Sudan University of Science and Technology

College of Graduate Studies and Scientific Research

COST MANAGEMENT IN CONSTRUCTION PROJECTS UNDER CRITICAL ECONOMIC CONDITION

A thesis submitted in partial fulfillment of the requirement for the degree of Master of Science in Civil Engineering (Construction Engineering) to Civil Engineering Department, College of Engineering

Prepared By:

Abeer Abd Al hadi Hussain Mahmoud

Supervised by:

Prof Dr .Awad Saad Hassan

December 2021

الآيـــــــة

قَالَ تَعَالَىٰ: ﴿ وَقُل رَّبِّ زِدْنِي عِلْمًا ﴾

صدق الله العظيم

(طه 114)

DEDICATION

To my beloved country
To my mother and father
To brothers and sisters
To friends
To both who supported me and tightened my hand
Dedicate my humble efforts

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to all those who provided me the possibility to complete this research, and my special thanks of gratitude to my Supervisor (Prof. Dr.Awad Saad Hassan) as well as our dean and the staff of Department of civil Eng. college of Engineering.
Secondly I would also like to thank my parents and friends who helped me a lot in finalizing this research within the limited time frame.

ABSTRACT

The primary goal of project cost management is to maintain the project under budget. It entails the procedures of planning, estimating, budgeting, financing, funding, managing, and controlling expenses so that the project can be finished within the agreed budget.

Planning and design, estimation, on-site specialty contractors, change orders, and, of course, the finished product are all affected by cost management. It can also help ensure that a team's reputation for being proactive, efficient, and accurate when estimating and executing on a project budget is maintained.

This study looks at the economic factors that surround a project and their impact on changing the cost in a construction project in Sudan, as well as some aspects of project management, planning, and cost estimating, as well as cost control and knowing the causes of cost deviation and determining them accurately throughout the project's life cycle.

There are numerous issues that arise as a result of unmanaged costing, which leads to cost deviation in construction projects. One of these issues confronting companies in the construction sector is the current economic climate, as well as a lack of developing cost management concepts and methods that apply modern ones and select the best ones to improve the company's competitive advantage.

For the objective of arriving at a conclusion, the researcher used case and descriptive analytical methods in this study.

A questionnaire was created to gather the essential data for the study, and it was then given electronically to select samples of the application, such as project managers and side engineers who specialize in the building area.

The researcher analyzed the study sample (80) copies using the statistical package for the social science (SPSS), which is one of the most prominent data analysis packages.

In order to identify the primary roadblocks that affects the building cost management process.

Also, to recommend a cost-cutting strategy based on project management methods or criteria in order to meet project objectives.

The most important finding of the research is, interest in applying the concept of cost management and spread this concept , increasing the knowledge in this sector ,The need to pay attention to feasibility studies for projects ,the untapped economy is based on inflation, so governments must keep pace with economic conditions and effective laws.

المستخلص

الوظيفه الاساسيه لادارة تكلفه المشاريع هي الحفاظ علي الاعمال ضمن الموازنة المحدده حيث تتضمن عمليات التخطيط والتقديرات والموازنه والتمويل ومراقبه والتحكم في التكاليف بحيث يمكن اكمال المشروع ضمن الميزانيه المعتمده.

تؤثر اداره التكاليف علي جميع مراحل المشروع بما في ذلك التخطيط والتصميم والتقديرات والتنفيذ وكذلك اوامر التغييرفي الموقع الخاصه بالاستشاري حتي نهايه المشروع كما تلعب دورا حاسما في ضمان ان يكون فريق العمل له سمعه استباقيه وكفاءه ودقه عندما يتعلق الامر بتقدير وتنفيذ المشروع ضمن الموازنه المعتمده.

حيث ناقش الباحث العوامل الاقتصاديه المحيطه بالمشروع واثرها علي تغيير التكلفه في مشروعات التشييد في السودان وكذلك بعض الجوانب المتعلقه باداره وتخطيط التكلفه في مشروعات التشييد ومعرفه مدي تطبيقها والمعوقات الاساسيه التي تؤثر عليها وكذلك ضبط التكلفه ومعرفه اسباب انحراف التكلفه وتحديدها بدقه من خلال المراقبه الدقيقه خلال دوره حياه المشروع وتحليلها باستخدام الاساليب الحديثه لمعالجتها في الوقت المناسب وعرضها في تقارير لوضع الحلول المناسبه واتخاذ القرار الصحيح بمشاركه اصحاب المصلحه.

تمثلت مشكله البحث في ان عدم تطبيق اداره التكلفه في المشروعات تقود لانحراف التكلفه في مشاريع التشييد و من اهم هذه المشاكل التي تواجه الشركات في قطاع التشييد هي العوامل الاقتصاديه المحيطه بالمشروع وعدم تطويرالمفاهيم وطرق اداره التكلفه وتطبيق الحديث منها لتعزيز الميزه التنافسيه للشركه .

في هذه الدراسه اعتمد الباحث علي المقابلات الشخصيه لدراسه بعض الحالات وطريقه التحليل الوصفي للوصول الي التنائج حيث تم تصميم استماره الاستبيان لجمع البيانات وتوزيعها الكترونيا علي مجتمع الدراسه عبر وسائل التواصل الاجتماعي لعينات مختاره من مدراء المشاريع ومهندسي المواقع المختصين في مجال التشييد وقد استخدم الباحث برنامج التحليل االاحصائي الذي يعتبر من اشهر برامج التحليل (spss) وذلك لتحديد العوائق الرئيسه التي تؤثر علي عمليه اداره التكلفه في مشاريع التشييد وكذلك الاشاره للخطط المناسبه لاداره التكاليف مستخدما طرق ومعايير في اداره المشاريع للوصول لاهداف المشروع.

اهم ما توصل اليه الباحث من خلال البحث ضرورة الاهتمام بتطبيق مفهوم اداره التكلفه ونشر هذا المفهوم وزيادة المعرفة في هذا القطاع وكذلك ضروره الاهتمام بدراسات الجدوي للمشاريع وان الاقتصاد غير المستقر يقود لحدوث التضخم لذلك يجب علي الحكومات مواكبه الظروف الاقتصاديه وتحديثها باستخدام السياسات والقوانين الفعاله.

Table of Contents

List of table

List of figures

List of symbols/Abbreviation

(WBS): work breakdown schedule
(VAT):Value-Added Tax
(SL): Straight-Line
(DDB): Double-Declining Balance
(SOYD): Sum-of-Years Digits
(MACRS): Modified Accelerated Cost Recovery System
(UOP): Units of Production.
(D)= depreciation charge
(C) = asset original cost
(S)= salvage value
(N)= asset depreciable life (years)
(BVr-1) = book value of asset at end of
(R)= rth year
(BV0) = book value at beginning of first year = C
(NPV): The Net Present Value
(CC): Capitalized Cost
(ROR): A Rate of Return
(B/C): Benefit-Cost Ratio
(RIBA): Royal Institute of British Architects
(RICS): Royal Institution of Chartered Surveyors
(VFM): value for money
(QS): Quantity Surveying
(PMI): Project Management Institute
(BPR): Business Process Reengineering
(BOQ): Bill of Quantities
(EVM): Earned value management
(EAC): estimate at completion
(PMIS): Project Management Information System
(EVA): Earned value analysis
(PV): Planned value
(PMB): performance measurement baseline
(BAC): budget at completion
(EV): Earned value
(AC): Actual cost

(VAC): variance at completion
(CV): COST variance
(SV): Schedule variance
(SPI): schedule performance index
(CPI): cost performance index
(TCPI): to-complete performance index
(QAB): Quantity Adjusted Budget
(QAB): Quantity Adjusted Budget
(ACWP): Actual Cost of Work Performed
(BCWP): Budget Cost of Work Performed
(BCWS): Budget Cost of Work Schedule
(TV): Total Variance
(PTV): Percent Total Variance
(EVS): Earned value S curve
(TAB): Total Allocated Budget
(MR): Management Reserve
(RCA): Root Cause Analysis
(SWAT): Strength, Weakness, Opportunities, Threats

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction:

The basic function of project cost management is to keep job on budget it includes the processes involved in planning, estimating, budgeting, financing , funding, managing, and controlling costs so that the project can be completed within the approved budget.

The Project Cost Management processes are Plan Cost Management of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled ,Estimate Costs that developing an approximation of the monetary resources needed to complete project work, Determine Bud-get to aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline and Control Costs by monitoring the status of the project to update the project costs and manage changes to the cost baseline.

Cost management affects all phases of project, including planning and design, estimation, on-site specialty contractors, change order, and of course, the finished product . It can also play critical role in ensuring your team has reputation for being proactive, efficient, and accurate when it comes to estimating and executing on a proposed project budget.

At its core, effective cost management means having the systems in place to ensure a construction project will be completed on budget and within scope.

1.2 Research Scope:

The scope of this research emphasizes the significance and of importance of cost management (planning, estimating, budgeting and controlling) in construction projects for effective decision making from financial information in the proper time and managing any change in the cost which ensures success of the project.

Also the determination of the major obstacles that confront of the management and scheduling of construction cost in order to suggest solutions through demonstrating that affect application of cost management and the responsibility of the parts involved in project.

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

1.3 Research problem:

There are many problems arising from ill managed costing which leads to cost deviation in construction projects.

One of these problems facing companies in the construction sector is the economic condition and Techniques lack of developing concept and methods

for cost management applying modern way and choosing the best ones to enhance the company's competitive advantage.

1.4 Objective of the study:

The objectives of this research comprise of the following:

To know how the economic factor affects cost management in the construction's projects in Sudan.

To understand the basics and the modern method of how to manage cost in the construction project and purplish them

To determine main obstacles that effect of the application cost management in construction projects in Sudan.

To assess the applications of the cost management in construction project in Sudan.

To study the cost management techniques in construction project.

1.5 Importance of study:

The importance of cost management in construction projects is that it play a key role in the success of the project because it is a fundamental process that takes place with increasing degrees of accuracy as progressing in the project stages, through directing and coordinating human and financial re-sources during the project life cycle through the use of modern technologies to set base line for project cost and prevent going out of budget to achieve the specified goals within the budget.

1.6 Research Assumptions (Hypothesis):

1- The economic factors effect of the cost management in the construction project in Sudan.

2- The application of modern method to manage cost in the construction project in Sudan.

3- To determine the main obstacles that effect of the application of cost management in construction projects in Sudan?

4 - To assessed the application of the cost management in construction project in Sudan.

1.7 Research Methodology:

In this study the researcher relied on case study and descriptive analytical method for the purpose of achieving real at results.

A questionnaire was designed to collect the necessary information for the study after reviewing and developing the text the questionnaire it was distributed electronically through the social media to select samples of the population which includes project managers, side eng specialized in the construction field.

The researcher used the data analysis program the statistical package for the social science (SPSS) in analyzing the data (8o) questionnaires and this program is considered one of the most popular programs.

In order to define the major obstacles that affects the process of construction cost management.

Also, to suggest an appropriate plan for cost management using method or criteria in project management to reach the project goals.

1.8 Research limit:

The research focuses on the effect of economic condition and knowing the extent to which the concept of cost management is applied in construction projects in Sudan in ((2018-2022)

as well as the factor of affecting the construction industry directly, the factor that affect the cost of the project, how to manage project resources, and knowledge of advanced and different methods of cost management and their application at each stage of project.

1.9 Research lay out:

Chapter One: General Introduction.

Chapter Two: Literature Review and Previous study.

Chapter Three: Data Collection

Chapter Four: Results and Discussion

Chapter Five: Conclusion and Recommendations

CHAPTER TWO

LITERATURE REVIEW AND PREVIOUS STUDY

Chapter Two
Literature Review and Previous study

2.1 Introduction:

Project management is the professional discipline of planning, monitoring, and controlling specific resources to achieve a set of goals for a project. The term project is defined as a one-time endeavor with well-defined, often unique goals, with specific limits of both time and cost. The temporary nature of a project is in contrast to businesses like manufacturing that are repetitive in nature. This type of management has predefined systems or processes that have been refined over time.

The management of a project, in contrast to manufacturing, requires a different paradigm and skill set on the part of the practitioner. The project manager's main test is to achieve all of the goals, including the deliverables, within the constraint of a fixed budget and fixed time frame. Specific goals and deliverables in the construction industry will vary from project to project.

Is the professional practice of planning, scheduling, monitoring, and controlling a finite number of resources—materials, labor, equipment, and subcontractors—to achieve a set of goals, which are usually a series of engineering improvements for a unique one-time event, the project. To com-pound this definition, planning, scheduling, monitoring, and controlling must occur within a defined duration and a frequently fixed budget.

To further complicate the process, let's add some unpredictable factors such as weather, labor strikes, material shortages, and a wide range of separate goals and conflicting agendas proposed by the participants. Lastly, let's not forget the ever-present threat of financial penalty as a "reward" for failing to master all of the above challenges!

(Wayne J, 2010, 1)

2.2 Importance of cost management in construction project:

1- Study plans and specifications and apply the concepts of value engineering to them, and then make the necessary recommendation to improve the performance of the project and possibility of reducing cost

2- Put the total cost of the project establishing schedules for implementation to the necessary cash flows and providing the necessary financing according to the implementation stages

3-Fragmentation of the project and putting it for public or private tender and awarding parts of the project to subcontractors

4-Following up the implementation through specialized engineering administrative body

5-Submit periodic reports to the project owner to advance implementation with comparative study of project plans with implementation ensure transparency by transferring information to the project owner and clarifying the causes of problems on the project site.

(Saco, Z,2009, 787)

2.3 The objectives of the cost management process:

The most effective cost management system is one that ensures consultation with the stakeholders in all triple-constraint tradeoff decisions, and one that facilitates a full and prompt dissemination of the subsequent disposition of each change request to project personnel.

-Track progress

-Compare actual values to planned values

-Analyze the impact of variances

-Make adjustments in light of these variances.

Progress data from the current project are interpreted in the light of historical data from previous projects and /or benchmarking data from other projects within the same industry.

These interpretations must be repeated or refreshed on a regular basis, particularly as part of the inevitable changes throughout the life of the project. The impact of each change must be evaluated in terms of scope, cost, schedule, and resource demand.

The determination of the variances between planned and actual values should not narrowly focus on the total project; instead, it should span all elements of the work breakdown schedule (WBS). As such, the current and or variance of individual component resource expenditure and costs, as well as those for the total project, should always be at the disposal of the project stakeholders. When the project is in its formative stages, very little information is available.

Consequently, the accuracy and dependability of the estimate are very low. In other words, the risks of unforeseen and undesirable occurrences in the project are very high.

Therefore, early plans and budgets are usually far from definitive and rarely predict the actual cost of individual components and the definitive cost of the total project.

By contrast, at the early stages of the project, modifications to project plans can be formulated and conducted with minimal impact on cost and schedule. As the

project proceeds into the various stages of growth, the cost of implementing modifications to the baseline plan increases substantially.

It would be unrealistic to expect good planning to eliminate the occurrence of all unexpected events. On the other hand, it is logical to expect a reduction in the magnitude and impact of project changes when the project is implemented with careful planning.

Whereas a project with casually Evolving plans contains many unexpected changes, a well-planned project has a significantly lower occurrence of unexpected events. It is therefore essential that the project manager conduct careful early planning to minimize the frequency and impact of project changes. (Pervez F,2002,81)

2.4 Role of the process of managing and planning in project:

1-Preparing feasibility studies or development appraisals
2-Assessing capital and revenue expenditure over the whole life of a facility
3-Advising clients on ways of procuring the project
4-Advising on the setting of budgets
5-Monitoring design development against planned expenditure
6-Conducting value management and engineering exercises
7- Managing and analyzing risk
8-Managing the tendering process
9-Preparing contractual documentation
10-Controlling cost during the construction process
11-Managing the commercial success of a project for a contractor
12-Valuing construction work for interim payments, valuing change, assessing or compiling claims for loss and expense and agreeing final accounts
13-Negotiating with interested parties
14-Giving advice on the avoidance and settlement of disputes

2.5 Basic stages of the economic project:

I - planning for project:
The idea of the project
We ex plain the motives and the reason for making the decision
Diagnosis of investment opportunity
Identify project objectives and productivity and service purposes
Determine its size and quality of products.
Standing over the availability of physical and human resources for its implementation and operation.

Identification of the geographical environment and the right location of his neutrality.
Guess the amount of investment required and identify sources of funding
Feasibility Studies
Preparation of economic and technical feasibility studies
The initial feasibility of the project:
Sometimes called pre-investment studies the purpose of it is to clarify the main objective of the projects prevention and to give an initial idea of its physical, financial and human resources as well as the initial guessing of reliance economic and expected benefit of the necessary investments.
This study seek to assist in the appropriate decision to proceed with the study of the project and study of the project and justify expenditures that will be implemented on the number of detailed feasibility studies.
Technical and economic studies of the project:
Detailed study of the executive and operational the project requirement in the technical and economic styles.
Precision and substitute is very important because they determine of the project but further or to give it later.
The task of the number of this study should therefore be taken into account by a number of specialists (economic evaluations, engineering, technicians and others) of highly experienced in the field required studies.
in view of the importance of this study the data that include them must be accurate realistic and modern rank and regularly and covered by all the joint .so we see that developed countries cultural has been to establish com-panies, institutions and professional advisory offices- specialized for this purpose and enjoy a more independent in its work on the advancement of its recommendations.
This seems that most of the private companies and government institution in those states to refer their projects to specialized consultancy companies instead of doing by its cadres.
This does not mean that their cadres are unable to include such studies, but because of ensuring the independence and objectivity required in the decision-making process to test the successful project.
The components of detailed feasibility study and their comprehensiveness are based on the nature of the project and the body to provide for the investment decision making.
Evaluation of the project

Evaluation of the results of the feasibility study Decide the investment decision of the project.

Preparation of the project

Preparation of engineering designs and identifying the technical specific-ations of the project.

Preparation of tender Identification of the contractual and financial conditions required to implement.

Integrated feasibility of the project:

-political feasibility:

It is appropriateness of the project to policy of the state policy of the system of political system and through particular development stage.

-Technical feasibility:

It ensures that the project is the technical methods selected for job implementation and achievement of required production targets and as well.

-Economic feasibility:

The budget of the total benefit in to total cost shall be determined within specific economic investment standers, especially what is associated with the level of national income from the one hand and distribution of the district in the other.

-Social feasibility:

It ensures the project accepts its indications and results of different benefits by special benefits and from the community in general and in accordance with social acceptance.

Evaluate and conduct the final negotiations and the execution of executive contracts with contractors.

The objective of the feasibility study:

- the identification of the projects ability to achieve the objectives of the technical, economic, social, and political aspects also indicators general for community requirements and policies.

- is to enable the investor and economic consultation to identify the best possible investment options between competitive orders on material, human and financial resources (limited resources and nutritional needs).

Feasibility Studies Methods:

- SWOT Analysis (Strength, Weakness, Opportunities, Threats):

Determine of strength and weak points as well as identifying opportunities and threats points

- Cash Flow Method:

Calculate the return is the façade or not, this method working on two kinds of revenue the simple interest or Complex interest.

$$F = P (1+in) \quad \text{Simple interest Rate……. (2-1)}$$

$$F = p (1+i)^n \quad \text{Complex Interest Rate…….(2-2)}$$

Cash in: expenses and budget cost related to schedule

Project cash out: revenues and invoices related to project schedule

Net cash: variance between cash in and cash out.

