etc. All such studies should be presented in reports issued by the CM and reviewed with the owner and designer. At this stage, expectations are managed, trade-offs assessed, and elements of the project prioritized to arrive at a realistic budget that will support the owner's desired outcomes of the project. It is important to guard against "optimism bias" at this stage. Project sponsors, designers, construction managers, and contractors naturally have "can-do" attitudes, confidence in their capabilities, and optimism in their outlook for project outcomes. Research suggests that optimism bias is a leading cause of project failure (with failure is defined as not meeting expectations.) This applies especially to cost, but also to scope and schedule. Clearly articulating uncertainties, risks, and opportunities can help prevent falling into the optimism bias trap. (CMAA, 2018)

2.12.4 Developing a Project/Construction Budget

The CM should develop an estimate of the cost of construction and, if required, the total project cost. Within the total project cost the CM may consider the following as appropriate for the project:

- Land acquisition cost
- Architectural, engineering, and other design related costs
- Estimated construction cost, including design contingency
- Escalation.
- Construction management cost.
- Financing cost.
- Owner's management cost.
- Owner's reserve / contingency.

• Other costs depending on the nature, type, and location of the project.

The sum of all these costs then forms the project budget. This type of budget is often referred to as the appropriation estimate and it is his initial budget which forms the basis of the cost control plan. All costs are then compared to this initial, or baseline, budget. Additionally, the Standards point out that the level of project definition at the budget estimate stage is typically of a very general nature. In preparing the initial project budget, the CM needs to make sure the owner aware that the ultimate cost of the project is highly sensitive to the quality and quantity of systems yet to be defined. The owner must be alerted to the fact that the budget estimate based upon the project concept will change as planning continues, design progresses, and construction takes place. At this stage, the project team should have a solid understanding of the budget change management process, including abilities and authorities to increase or decrease the overall budget, transfer budget allocations between line items, and how proposed and effected changes should be communicated to the project team and stakeholders. (CMAA, 2018)

2.12.5 Project & Owner Constraints

At the same time project objectives are being established, the CM must thoroughly explore both project and owner constraints. A constraint is generally considered to be a restriction on the project or some activities within the project or some action, which is compelled by an external requirement. Typically, project constraints result in budget implications. If constraints are not clearly identified early in the project, it is likely that the project budget will be overrun later in the life of the project. Some examples of owner and project constraints, which may have to be factored into the construction and project budgets by the CM, may include:

Financial, funding constraints (e.g. to meet appropriation restrictions the project must be under contract no later than or must be completed no later than, a certain date; cash flow.)

Time-to-market constraints (e.g. the fabrication facility must begin production no later than a certain date.)

Schedule constraints (e.g. certain buildings in the project must be ready for occupancy no later than specified dates or times.)

Seasonal, weather-related constraints (e.g. during rainy periods only one influent

pump may be shut down at a time or the project must shut down during certain periods of the year due to environmental considerations.) Work time constraints (e.g. work may only be performed at night, during selected shutdown periods, on weekends, etc.).

The list of project constraints, like the list of project objectives, may be much longer
and more detailed. Again, it is incumbent on the CM to draw out project constraint information from the owner at this early phase of project budgeting. Failure to do so may adversely impact the CM's ability to deliver the project within budget. There may be some merit in exploring options of removing or modifying constraints that have a significant impact of budget. For example, stakeholders may be willing to relax work time or schedule constraints if there is a significant budget benefit in time or cost or both... (CMAA, 2018)

2.12.6 Resource Availability, Productivity, & Other Factors

In addition to the owner's project objectives and project constraints the CM may need to know or learn about the local conditions to help refine feasibility cost estimates and conceptual project budgets. Such studies are intended to make the conceptual budget more realistic and more attainable. Some examples of early studies include the following:

Labor availability – Is there a good pool of labor locally available both in terms of quantity and quality output? Will contractors have to import labor to the area and pay additional costs to house and feed them?

Labor costs – Is the job in a union only area or will open shop contractors be able to bid the project? What are the prevailing wage rates and are current union contracts close to their time for renegotiation? Are the wage rates subject to the Davis-Bacon?

Completing Projects – What other projects in terms of size and requirements for labor and materials will likely be competing with the project under consideration?

Project location – Is the project located in or near an urban center where site utilities and site access offer little or no challenge, or is the site remote? If the project is outside the U.S. are there fees endemic to the country in which the project is to be built?

Climate related productivity factors – Is the job located in an area where severe

weather conditions (extreme heat/cold, hurricane season, etc.) impact labor productivity?

Again, the list of project factors can, and probably should, be much more inclusive. It is incumbent on the CM to identify these factors and include any cost implications in the conceptual or preliminary budget. (CMAA, 2018)

2.12.7 Project Conditions Impacting Budget

Other project conditions, which may need to be factored into the conceptual budget:

- Allowances (for known but undefined requirements).
- Contingency and/or management reserves.
- Cost escalation factors.
- Field and general conditions cost.
- Foreign currency fluctuations.
- Market conditions for material and equipment.

The CM may identify such costs and include them in the conceptual estimate and budget. As noted earlier, these terms often have different meanings to different people, so it is important to define the specific intent and methods used to estimate that contribution of these factors to the project budget. (CMAA, 2018)

2.12.8 Budget Organization

The estimates of construction and project costs are generally organized into project and construction budgets in some standardized format. It is recommended that they be formatted based upon the work breakdown structure (WBS) used by the owner. A WBS is a way to define a project by breaking down the project into its various works components and arranging them in a hierarchical structure. Each work element of a WBS generally should be a separate measurable work activity that is associated with a specific project deliverable. A WBS can be thought of as a coding system used to separately identify every activity that must take place on a project. Once established, a WBS identifies all project activities and deliverables, provides a logical and standardized mechanism for scheduling and budgeting and details a uniform system of communication.

AACE, in Recommended Practice 39R-06, Project Planning – as Applied in Engineering and Construction for Capital Projects, defines the ***WBS*** as follows:

The work breakdown structure (WBS) is a hierarchical division of the work elements be performed on a project. The function of the WBS is to divide the scope of work

into manageable parts that correspond to key deliverables, phases, and/or milestones with the intent to avoid the omission of key elements and assist in the communication of cost, schedule, and resource performance data to stakeholders. The WBS must balance between complexities required for control and simplicity for accurate progress reporting. (CMAA, 2018)

2.12.9 Preliminary Project Phase Contingencies

Contingencies are hard to develop at any stage of a project. During the early o preliminary phase of a project there is little detail known to the project team. Thus, it is hard to develop contingency amounts for estimating and budgeting purposes. Project teams often resort to some national standard for such costs, but many project owners desire something more concrete. One approach used by some project teams is to perform a risk analysis of the project. The project team brainstorms every possible thing that could go wrong on the project during planning, design, construction, or startup of the project. From this risk identification, the project team develops a probability of the risk occurring (optimistic and pessimistic), some rough order of magnitude costs, should any of these risks actually occur, or the costs of mitigation of the risk before it occur. Then, based upon experience, the project team ranks the likelihood/probability of event occurrence. (CMAA, 2018),

2.13 **Cost Management System:**

The purpose of a cost management system is to help ensure the project is completed within the approved budget. The cost management system (CMS) achieves this by supporting sound decision making through monitoring, reporting, forecasting, and communicating. Project cost management focuses on two areas of cost as they are related to the project. First, cost management is concerned with the cost of the resources needed to accomplish all project activities. Second, and equally as important, cost management is concerned with the effects project decisions have on the cost of the project and/or the cost of operating and maintaining the project. Thus, total cost management takes under consideration both the cost of delivering the project to the owner and the lifecycle cost of the project. (CMAA, 2018)

2.13.1 Developing & Implementing the System

Development of a cost management system involves several processes. Those processes are summarized below and require a high level of continuing interaction between project shareholder and participants.

Resource planning—determines what resources (people, equipment, material, etc.) And quantities of each resource are needed to accomplish the project.

Cost estimating—develop an approximate cost of the resources needed to deliver the project.

Cost budgeting—Allocate the overall cost estimated for the project to the various elements or activities involved in delivering the project.

Cost control—managing expenditures and controlling changes that impact the accepted project budget. (CMAA, 2018)

2.13.2 Understanding Cost Planning Concepts

Cost planning involves the resource planning and cost estimating. At the outset of cost planning, the CM needs to clearly delineate the scope of the project in as much detail as possible. During the conceptual stage of a project there is little detailed information available. However, to successfully identify project costs, the CM needs to find out as much detail as possible about scope definition.

In defining a costs system, it is important to recognize that costs must be identifiable, quantifiable, easily captured and measured, and allocable to a specific WSB activity. The level of detail defined is a balancing act. Too much detail may make it impossible to segregate and allocate the costs. Too little detail can render the information meaningless when attempting to determine the root cause of a cost overrun. Again, it is important that the system chosen has the flexibility to add detail as necessary as the project develops. Once the scope of the project is determined, the CM can start resource planning. Resource planning identifies the physical resources necessary to deliver a project. For example, a new building may require the following resources:

- Designer costs
- Land acquisition and access costs
- Labor costs
- Equipment costs
- Materials costs
- Furniture, fixtures, and equipment costs
- Inspection costs
- Facilities
- Permit costs
- Operations Costs

The basic inputs to resource planning include the following:

Work Breakdown Structure (WBS)—The WBS identifies all elements of the project. From this activity identification process the CM can determine which activities need resources and what resources are needed to accomplish each activity. This becomes the primary input to resource planning.

Scope of Work— the scope of work sets forth the description of the project and the project objectives. These help the CM analyze what resources are needed. Historical Information—In the event the CM and/or the owner are dealing with a project which is similar to one previously performed, the information from recent past projects can help the CM identify what resources are needed to deliver the current project. Resource Pool Description—in most construction projects this is considered a market survey. The CM should survey the marketplace to determine what resources are available and in what quantity. The CM should determine whether there are sufficient designers in the area to do this work, or will the owner need to look nationally? Is the labor pool adequate to construct the project? Is there sufficient construction equipment of the type necessary available locally? Are there sufficient contractors with capacity for the project to achieve the desired level of competitive proposals or bids?

Organizational Policies—The CM needs to consider the owner's organizational policies concerning the project when preparing the resource plan. Is there a part of the project the owner's staff can perform? Or, is it the owner's policy to perform the design in-house? To save on equipment costs and project delivery time, is it the owner's policy to pre-purchase in bulk large equipment items and provide them to the contractor for installation into the project?

Once the CM identifies the needed resources needed, the CM needs to estimate the costs of the necessary resources. Using the established WBS system and resource requirements list, the CM needs to associate costs with each identified resource. The CM can use known resource rates, historical information, cost databases, etc. to estimate the cost of the resources leading to a project budget. The outcome of resource planning and cost estimating is the development of a cost plan for the project which includes the total project cost for presentation to the owner. The cost plan is the total anticipated project budget, which includes, with best estimates, all costs related

to the project. The cost plan includes the expected cost of planning, design, construction, land cost, permit fees, financing costs, etc. Once accepted by the owner, the cost plan becomes the baseline budget for the project. Project performance will be continuously monitored and measured based on a comparison to the baseline budget. In tandem with resource planning, the CM is also develops the project baseline schedule, as neither the schedule nor the baseline budget can effectively be developed without the other (CMAA, 2018)

2.13.3 Project Cash Flow

One of the elements of a cost management plan is an estimate of the cash flow requirements for the project. Cash flow, in its simplest terms, is the projected rate at which the owner's cash resources will be expended on the project. The objective of a cash flow analysis for a project is to estimate the gross cash requirements for expenses throughout the project for the owner. Additionally, the project cash flow analysis tells the owner when certain amounts of cash must be available. For example, on a $25.0 million project, which is projected to take 36 months to construct, there is no need for the owner to have the entire amount of cash ready for disbursement on day one of the project lifecycle. (CMAA, 2018)

2.13.4 Models for Monitoring Cost

Once the project budget has been prepared and accepted, the CM is responsible for monitoring and reporting on actual cost incurred, costs, and cost variances. There are several models for monitoring costs. Among them are the following:

Planned vs. Actual Costs—This model is relatively simple and straightforward. Using this model, the CM establishes cost accounts for each element of the project from the approved project budget. Payments are recorded for each cost element and a comparison made to the baseline to determine whether the cost element is or is not performing within budget.

Planned vs. Actual Cash Flow—This model depends upon creating, submitting, and accepting a cash flow curve for the project. From this cost loaded schedule a time scaled cash flow curve can be established. Routine payment requests can be plotted on a cash flow curve to create an actual cash flow versus planned cash flow. This model allows the CM to monitor planned versus actual cash flow and extrapolates projected cost and time impacts on the overall project.

Cost Trending—For each cost element of the project and/or the total project cost

itself, the CM prepares a series of estimate at completion (EAC) or forecast calculations using the following model.

$$EAC = \text{Actual Cost of Work Completed or Committed} + \text{Estimated Cost to Complete Remaining Work}$$

If the CM performs this calculation on a routine basis, the results can be trended and reported upon. The EAC should be compared to the baseline budget and any variances identified and assessed. (CMAA, 2018)

2.13.5 External Economic Factors

In preparing a cost management plan and cash flow curves for a project, there may be times when the CM must consider the impact of external economic factors which exert an influence on the cost of the overall project. Some examples are:

- Time to market.
- Taxation laws.
- Funding restrictions.
- Advance commitments by the owner.
- Return on Investment.
- Calendar restrictions.