-Break-even Point:

Its simple way depends on the comparison of alternatives of the cost

Tie point: is the point where the costs are in total revenue or point of equity between profit and loss.

$$TC=F.C+V.C……..(2-3)$$

TIE POINT:

$$TC(X) =TR(X)……..(2-4)$$

– Comparison Method:

Is method of common elements in which the comparison is selected as 4 to 8 items compared to the comparison and the status of relatively owned by them are in the value of the value of the comparison and the status of the appropriate element is selected

ii- Implementation phase:

- Configuration of the site and temporary work
- The implementation of buildings and civil engineering works
- Receiving machines equipment
- preparation of equipment
- Implementing of complementary work and public services
- Providing preliminary materials and other supply supplies
- Training of operating cadres
- Experimental examination and project.
- Settlement of accounts for the implementation stage

iii- Operating stage:

- Continuous commercial operation
- Marketing products and control market developments
- Preventive maintenance and periodic maintenance
- Acquisition of technology rapid
- Continuous training and raising performance efficiency
- Cooperation and technical assistance

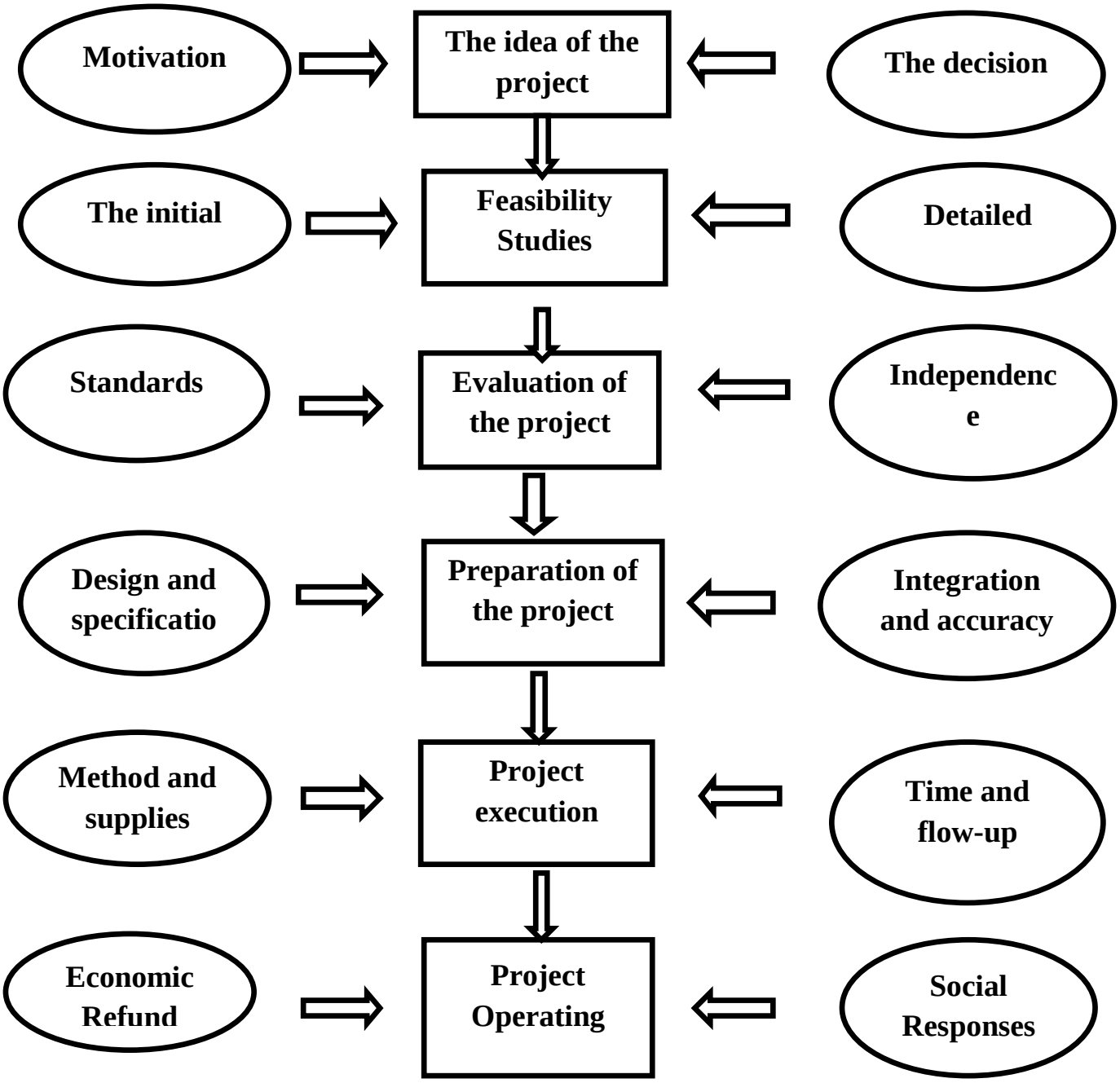


Figure 2.1 Economic and technical evaluation subsequent of project: Stage of the project.

(Khayal, O ,2018,)

2.6 Economic Analysis Techniques:

There are a variety of economic analysis techniques available to enable accurate choices between competing alternatives.

The general principle is that there are competing alternatives and the goal is to choose the alternative with the highest return.

Competing alternatives may be advanced by those in an organization favoring one alternative course of action over another.

Sound economic analysis that accurately assesses benefits and costs, along with the timing of these cash flows can avoid the organizational politics associated with the unjust selection of a particular course of action.

In order to analyze returns from alternative choices, there are a number of techniques.

2.6.1-Time Value of Money:

The Time Value of Money is a key area in economic cost analysis. Different alternatives will have differing amounts of cash income and cash expenses over their lifetime.

In order to compare these different alternatives on the same basis, these cash amounts of income and expenditure must be set to equivalent terms.

There is a common unit of measure set in a currency, whether it is dollars, Euros, pesos, yen, or some other measure; there will also be an interest rate set which provides the common basis for calculations. (When evaluating expected income/cost flows in the future, this interest rate can also be referred to as a “discount rate,” since money in the future is “worth” less than money in the present.) The interest rate may sometimes be the rate at which a firm is charged in the capital markets for borrowing funds to finance capital projects, such as through sales of corporate bonds.

Certain firms may set an interest rate higher than their cost of borrowed capital and this may be referred to as a "hurdle" rate.

Projects that meet this hurdle rate will be funded, whereas projects that do not meet these target rates will not be funded by the firm. However, usually investment capital is a scarce resource and only projects will be selected with the most beneficial returns.

In evaluating an interest rate, it is comprised of two components:

lender's long run expectations of the inflation rate and the risk of lending the capital. Therefore, if long-term inflation rates are projected to be three percent and the risk of the lender regarding a particular borrower is low at four percent, the derived interest rate would be summed at seven percent.

For riskier ventures and riskier borrowers, interest rates will correspond-dingly trend upward.

In order to perform this time-value-of-money analysis, certain information will be available with other information requiring calculation the economic calculation for potential vehicular damage can be taken from statistical sources.

2.6.2-Net Present Value Method:

In the comparison of alternatives, a common basis is needed for this comparison. Alternatives typically will have different costs and benefits over the analysis period.

The Net Present Value (NPV) method provides the platform to resolve alternatives into equivalent present consequences.

Economic analysis problems view re-purchase of the same unit, at four year intervals, will be at original cost unless there is concrete information to the contrary.

2.6.3-Capitalized Cost Method:

In some cases, problems present themselves which have an infinite analysis period.

The need for a structure, such as a road or a bridge for example, is perpetual. With these types of situations, the capitalized cost method is chosen.

Capitalized Cost (CC) represents the present sum of money that needs to be set aside now, at some interest rate, to yield the funds required to provide the service indefinitely.

The capitalized cost formula is

$$A = P*i \text{..... (2-5)}$$

Rate of Return Analysis Many organizations in making investment choices often set hurdle rates.

The hurdle rate is the benchmark rate of return that a capital investment decision must achieve to be acceptable.

A Rate of Return (ROR) is computed from the projected cash flows of the project.

ROR values provide a ready basis for the comparison of alternatives.

In the case where capital investment funds are limited, projects with the highest ROR values can be selected for the organization.

2.6.4-Benefit-Cost Ratio Analysis Method:

Benefit Cost (B/C) Ratio Analysis involves the simple comparison between benefits and costs of a proposed action.

Benefits are placed in the numerator and costs are placed in the denominator.

If the ratio of benefits to costs is greater than one, the project is viable.

Comparisons can be made between projects to select those projects with the highest B/C ratio

2.6.5-Payback Period Method:

Payback Period is the period of time necessary for the benefits of the project to pay back the associated costs for the project.

This is a very simple method and can prove to be inaccurate.

A project with a payback period of three years may be selected over a similar project with a five-year payback period. Differences in the timing of cash flows are not considered, nor are the benefits and costs beyond the payback period.

Payback period analysis is approximate and may not yield the same result as with other more precise methods, such as NPV or EUAC criteria.

The area of economic costs presents problems ranging from simple to complex.

The accuracy of future cost and value streams is essential in properly applying these concepts. Numerous organizations have badly underestimated cost streams and overestimated value streams, resulting in significant losses.

One large energy company in an industrialized country built a billion-dollar power plant in a lesser-developed country. However, the power produced from the plant was too expensive for the local market to afford, resulting in the abandonment of the investment.

Enhanced knowledge of these economic cost analysis tools will lead to improved-decision quality for an organization.

(Hastak,M, 2015, 70)

2. 7 Classification of cost (Cost Structuring):

Direct and indirect cost:

Direct COST “Any cost that is specifically identified with a particular final cost objective, but not necessarily limited to items that are incorporated in the end product as material, equipment

Indirect Costs Indirect costs are those resources that need to be expended to support the activity or asset, but are also associated with other activities and assets

Fixed and variable cost:

Fixed costs are those cost elements that must be provided independent of the volume of work activity or asset production that they support.

Variable costs are those cost elements that must be provided and are dependent on the volume of work activity or asset production that they support.

2.8-Economic cost:

The area of economic costs is a wide-ranging area of importance for cost engineers and cost managers. Ultimately, there is an owner or client for the project, public or private, that is supplying the funds for the project.

The project must be economically feasible to construct.

If instead of a project, the item is a product to be produced, the same criteria will apply to producing a product.

The price of the product must be in a range that is affordable to the target market for the product.

With globalization, the area of economic costs is complicated by the production of various components for a product in a number of countries.

These various countries, by definition, will have their own unique set of economic cost factors, including currency issues, inflation rates, and taxation rates.

Economic analysis techniques, properly applied, can pinpoint the alterna-tive with the most favorable cost aspects

Elements of economic costs may be outside the ability of the cost engine-eering professional to control.

Taxation policies and the respective rates of taxation are set by political entities responding to their often diverse constituencies.

Depreciation rules, again, are enacted by political entities.

Currency variations may be outside even the control of the particular political entity, and instead are influenced by the actions and inactions of governments and currency traders/speculators around the world.

Some aspects of inflation may be the result of government actions, as the government expands the money supply resulting in too much money chasing too few goods and services. While some elements of economic costs may be outside the control of any one decision maker, one still cannot ignore their potential impact on investment decisions.

2.8.1Typesof Economic cost:

-Opportunity Costs:

Economic decisions need to consider the impact of opportunity costs.

An opportunity cost represents the foregone benefit by choosing one alternative over another economic decisions need to consider foregone benefits for an accurate analysis.

-Sunk Costs:

Sunk costs represent funds already spent in by virtue of past decisions. Since these expenditures are in the past, by definition, they should not influence current decisions.

While a past investment may still be yielding benefits from an income stream, these current and future benefits are relevant.

The past expenditure is considered to be a sunk cost and is ignored in current and future decision-making.

-Book Costs:

Assets are carried on the firm's books at original cost less any depreciation.

Book costs represent the value of an item as reflected in the firm's books.

Book costs do not represent cash flows and thus are not taken into account for economic analysis decisions, except for potential depreciation impacts for tax consequences. Conservative accounting principles dictate that if the market price for financial assets, such as a stock, is lower than the original price, this asset will be carried at the lower cost or market value.

The underlying land values may have significantly escalated over a period of years, however, the asset will still be carried at its original or book cost.

For the firm, the sale of the land at a higher market price would not make sense unless this was part of a strategy to dispose of surplus assets.

-Incremental Costs:

In economic analysis decisions, focus must be on incremental costs or those cost differences between alternatives.

(Hastak,M, 2015, 70)

2.8.2Changes in Costs:

Changes in costs occur for a number of reasons in the economy:

Inflation:

Inflation is a rise in the price level of a good or service, or market basket of goods and/or services.

Inflation does not occur by itself but must have a driving force behind it.

There are four effects that can result in inflation:-

-Money supply:

Is influenced by the central bank of a country.

Most countries' governments are able to operate by selling and buying bonds and setting certain internal interest rates in that country.

These central bank operations will therefore have an impact on monetary policy, which can impact inflation.

A loosening of monetary policy will increase the flow of money in the system, which means the increased money supply is chasing the same amount of goods and services.

-Exchange rates:

Can impact inflation by influencing the price of imported goods and services.

If the currency of Country A falls in relation to the currency of Country B, imports from Country A are relatively less expensive.

On the other hand, a rising Country A currency relative to Country B currency will make those same imports more expensive.

-Demand-pull inflation:

Is when excessive quantities of money are chasing a limited amount of goods and services', resulting in what is essentially a "seller's market," as sellers receive premium prices.

Examples of this can be anything from automobiles to real estate.

An auto in short supply commands prices above list invoice.

The same demand-pull inflation would apply to real estate in a popular location.

-Cost-push inflation:

Takes place when product producers encounter higher costs and then push these costs along to others in the production chain through higher prices.

These higher costs may be for labor, material, or any other item with a significant cost element.

Deflation:

Deflation is the opposite of inflation, with a fall in the general price level for goods and services or a representative market basket of goods and services.

The same aforementioned factors of money supply, exchange rates, demand-pull, and cost-push factors operate, but in the opposite direction with a resultant decrease in prices.

If costs for producers of goods and services fall in competitive industries, this cost decrease will be passed on to purchasers.

Prices for personal computers have fallen across the board since their large-scale introduction in the 1980s, even while features have increased in the units.

Complete personal computers can now be purchased, 20 years later, for a fraction of their original cost.

A contracting money supply can result in price deflation.

Exchange rates that rise in one country, giving that country a stronger currency relative to those countries from which it imports goods and services, will result in deflationary price decreases for those same imports.

Escalation:

Escalation is a technique to accommodate price increases or decreases during the life of the contract.

An escalation clause is incorporated into the contract.

This provides that when prices increase, the purchaser for these relevant inflationary changes will compensate the supplier for the price increases if the price of fuel declines or de-escalates during the contract, the supplier will either charge less or rebate a like amount to the purchaser.

These escalation and de-escalation clauses help to shield both the supplier and the purchaser from unpredictable cost changes.

Without such clauses, suppliers would include contingency amounts that might later be found to be totally unrealistic and on the high side.

However, the supplier would gain from this windfall and the purchaser would be the loser. Similarly, excessive price increases in a commodity.

These escalation clauses may or may not be allowed in certain governmental sector contracts. For the firm facing escalation issues, and difficulty in forecasting inflation rates, a common solution is to pre-purchase items most subject to inflationary price increases.

Another alternative is to perform hedging through futures contracts for various commodities, including oil on the commodity exchanges around the world.

In order to overcome mitigate the effect of escalation there are many mechanism that over established locally and internationally.

Occur in severe way, this phenomenon's occur in severe way, the ministry of finance economic planning recommend ascertain equation delay with damage assessment and valuation this equation is applied in all government contracts where contractors always sufficing and incurred financial damages.

International fidic condition of contracts deal with such evens.

Currency Variation:

Currency changes can have a significant cost impact both on those inside the country, as well as those outside the country.

Currency prices are set in markets around the world and change on a con-stant basis as the result of daily trading fluctuations and moves by central banks.

Many organizations operate on a multi-national basis. Therefore, the curr-ency fluctuations in one country or many countries can have an overall impact on earnings.

A contract for work, or to supply products to one country, if set in that countries' currency can make the value of that contract go up or down when those earnings are repatriated to the home country of the firm.

Financial assets held in one country can witness a significant decline in value if that country's currency is devalued by the central bank.

2. 8.3Governmental Cost Impacts: -

The actions of governmental units and jurisdictions can impose significant cost impacts on a firm.

In some cases, the cost impacts of governmental units are direct, such as in the case of imposed taxes.

In other cases, governmental cost impacts are more difficult to measure, such as in governmental regulations that require or prohibit certain actions.

Whether direct or indirect, an accounting of costs must recognize these governmental actions.

- Governmental Regulations:

Regulations mandating certain actions by organizations may or may not have an impact on costs.

On the other hand, concurrent with these new governmental safety laws may be reporting requirements proving that the entity is complying with governmental strictures.

In this case, there is then an additional cost impact. Issues such as importing equipment into a foreign country may be no problem in one country and take six months in a neighboring country as a result of customs regulations.

Regulatory uncertainty is another burden placed on entities as they post-pone certain actions because they do not know what burdens will be placed upon them. Then there may be further uncertainty as to enforcement.

There are numerous laws on the books around the world that are not enf-orced by governmental units or the enforcement is non-uniform. Moreover, there may be uneven enforcement between nationally-based firms and foreign-based firms.

-Governmental Taxes:

Governments are most often maintained by the taxes that they impose. These taxes take many forms, such as income taxes, property taxes, inventory taxes, employment taxes, gross receipts taxes, and sales taxes.

With a sales tax the firm merely acts as the tax collector for the government, adding the sales tax and collecting it from customers.

While the firm does not pay the sales tax itself, excepting sales tax on items it may purchase for its own use, there are costs involved for the firm in administering these tax types.

Other taxes such as income taxes directly impact the firm in terms of profitability as they tax the net income of the firm.

Some countries have a Value-Added Tax (VAT).

The VAT is applied to the added value applied by the firm.

2. 8. 4- Effective Tax Rates and Marginal Tax Rates:

Effective tax rates also termed average tax rates are calculated for income taxation purposes by the percentage of total taxable income paid in taxes.

The effective tax rate results from dividing the tax liability by the total taxable income.

The marginal tax rate is the tax rate on the next dollar of taxable income.

For financial decision-making, the marginal tax rate is a key element because the firm is concerned with the tax impact of additional income or income deductions.

2. 8.5-Investment Tax Credits:

Governmental entities, in order to encourage economic activity, may give firms tax credits based on their investments in a given location.

Governments may want to encourage the location of new plants in economically depressed areas and therefore promote this through investment tax credits including abeyance on certain taxes, such as property taxes.

In other cases, tax credits may be granted for certain types of investment in a plant and equipment.

The investment tax credits may be tied to certain public policy goals. Thus, a firm installing more energy efficient equipment that reduces energy consumption may be able to take advantage of energy investment tax credits.

2. 8.6-Depreciation and Depletion:

In order to encourage firms to invest in new plants and equipment, governmental entities often allow these firms to depreciate their investments over time.

This investment depreciation allows the firm to reduce its income by a set proportion per year with a depreciation write-off until the investment is fully depreciated by the firm.

The limits on investment depreciation write-off are proscribed by the governmental tax code. It must be realized that depreciation itself is not a cash flow.

The rationale underlying depreciation concepts is that physical assets lose value over time as a result of such factors as deterioration, wear, and obsolescence.

Depletion is analogous to depreciation, but for natural resources. Thus, owners of a stone quarry, an oil well, or standing timber, can take depletion allowances based on the percentage of the resource used up in a given time period. However, common land used for agricultural or business purposes, such as the site for a building or lost parking, is not depreciable. Common land is an asset, but is not considered to wear out like plant or equipment assets.

Depreciation Techniques:

Given that governments allow firms to depreciate their investments, there are numerous methods to accomplish the depreciation process.

-Straight-Line Depreciation:

Straight-Line (SL) Methods take an equal amount of depreciation every year. The SL Method takes the original cost, less the salvage value, divided by the number of years of life by the formula:

$$D = (C-S)/N \text{……..(2-6)}$$

Where: D = depreciation charge C = asset original cost S = salvage value N = asset depreciable life (years)

-Double-Declining Balance Depreciation:

Double-Declining Balance Depreciation applies a constant depreciation rate to the assets' declining value. The DDB formula is:

$$D = (2/N)\,(BVr\text{-}1) \text{…….(2-7)}$$

Where: D = depreciation charge

C = asset original cost

BVr-1 = book value of asset at end of rth year

BV0 = book value at beginning of first year = C

N = asset depreciable life (years)

-Sum-Of-Years Digits Depreciation:

Sum-of-Years Digits (SOYD) method allows depreciation to be taken at a faster rate than SL.

This SOYD method takes depreciation in any one year, as the product of a fractional value times the total original depreciable value.

The fractional value for any given year has as its numerator, the years of asset life remaining, while the denominator is the sum of digits, including one through the last year of the asset's life.

The SOYD depreciation formula is:

$$Dr = (C - S)*[(2(N\text{-}r+1))/(N(N + 1) \text{……(2-8)}]$$

Where: Dr = depreciation charge for the rth year

C = asset original cost

S = salvage value

N = asset depreciable life (years)

r = rth year

In the comparison between SL and SOYD methods, SOYD is similar to DDB in that it allows faster write-offs of the asset value in the early years.

Again, as noted above, a general economic cost principle, given the time value of money, is that early money is of greater importance.

-**Modified Accelerated Cost Recovery System:**

Depreciation the Modified Accelerated Cost Recovery System (MACRS) method is unique to the U.S. Tax Code. Depreciation under this MACRS method is based on original asset cost, asset class, asset recovery period, and asset in-service date. Asset classes are differentiated based on three-year, five-year, seven-year, ten-year, and other property lives depending on asset type.

In the U.S., depreciation rates are set by percentages allowed under the U.S. Tax Code. In other countries, depreciation may or may not be allowed under the applicable taxation regulations.

-Units of Production Depreciation:

The Units of Production (UOP) method is used when depreciation is more accurately based on usage instead of time

The overall goal for any organization in choosing a depreciation method is to choose the method that will depreciate an asset as quickly as possible.

Depreciation is a non-cash expense that thereby reduces an organization's total taxable income in any given year.

Based on the principles in this section, higher depreciable amounts in early years result in less taxable amounts due from the firm to a given entity.

In addition, given the general inexorable trend of higher inflation, when the asset has been fully depreciated, there will be less funding available to buy the successor plant or equipment unit.

2.9-cost through Engineering Phase:

Cost management is undertaken in nearly all project phases, whilst its activities can vary widely. Drawing upon the pertinent descriptions drafted by the RIBA and the RICS, the cost management life cycle starts as early as cost estimate in the preparation phase, cost plan in the design stage, preparing tendering documents, cost control throughout the construction stage, and post-tender estimate until The construction project concludes.

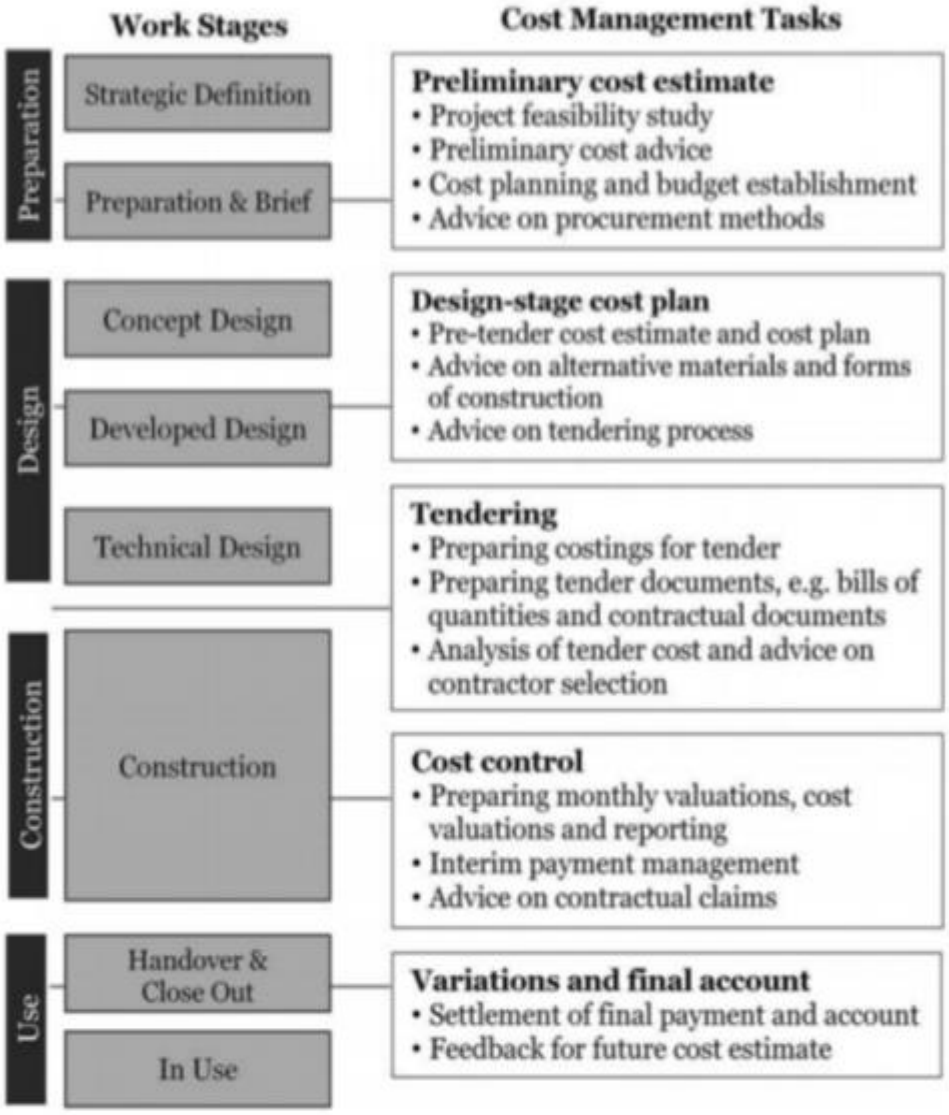


Figure (2.2) QS tasks and responsibilities summaries in the context of RIBA plan of work

Time and cost can easily get out of control on a construction project, even on a small project. While these two variables are independent, they are inextricably linked on all construction projects

Changes to schedule can affect the cost and vice versa. To avoid such a disaster, there needs to be a system for measuring the actual performance (in both time and cost parameters) against anticipated performance.

The system for measuring progress has to be dynamic and ongoing during the life of the project.

Waiting till the last minute to discover your project will deliver late is not only unacceptable, but offers little time (or hope) to recover.

Equally important is the cost to deliver.

Most construction contracts have a fixed price, or at the very least some form of accountability for the cost of the work as well as a time allotted for performance of the work.

These two basic parameters create the foundation of project control.

Enter the discipline of construction project control! Project control in its simplest terms is a four step process of measuring progress toward a goal:

- Create a plan against which performance toward the goal can be measured.
- formally and regularly measure progress toward the goal.
- Evaluate the causes of significant deviations from the plan.

Project cost management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling cost so that projects can be completed within budget.

Cost management in the construction industry relates to all cost-related activities from project initiation through to successful building occupation and use (Ashworth, 2010). Before construction begins, cost management focuses on cost estimation and cost planning.

The objective of the cost estimation is to establish a realistic budget whilst optimizing value for money (VFM) for the client.

Cost planning aims to develop a pre-agreed cost framework in the most economic manner, whilst cohering with programmer requirements, aesthetic considerations, and engineering feasibilities.

After construction commences, that focus shifts to cost control and ensuring expenditures are within budget and the pre-agreed cost framework.

After construction completes, QS will settle the final payment and final accounts.

Professional QS are usually brought on board from project inception through to settlement of final accounts. QS Generally shift their cost-related tasks and responsibilities throughout the project life cycle.

A project's life cycle involves several phases from project initiation, to plan and design development, construction, and ultimately handover of the finished product.

Table 2.4summarizes the core objectives at each stage proposed by the Royal Institute of British Architects (RIBA)

Type of estimate	Project phase	Primary use
Preliminary cost estimate Elemental cost plan Approximate quantities cost plan Pre-tender estimate	Strategic definition (S0), preparation and brief (S1) Conceptual design (S2), developed design (S3) Technical design (S4) Technical design (S4), before tendering	Study the feasibility of a project and select the most profitable scheme Refine and specify the design Prepare cost plan and tender documents Prepare tender documents

Table 2.4: Table Estimates types at different project phases

2.9.1Preliminary cost estimate:

Cost estimation, the process of forecasting the most likely cost of delivering a project, is perhaps the QS' most important cost-related activity.

It forms the basis for other relevant activities, such as tendering, construction contracting, paying back lenders, and revenue generation as early as possible.

Cost estimation can be conducted during several pre-contract stages, as summarized in Table.

Estimates at different project phases

In the preparation stage when planning for the project strategies and schemes, QS will undertake studies to counsel on the feasibility and profitability of the project.

This is usually done based on the preliminary cost estimate, which although quicker to do, usually proves less accurate as little information is available during this stage.

Usually, this process considers the land acquisition fee, construction cost, maintenance and operating cost, site servicing, cash flows, market analysis, and revenue and payback period forecast.

QS Draw on their accumulated experience and recorded cost data to establish a budget.

They also source data from past projects of a similar nature or character-istics.

If a fixed budget is given, QS may also help to analyses the budget requirements so as to provide guidance on cost planning and available procurement methods.

Early cost estimates and budgets

Are subject to further adjustment once more details become available. Nevertheless, these estimates are of vital importance to the client, helping to inform their decision-making, and even determine whether or not to proceed with the project.

Preliminary cost estimating, also referred to as a top-down, feasibility, or conceptual estimate, and still faces limited information being prior to design. Thus, the preliminary estimate relies more on the general project planning parameters, such as project size, type, and location, instead of detailed design or engineering information (Sabol, 2008).

QS Analyses this information by linking it with the cost information extracted from similar recent projects. Such an estimate method is ease to apply and fast to conduct, but it requires considerable experience and judgment on the part of skilled QS.

Some popular methods for preliminary cost estimation include 'floor area method', 'unit method', and 'story enclosure method' (Akinsiku et al., 2011). 'Floor area method' is one of the most commonly used methods for preliminary estimates.

It involves measuring the total floor area of all stores and multiplying that figure by the historical unit cost appropriated from similar closed out projects. 'Unit method' involves choosing a standard unit of accommodation and multiplying that figure by an approximate cost per unit. It is also known as 'cost according to building function'.

Storey enclosure method' measures the external walls, floors, and roof areas that effectively enclose the building and multiplies them by appropriate weighting factors to calculate the estimated cost.

This method takes many factors into consideration, such as the variations in plan shape, vertical position of the floors, overall height, story height, and usable floor areas below ground.

2.9.2 Design-stage:

Cost plan the advice of QS in the design stage can have profound cost implications. As more information surfaces, a more detailed cost estimate could be developed for each functional unit. The weighting of each functional unit against the total cost can also be estimated to justify the economic viability.

A comparative cost estimate could be conducted to provide alternatives for high-cost design or materials.

If necessary, the change of materials or methods of construction should be pointed out at the design stage to avoid rework in later stages, which bears additional costs.

The curves developed by the PMI (2013) illustrate this phenomenon.

It is thus of paramount importance for the client and the designer to work closely with an experienced QS during the design stage in order to control the project's overall cost.

The design-stage cost planning is generally conducted based on the detailed estimating, also known as analytical estimating, bottom-up estimating, fair-cost, or bid estimating, sprouts from detailed design and engineering information.

Such estimating is mainly for bid evaluation, contract changes, work scoping, permits and approvals, and often used by the contractor's estimator to perform price extension when the Bill of Quantities (BoQ) become available.

When creating an analytical estimate, each individual measured item, such as items listed in the BOQ, is independently analyzed by its constituent parts of labor, materials, and plant. Each part is then priced in terms of output, gang sizes, and material quantities

And plant hours. Therefore, the information of the project regarding size, type, and shape holds particular significance.

Given the increasing complexity of modern construction and fluctuating material and labor costs, reliable information is difficult to obtain.

The approximate estimating ostensibly generates results that are inferior to analytical estimating. However, when the information is inadequate, the approximate estimating method can help enhance accuracy. Traditionally, designers hand an insufficient amount of information to QS.

Therefore, QS principally employ the approximate estimating method. It should be noted, the easier the method of measurement, the more difficult to achieve precise pricing.

Perhaps more importantly, associated decisions must be made depending on what information, mainly regarding the quantities and unit prices of all indispensable resources, is at the time at hand to the estimator. Habit, familiarity, and the time available for the estimating process also influence the selected approach.

2.9.3 Tendering:

Once the architectural and engineering design drawings are completed, QS will start to conduct pre-tender cost estimation and prepare the tender documents to be sent to contractors/renderers. When the renderers return the bidding

packages, QS will analyses the tender price and provide advice on the selection of contractors based on their submitted tender documents. According to Cartlidge (2009), the tender documents typically include:

•Two copies of BoQ, one bound and one unbound. The bound copy is for pricing and submission; the unbound copy allows the contractor to split the bills up into trades so that they can be sent to subcontractors for pricing;

•Indicative drawings on which the BoQ were prepared

•The form of tender – a statement of the tender's bid;

•Instructions (precise time and place)

•Envelope for the return of the tender.

Specifically, a BOQ includes the quantities of materials, labor work, fees to cover contingency, and any other items that may incur costs during the construction process.

A BoQ forms an important part of the contract documents.

It not only translates the design documents, such as drawings, plans, and specifications, as reference for potential contractors to base their tender price upon, but also transforms contract documents upon award of tenders, providing an agreement between the client and the contractor.

A BOQ is normally prepared based on the Standard Method of Measurement (SMM).

SMM is a uniform industry-wide referencing resource for measuring building works.

It provides detailed information, classification tables, and rules for meas-uring building works to keep the various measuring practices consistent whilst avoiding measuring disputes. Various countries and regions have developed their own sets of SMM for QS' work, including the UK, Canada, the Middle East, Australia, New Zealand, Malaysia, Singapore, Sri Lanka, and Hong Kong to name a few.

The SMM, by and large, varies from place to place as each country/region has its own adopted construction methods, techniques, and risk allocation considerations (Hong Kong Institute of Surveyors [HKIS], 2017).

In Hong Kong, for example, the SMM is originated from the UK and lays down a uniform method and criteria for measurement of civil engineering. HKSMM was first published in 1962, but been revised and updated in 1966, 1979, and 2005 to reflect changes in QS practice. Now in its fourth edition, published in 2005, the HKSMM4 is believed to represent "a unanimous industrial agreement on the standard method of measurement", including "Definition Rule (how to

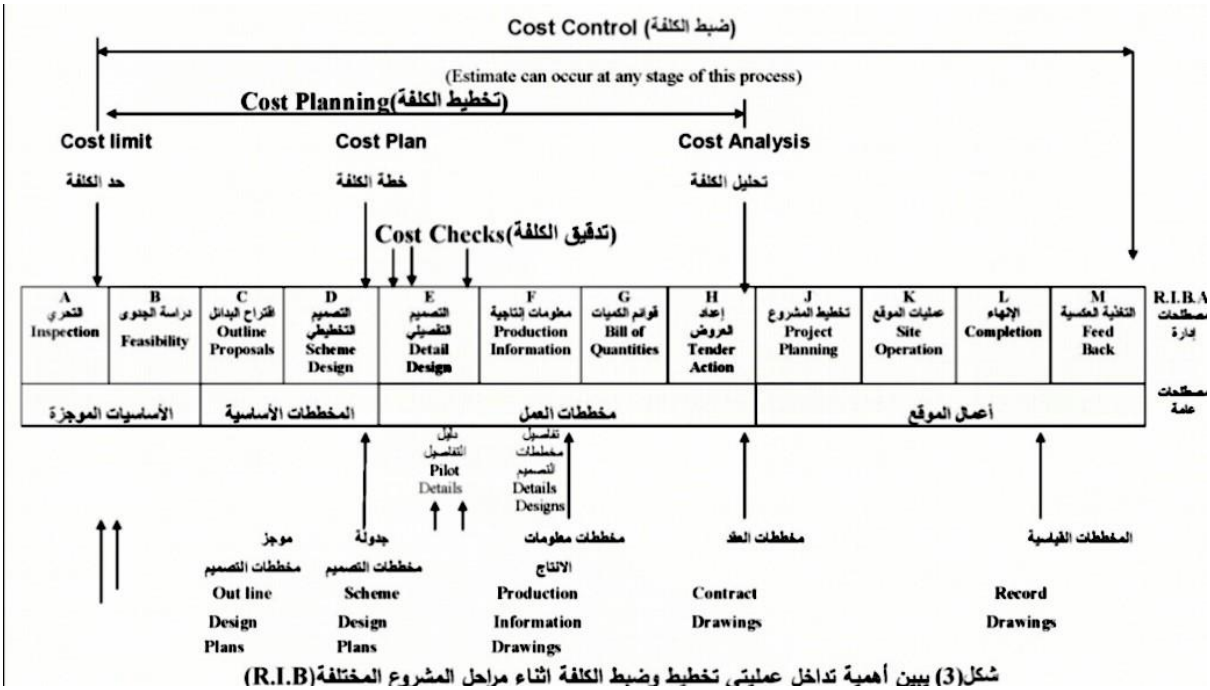
define), Measurement Rule (how to measure) and Coverage Rule (what to include and

Exclude)" (HKIS, 2017). As the increasing adoption of construction and information technology, the HKSMM4 is expected to be updated to reflect these changes and accommodate the existing QS practice in Hong Kong.

The cost management plan is a component of the project management plan and describes how the project costs will be planned, structured, and controlled.

The cost management processes and their associated tools and techniques are documented in the cost management plan.

(Weisheng Lu, Chi Cheung Lai, and Tung Tse,2019)



شكل(3) يبين أهمية تداخل عمليتي تخطيط وضبط الكلفة اثناء مراحل المشروع المختلفة(R.I.B)

Figure (2.3) the importance of over lapping the two-cost control planning process during the different phases of project.