Whenever special external economic factors exist, the CM must factor those into the cost management plan and the cash flow plan. Hard deadlines with high value to the owner may force a shorter time of performance for construction and therefore call for a more aggressive project cash flow. With a compressed schedule, the CM must pay close to influences affecting the project's scope and quality of work.
(European Commission Directorate General, 1998)

2.13.6 Project Funding Methods

While the mechanics of project funding are typically left to the owner, the CM provides valuable advice and analysis that support the funding process and expenditure. Cash flow and procurement commitment forecasts and cost breakdown structures (developed to align with the WBS) are important tools that facilitate funding analysis. The feasibility study factored into a ROI calculation may make the difference between achieving or not achieving project financing. (CMAA, 2018)

2.13.7 Funding Method Impact on Cost & Schedule

There are times when the method of project funding may impact the cost management and cash flow plans, therefore, the CM must take the project funding method into account. Some examples include:

- Government grants funding.
- Construction vs. permanent financing..
- Expiration of land options.
- Multiple sources of funding.
- Project Estimating.

For the project manager to effectively plan and control a project, accurate estimating is essential. The estimator's task is to predict the project's parameters by building a model of the project on paper. The quality and accuracy of the estimate should be seen as the best approximation based on:

- Time available.
- Techniques employed.
- Information available.
- Expertise and experience of the estimator.

The quality and accuracy of the estimate can be continually improved as the project is progressively executed as more detailed and accurate information becomes available. Unfortunately, the project manager may have to commit the company financially and contractually at the tender or quotation stage when the amount of data and information may be limited. For this reason alone it is important to be able to provide accurate estimates based on incomplete information at the tender stage. Although estimating usually focuses on the financial aspects of the project, it is important to remember that the costs cannot be accurately established until the other factors of scope, specifications, time, resources, materials, equipment and risks have been quantified. Estimating is an integral part of the project management process, which should be based on past experience together with market norms and standards. Although the estimate will have an input into all areas of the project the investigation here will be restricted to financial estimating. (CMAA, 2018)

2.14 **The Estimating:**

In industry and commerce it is common to label the estimate according to its level of detail and accuracy.

2.14.1 Estimating Terminology:-

The following estimating terms; concept, feasibility, definitive and costing, relate quite closely to the project life-cycle phases. This classification depends on the quality of information available and the amount of effort put into compiling the estimate. The text will identify three types of estimate according to their purpose, scope of work, detail and level of accuracy. (CMAA, 2018)

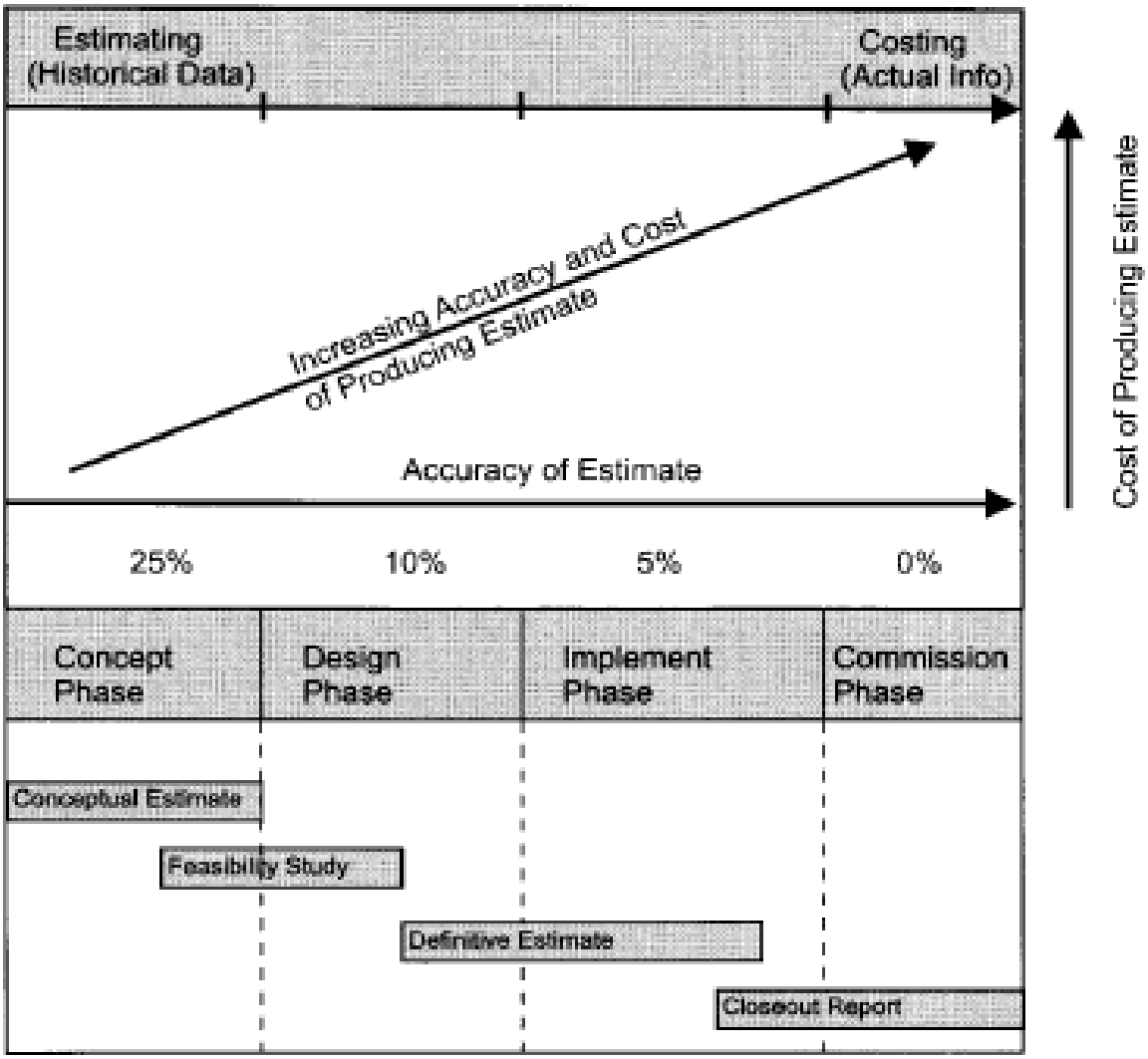

Figure 2.6 Estimating Costing Continuum (CMAA, 2018)

- **Conceptual Estimate**

Also called order of magnitude, budget figure, ball-park figure or thumb suck, the conceptual estimate addresses the needs of senior management who are presented with a number of possible projects. They need an initial filter to select those projects that warrant further investigation. This would occur in the concept and initiation phase the conceptual estimate will be based on a limited scope of w or using scale factors or capacity estimates to give a low level of accuracy +/- 25%. A conceptual estimate would not be a legally binding document; however, professional competence could be questioned if the estimates were too far adrift. If the conceptual estimate looks promising, senior management will then allocate funds to finance a more detailed feasibility study. (CMAA, 2018)

- **Feasibility Study**

Also called preliminary estimate or comparative estimate irrespective of how the project has evolved and crystallized the feasibility study investigates the feasibility of pursuing with the project within the defined boundaries and answers the question "Should we go ahead with this project? The feasibility study should be managed as a highly structured mini project as set out in your company's procedure manual. It is essential at the outset to determine the needs and expectations of all the stakeholders. This can be achieved through a structured needs analysis to determine if the proposal (or alternatives) offers a real solution to address the project's brief. Although the feasibility study is characterized by information gathering, processing and reporting, the accuracy of the estimate may still be somewhat limited at about +/-1 0%. (CMAA, 2018)

- **Definitive Estimate**

Also called detailed estimate, project control estimate, quotation or tender when the decision has been made to proceed to the next phase, the design and development phase, or planning phase, this will initiate another mini project to provide detailed designs and plans to build and manage the project.

The definitive estimate will be based on a considerable amount of data incorporating a developed scope of work, detailed WBS, detailed drawings, specifications, vendor quotations (that are now legally binding) and site surveys to give an improved accuracy of+/- 5%. (CMAA, 2018)

- **Accuracy of Estimate**

In ***(figure 2.6 page 37)*** the level of accuracy is presented as a continuum from conceptual estimate at 25% to closeout report at 0%. As the graph moves from estimating to costing so the data moves from historical to actual information, and the level of accuracy increases, but so does the time to produce the estimate and the associated cost to produce the estimate. Figure 2.2 shows the relationship between a higher level of accuracy and the increasing cost of producing it. Although it is not the project manager's function to set the company's profit margin, the project manager does need to know what the profit margin is, as this will influence the accuracy of the estimate and subsequent level of control. As a guide, the level of accuracy should be at least equal to, or greater than, the profit margin so that in the worst case a cost overrun would be accommodated by the profit margin. (CMAA, 2018)

2.14.2 Project Costs

A project estimate can be subdivided into a number of different costs, consider the following:

• Direct costs.
• Indirect costs.
• Time related costs.
• Labor costs.
• Material and equipment costs.
• Transport costs.
• Preliminary and general (P&G) costs.
• Project office costs.
• Project team costs.

- **Direct Costs**

As the term implies, direct costs are those costs that can be specifically identified with an activity or project. The current trend is to assign as much as possible, if not all costs to direct costs, because direct costs can be budgeted, monitored and controlled far more effectively than indirect costs.

• Direct management costs refer to the project office running costs, salaries for the project manager, project engineer, planner, accountant, secretary and QA.

• Direct labor costs refer to the people working on an activity, e.g. boilermakers, welders, fitters, computer programmers, etc.

• Direct material costs are for the materials, consumables, components which are used for completing an activity and an allowance for scrap and wastage.

• Direct equipment costs refer to machinery, plant and tools.

• Direct expenses include bought-in services that are specific to the project, for example, plant hires, surveyor, designer and subcontractor fees.

The distinctive nature of direct costs is that the total expense can be charged to an activity or project. (CMAA, 2018)

- **Indirect Costs**

Indirect costs, also called overheads, are those costs that cannot be directly booked to an activity or project, but are required to keep the company operational.

• Indirect management costs refer to senior managers, the estimating department, sales and marketing, accounts, IT, general office staff, secretarial, administration and the personnel department.

• Indirect labor costs refer to the reception, maintenance, security and cleaners. Basically it includes an the employees who are required to keep the company functioning.

• Indirect materials include stationery, cleaning materials and maintenance parts.

• Indirect equipment includes computers, photocopiers and fax machines.

• Indirect expenses include training, insurance, depreciation, rent and rates.

Indirect costs are usually financed by an overhead recovery charge added to the earned man-hour rate and if not properly managed will eat away at the company profits. The acid test for the project vis-a-vis indirect costs and overheads, is to compare internal costs with the same services available outside the company. (CMAA, 2018)

- **Time Related Costs**

Critical path method (CPM) was originally developed to address the time / cost trade-off (crashing). If a project's duration is reduced or extended how will the costs change? To do this calculation you need to determine how costs are affected by time. Consider the following:

• Rent increases with time.

• Running costs - water, electricity and gas would increase with time.

• If the project's duration is reduced, employee labor rate will increase if the workers have to work overtime.

• Contract labor on a fixed rate is not affected by time, but their productivity may reduce if they work long hours.
• Fixed price contracts may not be affected by time.

Simulating all the costs will give you the overall effect of time changes on project costs. This technique can also be used for project acceleration where you need to know the trade-off between the costs of accelerating a project to meet certain milestones compared with the penalties of failing to achieve them. (CMAA, 2018)

2.14.3 Estimating Methodology

This section will discuss some of the estimating techniques that can be used to predict the project's parameters quickly with reasonable accuracy. The estimating techniques used by industry and commerce can vary tremendously from one company to another, consider the following:

• Jobbing
• Factoring
• Inflation
• Economies of scale
• Unit rates
• Day work.

- **Jobbing**

Also termed job costing or operational estimating, jobbing is the process of including all the operations that go into executing an activity or task.

- **Factoring**

Also called component ratio or parametric method, factoring can be used when historical data from previous projects indicates that an item of the project can be expressed as a percentage of a known or calculated core cost, Once the core costs have been established the associated ratios can be calculated very quickly. These ratios should be confirmed progressively as performance data becomes available.

- **Inflation**

Also called **time based indices.** The project costs will change with time due to the non-reversible effect of inflation on the economy. If the current project is similar to a previous project completed a few years ago.

- **Economies of Scale**

Also called cost capacity factor. The cost capacity factor mathematically relates similar jobs of different sizes. If a job is twice as big as the previous job, will it cost twice as much? Usually not, for the following reasons:

Indivisibility: In a production process there may be certain indivisibilities, or fixed costs that are required just to be in business, but not related to output. For example, a firm may require a manager, a telephone and a secretary. These costs are indivisible because you cannot have half a manager merely because you want to operate at a lower output.

Specialization: In a small business people have to be flexible and become a Jack of all trades to survive, but as companies grow in size so they are able to group work and assign repetitive tasks to one person. It is obviously more efficient (if not a little boring for the operator) to setup jigs to perform the same task repetitively.

Technical: Large scale production is often able to take advantage of automated machinery. The high capital expenditure can be written off over large production runs, thus reducing the unit cost, e.g. car production lines.