2.10 Basic processes for cost management in construction project:

Project Cost Management includes the processes involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget.

2.10.1The fundamentals Project Cost Management processes:

- Plan Cost Management:

The process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled

-Estimate Costs:

The process of developing an approximation of the monetary resources needed to complete project work.

- Determine Budget:

The process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.

- Control Costs:

The process of monitoring the status of the project to update the project costs and manage changes to the cost baseline.

2.11 Plan Cost Management:

of this process is that it provides guidance and direction on how the project costs will be managed throughout the project

Inputs

-Project Management Plan:

…It includes Scope Baseline for any constraints and also Schedule baseline to determine the needed budget and the needed Funds in each time and Risk Management Plan to consider The Risk Management Activities Cost.

-Project Charter:

The project charter provides the summary budget and you can start with cost MGMT firstly

- Enterprise Environmental Factors:

The Materials is Ready in Local Market or Not or Currency Exchange Rate (If you will buy materials from Outside the Country or you have resources from outside the Country and take their salaries by Dollar.

-Organizational Process Assets:

Process of Controlling the Cost, Lessons Learned and Templates

Tools and Techniques:

-Expert Judgment

From previous similar project, information in the industry,cost estimating ,budgeted ad earned value management.

- Data analysis:

•Strategic options to fund the project:

- Self-funding,
- Funding with equity
- Funding with debt

• Project resources Finance:

- Making,
- Purchasing,

- Renting (Short Term),
- Leasing (Long Term).

• Financial analysis techniques:
- Payback period.
- Return on investment (value).
- Internal rate of return.
- Net present value
- Meetings

Outputs:

-Cost Management Plan:

The cost management plan can establish the following:

-Units of measure:

Each unit used in measurements (such as staff hours, staff days, or weeks for time measures; meters, liters, tons, kilometers, or cubic yards for quantity measures; or lump sum in currency form) is defined for each of the resources.

-Level of precision:

This is the degree to which cost estimates will be rounded up or down, based on the scope of the activities and magnitude of the project.

- **Level of accuracy:**

The acceptable range (e.g., ±10%) used in determining realistic cost estimates is specified , and may include an amount for contingencies.

- Organizational procedures links:

The work breakdown structure (WBS) (Section 5.4) provides the framework for the cost management plan, allowing for consistency with the estimates, budgets, and control of costs. The WBS component used for the project cost accounting is called the control account. Each control account is assigned a unique code or account number(s) that links directly to the performing organization's accounting system.

- Control thresholds:

Variance thresholds for monitoring cost performance may be specified to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken. Thresholds are typically expressed as percentage deviations from the baseline plan.

-Rules of performance measurement:

Earned value management (EVM) rules of performance measurement are set. For example, the cost management plan may:

- Define the points in the WBS at which measurement of control accounts will be performed;
- Establish the EVM techniques (e.g., weighted milestones, fixed-formula, percent complete, etc.) to be employed; and
-Specify tracking methodologies and the EVM computation equations for calculating projected estimate at completion (EAC) forecasts to provide a validity check on the bottom-up EAC.
- Reporting formats:
The formats and frequency for the various cost reports are defined.
- Additional details:
Additional details about cost management activities include but are not limited to:
- Description of strategic funding choices,
-Procedure to account for punctuations in currency exchange rates.
- Procedure for project cost recording.

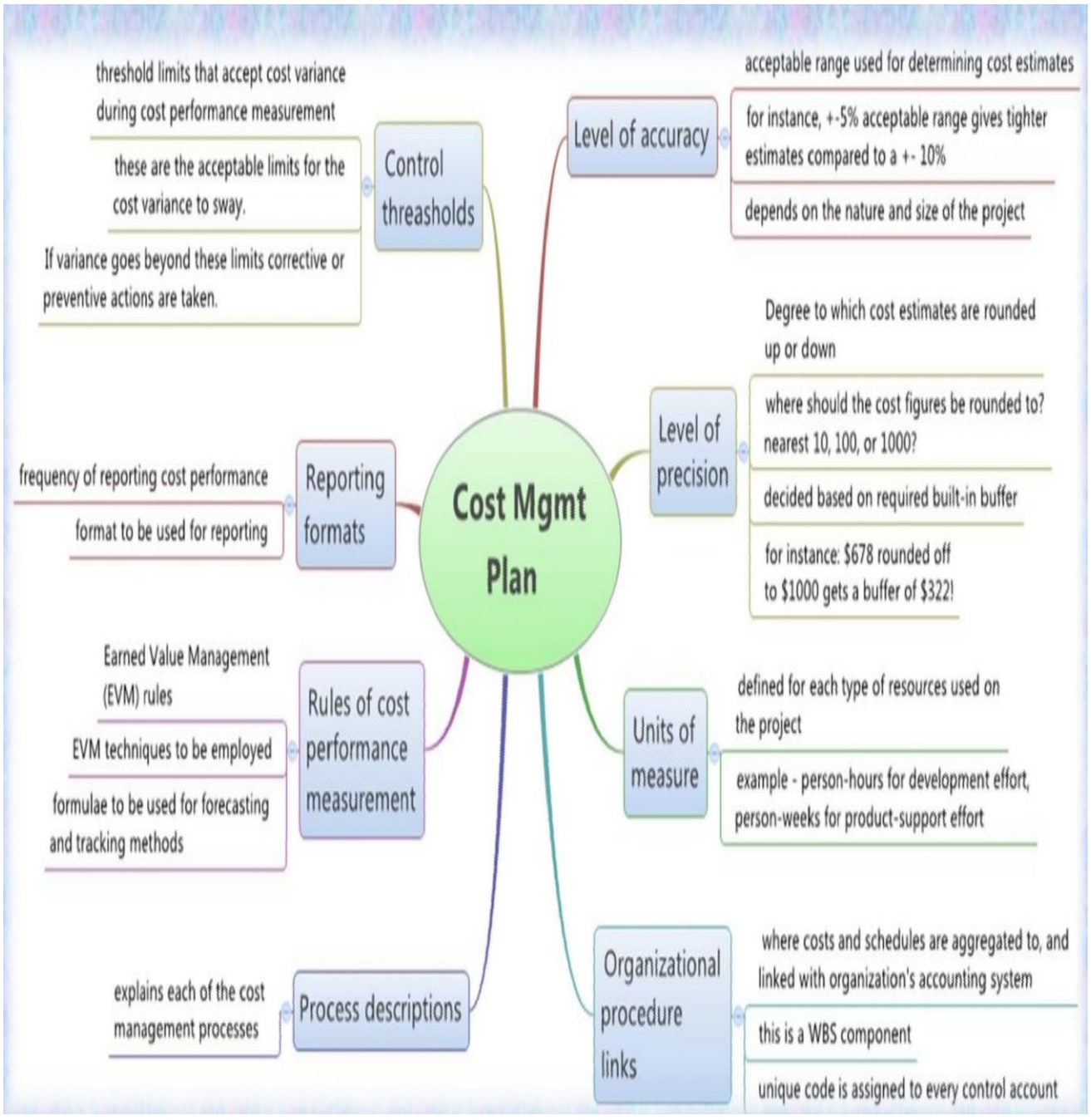


Figure (2.4) cost management plane

2.12 Estimate Costs:

Estimate Costs is the process of developing an approximation of the cost of resources needed to complete project work.

The key benefit of this process is that it determines the monetary resources required for the project.

Estimate Costs is the process of calculating the costs of the identified resources needed to complete the project work.

Estimate Costs is the cost of the resources required to complete the project work & Pricing includes a profit margin

Estimates are generally expressed in units of currency

The accuracy of a project estimate will increase as the project progresses through the project life cycle. For example, a project in the initiation phase may have a Later in %. 75% to +25−(ROM) estimate in the range of of magnitude rough order could narrow the definitive estimates, is known the project, as more information range of accuracy.%10% to +5-

Inputs

•Project Management Plan

The cost management plan describes estimating methods that can be used and the level of precision and accuracy required for the cost estimate.

•Resource Management Plan:

It includes the salaries of Teams or rate per hour or Reward System like there is an allowance to work outside Khartoum is 100/Day or if the team finish 10 Sites per month will get 500 SDG for each member

•Quality management plan:

The quality management plan describes the activities and resources necessary for the project management team to achieve the quality objectives set for the project.

• Scope baseline:

The scope baseline includes the project scope statement, WBS, and WBS dictionary:

- Project scope statement:

The scope statement reflects funding constraints by period for the expen-diture of project funds or other financial assumptions and constraints.

-Work breakdown structure:

The WBS provides the relationships among all the project deliverables and their various components

-WBS dictionary:

The WBS dictionary and related detailed statements of work provide an identification of the deliverables and a description of the work in each WBS component required to produce each deliverable.

•Project Documents:

Project documents that can be considered as inputs for this process include but are not limited to:

-Lessons learned register:

Lessons learned earlier in the project with regard to developing cost estimates can be applied to later phases in the project to improve the accuracy and precision of the cost estimates.

-**Project schedule:**

The schedule includes the type, quantity, and amount of time that team and physical resources will be active on the project will affect cost estimates when resources are charged per unit of time and when there are seasonal fluctuations in costs. The schedule also provides useful information for projects that incorporate the cost of financing (including interest charges).

- Resource requirements:

Resource requirements identify the types and quantities of resources required for each work package or activity.

-Risk register:

The risk register contains details of individual project risks that have been identified and prioritized, and for which risk responses are required. The risk register provides detailed information that can be used to estimate costs

•Enterprise environmental factors:

The enterprise environmental factors that can influence the Estimate Costs process include but are not limited to:

-**Market conditions:**

These conditions describe what products, services, and results are available in the market, from whom, and under what terms and conditions. Regional and/or global supply and demand conditions greatly influence resource costs.

-**Published commercial information:**

Resource cost rate information is often available from commercial databases that track skills and human resource costs, and provide standard costs for material and equipment. Published seller price lists are another source of information.

-**Exchange rates and inflation:**

For large-scale projects that extend multiple years with multiple currencies, the fluctuations of currencies and inflation need to be understood and built into the Estimate Cost process.

•Organizational process assets:

The organizational process assets that can influence the Estimate Costs process include but are not limited to:

-Cost estimating policies,

- Cost estimating templates,

- Historical information and lessons learned repository.

Tools And Techniques:

•Expert Judgment:

-Expertise should be considered from individuals or groups with specialized knowledge or training in the following topics:

-Previous similar projects

-Information in the industry, discipline, and application area; and

Cost estimating methods.

• **Analogous estimating:**

Analogous cost estimating uses values, or attributes, of a previous project that are similar to the current project. Values and attributes of the projects may include but are not limited to: scope, cost, budget, duration, and measures of scale (e.g., size, weight). Comparison of these project values, or attributes, becomes the basis for estimating the same parameter or measurement for the current project.

•Parametric estimating:

This technique can produce higher levels of accuracy depending on the sophistication and underlying data built into the model.

Parametric cost estimates can be applied to a total project or to segments of a project, in conjunction with other estimating methods.

• **Bottom – up estimating:**

The cost of individual work packages or activities is estimated to the great-est level of specified detail.

The detailed cost is then summarized or "rolled up" to higher levels for subsequent reporting and tracking purposes.

The cost and accuracy of bottom-up cost estimating are typically influenced by the size or other attributes of the individual activity or work package.

•Three-point estimating:

The accuracy of single-point cost estimates may be improved by consider-ing estimation uncertainty and risk and using three estimates to define an approximate range for an activity's cost:

-**Most likely (cM):**

The cost of the activity, based on realistic effort assessment for the required work and any predicted expenses.

- **Optimistic (cO):**

The cost based on analysis of the best-case scenario for the activity.

- **Pessimistic (cP):**

The cost based on analysis of the worst-case scenario for the activity.

Depending on the assumed distribution of values within the range of the three estimates, the expected cost, cE, can be calculated using a formula.

Two commonly used formulas are triangular and beta distributions. The formulas are:

Triangular distribution:

$$cE = (cO + cM + cP) / 3 \quad \text{(2-9)}$$

Beta distribution:

$$cE = (cO + 4cM + cP) / 6 \quad \text{(2-10)}$$

Cost estimates based on three points with an assumed distribution provide an expected cost and clarify the range of uncertainty around the expected cost.

•Data Analysis:

Data analysis techniques that can be used in the Estimate Costs process include but are not limited to:

-Alternatives analysis:

Alternatives analysis is a technique used to evaluate identified options in order to select which options or approaches to use to execute and perform the work of the project. An example would be evaluating the cost, schedule, resource, and quality impacts of buying versus making a deliverable.

-Reserve analysis:

Cost estimates may include contingency reserves (sometimes called contingency allowances) to account for cost uncertainty.

Contingency reserves are the budget within the cost baseline that is allocated for identified risks.

Contingency reserves are often viewed as the part of the budget intended to address the known unknowns that can affect a project. For example, rework for some project deliverables could be anticipated, while the amount of this rework is unknown. Contingency reserves may be estimated to account for this unknown amount of rework. Contingency reserves can be provided at any level from the specific activity to the entire project. The contingency reserve may be a percentage of the estimated cost, a fixed number, or may be developed by using quantitative analysis methods.

As more precise information about the project becomes available, the contingency reserve may be used, reduced, or eliminated. Contingency should be clearly identified in cost documentation. Contingency reserves are part of the cost baseline and the overall funding requirements for the project.

•Cost of quality:

Assumptions about costs of quality may be used to prepare the estimates. This includes evaluating the cost impact of additional investment in conformance versus the cost of nonconformance. It can also include looking at short-term cost reductions versus the implication of more frequent problems later on in the product life cycle.

•Project Management Information System (Pmis):

The project management information system can include spreadsheets, simulation software, and statistical analysis tools to assist with cost estimating. Such tools simplify the use of some cost-estimating techniques and thereby facilitate rapid consideration of cost estimate alternatives.

•Decision-making:

The decision-making techniques that can be used in the Estimate Costs process include but are not limited to voting.

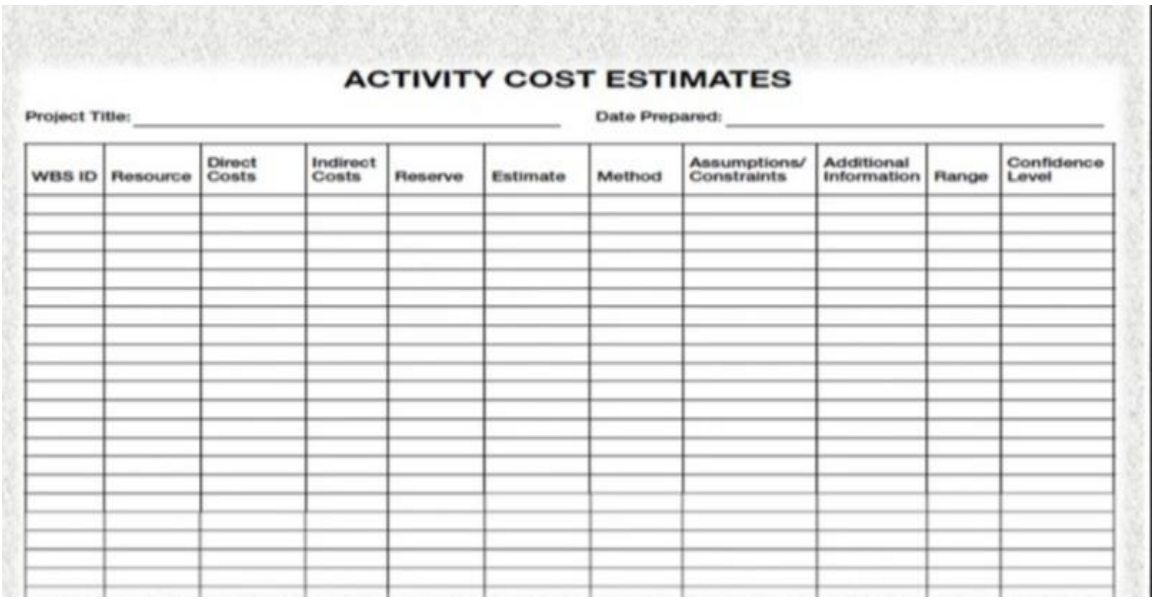
Voting is an assessment process having multiple alternatives with an expected outcome in the form of future actions. These techniques are useful for engaging team members to improve estimate accuracy and commitment to the emerging estimates.

Outputs:

• **Cost estimating:**

Activity Cost Estimates Quantitative assessments of the probable costs Required to complete project work

Activity cost Estimating



ACTIVITY COST ESTIMATES

Project Title: _____ Date Prepared: _____

WBS ID	Resource	Direct Costs	Indirect Costs	Reserve	Estimate	Method	Assumptions/ Constraints	Additional Information	Range	Confidence Level

Table (2.5) Activity Cost Estimates

•Basis Of Estimates:

The amount and type of additional details supporting the cost estimate vary by application area.
Regardless of the level of detail, the supporting documentation should provide a clear and complete understanding of how the cost estimate was derived.
Supporting detail for cost estimates may include:
-Documentation of the basis of the estimate (i.e., how it was developed),
-Documentation of all assumptions made,
-Documentation of any known constraints,
-Documentation of identified risks included when estimating costs,
-Indication of the range of possible estimates (e.g., US$10,000 (±10%) to indicate that the item is expected to cost between a range of values), and
- Indication of the confidence level of the final estimate.

•**Project documents updates**:

Project documents that may be updated as a result of carrying out this process include but are not limited to:

•**Assumption log**:

During the Cost Estimates process, new assumptions may be made, new constraints may be identified, and existing assumptions or constraints may be revisited and changed. The assumption log should be updated with this new information.

•**Lessons learned register:**

The lessons learned register can be updated with techniques that were efficient and effective in developing cost estimates.

•**Risk register:**

The risk register may be updated when appropriate risk responses are chosen and agreed upon during the Estimate Cost process.

2.13 Determine Budget:

Determine Budget is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline.
The key benefit of this process is that it determines the cost baseline against which project performance can be monitored and controlled. This process is performed once or at predefined points in the project.
A project budget includes all the funds authorized to execute the project.
The cost baseline is the approved version of the time-phased project budget that includes contingency reserves, but excludes management reserves
Inputs:

•**project Management Plan:**

The cost management plan describes how the project costs will be structured into the project budget.

•Resource management plan:

The resource management plan provides information on rates (personnel and other resources), estimation of travel costs, and other foreseen costs that are necessary to estimate the overall project budget.

•Scope baseline:

The scope baseline includes the project scope statement, WBS, and WBS dictionary details for cost estimation and management.

•Project documens:

Examples of project documents that can be considered as inputs for this process include but are not limited to:

•Basis of estimates:

Supporting detail for cost estimates contained in the basis for estimates should specify any basic assumptions dealing with the inclusion or exclusion of indirect or other costs in the project budget.

•Cost estimates:

Cost estimates for each activity within a work package are aggregated to obtain a cost estimate for each work package.

•Project schedule:

The project schedule includes planned start and finish dates for the project's activities, milestones, work packages, and control accounts. This information can be used to aggregate costs to the calendar periods in which the costs are planned to be incurred

•Risk register:

The risk register should be reviewed to consider how to aggregate the risk response costs. Updates to the risk register are included with project documents updates described in

•Business documents:

The business documents that can be considered as inputs for this process include but are not limited to

•Business case:

The business case identifies the critical success factors for the project, including financial success factors

•Benefits management plan:

The benefits management plan includes the target benefits, such as net present value calculations, timeframe for realizing benefits, and the metrics associated with the benefits.

•**Agreements:**

Applicable agreement information and costs relating to products, services, or results that have been or will be purchased are included when determining the budget.

•**Enterprise environmental factors:**

The enterprise environmental factors that can influence the Estimate Costs process include but are not limited to exchange rates. For large-scale projects that extend multiple years with multiple currencies, the fluctuations of currencies need to be understood and built into the Determine Budget process.

•**Organizational process assets:**

The organizational process assets that can influence the Determine Budget process include but are not limited to:

- Existing formal and informal cost budgeting-related policies, procedures, and guidelines;
- Historical information and lessons learned repository.
-Cost budgeting tools; and
-Reporting methods.

Tools and techniques:

• **Experts judgments:**

Expertise should be considered from individuals or groups with specialized knowledge or training in the following topics:

-Previous similar projects;
-Information in the industry, discipline, and application area;
-Financial principles;
-Funding requirement and sources:
-Cost aggregation:

Cost estimates are aggregated by work packages in accordance with the WBS. The work package cost estimates are then aggregated for the higher component levels of the WBS (such as control accounts) and, ultimately, for the entire project.

•**Data analysis:**

A data analysis technique that can be used in the Determine Budget process includes but is not limited to reserve analysis, which can establish the management reserves for the project. Management reserves are an amount of

the project budget withheld for management control purposes and are reserved for unforeseen work that is within scope of the project.

Management reserves are intended to address the unknown unknowns that can affect a project.

The management reserve is not included in the cost baseline but is part of the overall project budget and funding requirements. When an amount of management reserves is used to fund unforeseen work, the amount of management reserve used is added to the cost baseline, thus requiring an approved change to the cost baseline

• Historical information review:

Reviewing historical information can assist in developing parametric estimates or analogous estimates. Historical information may include project characteristics (parameters) to develop mathematical models to predict total project costs.

Both the cost and accuracy of analogous and parametric models can vary widely. They are most likely to be reliable when:

-Historical information used to develop the model is accurate,

- Parameters used in the model are readily quantifiable, and

-Models are scalable, such that they work for large projects, small projects, and phases of a project.

•Funding Limit Reconciliation:

The expenditure of funds should be reconciled with any funding limits on the commitment of funds for the project. A variance between the funding limits and the planned expenditures will sometimes necessitate the rescheduling of work to level out the rate of expenditures. This is accomplished by placing imposed date constraints for work into the project schedule.

•Financing

Financing entails acquiring funding for projects. It is common for long-term infrastructure, industrial, and public services projects to seek external sources of funds. If a project is funded externally, the funding entity may have certain requirements that are required to be met.

Outputs

•Cost Baseline

The cost baseline is the approved version of the time-phased project budget, excluding any management reserves, which can only be changed through formal change control procedures.

It is used as a basis for comparison to actual results. The cost baseline is developed as a summation of the approved budgets for the different schedule activities.

Cost estimates for the various project activities, along with any contingency the work package cost estimates, along with any contingency reserves estimated for the work packages, are aggregated into control accounts. The summation of the control accounts make up the cost baseline

Since the cost estimates that make up the cost baseline are directly tied to the schedule activities, this enables a time-phased view of the cost baseline, which is typically displayed in the form of an S-curve .For projects that use earned value management, the cost baseline is referred to as the performance measurement baseline.

As changes warranting the use of management reserves arise, the change control process is used to obtain approval to move the applicable management reserve funds into the cost baseline

•Project Funding Requirements:

Total funding requirements and periodic funding requirements (e.g., quarterly, annually) are derived from the cost baseline. The cost baseline will include projected expenditures plus anticipated liabilities. Funding often occurs in incremental amounts, and may not be evenly distributed, which appear as steps, if any. Funding requirements may include the source(s) of the funding.

•Project Documents Updates:

Project documents that may be updated as a result of carrying out this process include but are not limited to:

- Cost estimates:

Cost estimates are updated to record any additional information.

- Project schedule:

Estimated costs for each activity may be recorded as part of the project

schedule. --Risk register:

New risks identified during this process are recorded in the risk register and managed using the risk management processes.

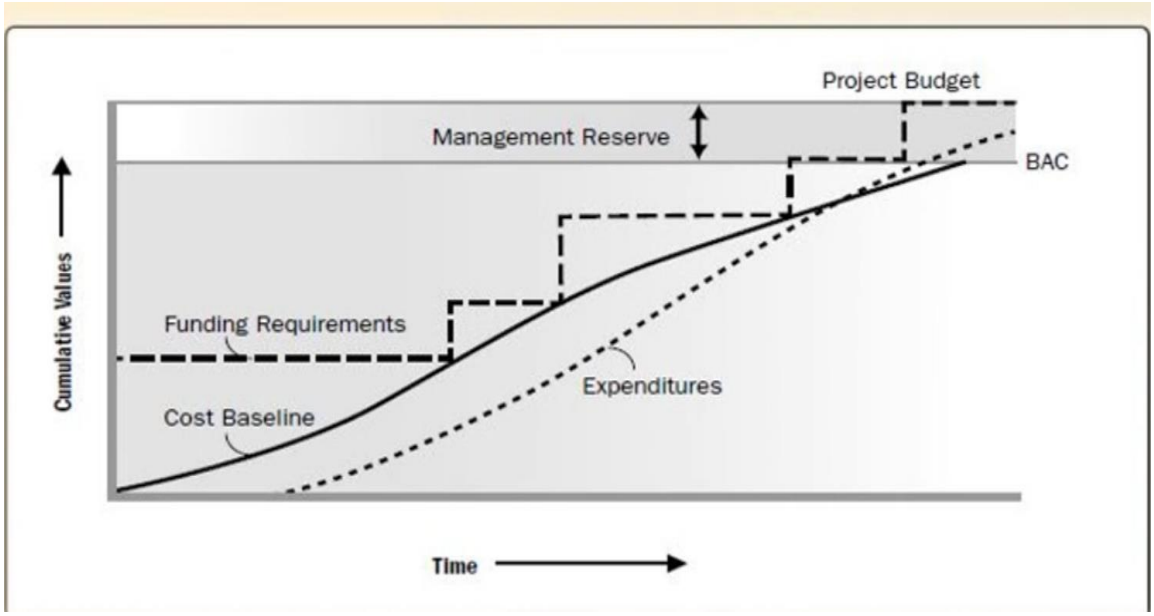
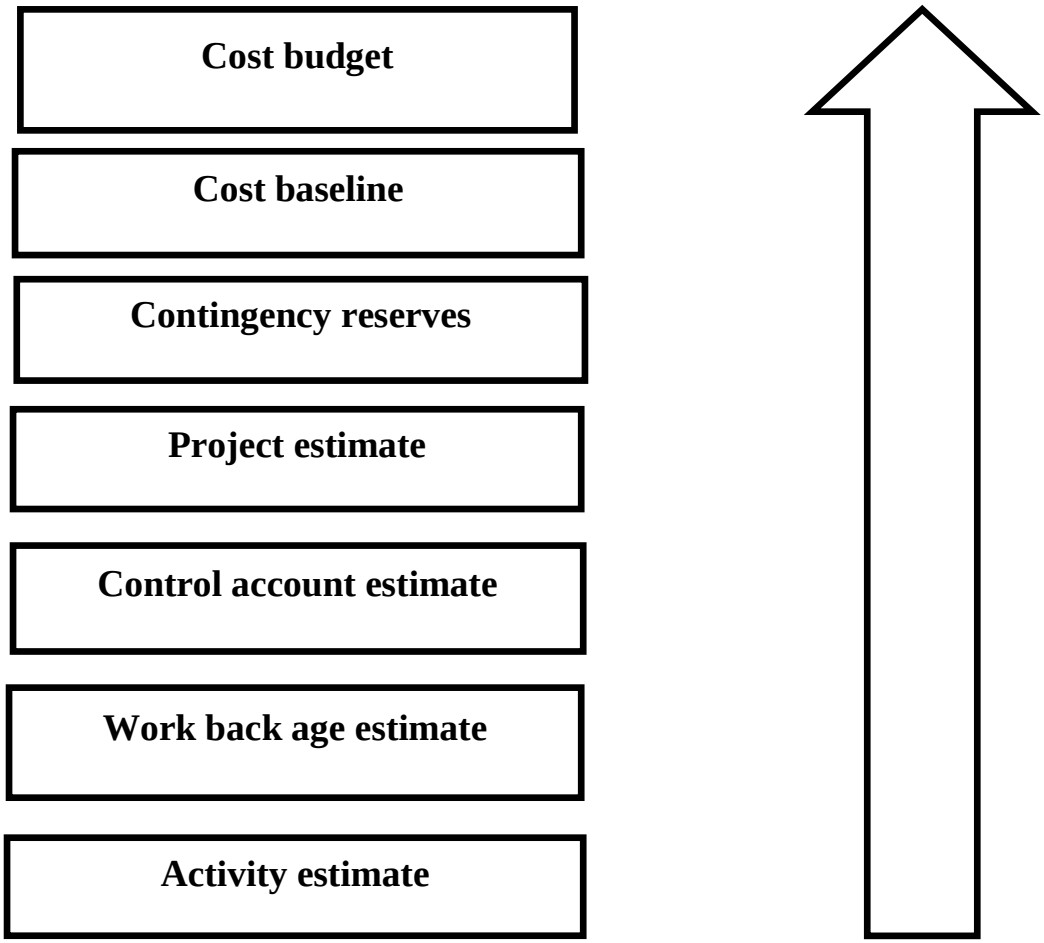


Figure (2.5) cost base line expend expenditures and funding requirement



2.14 Control cost:

Control Costs is the process of monitoring the status of the project to update the project costs and managing changes to the cost baseline.

The key benefit of this process is that the cost baseline is maintained throughout the project. This process is performed throughout the project.

Updating the budget requires knowledge of the actual costs spent to date.

The key to effective cost control is the management of the approved cost baseline.

Project cost control includes:

- Influencing the factors that create changes to the authorized cost baseline;

-Ensuring that all change requests are acted on in a timely manner;

- Managing the actual changes when and as they occur;

- Ensuring that cost expenditures do not exceed the authorized funding by period, by WBS component, by activity, and in total for the project;

- Monitoring cost performance to isolate and understand variances from the approved cost baseline;

-Monitoring work performance against funds expended;

-Preventing unapproved changes from being included in the reported cost or resource usage;

-Informing appropriate stakeholders of all approved changes and associated cost; -Bringing expected cost overruns within acceptable limits.

Inputs

•Project Management Plan

Project management plan components include but are not limited to:

-Cost management plan:

The cost management plan describes how the project costs will be managed and controlled.

-Cost baseline:

The cost baseline is compared with actual results to determine if a change, corrective action, or preventive action is necessary.

-Performance measurement baseline:

When using earned value analysis, the performance measurement baseline is compared to actual results to determine if a change, corrective action, or preventive action is necessary.

•Project Documents:

Examples of project documents that can be considered as inputs for this process include but are not limited to the lessons learned register

•Project Funding requirements:

The project funding requirements include projected expenditures plus anticipated liabilities.

•Work Performance Data:

Work performance data contains data on project status such as which costs have been authorized, incurred, invoiced, and paid.

•Organizational Process Assets:

The organizational process assets that can influence the Control Costs process include but are not limited to:

- Existing formal and informal cost control-related policies, procedures, and guidelines;
- Cost control tools;
-Monitoring and reporting methods to be used.

Tools And Techniques:

•Expert Judgment:

Examples of expert judgment during the Control Costs process include but are not limited to(Variance analysis, Earned value analysis, Forecasting, and Financial analysis).

•Data Analysis:

Data analysis techniques that can be used to control costs include but are not limited to:

- Earned value analysis (EVA):

Earned value analysis compares the performance measurement baseline to the actual schedule and cost performance. EVM integrates the scope baseline with the cost baseline and schedule baseline to form the performance measurement baseline. EVM develops and monitors three key dimensions for each work package and control account:

Planned value:

Planned value (PV) is the authorized budget assigned to scheduled work. It is the authorized budget planned for the work to be accomplished for an activity or work breakdown structure (WBS) component, not including management reserve.

This budget is allocated by phase over the life of the project, but at a given point in time, planned value defines the physical work that should have been accomplished. The total of the PV is sometimes referred to as the performance measurement baseline (PMB). The total planned value for the project is also known as budget at completion (BAC).

Earned value:

Earned value (EV) is a measure of work performed expressed in terms of the budget authorized for that work. It is the budget associated with the authorized work that has been completed. The EV being measured needs to be related to the PMB, and the EV measured cannot be greater than the authorized PV budget for a component.

The EV is often used to calculate the percent complete of a project. Progress measurement criteria should be established for each WBS component to measure work in progress. Project managers monitor EV, both incrementally to determine current status and cumulatively to determine the long-term performance trends.

Actual cost:

Actual cost (AC) is the realized cost incurred for the work performed on an activity during a specific time period. It is the total cost incurred in accomplishing the work that the EV measured. The AC needs to correspond in definition to what was budgeted in the PV and measured in the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs). The AC will have no upper limit; whatever is spent to achieve the EV will be measured.

-Variance analysis:

Variance analyses can be performed by comparing planned cost against actual cost to identify variances between the cost baseline and actual project performance. Further analysis can be performed to determine the cause and degree of variance relative to the schedule baseline and any corrective or preventive actions needed. Cost performance measurements are used to assess the magnitude of variation to the original cost baseline.

Schedule variance:

Is a measure of schedule performance expressed as the difference between the earned value and the planned value.

It is the amount by which the project is ahead or behind the planned delivery date, at a given point in time.

It is a measure of schedule performance on a project. It is equal to the earned value (EV) minus the planned value (PV).

The EVA schedule variance is a useful metric in that it can indicate when a project is falling behind or is ahead of its baseline schedule.

The EVA schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned.

Schedule variance is best used in conjunction with critical path method (CPM) scheduling and risk management. Equation:

$$SV = EV – PV \text{……..(2-11)}$$

Cost variance:

is the amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and the actual cost.

It is a measure of cost performance on a project. It is equal to the earned value (EV) minus the actual cost (AC).

The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent.

The CV is particularly critical because it indicates the relationship of physical performance to the costs spent. Negative CV is often difficult for the project to **recover. Equation:**

$$CV = EV – AC \text{……..(2-12)}$$

Schedule performance index:

Performance index (SPI) is a measure of schedule efficiency expressed as the ratio of earned value to planned value. It measures how efficiently the project team is accomplishing the work.

It is sometimes used in conjunction with the cost performance index (CPI) to forecast the final project completion estimates.

An SPI value less than 1.0 indicates less work was completed than was planned. An SPI greater than 1.0 indicates that more work was completed than was planned. Since the SPI measures all project work, the performance on the critical path also needs to be analyzed to determine whether the project will finish ahead of or behind its planned finish date.

The SPI is equal to the ratio of the EV to the PV. Equation:

$$SPI = EV/PV \text{……..(2-13)}$$

Cost performance index:

The cost performance index (CPI) is a measure of the cost efficiency of budgeted resources, expressed as a ratio of earned value to actual cost.

It is considered the most critical EVA metric and measures the cost efficiency for the work completed.

A CPI value of less than 1.0 indicates a cost overrun for work completed. A CPI value greater than 1.0 indicates a cost underrun of performance to date.

The CPI is equal to the ratio of the EV to the AC. Equation:

$$CPI = EV/AC \text{…….(2-14)}$$

- Trend analysis:

Trend analysis examines project performance over time to determine if performance is improving or deteriorating. Graphical analysis techniques are valuable for understanding performance to date and for comparison to future performance goals in the form of BAC versus estimate at completion (EAC) and completion dates. Examples of the trend analysis techniques include but are not limited to

Charts:

In earned value analysis, three parameters of planned value, earned value, and actual cost can be monitored and reported on both a period-by-period basis (typically weekly or monthly) and on a cumulative basis. Figure 7-12 uses S-curves to display EV data for a project that is performing over budget and behind the schedule.

Forecasting:

As the project progresses, the project team may develop a forecast for the estimate at completion (EAC) that may differ from the budget at completion (BAC) based on the project performance.

If it becomes obvious that the BAC is no longer viable, the project manager should consider the forecasted EAC.

Forecasting the EAC involves making projections of conditions and events in the project's future based on current performance information and oth-er knowledge available at the time of the forecast.

Forecasts are generated, updated, and reissued based on work performance data

The work performance information covers the projects past performance and any information that could impact the project in the future.

EACs are typically based on the actual costs incurred for work completed, plus an estimate to complete (ETC) the remaining work.

It is incumbent on the project team to predict what it may encounter to perform the ETC, based on its experience to date.

Earned value analysis works well in conjunction with manual forecasts of the required EAC costs.

The most common EAC forecasting approach is a manual, bottom-up summation by the project manager and project team.

The project manager's bottom-up EAC method builds upon the actual costs and experience incurred for

The work completed, and requires a new estimate to complete the remaining project work. Equation:

EAC = AC + Bottom-up ETC……..(2-15)

The project manager's manual EAC is quickly compared with a range of calculated EACs representing various risk scenarios. When calculating EAC values, the cumulative CPI and SPI values are typically used.

While EVM data quickly provide many statistical EACs, only three of the more common methods are described as follows:

EAC forecast for ETC work performed at the budgeted rate:

This EAC method accepts the actual project performance to date (whether favorable or unfavorable) as represented by the actual costs, and predicts that all future ETC work will be accomplished at the budgeted rate. When actual performance is unfavorable, the assumption that future performance will improve should be accepted only when supported by project risk analysis.

Equation:

$$EAC = AC + (BAC - EV) \quad \text{(2-16)}$$

- EAC forecast for ETC work performed at the present CPI:

This method assumes that what the project has experienced to date can be expected to continue in the future. The ETC work is assumed to be performed at the same cumulative cost performance index (CPI) as that incurred by the project to date. Equation:

$$EAC = BAC / CPI \quad \text{(2-17)}$$

EAC forecast for ETC work considering both SPI and CPI factors. In this forecast, the ETC work will be performed at an efficiency rate that considers both the cost and schedule performance indices.

This method is most useful when the project schedule is a factor impacting the ETC effort. Variations of this method weight the CPI and SPI at different values (e.g., 80/20, 50/50, or some other ratio) according to the project manager's judgment. Equation:

$$EAC = AC + [(BAC - EV) / (CPI \times SPI)] \quad \text{(2-18)}$$

-Reserve analysis:

During cost control, reserve analysis is used to monitor the status of contingency and management reserves for the project to determine if these reserves are still needed or if additional reserves need to be requested.

As work on the project progresses, these reserves may be used as planned to cover the cost of risk responses or other contingencies.

Conversely, when opportunities are captured and resulting in cost savings, funds may be added to the contingency amount, or taken from the project as margin/profit.

If the identified risks do not occur, the unused contingency reserves may be removed from the project budget to free up resources for other projects or operations.

Additional risk analysis during the project may reveal a need to request that additional reserves be added to the project budget.