Scaling: There is not always a linear relationship between dimensions and volumes,

- **Unit Rates**

Also called parameter costs, although a project tends to be a unique undertaking, much of the work may be repetitive. Parameter costs are developed from unit rates for common items of work based on previous projects. This technique estimates a project's cost from an empirically developed book of unit rates. Unit rates work well in a controlled work environment. However, many projects by virtue of their location and scope of work may involve other considerations:

• Unit rate estimating is appropriate for a contractor with a record of small jobs within a limited geographical area.

• As the contracts increase in size so the data base samples will tend to decrease in number.

• Costs are influenced by remote locations, logistics, travelling distances and the conditions of the roads.

• Weather conditions can be statistically predicted but what happens in practice may be very different.

• Are there utilities available; water supply, power supply, accommodation, public transport, etc.?

Unit rates are probably the most commonly used estimating technique and will form the basis of most estimates. Unit rates are commonly used as they provide a simple contract to measure and budget. Even a fixed price contract usually contains a unit price clause for additional work. When I worked in a ship repair yacht in the Middle East, most of our work was tendered and charged this was from a booklet of tariffs.

- **Day Work**

Day work is the term used to quantify the hourly rate or daily rate for labor, materials, plant, preliminary and general (P&G's). The complete project could be financed on day work as a cost plus contract. This type of contract used to be quite common on military projects, but not on commercial projects where fixed prices are preferred by the client. On a fixed price project the client often requests day work rates to be quoted at the tender stage to provide a framework for costing changes and additional work. The contractor's overheads and profit are included in the rate. The contractor must ensure that the day work sheets are signed by the client at the end of each shift. The client meanwhile needs to monitor performance to ~ ensure good productivity.

2.14.4 Estimating Problems

The following list is a collection of points to be considered when estimating. Some of the common pitfalls to be aware of include:

• Keeping new technology under control - consider incrementally increasing technology, phased implementation and proving systems progressively. This is less risky than the big bang approach.

• Misinterpreting the scope of work and omissions.

• Risk and uncertainty are not considered.

• If work is priced out at the department average, regardless of who is doing the work, this simplifies the estimating, but the client may not be happy paying engineers' rates for an apprentice.

• The performance of individuals within a trade can vary considerably depending on their ability and commitment.

• Poorly defined or an overly optimistic schedule.

• Inflation on a long term project not considered.

• Lack of historical data, especially if this is a new type of project for the company.

• The main contractor will be at risk if they have to give a fixed price quotation to\ their client based on budget estimates from their subcontractors. However, the subcontractors may not be in a position to give a fixed quotation if the detailed drawings are not available.

• Closeout Report: Some managers prefer not to document their problems: "If my project fails the last thing I want around is hard data to nail me.

• Make sure that costs are debited from the appropriate activity and not off-loaded to the activity with the fattest budget otherwise this will devalue your closeout report, and mislead future estimating.

• Consider your response to this reaction when requesting information, "My people have no time to collect data, they are too busy doing the work."

• A NASA astronaut was asked what concerned him most about the flight. He replied, "It's not sitting on a potential fuel bomb that concerns me most, but the 10,000 components that were made by the lowest bidder.

• Terms and conditions of contract not quantified.

• Validity of the quotation not stated.

Expenses often forgotten when estimating include:

a) Commissioning and customer acceptance.

b) Training of the client's technicians to use the installed equipment.

c) Protective painting.

d) Writing user manuals.

(CMAA, 2018)

2.14.5 Estimating Techniques

Many aspects of the overall budget, particularly during the conceptual phase, are derived from the estimated construction costs and planning metrics. Typically, the overall project budget is comprised of three major categories: land acquisition costs, hard costs, and soft costs. Hard costs typically represent those items associated with the construction aspect of the project but also include most of the owner outfitting items. Outfitting costs include specialized equipment, technology systems, furnishings

and fixtures, artwork, security, and signage. Typical soft costs include design and consultant fees, permits, site assessments costs, testing and inspections, administration, connection fees, contingencies, finance costs, legal, and escalation allowances. The owner may stipulate that some permit and outfitting costs are carried in the construction costs. It is incumbent upon a member of the team to investigate and determine the full extant and value of all possible fees and exactions that may be imposed on the project by local jurisdictions and utility service providers. Exactions may include public works agreements for road improvements, utility service extensions, sewer and water infrastructure upgrades, community improvement projects, and environmental or enhancement reforestation projects. (CMAA, 2018)

The basis of the cost management plan for a project is a reliable project cost estimate for all items that make up the total project budget. The cost estimate should be neither neither optimistic nor pessimistic. The CM should set forth its assumptions with respect to scope of work, contracting plan, schedule, labor productivity, construction techniques, estimating methods, financing cash flow, etc. Based on this information, users of the estimate can make their own judgment concerning reliability and accuracy. (CMAA, 2018)

Depending on which type of estimate is being prepared, the CM has a range of techniques available. Some examples include the following:

In-House Estimating Data Files—CM firms with a history of multiple projects of a similar type in the past can take historical construction cost data and update it for current time and a specific location. Owners, particularly serial builders, may also use their extensive historical cost information to adjust final estimates.

Outside estimating software data files and publications —If the CM does not have much experience with a particular project type, specific cost data by project type and location can be purchased from outside vendors for use in the CM's computerized estimating system.

Outside estimating services—A CM Can hire an outside estimating firm and provide all known project data. This outside service then produces the estimate and returns it to the CM.

Benchmarking —This method can be used when the CM has sufficient experience and historical data with a particular project type to relate end units with construction costs. Benchmark estimates are typically provided in ranges.

Scale of operations method—This estimating method uses historically derived empirical equations to obtain an estimate of approximate costs for different sizes of the same type of facility.

Ratio or factor methods—There are many ratio or factor methods available for use by the CM, including:

Multiple of Equipment Cost Method—Most commonly used in chemical and process plants, this method depends on the cost of the equipment in the facility multiplied by a historical total cost factor to estimate the total project cost.

Lang Factors—Lang factors are standard multipliers for use in specific situations. Lang factors were developed for use in estimating various processes in the chemical manufacturing industry and were based upon a study of various chemical production facilities.

Hand Factors—Hand factors expand on the Lang factors approach by using the individual components of permanent equipment or systems. Each factor converts the cost of the equipment item to its share of the total construction cost. The sum of all factored line items yields the total estimated project cost.

Physical Dimensions Method—This type of estimate is based on physical dimensions such as length, area, volume, etc. For example, a gas pipeline project may be estimated using the number of lineal feet × the diameter of the pipe × the average depth of the pipe.

Parametric Estimates—This type of estimate is based on certain parameters that reflect the size or scope of the project. Parametric estimates are most commonly used in the building construction industry for preparing estimates. Typically, parametric estimates are used after the preliminary design phase is completed.

Quantity Take-Off Method—This is the most detailed type of estimate. To perform this estimate, the CM must have well developed design documents to take off, measure, and catalogue the various quantities of work to be performed. The quantities of equipment and bulk materials are used by the CM to calculate labor costs, material costs, construction equipment cost, indirect costs, etc.

There may be other methodologies used in estimating costs. As the available amount of project information increases, so does the amount of effort necessary to perform definition/estimate, as does the accuracy of the estimate itself.

(CMAA, 2018)

2.14.6 Conceptual Estimating Factors

There is little detail at the conceptual stage of the project. The minimum amount of information necessary to perform a conceptual estimate includes:

Project type—School, commercial office building, hydroelectric facility, petrochemical facility, manufacturing facility, etc.

Project size or capacity—Number of classrooms, offices, megawatts per day, product output, gallons per day, etc.

Project location —needed to estimate labor and material costs, camp costs, distributable costs, etc.

Project schedule—Needed to calculate overtime costs, field general conditions and requirements costs, escalation, contingencies, etc. (CMAA, 2018)

2.15 **Cost Compliance Monitoring:**

Cost monitoring is as critical to the success of cost management as estimating and budgeting. The CM must implement both a cost management system to capture and monitor actual cost data a cost management plan to determine how cost variances will be dealt with, should they occur. (CMAA, 2018)

The cost management plan is based on the current project budget. It focuses on maintaining the cost; that is, delivering the project to the owner within the approved budget. The objective of the cost management plan is to set forth decision-making processes in the event that cost variances or budget changes arise during the performance of the project. The decision-making process set forth in the plan focuses on whom makes what decisions and what type of decisions should be considered under various circumstances. (CMAA, 2018)

2.15.1 Cost Monitoring & Compliance Systems:

Cost monitoring should begin early in the project lifecycle, so that decision makers can be fully informed about the cost implications of project developments, options, and choices. The first priority when developing a cost monitoring system is determining what cost elements of the project should be monitored. Some argue that tracking pay items under a contract is sufficient. On small, short-term projects this may be acceptable. Larger more complex projects generally tend to have higher

visibility and greater sensitivity in most owner organizations. Large, complex projects are more likely to encounter cost overruns. In larger projects, items other than pay items may need to be monitored. Some cost items, which can be routinely monitored, tracked, and trended, include the following:

• Actual vs. planned project cash flow
• Actual vs. planned labor hours
• Actual vs. planned activities from a cost loaded schedule
• Project earned value calculations
• Subcontractor participation goals (e.g. DBE programs)
• Indirect or distributable cost usage. (CMAA, 2018)

2.15.2 Specifying Cost Monitoring Methods

Once the cost monitoring plan has been accepted by the owner, the CM must write certain requirements into the contract documents to capture the necessary data in a timely manner. It can be difficult to obtain cost breakdown information after the contract is executed. Confirm the owner's requirements for asset classification, funding allocation, supplier diversity tracking, and other issues. "Beginning with the end in mind" will make specifying cost reporting requirements more straightforward. (CMAA, 2018)

Construction Cash Flow - If the owner chooses to monitor actual compared to planned construction cash flow, then the CM should specify submittal of an approvable cash flow curve around the time of the contractor's Notice to Proceed. The CM can then plot planned cash flow and record actual cash flow on a routine basis as the project progresses.

Total Project Cash Flow - If the owner chooses to monitor actual versus planned total project cash flow then the parameters and process must start earlier to encompass design and other owner cost related activities.

Other cost monitoring requirements can be written into the contract documents, provided that the owner and the CM determine which cost elements are to be monitored prior to project bidding.

- **Design Phase cost Management**

This phase deals with project cost control during the design phase. It does not

address the cost of the design itself, but rather, deals with the cost impact of decisions made during the design phase.

- **Estimating Cost & Budget Impacts**

The approach to managing costs during the design process should be proactive, not reactive. The CM, regardless of acting as owner's agent should participate with the project team in the development of the overall project budget. (CMAA, 2018)

At the very least, the CM should provide a budget validation estimate as soon as possible. The project budget should be founded on reasonable costs based on historical data. In an effort to assure that design meets the budget, the project team should establish and employ the Lean Construction Process of Target Value Design. Target values should consist of both planning metrics and associated cost metrics since both are inherently related. To better manage and control design and costs, target values should be established for project elements of the work breakdown structure which can be clearly quantified.

The further down in the WBS hierarchy these values can be established, the greater the opportunity to manage the process proactively and successfully. (CMAA, 2018)

To verify that the project remains within the construction and project budgets, the following estimates should be prepared by the CM at the various stages of the design process: Program estimate at planning (or programming) completion—Upon completion of the planning (or programming) process, and prior to initiation of design, the CM should prepare a program estimate. Such an estimate is intended to predict the probable cost of the approved plan. The purpose of this estimate is to determine whether the plan can be delivered within accepted budgetary constraints.

Completion of schematic design—The CM should prepare a schematic design cost estimate based on measurement of parameter quantities from the designer's schematic design stage submittal. It may also be possible to measure approximate quantities for certain elements of the project more completely at this stage.

Completion of preliminary design—The CM should prepare a preliminary design cost estimate based on measurement of approximate or parameter quantities from the designer's preliminary design submittal. As the mechanical and electrical designs typically lag behind the civil, architectural, and structural designs, preliminary design estimates often contain approximate quantities for the architectural, structural, and civil works and parameter quantities for the mechanical equipment and electrical

components.

In-progress final design— Cost estimates prepared from working drawings and specifications should be based on quantity estimates for all major components. Any allowance and alternates to be called out in the bidding documents should also be quantified and estimated, as they become known during the design phase.

Completion of bidding documents (including any bid addenda issued)—At completion of the bidding documents, the CM should prepare the definitive estimate for use by the owner in establishing its project construction budget. This estimate should include quantities for all portions of the designed project plus an estimate of allowable contingency during construction. Although bids should be received shortly after this point, this cost estimate is necessary for many owners to advertise for bids. For example, many states require that a public owner has a formal written independent estimate of costs based on the final design prior to advertising for bids. Some public owners require such independent estimates in order for the county or city council to pass the formal motion authorizing bid advertisement. (CMAA, 2018)

2.16 **Contingency Management:**

The creation and management of budget contingency during the planning and design phases of a project are often a difficult exercise. Both the CM and the owner must plan for contingency funding that is realistic and that covers the inherent risks associated with each project. The project cost estimate must not only create budget line items for the full project scope, but should also include an appropriate contingency budget to accommodate protection against unknown project risks that do not necessarily attach to specific scope items. (CMAA, 2018)

2.16.1 Schedule of Values & Prompt Payment Requests

An acceptable schedule of values should allow faster progress payment reviews by establishing the value of work items. The CM simply needs to check that the work items on the progress payment application conform to the schedule of values and represent the work put into place during the established payment period. The real work concerning payment requests will then be reduced to determine how many units of each work item have been put in place during the payment cycle. A practice

becoming more commonplace is for the CM to make the determination of the contractor's progress for each activity in preparation of the application for payment. The contractor's responsibility is to accept the CM's observations or discuss any differences of opinion. (CMAA, 2018)

2.16.2 Factors Governing Cost Changes

In accordance with the Standards, and as part of the overall cost control system during the construction process, the CM should establish and implement a change order management system. Once the CM and owner agree to a contract price adjustment (and/ or time), they must understand the scope of the changed work and obtain supporting data of costs to determine the amount of the adjustment that is fair and equitable. The CM should prepare an estimate of the cost of the change order listing the anticipated labor, materials, equipment, subcontract work, contractor's overhead, and profit, as well as any justified impact costs. The effect of the change on the current updated schedule should also be analyzed for any identifiable time impact.

This effort should be completed by the CM in advance of receiving the change order pricing from the contractor, so that an evaluation of the proposed price can be made independently and without delay. Additionally, the CM should alert the owner to potential change orders based on identified issues. An early warning system, with a range of potential costs, while the issues are being vetted and further evaluated helps to prevent surprises. Generally, there are three ways to price change orders:

Forward Pricing— The change order pricing is done prior to the start of, or early in, the performance of the changed work. The estimates of costs might itemize production rates, crew composition, hours, and equipment. Material cost should be listed and substantiated with written cost quotations and price lists. Markup including overhead, profit, and bond should be added. If this can be accomplished successfully between the owner and the contractor, "mutual accord and satisfaction" language can be included in the change order.

Actual Pricing— This is sometimes referred to as force account or time and materials (T&M) work. The pricing is done while the changed work is being performed and represents actual costs based on job cost records of man-hours consumed and material and equipment used. Comprehensive cost records are imperative. On force account or

T&M work, the work should also be documented and verified daily by both the CM and the contractor. The mark-up cost for overhead and profit to be added to the actual costs incurred for labor, materials, and equipment, may be established in the contract documents.

Post or Retroactive Pricing— Change order pricing is done after the work has been completed and no records were maintained nor were job cost records segregated between base contract and changed work. Cost estimates, like forward pricing, are produced to quantify the scope and cost of the work. This scenario often occurs because the contractor does not provide timely notice of the change and the work has been performed before the CM got involved. Many contracts require the contractor provides timely notice or it will have waived all of its rights for a change order to the contract specifically to avoid this scenario. Before any pricing is done, the contractor must first establish entitlement to a change.

Markup Pricing—Some contracts define the markups allowed for changed work and what is included in those markups for forward priced and T&M work. Including this in the contract means this issue is settled up-front without further discussion. If the contract does not spell out the markups, those should be negotiated as soon as possible to expedite the execution of change orders. In forward pricing of change order work, the CM may consider the following special factors when evaluating labor production rates:

- Status and condition of the work
- Relative size and capability of the contractor
- Size and complexity of the change
- Climatic conditions
- Mechanization possible
- Labor agreements
- Trade practices
- Learning curve
- Additional supervision required by the change

When evaluating material and equipment costs, the CM may consider the following special factors:

- Value of salvaged material
- Odd lot sizes that add to cost

• Special delivery costs
• Potential higher price for proprietary items
• Cost escalation since bid opening
• Storage costs that may be necessary
• Minimum quantities of bulk materials to be purchased
• Restocking charges
• Premiums for payment and performance bonds
• Additional insurance coverage
• Additional inspection and testing costs required to perform the changed work
• Price paid for unused inventory While impact costs, if any, may be difficult to quantify, the following issues may need to be addressed:
• Changes in sequence of work
• Changes in means, methods, or manner of performance for the work
• Discontinuity of the work (stops and restarts)
• Premium time incurred to avoid delays
• Congestion of work area
• Mobilization and demobilization
• Effect on other contractors
• Loss of efficiency with respect to labor productivity
The CM should also consider the potential for schedule-related impact or time extension costs such as:
• Extended general conditions
• Extended field office overhead
• Extended or unabsorbed home office overhead
• Extended insurance costs
Large impact costs, if any, can sometimes be determined by the following:
• Actual cost of identical work performed
• Reasonable estimate of the cost of the work if a change had not been encountered, compared to the estimated cost of change order job conditions, or compared to the actual cost of work performed if retroactive pricing was used
• Audit of the contractor's job cost records to determine actual costs
Overhead and profit allowed on change order work is often established as fixed percentage rates in the contract documents. If they are not, the CM needs to facilitate

agreement between the owner and contractor on such rates before change orders are executed. (CMAA, 2018)

2.17 **Cost Control in Construction:**

During the execution of a project, procedures for project control and record keeping become indispensable tools to managers and other participants in the construction process. According to Dharwadker (1985), cost control can be achieved by selecting the right man for the right job, the right equipment and tools for the right work and the right quality of materials, in the right quantity, from the right source, at the right price and delivered at the right time. Managers are expected to be well equipped to execute the project, with due consideration to the quality of work, yet within the estimated cost and limits. (Otim, et al., 2008)

2.17.1 Project Resources and Controls

Resource inputs at the project site which produce outputs in the form of work include: men, materials, machinery and money. The success of a project depends upon the performance of these input resources when controlling costs (Hendrickson 1998). The clients should do everything possible to avoid unnecessary delays as it is one of the leading causes of cost escalation. (Otim, et al., 2008)

- **Materials**

One of the big problems on most building sites is the large amount of materials wastage due to varying circumstances (Butler 1982). This problem requires a supervisor to constantly be on the lookout for the losses. According to Hendrickson (1998), wastage of materials can take place during the procurement process, storage, and during utilization+*-. Wastage during procurement can result from one or more of the following causes: buying materials of wrong specifications, buying more than the actual requirements to cater for unrealistic and unforeseen eventualities, untimely buying of short-life materials, improper and unnecessary handling of materials, and wastage in transportation. Wastage during storage can occur due to the following reasons: damages and breakages during handling, deterioration due to incorrect storage, incorrect maintenance and short-shelf life and losses due to fire, thefts/vandalism, and exposure to extreme climatic conditions. Other causes are lack of pre-work preparation and coordination, improper accounting and poor storekeeping, negligent and careless attitude of the supervisor, high rate of deterioration due to long storage at the place of work, and over-issues from the central

stores and failures to return unused surplus materials to the stores. According to Chitkara (2005), some unavoidable wastages are inherent during utilization, but excessive wastage is of concern to the management as it affects the productivity adversely, with consequences of extra costs. Most problems relating to material wastage revolve around requisitioning and ordering, receipt and checking of deliveries from suppliers, offloading and handling, storing and protecting, and issuing, distributing and use of materials. (Otim, et al., 2008)

- **Plant**

In construction, some tasks are labor intensive, some predominantly employ equipment, and some use a combination of both. While the actual work done and the associated labor is accounted by the supervisor concerned, the equipment and productivity control is undertaken to determine its employment time, the output achieved, and its productivity at site (Hendrickson,
1998).The main purpose of the control is to minimize wastage in utilization so that the overall project cost is not affected (Chitkara, 2005). Alinaitwe (2006) observed that industrializing construction would probably reduce the cost of construction by about 30% which would likely settle the back log of 25% of Ugandans without proper housing. (Otim, et al., 2008)

- **Labor**

Labor productivity achieved at the site for a given work provides a measure of the laborer's efficiency and effectiveness and the level of site organization. It shows the total time for which
the laborer was employed at work, the time he was productive on work and the time he remained unproductive (Chitkara ,2005). Craftsmen use about 40% of available time on productive activities, and about 33% of the time on non-value adding activities (Alinaitwe 2006). Productive times are wasted for various reasons such as idle waiting, unnecessary travelling, late starting, early quitting, unscheduled breaks, and delays in the receipt of tolls, delays to receive materials and work instructions. Assessment of the level of industrialization in Uganda and the effect on productivity and other metrics were done by Alinaitwe, (2006) and the results indicated that the cost of labor is of the order of 30 to 40% of project costs. The metrics confirmed that labor is a significant factor in the cost of buildings and more efforts are required to industrialize the industry. According to Chitkara, (2005) cost control process involves

accounting of actual productivity, and comparing with the standard, analyzing the causes for variations taking remedial measures for improvement. Raina (1999) emphasizes the need for close supervision and good working relationship. (Otim, et al., 2008)

2.17.2 Time-Cost Relationship:

Chitkara (2005) said the relationship between time and cost is a very important aspect in the control of costs on site as any variation in time has automatic implication on cost. It is important to report and record all the works involving materials, plant and labor on sites. This enables the contractor is able to know the costs and expenses of the resources used on site and compare with the initial cost budget. Various report techniques used include; daily or weekly and monthly recording, schedule control, site daily diary report and the project budget. (Otim, et al., 2008)

2.18 **Project Closeout:**

Depending on the terms and conditions of the CM's contract, the CM's cost management responsibilities may carry on beyond completion of construction. The Standards specifically mention CM obligations regarding the following as related to completion of construction and turnover to the owner of the completed facility.

- Final payment
  - Contract closeout, including:
  - Certificate of substantial completion
  - Final lien waivers
  - Final payment application
  - Release of retainage
  - Final cost accounting

Obtaining final lien waivers from the contractor and all subcontractors, suppliers, and vendors help ensure that all project participants have been properly paid and will deliver alien-free job to the project owner. Processing the final payment to the prime contractor and releasing retainage is also, generally, a CM function. This may also require close coordination between the CM and designer. To the extent that there are claims at the end of the project, the CM is normally involved in claim analysis and either settlement or defense of such claims. Additionally, the CM may be required to provide a written report summarizing total project cost, listing all change orders, and

identifying any unresolved issues which may have a cost impact. The CM should also prepare and file a "lessons learned" report setting forth the causes of all cost variances, the reasoning behind the actions taken, and other types of lessons learned from the cost control perspective. This helps the owner respond to inquiries and assists if there is a project audit performed by an outside agency. It will also useful for the CM and its staff on future projects. (CMAA, 2018).

2.19 **The Implementation of Cost Management in The Local Construction Projects in Sudan:**

Poor planning and delay in construction projects has been a major issue in the Sudanese construction industry over the past decades. The government spends huge amount of money in the construction sector in an attempt to carry out economic development. It's a normal tradition to allocate developmental funds in her yearly budget. Majority of this fund is set aside for the construction of roads, railways, hospitals, schools, residential and nonresidential buildings and airports. If these projects are delayed, it will not only slow down economic growth in the country but it will also increase government expenditures. This will be due to procurement of materials at a higher price, and also due to change of contractors. The result will be wastage of country's resources that could have been used to for other purposes. In addition, business organizations every year invest a lot of capital in construction of new facilities in an attempt to expand their businesses and generate more profits by increasing their sizes of operations and also to meet up with competition. When the problem of delay occurs, the companies turn to loss large amount of money that can sometimes render the company insolvent. Moreover contractors are constantly loosing contracts due to poor planning or incompletion of previous projects. Most often they are obliged to share the cost of the delay which is not necessarily caused by them.

Delay has also led to a lot of disputes amongst stake holders in the construction industry. If these disputes cannot be resolved amicably to the satisfaction of every party, some parties will prefer litigation and arbitration. All this will go a long way to increase the cost of the overall project. (MOHAMED, 2015)

2.19.1 Effects of Construction Project Delay:

When construction projects are delayed, the effects are often injurious to the stakeholders. A research conducted in Nigeria by (Aibinu and Jaboro). They studied

the effects of the delay in the construction industry of Nigeria. They discovered six possible common effects which arising in most countries as a result of delay. These effects were; cost overrun, time overrun, disputes, arbitration and litigation and total abandonment of project. (MOHAMED, 2015)

2.19.2 Cost Overrun:

This refers to the excess of the actual cost that was planned or budgeted for the project from the conception phase to the construction and finishing phase. It can be referred to sometimes as cost escalation, cost increase or budget overruns (Singh, 2009). It can also be explained as the difference between the actual cost of the project and the initial cost budgeted. Researchers such as (Flyvberg et al, 2002) have shown that infrastructure projects often suffer from cost overruns. Cost overruns can sometimes be attributed to political factors (Holm and Bubl, 2002). Politicians lie by either underestimating or exaggerating the benefits of projects to make it saleable and for their own interests when construction projects are delayed, the specific and overall cost of the project will certainly increase. This is due to the fact that prices of materials in the market fluctuate over time. Thus the amount that was budgeted for materials may increase when delay occurs. In addition exchange rates will affect the prices of materials purchased from other countries, increase in price of labor. Moreover if the delay is as a result of changes in the design, the cost of the project will increase because the new design will be more expensive than the initial. And finally the change of government policies over time will also lead to cost increase of the projects particularly due to increase in tax rates. (Shibani & Arumugam, 2015)

2.20 **Previous Study on the Construction management in Sudan:**

The consequences of building construction projects are always negative thus delay should be avoided at all cost. To avoid construction delays, it is imperative for project Participants to first of all identify the possible factors that can cause delay and label them as critical success factors. Once these factors have been identified, suitable preemptive measures can also be put in place to counter the negative effects that may arise as result of their occurrence.

The already identified delay factors can then be traced to their possible causes that are due to either contractor, consultants, clients, environmental, government or others. With all this resolution method put in place it will be very easier to identify whoever is at default. Sudan is an underdeveloped country lacking all the resources needed to successfully complete a building construction project within the allocated time and budget. This has had adverse effects on infrastructural development aspect of the economy and also its construction industry reputation in the global market. Therefore

it is not doubtful that the government and private institution keep spending huge amount of money on construction projects which are later delayed and some abandoned. From our findings, we conveniently pointed out that the most common causes of construction project delays were, fluctuation of prices of construction materials, shortage of materials, inaccurate time estimation, errors during construction, improper planning, delay in payment to contractors, compensation issues, design changes and inaccurate cost estimation. (MOHAMED, 2015)

Chapter Three

Data Compilation

Chapter Three.