•To-Complete Performance Index:

The to-complete performance index (TCPI) is a measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.

TCPI is the calculated cost performance index that is achieved on the remaining work to meet a specified management goal, such as the BAC or the EAC.

If it becomes obvious that the BAC is no longer viable, the project manager should consider the forecasted EAC.

Once approved, the EAC may replace the BAC in the TCPI calculation. The equation for the TCPI based on the BAC:

(BAC – EV) / (BAC – AC)……(2-19)

All future work of the project will need to be performed immediately in the range of the TCPI (BAC) (as reflected in the top line of Figure 7-13) to stay within the authorized BAC.

Whether this level of performance is achievable is a judgment call based on a number of considerations, including risk, time remaining in the project, and technical performance.

This level of performance is displayed as the TCPI (EAC) line. The equation for the TCPI is based on the EAC:

(BAC – EV) / (EAC – AC)…….(2-20)

•Project Management Information System (PMIS):

Project management information systems are often used to monitor the three EVM dimensions (PV, EV, and AC), to display graphical trends, and to forecast a range of possible final project results.

Outputs

•Work Performance Information:

Work performance information includes information on how the project work is performing compared to the cost baseline.

Variances in the work performed and the cost of the work are evaluated at the work package level and control account level.

For projects using earned value analysis, CV, CPI, EAC, VAC, and TCPI are documented for inclusion in work performance reports

•Cost Forecasts:

Either a calculated EAC value or a bottom-up EAC value is documented and communicated to stakeholders.

•Change Requests:

. Analysis of project performance may result in a change request to the cost and schedule baselines or other components of the project management plan. Change requests are processed for review and disposition through the Perform Integrated Change Control process.

•Project Management Plan Updates:

Any change to the project management plan goes through the organization's change control process via a change request. Components that may require a change request for the project management plan include but are not limited to:

- Cost management plan:

Changes to the cost management plan, such as changes to control thre-sholds or specified levels of accuracy required in managing the project's cost, are incorporated in response to feedback from relevant stakeholders.

-Cost baseline:

Changes to the cost baseline are incorporated in response to approved changes in scope, resources, or cost estimates. In some cases, cost variances can be so severe that a revised cost baseline is needed to provide a realistic basis for performance measurement.

- Performance measurement baseline:

Changes to the performance measurement baseline are incorporated in response to approved changes in scope, schedule performance, or cost estimates. In some cases, the performance variances can be so severe that a change request is put forth to revise the performance measurement baseline to provide a realistic basis for performance measurement.

-Project Documents Updates:

Project documents that may be updated as a result of carrying out this process include but are not limited to:

Assumption log.:

Cost performance may indicate the need to revise assumptions on resource productivity and other factors influencing cost performance.

Basis of estimates:

Cost performance may indicate the need to revisit the original basis of estimates. - Cost estimates:

Cost estimates may need to be updated to reflect the actual cost efficiency for the project.

Lessons learned register:

The lessons learned register can be updated with techniques that were effective in maintaining the budget, variance analysis, earned value analysis, forecasting, and corrective actions that were used to respond to cost variances.

Risk register:

The risk register may be updated if the cost variances have crossed, or are likely to cross, the cost threshold.

((PMBOK® GUIDE, Sixth Edition)

2.15 Cost measurement:

A crucial part of the project control process is the accurate measurement of the progress of the work, without which it would be impossible to calculate the status of the project accurately.

It is the measurement of progress for each individual item, however dissimilar from the next that summarizes the overall progress of the project.

Analyzing progress and its monetary value is part of the tracking process and occurs during the execution of the work. However, it has little chance of success if the appropriate baseline controls for costs and schedule have not been established.

Integrating the Schedule and the Budget, will explore ways in which to measure the units of completed work and apply it to the calculation of monetary earned value.

2.16 Measuring Performance:

The application of sound measurement techniques during the analysis of earned value makes it possible to determine the status of the progress accurately.

It also has the distinct advantage of providing an early warning sign for projects that are in trouble.

As a first step in the Earned Value Analysis, the project manager must accurately calculate the units of work that have been accomplished.

2.16.1There is generally six recognized methods for calculating progress on a construction task:-

-Incremental Milestone:

The second method is best used for a cost account that is comprised of subtasks that must be completed in sequence.

It is called the incremental milestone or steps method.

The percentage chosen to represent each operation is based on the labor-hours expended as a ratio to the total. Each step is cumulative and is equivalent to having

Completed that percentage listed of the total installation.

-Start/Finish

The Start/Finish method has its greatest appeal for those tasks that lack readily definable intermediate milestones or for which the time required for each operation is difficult to estimate.

It focuses on only the start and finish of the task.

This method has its greatest success with tasks that are fairly short in dur-ation. These tasks have an easily discernible start and finish date, but status up-dates in between are not always possible..

-Cost Ratio

The Cost Ratio approach is applicable to tasks such as project management, general conditions, quality controls, and contract administration.

This approach works best on tasks that involve long durations and are continuous over the life of the project.

They are budgeted on mass allocation of dollars versus labor-hours of production.

The Cost Ratio approach allows the contractor to earn value commensurate with the overall percent of project completion.

-Experience/Opinion:

This is the most subjective approach with often no factual substantiation to support the results.

It is used for minor tasks only where a more definitive basis

Cannot be used. It is most often used for operations such as dewatering, frost removal/protection, or constructing support facilities.

It should come as no surprise that this method can be the source of substantial disagreement between the contractor and the owner or architect.

The Experience/Opinion approach should be used sparingly, and avoided whenever possible.

-Weighted or Equivalent Units:

This method has its greatest appeal where the task under control has a long duration and is composed of multiple subtasks with dissimilar units of measurement .

2.16.2-Earned Value:

Having reviewed the accepted methods for measuring progress on indivi-dual tasks, the next challenge is to determine the percentage of completion for the project as a whole.

The process for determining either the progress on an individual task or the project as a whole is called Earned Value Analysis.

Earned value is linked to the budget values used in the Schedule of Values.

It is typically expressed in dollars (or labor-hours) since they are the only common denominator among the variety of cost accounts found on a project.

The Earned Value Analysis starts with the time-phased costs that we addr-essed in the discussion of the SOV, which provides the project baseline that is the anticipated or planned value of the work scheduled in accordance with the budget.

Earned Value Analysis can be applied when budgets are both fixed (stipulated sum contracts) and variable (cost plus contracts).

-Fixed Budget Approach:

The Fixed Budget approach is used with stipulated sum contracts in which the scope of work is tied to a fixed dollar amount.

The fixed budget amounts are the basis of the cost accounts.

As in the discussion of the Schedule of Values the Fixed Budget approach utilizes each individual line in the SOV as the maximum amount that can be earned for that item when the work is 100 percent complete.

It establishes a direct relationship between the percent complete and the SOV maximum.

The relationship for a single task is expressed by the following formula:

Earned Value (EV) = Percent Complete × Maximum Budget

As demonstrated by the formula, the higher the percentage of completion, the higher the earned value until the maximum budget amount has been earned when the task is 100 percent complete.

The contractor can never earn more than the maximum budget amount for the task since mathematically he or she can never be more than 100 percent complete.

Since progress in all cost accounts can be calculated using the same formula, the products can then be summarized to arrive at the total progress of the project as a whole:

% Complete = Sum of EV of all tasks ÷ Maximum Budget value of all tasks

The Fixed Budget approach derives its accuracy from the correct distribu-tion of

costs within cost accounts. Should the initial distribution prove incorrect due to poor estimating practice, incorrect quantities, or even unrealistic productivity assumptions, the project manager should redistribute the available budget amounts to match the recently acknowledged work conditions or the corrected requirements.

If the project has been correctly estimated, the redistribution will provide a more accurate view of progress.

If the cost account is under budgeted, it will become evident fairly quickly by showing a higher percentage of completion than visual inspection will support.

Cost overruns that arise on properly distributed cost accounts have the advantage of helping provide more accurate historical data for estimating the same task in the future.

-Variable Budget Approach:

The Variable Budget approach is particularly suited to projects with a no fixed or cost-plus delivery methodology.

On projects with Cost-Plus Fee contracts, the maximum upset is estimated based on the best information available at the time, but is subject to change as the full scope becomes known or the contract documents are completed.

In contrast to the Fixed Budget approach, which is constrained by the fixed budget for the entire project, the Variable Budget approach makes use of the changing budget.

In much the same manner as the Fixed Budget approach, each task is assigned a dollar amount in the Schedule of Values based on known information at the time of budget development.

As each task is further defined, its budget is adjusted to reflect the change in quantities (or scope).

At regular intervals, typically just prior to the Application for Payment, the control budget is updated to acknowledge the change in quantities.

Most often the updating of the budget is done with the owner, design team, and contractor all in agreement with the new quantities and values.

When agreed upon, the new budget is called the Quantity Adjusted Budget (QAB).

Here is the formula for calculating EV with this approach:

EV = Percent Complete × Quantity Adjusted Budget (QAB)

It is not uncommon for percentages of completed work to decrease after new QABs have been introduced. While the appearance of “going backwards” is always considered disheartening, it is the nature of variable quantity work.

The reader is offered a word of caution in using the Variable Budget approach. Most cost-plus contracts commence work in advance of having completed Documents.

This is done under the moniker of fast-track delivery, which by its nature has a high degree of "rework," which is defined as taking recently comple-ted work apart and redoing it to accommodate changes in the design. Rework adds costs that are often substantial to a project, and as such it should be tracked Separately.

This is especially true if the reporting of costs on rework is a contractual requirement.

Even though the client often pays for the rework, it would be incorrect to include the added cost for the rework in the percentage complete Calculation.

The result would be an erroneous value for the percent complete of the task or the project.

To avoid skewing the data, cost accounts are set up for rework to be tracked independently.

-Choosing a Fixed or Variable Approach:

The choice of which approach to apply is often a matter decided by the contract. In other cases, it is dictated by the project conditions or by choice.

Stipulated sum contracts orchestrated under the design/bid/build methodology are best served by the Fixed Budget approach.

For projects that have been started with incomplete contract documents and flexible budgets, the Variable Budget approach is used.

This method is most responsive to the varying quantities and maturing budgets that occur as the project becomes fully defined.

Each approach has definitive characteristics that reflect the desired control.

•The Fixed Budget approach is defined by the following characteristics:

- Simplified tracking and bookkeeping offers less chance for human error.

-The performance data (SPI, SV, CPI, and CV) are subject to erroneous results if the cost account budgets are not accurately distributed.

- The cost account budgets provide a fixed target that is easy to see and interpret.

- It provides a direct evaluation of cost and schedule performance.

- It requires a separate system for the evaluation of productivity.

•The Variable Budget approach has the following characteristics:

- It requires more frequent attention to data management due to constantly changing baseline/budget values.
- Special provisions and data management are needed for tracking rework costs and time.

-it is ideal for projects with fluctuating budgets and partially defined documents.

-it can be used during initial phases of a project when there is a variable budget and then can be converted to a Fixed Budget approach when all parameters are known.

-It provides a direct evaluation of productivity when there is no change in wage rate

- It provides a moving budget that has a direct relationship to the actual quantities of work and the productivity rate for the tasks.
- It requires a supplementary system for the evaluation of cost performance if used with a fixed budget.

•Regardless of the approach employed, measuring performance hinges on two key computations:

- Comparing earned value with the planned value
- Comparing earned value with its actual costs these comparisons are made at the cost account level or even at the cost element level.

2.16.3 Schedule and Cost Performance:

The concepts previously mentioned provide a process for determining the percent complete and earned value of various tasks or the entire project.

The next step is to analyze the results for determining how well the work is proceeding in accordance with the plan.

The earned value system is particularly adept at providing the information with little additional calculation.

Until now the discussion has centered on planned value and earned value amounts. However, there is a third category that is needed for the analysis of Performance.

2.16.4Consider the following outline of the three categories needed for analysis:

● Budgeted dollars (or labor-hours) to date is what the contractor had planned to do and is called the Budgeted Cost for Work Scheduled (BCWS).

This is also known as the Planned Value (PV).

● Earned dollars (or labor-hours) to date is what the contractor actually did and is called the Budgeted Cost for Work Performed (BCWP).

This is also known as the Earned Value (EV).

● Actual dollars (or labor-hours) expended to date is what it costs the contractor and is called the Actual Cost of Work Performed (ACWP).

It is what it costs the contractor to earn the value of the BCWP.

This is also known as the Actual Cost of Work Completed (AC).

The newly introduced category of ACWP is the final component in the trinity of Earned Value Management.

It is defined as all actual costs measured against the budget amounts for the cost elements in each cost account.

Performance measured against schedule is the comparison of what was planned to have been done to what was actually done. In other words, it is a ratio of Budgeted value to earned value.

It is a measure of schedule efficiency.

If budgeted dollars (or labor-hours) are less than earned dollars (or labor-hours), it translates to performing more work than planned.

It also suggests that the task may be ahead of schedule.

If budgeted dollars are more than earned dollars, it means less work is being performed than planned and the task is more than likely behind schedule. Schedule performance efficiency can be measured using the schedule performance index (SPI):

SPI =

(Earned Value (in dollars or labor-hours))/ (Budgeted Value (in dollars or labor-hours))……(2-21)

or

SPI = BCWP/BCWS……(2-22)

For SPI values that are equal to 1.0, it means that the work is progressing exactly as planned.

For values of less than 1.0, the work is behind schedule and considered an unfavorable performance.

For values greater than 1.0, the work is progressing faster than planned and is recognized as a favorable performance.

It is also possible to report the difference between planned and earned value in monetary terms as a variance, instead of as a ratio.

This is called the Schedule Variance (SV):

SV = Earned Value − Budgeted Value

or

SV = BCWP – BCWS……(2-23)

The SV is calculated in terms of the difference between the work actually performed and the amount of work scheduled to be completed in any given time period.

It can be expressed in dollars or labor-hours. Variances that result in positive numbers (dollars or labor-hours) are considered favorable, and those that are negative are not favorable.

Schedule performance reported as a variance (SV) or as a ratio (SPI) can be confusing due to the use of the word "schedule" since SV and SPI are not measured in days, the typical unit of schedule.

A quick review of the cost account reveals that Task A performed better in all cost elements than scheduled.

*For CPI values that are equal to 1.0, it means that the cost of the work is exactly as planned.

*For values of less than 1.0, the work is costing more than what is being earned. This is considered an unfavorable cost performance.

* For values greater than 1.0, the work is costing less than the amount earned and is recognized as a favorable cost performance.

Similar to schedule performance, it is also possible to report the difference between planned value and cost in monetary terms as a variance, instead of as a ratio.

This is called the Cost Variance (CV):

$$CV = \text{Earned Value} - \text{Actual Cost} \quad \text{.....(2-24)}$$

or

$$CV = BCWP - ACWP \quad \text{.....(2-25)}$$

CV can be expressed in dollars or labor-hours.

Variances that result in positive numbers (dollars or labor-hours) are considered favorable, and those that are negative are not favorable.

The reader should note that in cost performance measurement, the planned value, especially as represented in the Schedule of Values, is often burdened with overhead and profit.

The real planned value referenced is that which is represented by the cost account.

The difference between the two is the application of overhead and profit. In the case of a Schedule of Values, which has separate individual lines for overhead and profit, the planned value is the same as the planned cost and can support a direct comparison in computing the CV.

TV = BCWS – ACWP……..(2-26)

A positive value for the TV indicates that the project as a whole is under budget at the time of analysis.

It indicates that there has been less spent by the analysis date than originally planned.

It is less useful because it does not address the reason behind the underrun. There is also a formula for calculating the percent total

variance (PTV):

PTV = BCWS − ACWP/BCWS……..(2-27)

Again, TV and PTV are "big picture" tools and not that helpful to the project manager diagnosing the status of the project.

CV can be expressed in dollars or labor-hours.

Variances that result in positive numbers (dollars or labor-hours) are considered favorable, and those that are negative are not favorable.

The reader should note that in cost performance measurement, the planned value, especially as represented in the Schedule of Values, is often burdened with overhead and profit.

The real planned value referenced is that which is represented by the cost account. The difference between the two is the application of overhead and profit.

In the case of a Schedule of Values, which has separate individual lines for overhead and profit, the planned value is the same as the planned cost and can support a direct comparison in computing the CV.

TV = BCWS – ACWP…….(2-28)

A positive value for the TV indicates that the project as a whole is under budget at the time of analysis.

It indicates that there has been less spent by the analysis date than originally planned.

It is less useful because it does not address the reason behind the underrun. There is also a formula for calculating the percent total

Variance (PTV):

PTV = BCWS − ACWP/BCWS…….(2-29)

Again, TV and PTV are "big picture" tools and not that helpful to the project manager diagnosing the status of the project. Work evaluation manner:

2.16 View result:

There are numerous ways in which project data can be viewed:

2.16.1 S-Curves

The S-curve is a graphic illustration that most project managers in the construction industry are familiar with. An S-curve is a sigmoid function, which is a mathematical process with results that, when plotted on an X-Y axis, vaguely represent the letter “S.” Many processes, including the complex system that we know as the construction project, exhibit a slow buildup that accelerates to a peak loading of labor and equipment, followed by a tapering off and demobilization at completion.

When progress, measured in dollars or labor-hours, is plotted against time, the resulting S-curves can be used to visually demonstrate progress for a variety of tasks or the project as a whole.

and Reporting Variances in Schedule and Cost As part of the control process, the project manager must monitor actual progress against planned progress for the entire project.

The Earned Value S-curve allows the project manager to view the relationship between three main measurement values: BCWS, BCWP, and ACWP.

It illustrates the cumulative progression of work over time for each value. When the results of all three are plotted on a graph of dollars versus time, it is possible to determine at any given date (status date) the difference between planned, earned, and actual.

It is displayed in terms of deviation from the planned schedule and cost.