3 **Data Compilation**

3.1 **Introduction**

This chapter comprises of the method that was used to conduct the research. It was a quantitative research in which the data was collected using questionnaires. In addition this chapter also presents the questionnaire design, the different sections of the questionnaires, the scale as well as the pilot study that was conducted to ascertain the reliability of the questionnaire.

The research methodology chosen for this study comprised of intensive literature review, questionnaire to building construction stake holders in Sudan and a statistical analysis of the Survey.

- ✓ Questionnaire preparation
- ✓ Questionnaire Survey
- ✓ Data collection
- ✓ Data analysis

3.2 **Research population:**

The population was made of clients, contractors and consultants who represented by engineers

3.3 **Research Sampling:**

In this questionnaire, we used a random sampling method to select the contractors and consultants. Random sampling is defined as the probability of choosing people or things in a random manner, without any criteria with the aim of eliminating bias (Komb and Tromp, 2006).

3.4 **Research Tool:**

The primary data was obtained using questionnaires; the primary data refers the first hand information obtained by the researcher himself in his or her study. This information is made available for the first time only by the researcher. The information can be collected through direct personal investigations, through respondents, and survey using questionnaires. The advantages of this method of data collection include; reliability and accuracy.

3.5 **Questionnaire Design:**

The questionnaire was designed to get opinions from clients, consultants and contractors of construction companies in regards to the effects of cost management in construction planning in Sudan. The effects, the success factors and stages and process were identified from the literature and these factors were tested with the stakeholders of the Sudanese construction industry.

The questionnaire was structured into 5 sections to meet all research objectives and questions.

- Section One had questions to determine the respondents' background.
- Section Two had question to identify the factors that affect the planning in the constructions projects in Sudan.
- Section three had questioned to identify the applications of cost management in construction projects in Sudan.
- Section four had questioned to identify the relationship between the cost management and the effective planning in constructions projects in Sudan.
- Section Five had questioned to identify the techniques of the cost management's in construction projects.

The questions were design based on the 5 point Likert Scale which measures from 1-5 according to the level of contribution and impact of each statement.

Strongly Agree	(5)
Agree	(4)
Moderate	(3)
Disagree	(2)
Strongly Disagree	(1)

3.6 **Questionnaire Pilot:**

A pilot study involves testing a questionnaire with a small group of experts in the field was conducted and all remarks were introduced to the text. This helped to pin point mistakes in the questionnaire and also to determine if the questions understood and easily answered by the respondents.

3.7 **Questionnaire Distribution:**

In order to determine the perception of different stake holders in Sudan construction industry regarding the effects from the application of cost management in constructions in Sudan, an online questionnaire created (by using google forms) through social media and e-mails; to collect the data from our target respondents, the number of distributed copies was (**100)** the number of returned back copies (**80**) with percentage of 80% responded.

Chapter Four

Data Analysis Interpretation

Chapter Four.

4 Data analysis and Interpretation

4.1 Introduction

This chapter presents a series of statistical tests and analysis carried out for sections. These include the effects, the success factors and stages and process of applying cost management in construction in Sudan. It also presents the results of the questionnaires. The results were represented using descriptive statistics such as the bar charts.

4.2 Data analysis

4.2.1 Section one

Table 4-1 showing the participant's academic degree.

What is the highest academic degree you have completed?		
The Academic degree	Participants Frequency	Participants Percentage %
Bachelor's degree	52	65%
Higher diploma degree	4	5%
Master's degree	22	28%
Doctorate degree	2	3%
Total	80	100%

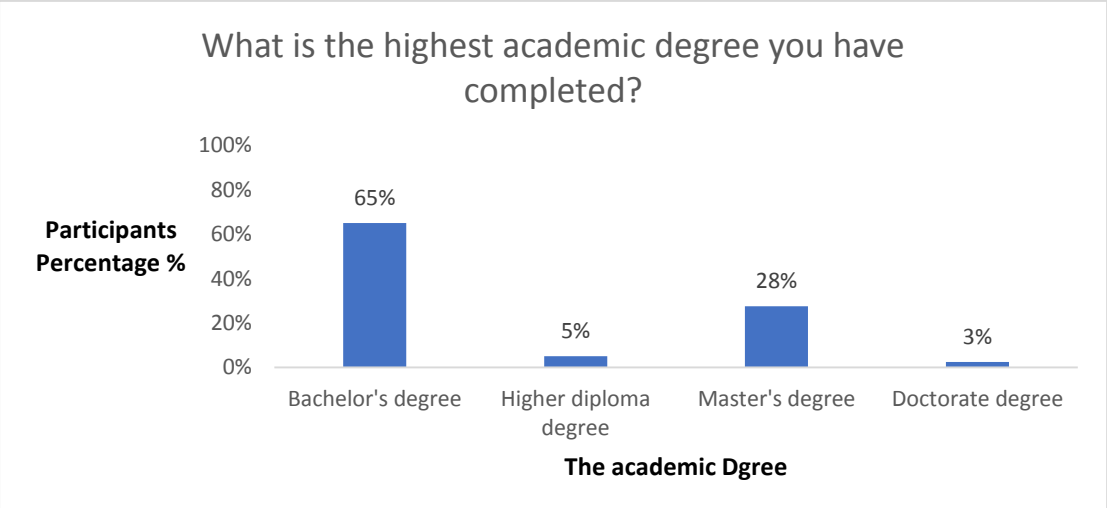

Figure 4.4.1 Bar chart showing the participant's academic degree.

According to the qualification of people who participated in this questionnaire, it is clear to us that they are consistent with the academic pyramid and this is good for the research questionnaire results so that we get correct, logical and more realistic results

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Table 4-2 Bar chart showing the participant's ages.

What is your age?		
The Ages	Participants Frequency	Participants Percentage %
25-35	55	69%
>35-45	15	19%
>45-55	9	11%
>55	1	1%
Total	80	100%

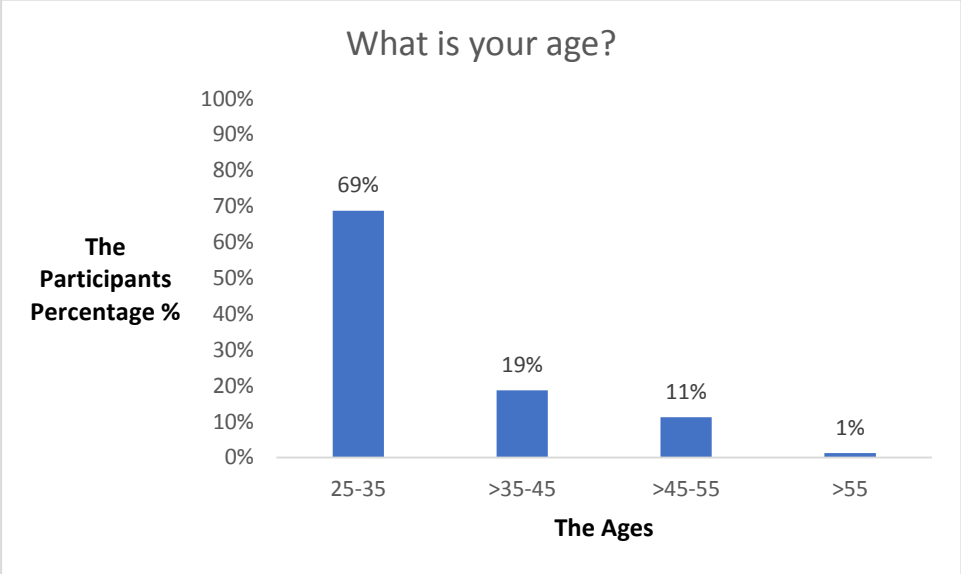

Figure 4.2 Bar chart showing the participant's ages.

Table 4-3 showing the participants years of experience.

What are your total years of experience within construction projects field?		
The Experience	Participants Frequency	Participants Percentage %
Less than 5 yrs.	23	29%
5 - < 10 yrs.	31	39%
10-15 yrs.	12	15%
More than 15 yrs.	14	18%
Total	80	100%

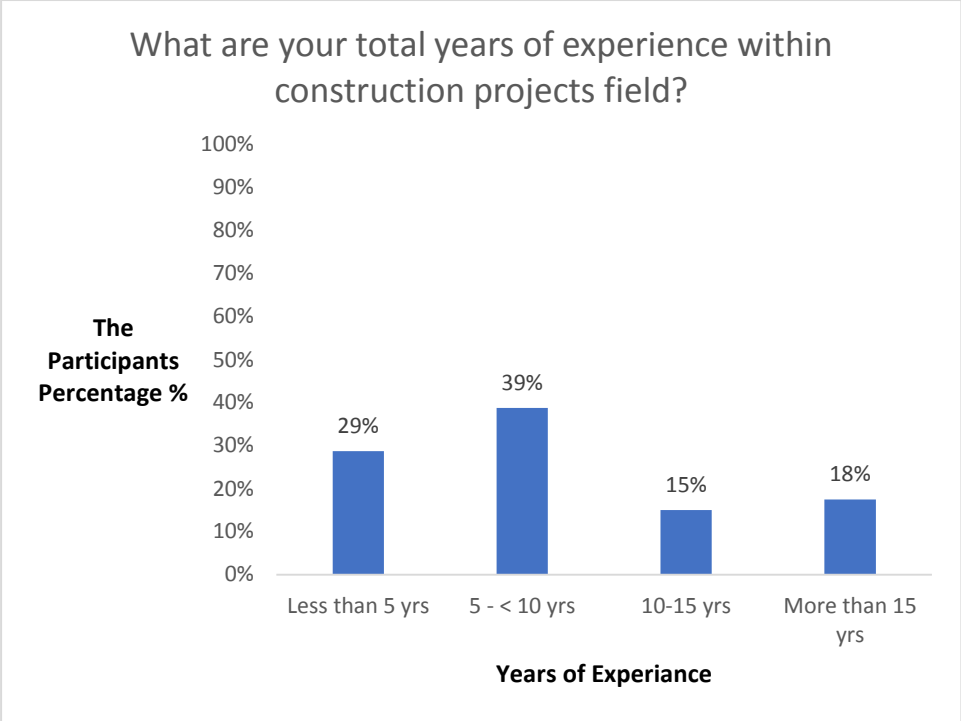

Figure 4.3 Bar chart showing the participant's years of experience.

Also considering the people involved in the questionnaire in terms of age and experience and the level of occupation, we found that the majority from the average experience and grades, who are make up the great category of workers in this area.

Table 4-4 showing the participant's organization category.

What is the category of your current organization?		
The Organization Category	Participants Frequency	Participants Percentage %
General contractors	34	43%
Specialized contractors	8	10%
General engineering consultants	21	26%
Project management	17	21%
Total	80	100%

Figure 4.4 Bar chart showing the participant's organization category.

When analyzing the questionnaire it is also clear that the majority of participants working in General contracting organization, which may be in various fields, which gives us a more comprehensive diversity and not focusing on a particular area.

4.2.2 Section Two

Table 4-5 showing effect of using modern technology factor

The Factors that affect planning in construction projects.					
The use of modern technology encourage for good results gained by genuine planning	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	1	2	34	42
Percentage %	0%	1%	3%	43%	53%

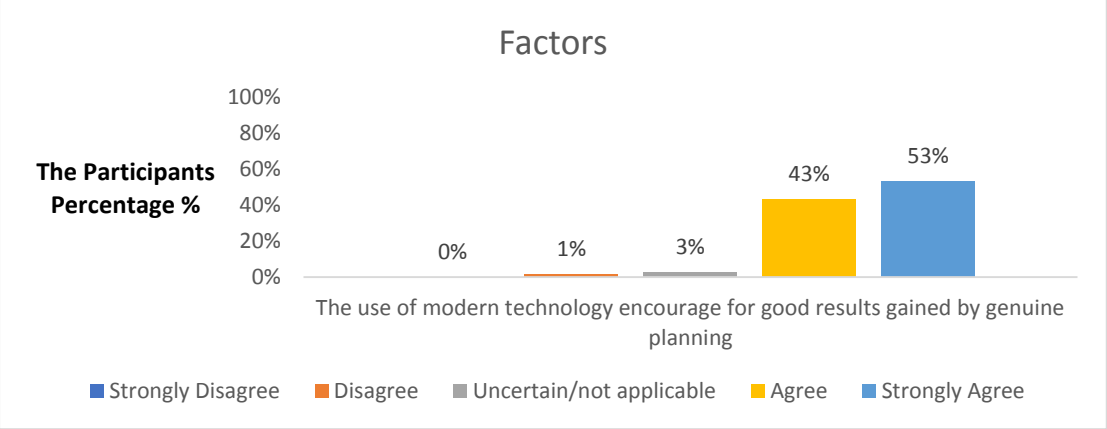

Figure 4.5 Bar chart showing effect of using modern technology factor

A Considerable of the respondents 96% said that the use of modern technology encourage for good results gained by genuine planning. This means that the unused modern technology one of the reasons why genuine planning in construction projects is not implemented and sometimes the failing.