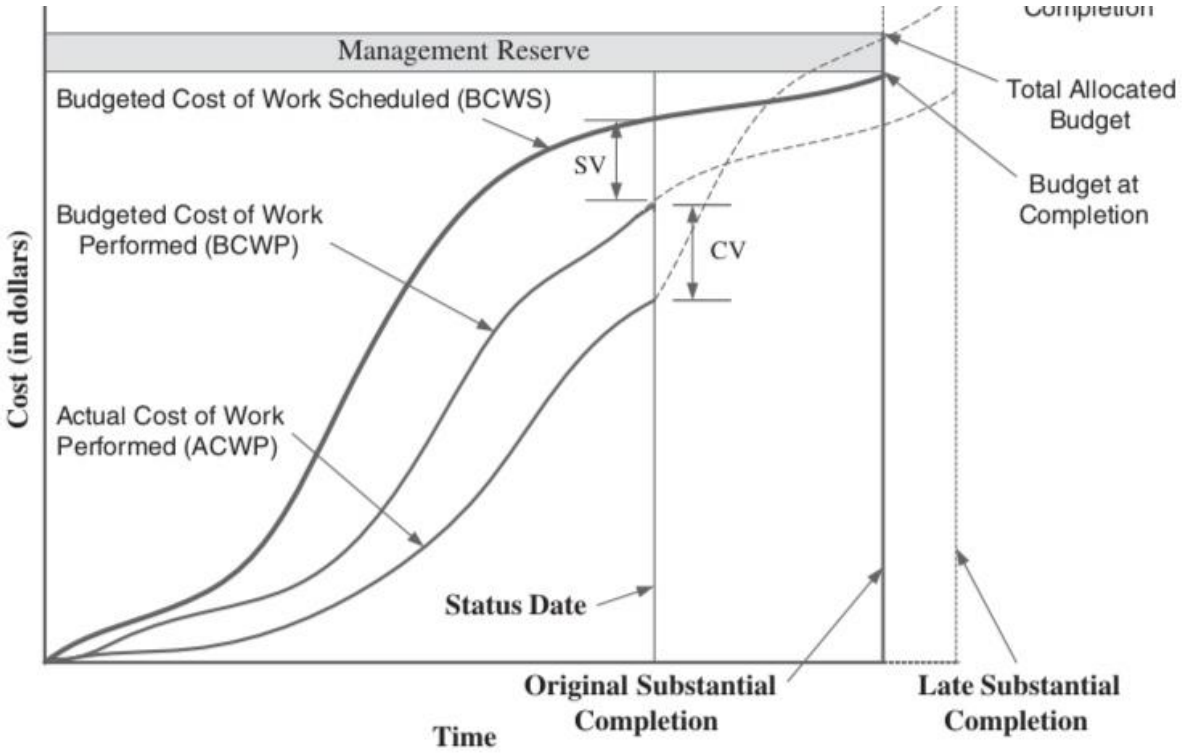


Figure (2.7) S curve:

The EV S-curve (EVS) forms a historical record of what has happened over time Analyses of EVSs allow the project manager to quickly identify project growth, slippage of tasks, or potential problems that could impact the project as a whole if no corrective action is taken.

It should also be noted that while most example graphs show smooth flowing lines for the actual cost of work performed (ACWP), it is rarely the case. Graphed lines for ACWP will ebb and peak with job conditions.

Understanding the S-Curve Data the EVS provides a tremendous amount of data, some of which can be very confusing as well as informative.

Before proceeding with interpreting the data, a review of some of the basic information on the EVS might be helpful.

Here are a few generalizations that may offer guidance in interpreting the data:

● The line for ACWP ideally should be below the line for BCWP on the graph. This represents that cost to perform the work is less than what is earned, indicating a potential profit.

● The completion line should move to the right as extensions of time are granted to the contract.

● If the project experiences actual acceleration directed by the owner/client, the completion line will move to the left. This may also increase the BAC if there are costs associated with actual acceleration.

● BCWS lines with sharp rises over short time periods (horizontal runs) can be an indicator of aggressive, potentially unrealistic scheduling.
● BCWP lines that consistently exceed (are above) BCWS are a reasonable indicator of work progressing faster than anticipated.
● Large initial separations between the lines for ACWP and BCWP with BCWP above the ACWP may be an indicator of excessive front loading.
The positions of the two lines will reverse near the end of the project to reflect the shortfall.
● It is not uncommon for the ACWP graph to intersect and exceed the BCWP at certain times during the project. Sharp rises in the costs of a task may be an indicator of a problem or a negative trend. It can also be the routine posting of a large invoice for materials or equipment.
● A sharp rise in the AWCP line could be attributable to an acceleration of work or an increase in crew size. This can often be expected after the resolution of issues that have stymied progress.
● Delays are often represented by steep dips in the line for the ACWP, which may be mirrored by the graph for the BCWP.

2.16.2 Tracking Gantt chart:

Clearly one of the best sources of data is the Tracking Gantt chart.
Tracking Gantt charts compare actual start and finish times to baselines for individual tasks.
Professional scheduling software is equipped to set a baseline schedule and, with the appropriate data entry, monitor how closely the actual schedule performs in comparison to the baseline.
In an easy-to-follow visual format, the baseline for the task is identified as a bar with starts and finish dates defined on the timescale.
Updates to the baseline are shown in bar style beneath the task with actual start and finish dates.
The different bars are illustrated in contrasting colors or infill patterns to avoid confusion.
When the critical path is defined by linking the tasks, any deviation from the baseline illustrates the impact on the overall schedule.
In the case of delay to the critical path, the project manager is alerted to the need for corrective action, or at the least investigation as to the cause.
Very few tools in the project control toolbox have the immediate visual impact of the Tracking Gantt.

Activities in process show the progress to date and show the remaining scheduled duration assuming the task will complete on time.

Activities that have not yet started show a revised start date based on links to their predecessors.

Multiple updates of the Tracking Gantt can often show trends for a task and possibly identify the cause of the delay.

- Control Charts:

The control chart is another management tool to monitor schedule performance

It tracks past and current performance by update and can be used to predict future performance with modest accuracy.

It is a summary view that focuses on the project's critical path in contrast to individual tasks.

A study of Figure indicates that the data is plotted against an X-Y axis. The horizontal or X-axis starts with project commencement at zero and is delineated by the number of expected update reports.

The vertical or Y-axis is divided in two horizontal sections with zero again as the

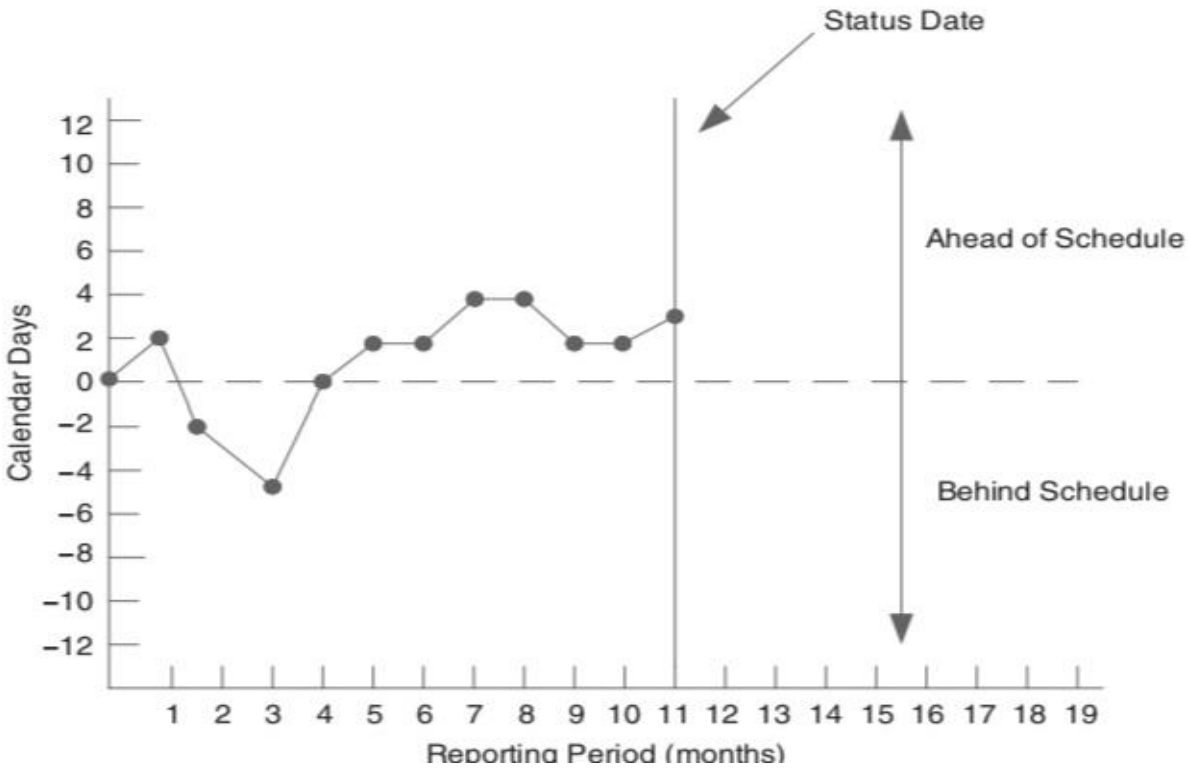


Figure (2.8) control chart

starting point approximately halfway up the Y-axis. A horizontal line starting at the mid-point of the Y-axis is drawn through the last update.

This horizontal line is considered the baseline schedule.

The scale above the baseline represents the number of days the project is ahead of schedule, and the scale below is days behind.

The chart is used to plot the difference between the scheduled time on the critical path (represented by the zero baseline) and the actual time on the critical path as of the report date.

indicates that the project was two days ahead of schedule at the first reporting period, but suffered a setback that would continue through reporting

period 3. From reporting periods 3 through 6, there is an almost steady improvement that results in once again being two days ahead of schedule. Without knowledge to the contrary, it might be concluded that the improvement suggests that corrective action brought the schedule back on track.

This data could be used to suggest that if the trend is sustained, the project will deliver ahead of schedule.

Since most task times represent average durations, four updates that each support a trend usually indicate, with high probability, that there is a reason for the improvement.

The project manager should attempt to ascertain the cause and potentially exploit it to maintain the trend.

The disadvantage to the control chart is its lack of detail. It is a summary tool with its greatest appeal on projects of long duration.

From the update points alone, there is insufficient data to determine anything other than a positive or negative position at that date.

Control charts are most often used to track progress toward a milestone or as an update to upper management.

Slippage that results in work a few days behind schedule in the first half of the project is less alarming then if it occurs in the last quarter of the schedule.

So control charts have the advantage of representing the time remaining for correcting any problems.

As remaining time in the schedule expires, the flexibility and opportunity to rectify the delay diminishes.

-SPI and CPI Charts :

Similar to the control chart, the SPI and the CPI can be plotted on an X-Y axis graph to track each over time .

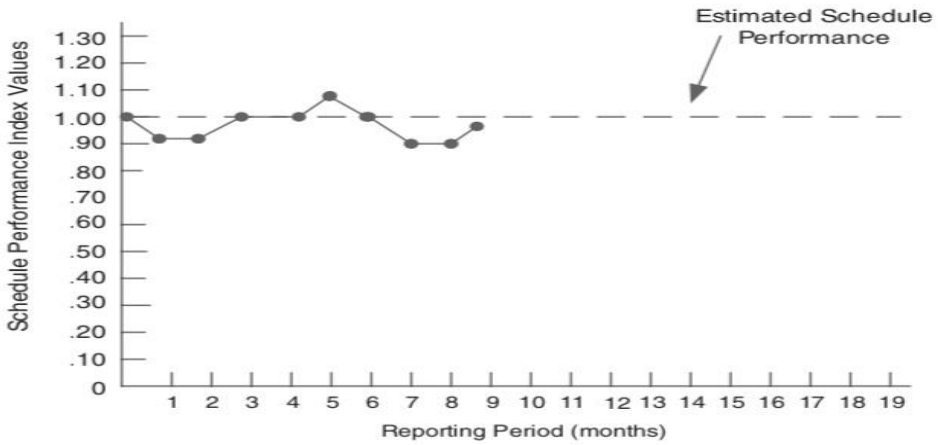


Figure (2.9) SPI and CPI Charts :

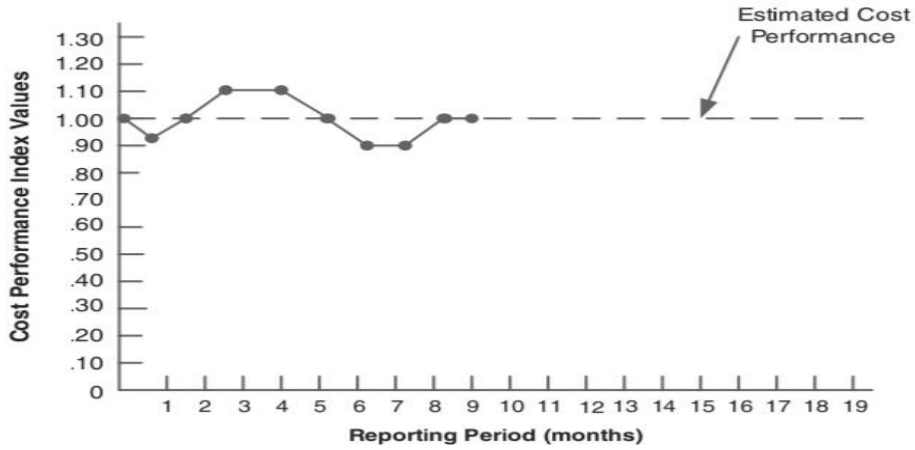


Figure (2.10) CPI Charts

In each of the charts, the X-axis is delineated by the reporting period and the Y-axis is divided in two horizontal sections with 1.00 as the starting point approximately halfway up the Y-axis. For both the SPI and the CPI, 1.00 indicates a perfect performance. Above the horizontal line are delineations that increase in .10 increments: 1.10, 1.20, and 1.30.

Below the line the values are decreased in .10 increments. As the CPI and SPI values become available at each reporting period and are plotted on the graph, they indicate a history of schedule and cost performance for the project. When the variance threshold for SPI and CPI (discussed in the section to follow) are highlighted in red, it is a great visual tool for indicating when the project or one of its tasks has a potential problem

2.18 Corrective action:

Causes of Variances In any project a variance is defined as a deviation from any schedule or cost value. The reasons behind cost and schedule variations are numerous and can be attributable to a myriad of reasons from poor estimating

and scheduling practices to gross mismanagement by the contractor. Assuming that estimating, scheduling, and management practices by the contractor are commensurate with professional practice standards, it would be prudent to consider some other potential causes of the variances.

2.19 Cost Variances:

Cost and schedule variances are interdependent, yet a positive schedule variance does not necessarily translate to a positive cost variance.

Some of the identifiable causes of cost variances, both positive and negative, are the following:

- poorly defined scope during the buyout phase that can often add to subcontractor/vendor costs as the work packages are executed
- incorrect distribution of dollars to cost accounts in the budgeting phase that may show up as excessive positive or negative cost variance
- Unrealistic or overly aggressive target budgets at completion (BAC)
- Excessive front loading of costs
- Performing work out of sequence
- Scope creep due to the rejection of change order requests
- Excessive use of premium wages with little or no benefit to the schedule
- Crew sizes too small or too large for the task resulting in inefficient use of resources
- Hastily or partially purchased materials resulting in premium costs
- Frequent delays of crews from inadequate material stores on-site
- Insufficient/incorrect tools or equipment for the task
- Excessive handling, freight, and storage costs
- Changes in labor rates, benefits, or labor burden

2.19.1 Schedule Variances some of the more common causes for schedule variance include:

Continual or excessive interruptions to production forces

Lack of provisions for adequate and clear direction to workforce

Rework due to inadequate supervision

Provision of material stores not adequate to prevent interruption in production

Use of overtime when there is no tangible benefit to the schedule

Unforeseen latent conditions resulting in a work stoppage

improper equipment or tools for the task

Crew size not appropriate for the task

Delays due to equipment breakdown

Performing work out of sequence

late start of a critical task
Incorrect linkage of a critical task to a noncritical task
Loss of continuity due to change in supervision
Change in crew composition (tradesmen vs. apprentices)
Attrition of labor force
Understaffed subcontractor labor workforce
Scope more extensive than was initially planned
Staging area too far from work area

2.19.2 Variance Thresholds:

Monitoring project success by tracking cost and schedule variances becomes a little more realistic and considerably easier if all variances do not require immediate investigation.

Many variances to both schedule and cost are a result of common everyday issues like timing.

Variances due to timing usually sort themselves out in subsequent reports.

While variances are important, they are only helpful when the correct frame of reference is applied.

In order to manage more efficiently, project managers with the help of their project teams set a threshold on both cost and schedule variance.

A threshold is a limit or boundary of a variance expressed as a percentage of its performance index.

Thresholds allow the team to know when to take corrective action and when to apply a “wait-and-see” strategy.

Performance indices are indicators that are relative to the size of the project and offer more useful information than variances especially in terms of setting thresholds

A review of the data indicates that the project is behind schedule by 10 percent but we are ahead financially by 7 percent.

If in the planning stage the team defined the thresholds for SPI at plus or minus 5 points (5 percent) and CPI at plus or minus 8 points (8 percent), it would trigger an investigation of the schedule overrun. However, the cost underrun does not warrant concern, as it is within the limits prescribed by the threshold.

The SPI indicates to the project manager that for every dollar that the team planned on spending, they are getting 90 cents worth of performance. The CPI indicates to the team that for each dollar spent, the team is achieving $1.07 worth of performance.

Clearly, with these thresholds in place, some investigation of the schedule slippage is required. The difficult task is choosing the correct threshold for a task.

There is no uniform methodology for deciding variance thresholds.

●**Thresholds may be dependent on a variety of factors such as:**

Overall project duration

Specific task duration

Dollar value of the task as a percentage of the total contract

Type of contract— fixed price or cost-plus

Profit margin of the contract

Phase of the project

Contractor's tolerance for risk

Thresholds may be different from project to project or from task to task. Thresholds may even be permitted to change over the life of the project with larger thresholds at the beginning than at the end of the project. The theory is that risk

diminishes as the task gets closer to completion. Variance thresholds are based on risk tolerance of the company for that individual project.

There are some general guidelines that may be helpful:

Variance thresholds set at less than 5 percent suggest the contractor has a low tolerance for risk.

Variance thresholds set at between 5 percent and 10 percent suggest the contractor has a moderate tolerance for risk.

Variance thresholds set at 10 percent or over suggest the contractor has a high tolerance for risk.

Variance thresholds for critical path tasks with SPIs and CPIs can be interpreted as follows:

Less than 5 percent is viewed as an early warning of a potential problem.

Between 5 percent and 10 percent is cause for investigation and possibly action.

Over 10 percent is cause for immediate and substantial action.

Higher percentages on thresholds can also be translated into taking action later rather than earlier.

2.19.3 -Root Cause Analysis:

Once the data has been reviewed and analyzed and the problem task(s) are known, the next step is to identify what is driving the variance.

In much the same manner as a doctor must diagnose and treat the cause of an illness to prevent the symptom from reappearing, the project manager must look

deeper to determine the reason for the variance and then correct it to either stop further harmful effects or prevent it from reoccurring in the future. If the project manager is unable to determine why a particular variance occurred, how will he or she be able to specify corrective measures with any confidence or success? Understanding what led to a particular cost or schedule failure is the key to developing an effective and efficient plan of corrective action. The more specific the diagnosis, the more focused the remedy.

While not developed specifically for the construction industry, there is a process aimed at identifying the source of the problem event that precipitated the variance.

It is called Root Cause Analysis (RCA). RCA is a systematic approach for discovering the factors that resulted in the failure.

It identifies what actions, inactions, individuals, conditions, or processes need to be changed to prevent continued or future failures (Figure 8.6). RCA is more reactive than proactive in nature; however, it can be used to forecast problems before they happen.

Effective root cause analysis over time can be used to structure opportunities for improvement in the construction process

Root causes can generally be defined as follows:

- The specific underlying cause of a problem

-Within the purview of the project team to correct

- Causes that can be identified and isolated

Problems for which practical effective solutions can be found There are four major steps to the RCA process:

Step 1—

Collect the data required to fully identify the problem. While data from the S-curve, CPI, and SPI may be the trigger to the investigation, additional who, what, where, and when questions are needed. Make assumptions only if necessary.

Step 2—

Organize the data into factors that were contributors to the event. Create a written list of all contributing factors. The factors can be laid out sequentially or chronologically leading up to the problem. This particular step allows the project team to see the interrelationship between the factors.