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Table 4-6 showing effect of applying training courses factor

The Factors that affect planning in construction projects.					
The application of training courses in the field of costing and planning assist in having successful project	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	1	7	33	39
Percentage %	0%	1%	9%	41%	49%

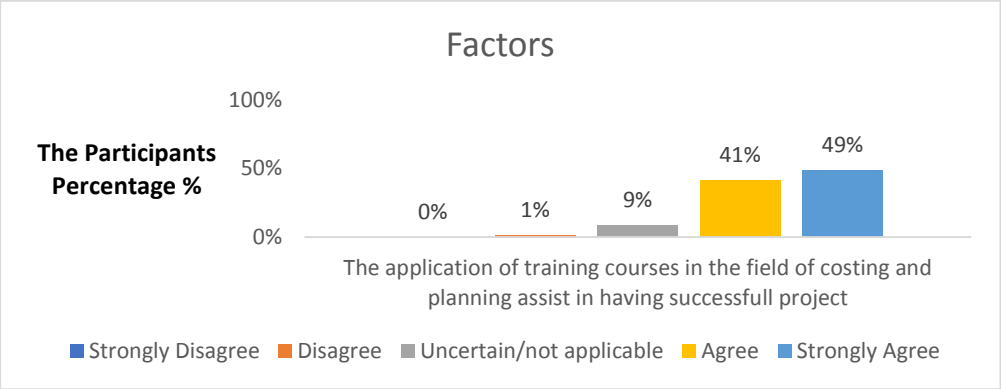

Figure 4.6 showing effect of applying training courses factor

A large number of respondents 96% also consider that the application of training courses in the field of costing and planning assist in having successful project and therefore the failure of applying these courses may lead to failure of construction projects in Sudan.

Table 4-7 showing effect of planning awareness factor

The Factors that affect planning in construction projects.					
The lack of awareness about planning is a reason behind omitting the process	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	3	2	38	34
Percentage %	0%	4%	3%	49%	44%

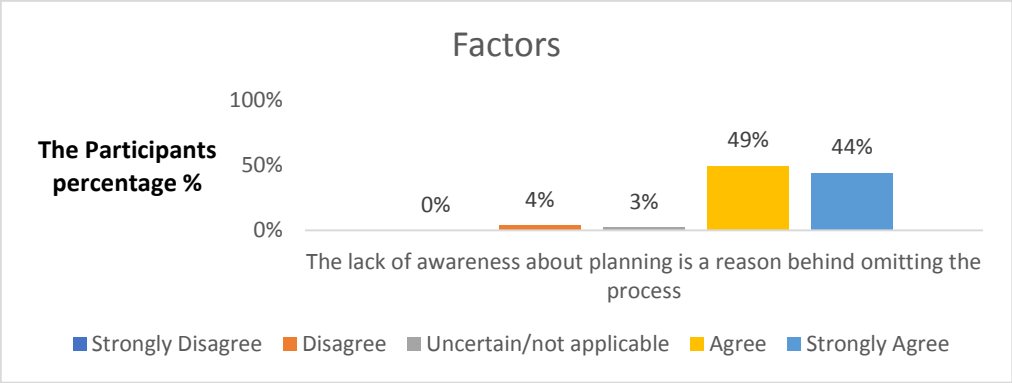

Figure 4.7 Bar chart showing effect of planning awareness factor

Most of the respondents 94% agreed that the lack of awareness about planning is a reason behind omitting the process of planning in construction projects in Sudan, that's why most of contractors ignoring planning and this leads them to cost overrun or inability to deliver the project on time.

Table 4-8 Showing effect of Top Management factor

The Factors that affect planning in construction projects.					
The Top management is the main factor to successful	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	3	2	38	34
Percentage %	0%	4%	3%	49%	44%

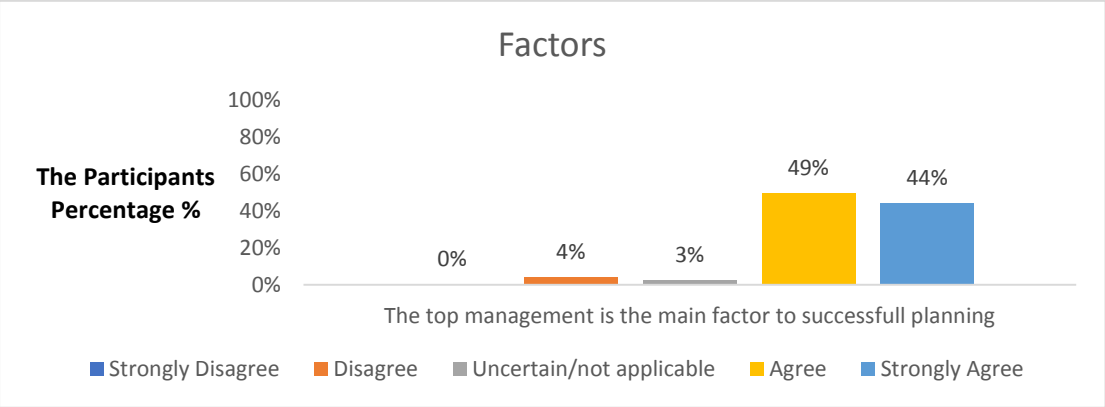

Figure 4.8 showing effect of Top Management factor

94% of the respondents saw that the top management is the main factor to successfully planning; this shows the importance of the role played by top management in the planning process in construction projects in Sudan.

Table 4-9 showing effect of lack of resources factor

The Factors that affect planning in construction projects.					
Lack of resources is always affect the conduct of planning	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	2	7	37	32
Percentage %	0%	3%	9%	47%	41%

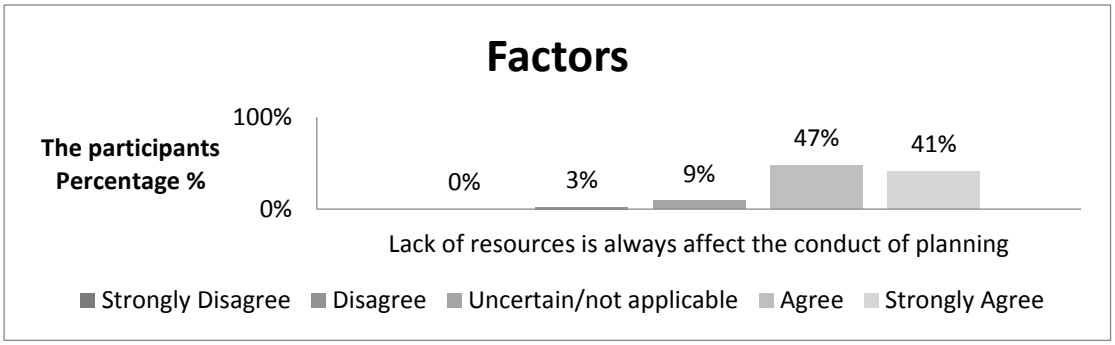

Figure 4.9 Bar chart showing effect of lack of resources factor

Also 88% of the respondents saw that lack of resources is always affect the conduct of planning; from this we find that the lack of resources is one of the factors that may threaten the successful planning.

4.2.3 Section Three:

Table 4-10 showing projects subjected to planning and costing system

Application of Cost Management in Construction Projects					
All projects are subjected to complete planning and costing system	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	1	9	28	31	11
Percentage %	1%	11%	35%	39%	14%

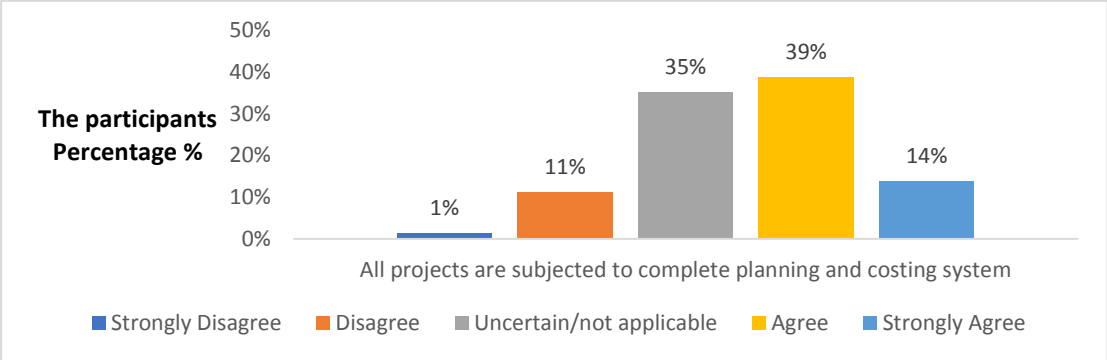

Figure 4.10 Bar chart showing projects subjected to planning and costing system

53% of the respondents said that in their organizations all projects are subjected to complete planning and costing system, this is a very small percentage indicating a problem and a very large defect in the planning of construction projects in Sudan should not be overlooked and solved.

Table 4-11 showing projects completed without disputes

Application of Cost Management in Construction Projects					
Projects are completed without disputes	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	5	13	20	28	14
Percentage %	6%	16%	25%	35%	18%

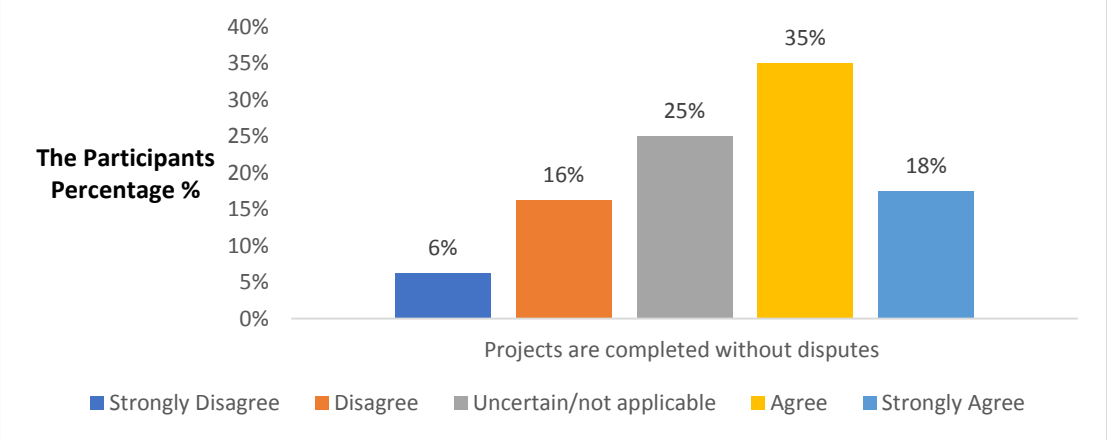

Figure 4.11 Bar chart showing projects completed without disputes

Similarly, 53% of the participants in this questionnaire agreed that in their organizations projects are completed without disputes. This means that still the disputes are accrue in the construction projects in Sudan in a significant way.

Table 4-12 showing the data base system for planning

Application of Cost Management in Construction Projects					
Planning is established based on data base in costing system	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	1	10	21	41	7
Percentage %	1%	13%	26%	51%	9%

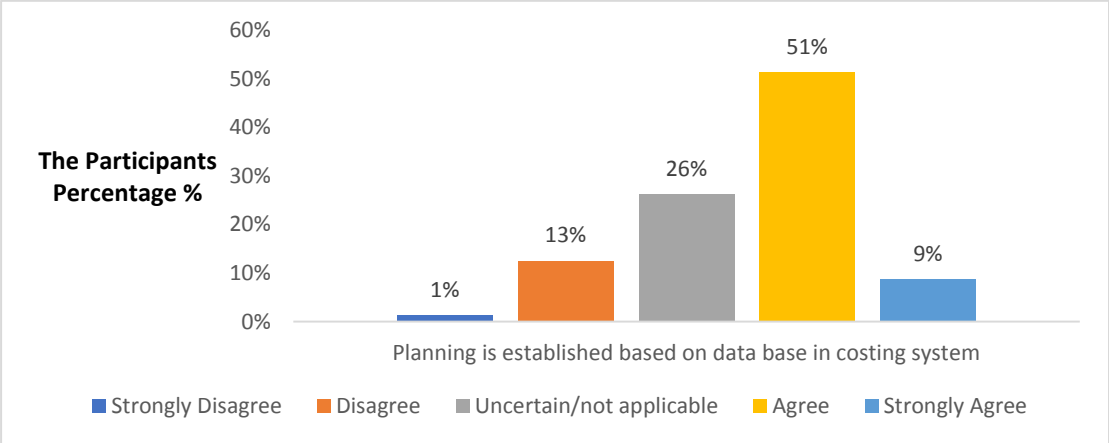

Figure 4.12 Bar chart showing the data base system for planning

60% of the participants acknowledged that in their organizations, the Planning is established based on data base in costing system , this means that a great amount of construction projects in Sudan which their planning does not established based on data base in a proper costing system may face troubles during construction or may fail.

Table 4-13 showing the pre scheduled planning projects.

Application of Cost Management in Construction Projects					
Most of projects are completed according to the pre scheduled planning	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	4	20	24	28	4
Percentage %	5%	25%	30%	35%	5%

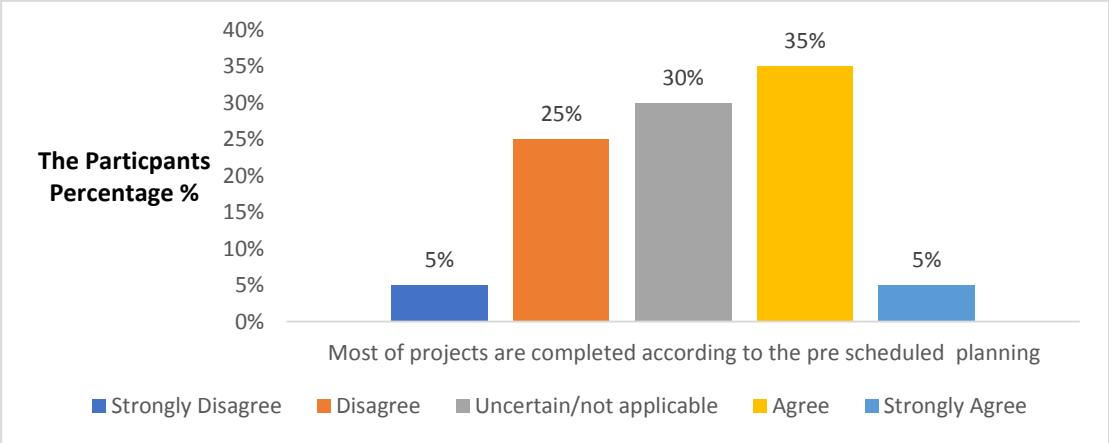

Figure 4.13 Bar chart showing the pre scheduled planning projects.

Only a few percentage 40% agreed that their most projects are completed according to the pre scheduled planning while 30% were Uncertain; which is mean the completed projects according the pre scheduled planning is very rare in the construction projects in Sudan.

Table 4-14 showing the projects finished within the estimated cost

Application of Cost Management in Construction Projects					
Most of projects are finished within the estimated cost	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	6	21	30	17	6
Percentage %	8%	26%	38%	21%	8%

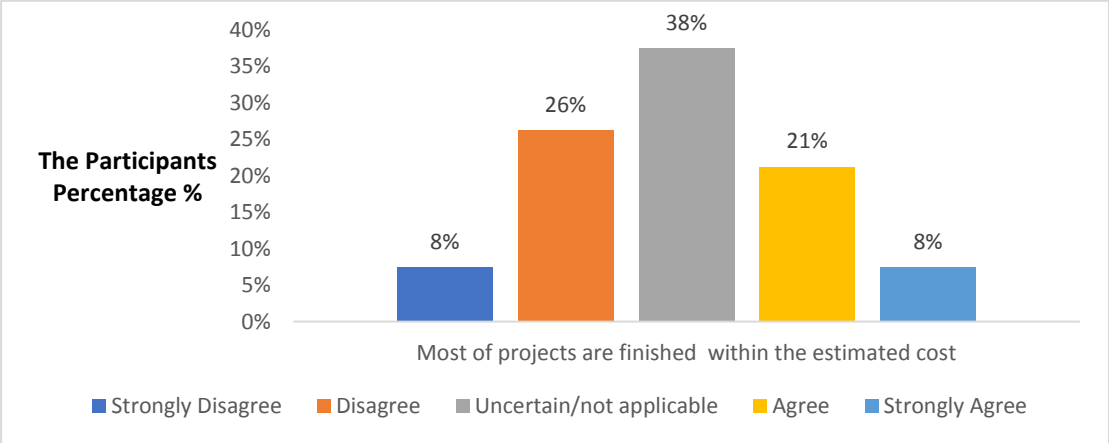

Figure 4.14 Bar chart showing the projects finished within the estimated cost

Also a few percentage 29% agreed that their most projects are finished within the estimated cost while 34% were Uncertain; which is mean the completed projects within the estimated budget is very rare in the construction projects in Sudan.

Table 4-15 showing the phenomenon of project cost overrun

Application of Cost Management in Construction Projects					
Project cost overrun is a common phenomenon in your company	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	17	22	29	12
Percentage %	0%	21%	28%	36%	15%

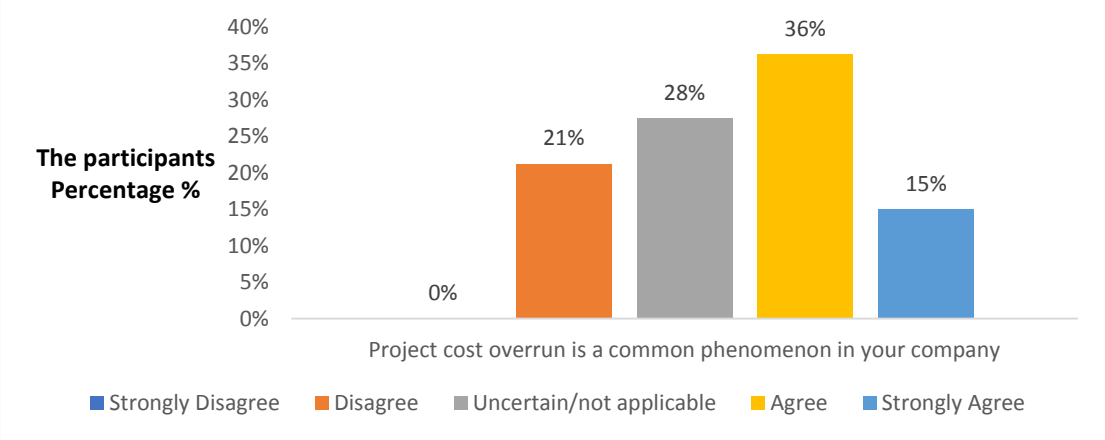

Figure 4.15 Bar chart showing the phenomenon of project cost overrun

51% of the construction companies in Sudan have a phenomenon of cost overrun in their projects and thus is considered as widely spreading negative phenomenon in construction projects in Sudan.

4.2.4 Section Four:

Table 4-16 showing the usage of strategic or specific method of cost management in projects planning

The Relationship between Cost Management and the Effective Planning in Construction Projects					
The organization used a strategic or specific method of cost management in project planning.	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	6	8	18	37	11
Percentage %	8%	10%	23%	46%	14%

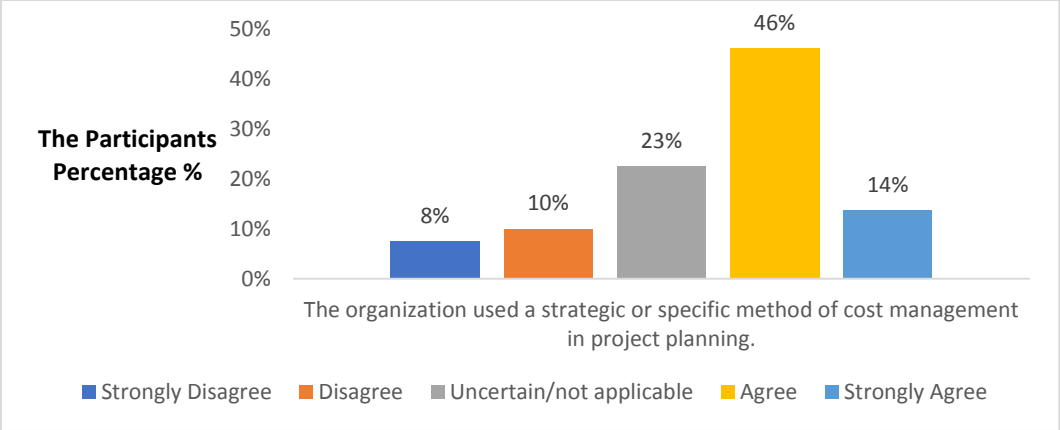

Figure 4.16 Bar chart showing the usage of strategic or specific method of cost management in projects planning

Only 60% of the construction organizations in Sudan are using a strategic or specific method of cost management in project's planning.

Table 4-17 showing the application of cost management in all projects phases

The Relationship between Cost Management and the Effective Planning in Construction Projects						
The Top management is the main factor to successful		Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
. Pre – Design Phase	No	3	17	18	35	7
	Percentage %	4%	21%	23%	44%	9%
Design Phase	No.	2	14	11	44	9
	Percentage %	3%	18%	14%	55%	11%
Construction Phase	No.	1	9	17	41	12
	Percentage %	1%	11%	21%	51%	15%

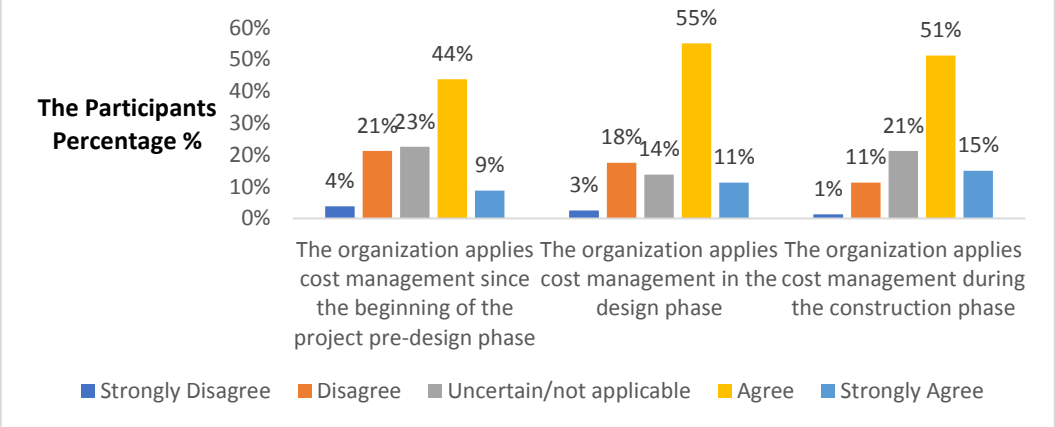

Figure 4.17 Bar charts showing the application of cost management in all projects phases

53% of the construction organizations in Sudan apply the cost management since the beginning of the project pre-design phase while 66% of the construction organizations in Sudan apply the cost management in the design phase and during the construction phase.

Table 4-18 showing the application of cost management in post-construction phase

The Relationship between Cost Management and the Effective Planning in Construction Projects					
The organization applies cost management in the post-construction phase	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	5	13	31	26	5
Percentage %	6%	16%	39%	33%	6%

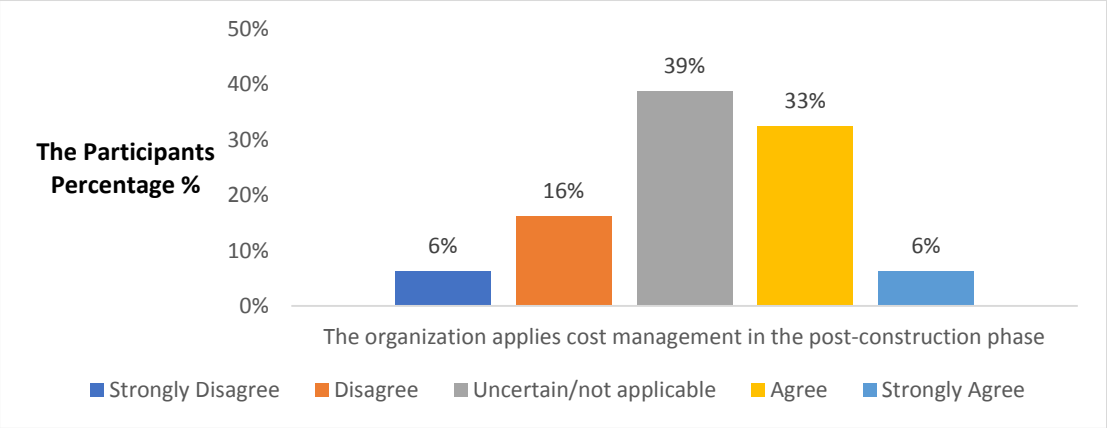

Figure 4.18 Bar chart showing the application of cost management in post-construction phase

39% of respondents said that their organizations are implementing post-construction cost management, while 39% have no idea whether it is implemented or not. This is a large proportion that has no awareness of cost management.

Table 4-19 showing the effect of unmanaged costing system

The Relationship between Cost Management and the Effective Planning in Construction Projects					
unmanaged costing in construction projects leads to deviation from the planned target (profit, time, quality)	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	2	1	4	22	51
Percentage %	3%	1%	5%	28%	64%

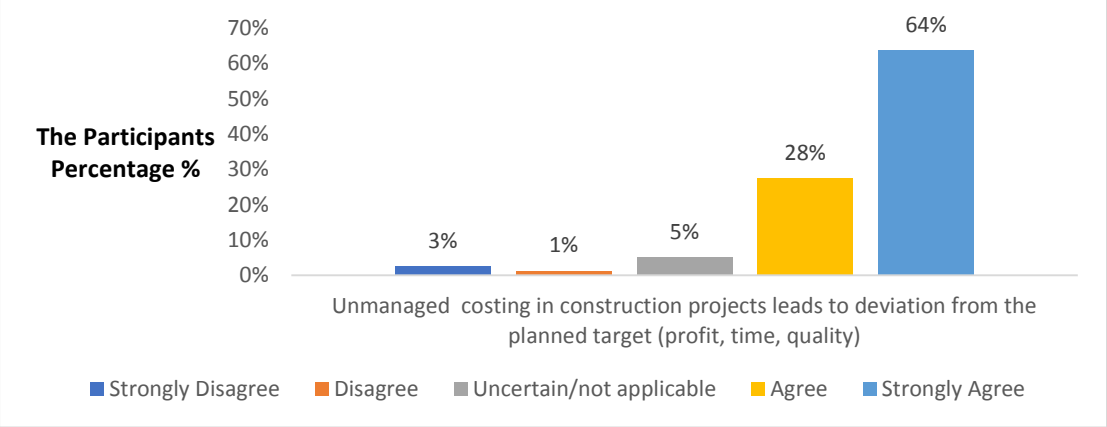

Figure 4.19 Bar chart showing the effect of unmanaged costing system

The majority of respondents (91%) said that unmanaged costing in construction projects leads to deviation from the planned target (profit, time, quality).

4.2.5 Section Five:

Table 4-20 showing the allocation of resource to each project activity

The Techniques of Cost Management in Construction Projects					
The organization always allocate suitable resources to each project activity	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	1	9	13	38	19
Percentage %	1%	11%	16%	48%	24%

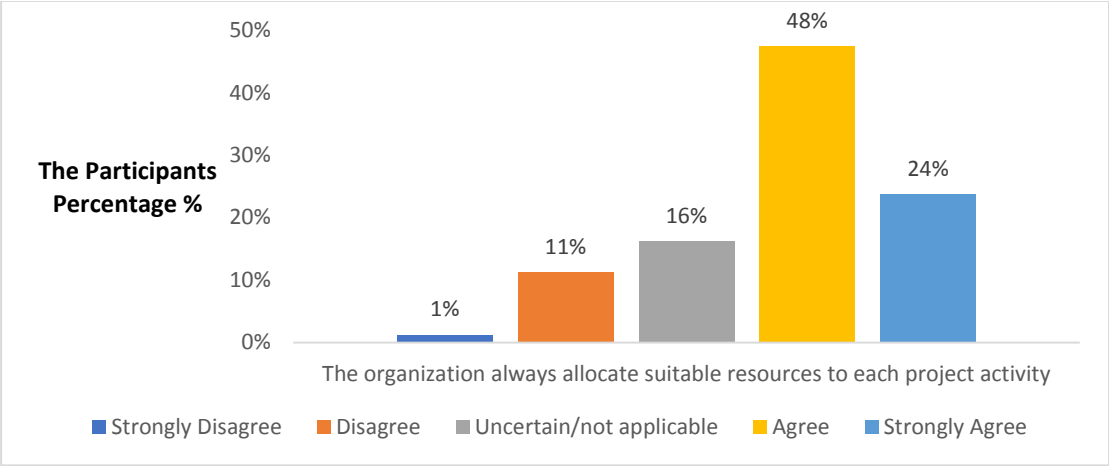

Figure 4.20 Bar chart showing the allocation of resource to each project activity

71% of the construction organizations in Sudan allocate suitable resources to each project activity to ensure projects proceed as planned.

Table 4-21 showing the dependency on preliminary cost.

The Techniques of Cost Management in Construction Projects					
The organization always depend on preliminary cost established from planning and scheduling	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	2	7	13	43	15
Percentage %	3%	9%	16%	54%	19%

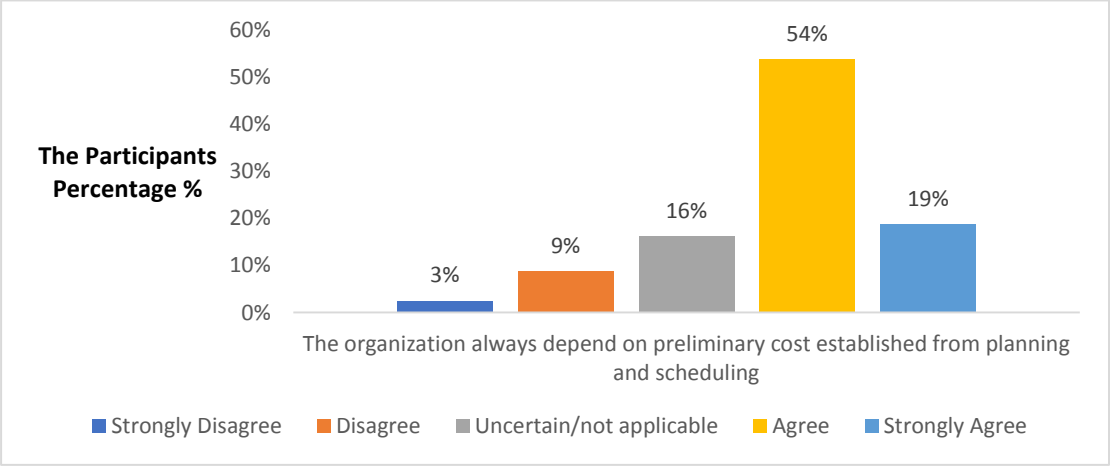

Figure 4.21 Bar chart showing the dependency on preliminary cost.

73% of the respondents agreed that their organization always depend on preliminary cost established from planning and scheduling for their great importance in the success of the construction projects in Sudan.

Table 4-22 showing the using of (WBS) to overall cost

The Techniques of Cost Management in Construction Projects					
The organization always use work breakdown structure (WBS) to overall cost	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	7	23	37	13
Percentage %	0%	9%	29%	46%	16%

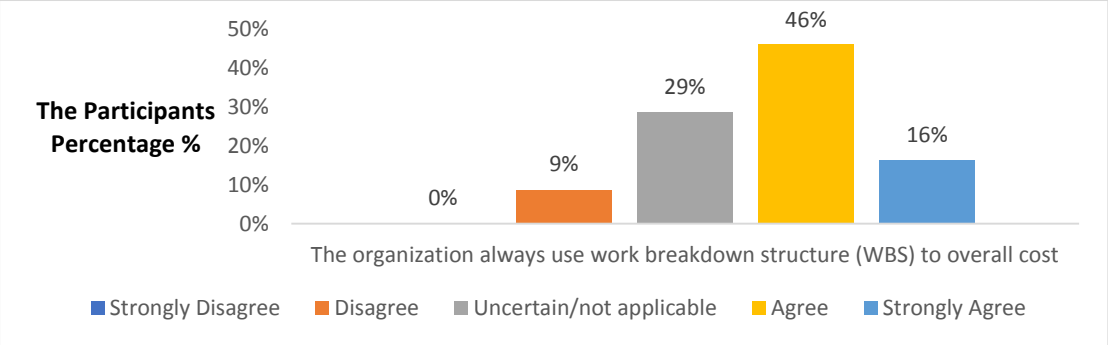

Figure 4.22 Bar chart showing the using of (WBS) to overall cost

63% of the construction organizations in Sudan are using work breakdown structure (WBS) to overall cost to help them in their projects cost management.

Table 4-23 showing the controlling changes in projects budget

The Techniques of Cost Management in Construction Projects					
The organization always controlling changes in projects budget	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	8	21	37	14
Percentage %	0%	10%	26%	46%	18%

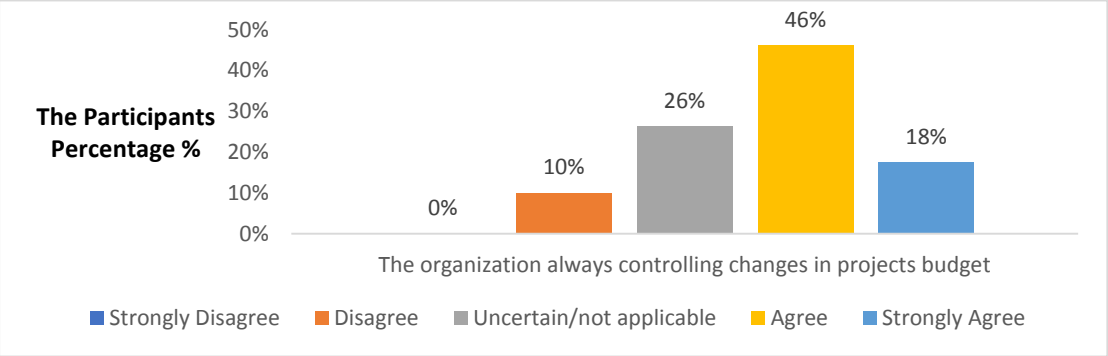

Figure 4.23 Bar chart showing the controlling changes in projects budget

Only 64% of the construction organizations in Sudan acknowledged that they are controlling changes in projects budget.

Table 4-24 showing the outputs from following the cost management steps

The Techniques of Cost Management in Construction Projects					
Following the steps of cost management carefully leads to successful outputs	Strongly Disagree	Disagree	Uncertain/ not applicable	Agree	Strongly Agree
No.	0	0	3	32	45
Percentage %	0%	0%	4%	40%	56%

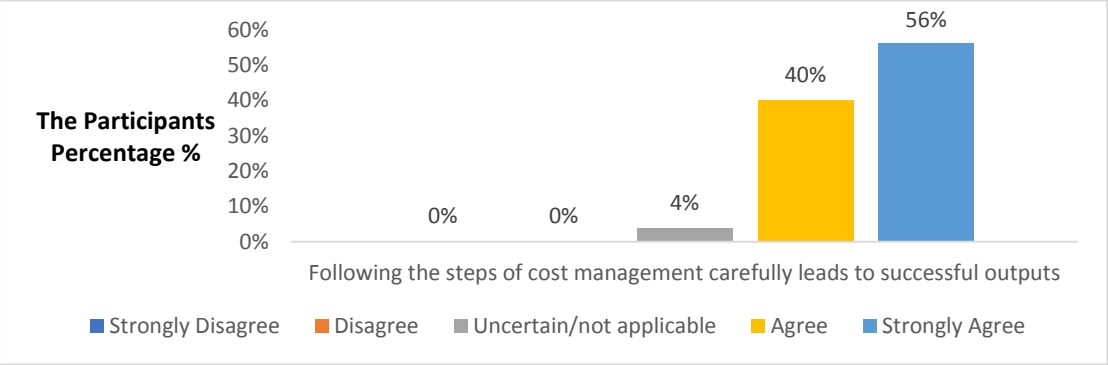

Figure 4.24 Bar chart showing the outputs from following the cost management steps

96% of the respondents agreed that following the steps of cost management carefully leads to successful outputs according to their experience in the field of construction in Sudan.

Chapter Five

Conclusion and Recommendations

Chapter Five.

5 **Conclusion and Recommendations**

From the literature review and the questioner we found that there are many problems arising from unmanaged costing and their side effects since the initial stage of the project till the project hand over. These problems always lead to project overrun in term of cost, scope and time deviations.

5.1 **Results:**

1. In terms of the implementation of planning and cost management, we find that a relatively simple rate is the one that is implemented, which is a risk to the success and achievement of the objectives of construction projects in Sudan
2. The awareness about planning, top management, resources, the use of modern technology and the application of training courses in the field of costing and planning are altogether assist in having successful project
3. Most of the construction projects in Sudan have no completed planning and costing system.
4. The attention for costing system database in construction projects in Sudan is very weak or largely ignored.
5. The disputes are occurring in the construction projects in Sudan in a significant way, due to the lake of awareness of planning and costing system.
6. The Project cost overrun is a common phenomenon in construction projects in Sudan.
7. The Awareness of cost management stages (pre-construction, during construction, post construction) in construction projects in Sudan is very poor.
8. The main reason for not reaching project goals (profit, duration and quality), which are planned in advance, is not to implement an integrated cost management system.
9. The primary cost is very important on the majority of construction projects in Sudan and is very reliable.
10. The work breakdown structure (WBS) s one of the strategies or the methods of controlling the overall cost in cost management in the project planning.
11. Following the steps of cost management carefully leads to successful outputs.

5.2 **Conclusion:**

In terms of the implementation of planning and cost management, we find that a relatively simple rate is the one that is implemented, which is a risk to the success and achievement of the objectives of construction projects in Sudan.

The unmanaged costing and their side effects since the initial stage of the project till the project hand over will increase the possibility to go far from the planned outputs.

All of the above shows that the cost management of any construction project has a direct effect on the implementation of the project planning, and they are linked and complementary to each other, and to ensure the increase in the success rate of construction projects in Sudan, this relationship between cost management and planning must be maintained by making a Great attention to the development of integrated costing and planning system, and apply it in all projects no matter the size or the budget or the type of project, and this system should be monitoring periodically throughout all of the project stages until the project handover phase.

And to achieve this goal more awareness is required of planning technique, the top management strategy, the resources attention, the use of modern technology and the application of training courses in the field of costing and planning.

5.3 **Recommendation:**

After the research, analysis of the questionnaire and finding the previous results we recommend the following:

1. Apply all planning factors that help to get a successful construction project such as the awareness about planning technique, the top management strategy, the resources attention, the use of modern technology and the application of training courses in the field of costing and planning.
2. Greater attention must be given to the development of integrated costing and planning system.
3. Continuous monitoring must be done to this costing and planning system to prevent any future disputes.
4. Create Costing database to be considered in all construction projects.
5. Increase and develop the awareness of cost management with all stages and steps through workshops and training courses.
6. Increase the awareness in developing the primary cost.
7. Apply the planning and cost management in all projects no matter the size or the budget or the type of project.

5.4 **Recommendations for Future Studies:**

To understand the role of the cost management on construction projects, and to decrease the overrun in project budgeting and non-matching specification on delivery and to develop approaches to avoid these problems more research should be done to. emphasizes the significance of sound management and cost planning from the beginning of the project undertaking in order to facilitate the proper establishment for conducting and systemizing the project costs, here below some recommendations :-

1. Types of The new technologies that improve the cost management and planning on construction projects
2. Ways to increase the awareness of cost management in construction projects in Sudan.
3. The role of managers in applying cost management in construction projects in Sudan.

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Appendices