Step 3—

Identify the root cause of the event. Find the base reasons for each contributing factor in order to understand how to correct the failure. Verify that assumptions made are valid.

Step 4—

The final step in the process is to generate a recommended solution and craft a plan to implement it. Once implemented it must be tracked and analyzed to ensure it is the correct solution. Frequently, adjustments to the initial plan are needed to optimize the fix.

As with any acknowledged problem, those accountable for solving the problem want everyone to know when it's corrected. For any major RCA, a dedicated report is generated. However, for most routine corrections, a redacted version of the events is adequate in the normal course of update reports.

2.19.4 Reporting Project Status:

Much of the data that is analyzed comes from multiple sources.

They include daily reports, job cost reports, look-behind schedules, updated tracking schedules, and a myriad of other, less formal means.

Some of the data may even be contradictory and require further analysis.

Regardless of the source, it all is part of the snapshot that is the status of the project.

It is the responsibility of the project manager to sift through the data and decide what issues are of importance and what doesn't make the cut, then share it with the team and other stakeholders.

Effective communication is the key to successful project management.

Sharing the correct information with the right people in a timely manner is paramount to project success.

The status report is a way of ensuring that all team members are on the same page and have the latest progress update information.

The project status report is a regular, formalized report on project progress as compared with the project plan.

Status reports are not meant to be creative writing assignments; they are meant to convey information to busy people.

there are some key components that all status reports share:

Reports should be concise and clearly written.

Reports must have basic information: date, project, recipient list, how the report is delivered, etc.

Regular status reports should follow the same format.

Reports must convey what has been completed.

Reports must identify what tasks are behind or in danger of falling behind
Reports should identify the reason for a slipped task if known.
Reports should identify milestones that have been achieved and those that have slipped.
Reports should identify ongoing or potential problem tasks or issues that are being monitored.
Reports should be written in the third person.
Reports are less narrative and more declarative; bulleted information is acceptable.
Reports should present the facts and avoid presenting opinion.
Reports should remain positive, but avoid the Pollyanna syndrome (robust optimism).
If the report expects action from a team member, it must make sure that the action is clear to the reader.
Reports must maintain simple, but effective status reporting.
The report must be available at the same day and time so that participants can expect it with regularity.
Good, consistent project status reporting helps guard against unexpected surprises to the participants.
It is intended to provide team members with a clear view of the project at that date.
It should address topics such as schedule, cost, resources, changes, disputes, and any issue requiring the focus of the team.
Remember the status report is a documented history of the project and the decision making of its managers.
It is different from meeting minutes since it originates with the project manager.
It will become part of the project record and, as such, should be written with sufficient detail so that minimally involved individuals can understand the report at a later date.
Frequency of reporting will vary from project to project depending on factors such as project size, expectations of information, distribution by management, and project complexity with the associated risks.
The most common reporting period is the week. Project status is typically reported by the project manager to those in upper level management, such as senior and project executives.
It is also shared with functional managers, such as team leads, superintendents, and other parties needing updated information.

The finalized project status report should be distributed among team members in accordance with the project's communication plan

It is important to realize that the status report is not intended as a substitution for ongoing project communication between team members, the project manager, the client, or other parties requiring updated information to perform their duties.

2.20 Previous studies:

-The consequences of building construction project are always negative thus delay should be avoided at all cost .to avoid construction delay , it is imperative for project participants to first of all identify the possible fac-tors . one of these factor 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 ca-use that are due to either contractor, consultant, clients, environmental, governmental or others.

With all this resolution method put in place it will be very easier to identify who ever is at default. Sudan is an underdeveloped country lacking all the recourses need to successfully complete building construction project with-in the located time and budget. this has had adverse effect on infrastructural development aspect of the economy and also its construction industry reputation in the global market. there for it is doubtful that the government and private institution keep spending hug amount of money on construction projects which are later delay and some abandonee . from our finding ,we conveniently pointed out most common causes of construction project delays were inflation of prices of construction , materials , shortage of materials , inaccurate time estimation , errors during construction ,improper planning , delay in payment to contractor , compensation issues , design change and inaccurate cost estimation .

(MOHAMED, 2015)

-The scientific importance is due to that study is subject to one of the problems facing the construction and A an integrated framework between cost management and model methods for the engineering projects to adjust the time and cost. - The problem of the study was in the length of time for contracting contracts, resulting in difficulty estimating costs and non-existent costs in good picture and also show the problem of proper non-planning and the use of methods and planning tools.

The goal of the student to achieve major aggravation to assess cost accounting and its role in reaching the success of the success of construction projects with

high efficiency and the results of the study. The lowest possible cost and without misuse and abuse of employee employees must be paid to the use of scientific and effective methods that enable it to achieve this (studies of Omar Taj Age 2008)

-The problem of the study highlighted the impact of poor planning on the delay in the implementation of construction projects in the Emirate of Dubai. The delay in achieving engineering projects back

In the lack of adoption of contracting companies on the ingredients and effective administrative and engineering planning as a foundation for the success of their plans and understanding of the success of the plan and understanding the effectiveness of planning. Recommendations are the need for contracting companies using a suitable model for projects to adjust cost management (studies Aladdin on Deiri (2011).

***This study is differing from previous studies** by its focus on the impact of critical economic condition and failure to develop the concept and methods of cost management on construction project.

CHAPTER THREE

DATA COLLECTION

3.1Introduction:

This chapter deals with how the research problem was Investigated and data was collected the method used and how Information was analyzed in order to accomplish the objectives of the study.

The chapter was organized around (collect detailed information this was followed by interviews with projects participants, Field Study, Planning field student, Study area, Search community and sample selection ,Design of the questionnaire form, The statically methods used in the study, Study sample analysis).

The current study aims to identify and analyze the impact of Economic reasons and their impact on changing cost in construction project site in Sudan and the impact of application cost management in construction project.

3.2 case study:

Case NO (1)

Project name	Construction of secretarial building
location	Northern state
The scope of work	Construction of government office
the owner	Governmental of north state
The contractor	Abdul mutal hamudto
The consultant	Teknion company
No of floor	Three
Built area	m2
Project delay method	Tender
Type of contract	Fixed price
Date of contract signing	25/11/2017
Date of commencement	9/7/2018
Contract duration	
Date of actual finish	The project not end
Contract price	27,000,000
Actual cost of project	500,00,0000
Contract increase	473,000,000

Case NO (2)

Project name	Implementation of development projects
location	North of cordovan state
The scope of work	Construction of rain water harvesting basins
the owner	Ministry of water resources energy and mining
The contractor	Drilling and investment company LTD
The consultant	Practical consult company
Project delay method	Tender
Type of contract	Measure contract
Date of contract signing	1/2/2018
Date of commencement	28\2\2018
Contract duration	10 month
Date of actual finish	Not finish
Contract price	96,836,589
Actual cost of project	122,982,467
Contract increase	26,145,878

Case NO (3)

Project name	Implementation of underground awell
location	kassala , algadaref sea red, states
The scope of work	Dirilling of well
the owner	Implementation unit
The contractor	Drilling and investment company LTD
The consultant	General administration of the underground water and the wells
Description of project components	Drilling 29 under ground well
Project delay method	Tender
Type of contract	Fixed price
Date of contract signing	1/2/2018
Date of commencement	13\2\2018
Contract duration	10 month
Date of actual finish	Not finish
Contract price	46,613,628
Actual cost of project	57,552,385
Contract increase	10,938,757

Case NO(4)

Project name	implantation Drilling underground awell
location	Darfur states
The scope of work	Drilling 50 underground awell
the owner	Ministry of finance and economic planning

The contractor	Drilling and investment company LTD
The consultant	Practical consult company
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1/2/2018
Date of commencement	28\2\2018
Contract duration	1 year
Date of actual finish	Not end
Contract price	42,506,626
Actual cost of project	65,460,205
Contract increase	22,953,579

Case NO (5)

Project name	implantation dam rahad omgedad
location	north Darfur states
The scope of work	construction of dam
the owner	Implementation unit
The contractor	Drilling and investment company LTD
The consultant	Etgan consult company
Project delay method	tender
Type of contract	
Date of contract signing	1/2/2018
Date of commencement	28\2\2018
Contract duration	11 month
Date of actual finish	Not end
Contract price	33,564,375
Actual cost of project	54,096,266
Contract increase	20,531,891

Case NO (6)

Project name	implantation dam
location	White Nile states
The scope of work	construction of dam
the owner	Implementation unit
The contractor	National Drilling and investment company LTD
The consultant	Practical consult office
Project delay method	tender
Type of contract	
Date of contract signing	1\12\2017
Date of commencement	20\12\2017
Contract duration	11 month
Date of actual finish	19\12\2018

Contract price	22,849,099
Actual cost of project	34,923,385
Contract increase	12,081,286

Case NO(7)

Project name	Residential bulding
location	khartoum
The scope of work	construction of multi storey building
the owner	Smelter s international
Date of contract signing	1/3/2021
Date of commencement	20\3\2021
Contract duration	11 month
Date of actual finish	19\12\2018
Contract price	23,390,000
Actual cost of project	31,950,000
Contract increase	8,560,000

Case NO(8)

Project name	Rehapition of treated waste water
location	khartoum states
the owner	Khartoum state sanitary corporation
The contractor	Omerab alerania
The consultant	Teknon company
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1\1\2019
Date of commencement	20\1\2019
Contract duration	12month
Date of actual finish	Not end
Contract price	200000
Actual cost of project	1,900,000
Contract increase	1,700,000

Case NO(9)

Project name	Construction of bathroom
location	The river Nile states
The scope of work	Construction of bathroom
the owner	Aldamer distric
The contractor	Ministry of construction planing
The consultant	Teknon
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1/2020
Date of commencement	8/1/2020
Contract duration	6 month

Date of actual finish	Not end
Contract price	5,250,000
Actual cost of project	28,650,000
Contract increase	23,400,000

Case NO (10)

Project name	Construction of bathroom
Location	The river Nile states
The scope of work	Rehabitaion of mosque and Construction of bathroom
the owner	Aldamer distric
The contractor	Kushabi contracting
The consultant	Ministry of construction planing
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1/7/2020
Date of commencement	28/7/2020
Contract duration	8 month
Date of actual finish	Not end
Contract price	1,545,288
Actual cost of project	2,384,159
Contract increase	83,8871

Case NO(11)

Project name	Construction of school
location	Northern state
The scope of work	Construction of school
the owner	Dongle distric
The contractor	Haton -contracting
The consultant	Ministry of construction planning
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1/1/2019
Date of commencement	8/1/2019
Contract duration	2 year
Date of actual finish	1/1/2021
Contract price	968,750
Actual cost of project	7,604,600
Contract increase	838,871

Case NO(12)

Project name	Construction of school
location	Northern state
The scope of work	Construction of school
the owner	Dongle distric
The contractor	Haton -contracting
The consultant	Ministry of construction planning
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	1/1/2020
Date of commencement	8/1/2020
Contract duration	1 year
Date of actual finish	1/1/2021
Contract price	8,810,517
Actual cost of project	18,399,302
Contract increase	9,588,785

Case NO(13)

Project name	Construction building of ministry of finance and economic
location	Northern state
The scope of work	Construction governmental building
the owner	Northern state
The contractor	Almohager company
The consultant	Teknion company
Project delay method	tender
Type of contract	Fixed price
Date of contract signing	25/11/2017
Date of commencement	7/6/2018
Contract duration	2 year
Date of actual finish	Not end
Contract price	25,000,000
Actual cost of project	100,000,000
Contract increase	75,000,000

3.3 Field Study:

In this part, actual practices in Sudan will be implemented from the point of view of the public and private sectors to help choose the health and accuracy of the presentation and identification of the difference between what has been applied and approved by normative roads Depending on the different theoretical frameworks

3.4 Planning field student:

The purpose of planning field student is the components of this study, which helps to achieve their objectives and hypotheses, through the knowledge of the components of the and student identical and identify the sources of information and the methods of collection from the community of the study, and then determine the method of proof of hypotheses in the study and thus reaching access To the results that support and prove the impulse of the student.

3.5 Study area:

This study was conducted in the Republic of Sudan, in a number of capital of different states of Sudan and the focus was capital, due to the urban development it has witnessed in recent years.

Khartoum was chosen in the Turkish government's capital of 1821 and this period is important in the history of Khartoum, where the first planning of Khartoum.

Sudanese After independence, Al-Hagarat increased towards Khartoum for the national sense of freedoms and the be urban, which has returned to the concerned, making the rural aspires looking for a better life in urban. The first multi-story buildings were "bilateral judgment" Palace of public governor and other buildings on the Blue Nile and multi-floors are behind administrative buildings.

The post-independence period and during the 1970s, the expansion of the ground in the deployment in residential areas in Khartoum and net neighborhoods began. After Khartoum suffered numerous planning experiences, I did not keep keeping with rapid unchanged Amarni and security on the center under extended, resulting in a broad horizontal horizontal horizontally for the major city of Khartoum, but Khartoum lost its urban features and entered the labor market unqualified companies played by mediation A landmark role to receive the matter in construction and construction problems, engineering problems have emerged administrative mistakes in management, planning and conceals in condemnation and design. Sergeant missed buildings and private engineers and private engineers. As a result of the volatility of the contract today in construction projects and the use of modern means of managing the administrative and financial imbalance of these projects

3.6 Search community and sample selection:

The sample requires the availability of certain key characteristics and characteristics that are directly and strongly related to its original and necessary relationship as a fundamental and necessary step to reach accurate results on the

subject of the study. The researcher has been keen to be a sample of the search engineers in various fields.

Where a regular random sample was selected in a scientific basis so that this sample represents a true representation.

$N=\frac{Z^2*S^2}{D^2}$…….. (3-1)

The total number of sampled people80

3.7 Design of the questionnaire form:

The questionnaire for the collection of the necessary information for the study was designed and distributed to selected samples of project probes, to determine the effectiveness of the management and planning of the cost of construction projects in Sudan and the researcher has adopted its preparation for the search form on the rules Scientific and through previous theses, as well as through Technical Experience for Researcher, and then was introduced to a set of specialized project prints and projectors contractors and also on a number of administrators to know how to harmonize this questionnaire and after amendment of resolutions and in accordance with their ability to examine and test the hypotheses and achieve their objectives even access to formula The final is simply identified and after cost.

The questionnaire department to four axes:

First Axis:

Analysis of Demographic Characteristics of of sample personnel included: Name, company name, Career for your company, age, academic class, professional grade, enterprise status, years' experience for institutions, years' experience to improve.

The second axis:

Economic reasons and their impact on changing cost in construction project site in Sudan

Where he used in this tribute to the pentagram

(Liker Scale) (Highly agree, I agree, neutral, no agree, do not strictly agree)

The third axis:

About the Cost management in construction project site in Sudan has included: - (Always, sometimes, never)

The four axes:

Techniques and methodologies followed in the management and planning of cost has included:

Earned value analysis, variance analysis, trended analysis, reserve analysis, Liker scale (always, sometimes, never)

The fifth axis:

Follow-up processes, control and control of construction.

It is essential in the management and planning of the cost and the form included in Sudan, where he used in this tribute to the pentagram

(Liker Scale) (Highly agree, I agree, neutral, no agree, do not strictly agree)

3.8 Tool of Study:

Liker scale (Liker Scale) is used To identify the descriptive opinions of the eye data

3.8.1The test of the measurement tool:

Authenticity of the tool: This process aims to make sure that tool that Used in this research is actually measured, and thought of honesty Used in this study

A -The virtual is the process of ensuring

That the views contained in the research tool can result in accurate data collection, and to do so the research tool has been displayed on a group of academic and professional specialists, to identify the degree of praise used, and its utilization, and its name of the study has been adjusted and the vertebrates had been modified.

B-The content believed:

I mean this honesty The extent of the following paragraphs after the dimensions of the search tool they belong to, and the attention has been paid to ensure That each dimensional is under the dedication of the representative in accurately with a group of vertebrates And that these vertebrates already measure this dimension.

C-The stability of the tool intakes steadfastness (Reliability):

Enabled you get the same data when you re-search using the same research tool on individuals themselves under one conditions.

The stability of the tool was measured by using an alpha internal consistency scale.

3.8.2 The data collection tool:

The data collection tool was using the questionnaire as a more data collec-tion tools using in research and studies, a questionnaire is designed to cover all topics and trends based on the research and practices in this area. The questionnaire is designed to provide data through which they are intended to be answered and tested by research questions, and then test the hypothe-ses and then put public guidelines that provide the recommendations to pr-ocess the gap between the normative and local practice that will help solve the problems we addressed search.

3.9 The statically methods used in the study:

3.9 .1Data reliability test:

To measure the extent of the credibility and consistency of the answers of the individuals of the research sample the researcher used the Cronbach alpha co efficient so the degree of credibility related to the answers to the hypotheses 0.915bearing in mind that the acceptable degree of the Cronbach's alpha coefficient is 0.837therefore it is possible to rely on the answers of the study sample and then analyze its data.

This table (3.1) show the result validity and reliability of the study tools according to Cronbach's Alpha where that (0.92) and this value very high near one ,any increasing in Cronbach's Alpha value that means reliability of data, and the study tools can measuring for which it put for

No	pivots	N of tiems	Cronbach's Alpha	reliability
1	Economic reasons and their impact on	11	0.615	0.784
2	Cost management in construction	10	0.551	0.743
3	Technologies and methodologies for	10	0.803	0.896
4	follow-up processes, control	12	0.795	0.892
	Total	43	0.837	0.915

Table (3.1) shows the result validity and reliability of the study tools according to Cronbach's Alpha

3.9.2 Descriptive statistical method:

The researcher used the frequency distribution method for the answers of the members of the research sample to obtain on the features of the structure of the study population which is a type of statistical method descriptive information helps make general decisions about the features and composition of a society study and method of distribution.

3.9.3UseT- test:

The one sample t test examines whether the mean of population is statically different from a known or hypothesized value. The one sample t test is parametric test.

Single sample t test the variable used in this test is known as:

T test variable:

In one sample t test the test variables mean is compared against a test value which is a known or hypothesized value of the mean in the population.
Test values may come from literature review trusted research organization legal requirement or industry standards.
T. test is statically test that is used to compare the means of two group.

3.10 Study sample analysis:

The researcher used the data analysis program the statistical package for the social science (SPSS)in analyzing the study sample questionnaires and this program is considered one of the most popular programs it is widely used in the analysis of statically information in sociology and is widely used today it is used by researchers in various field and is also used in information management and documentation.

CHAPTER FOUR

RESULT AND INTERPRETATION

DISCUSSIONS

4.1 Introduction:

This Chapter include(study case Analysis ,case for building projects were studies as mention in chapter three the result are show table figure And questionnaire Analysis Results and Discussion).

4.2 case study analysis:

In the table below the reason of change cost in some project selected by the researcher, and then make analyses to explain the variance between the initial cost in the contract and the actual cost in the figure below (comparing between initial cost and final cost and final cost for study project).

Table (4.1) the reasons that led to the deviation of cost:

NO	initial cost	final cost	increase	percentage
case(1)	27,000,000	500,000,000	473,000,000	17.5%
The reasons that led to deviation	Increase prices(inflation), economic polices , korona			
case(2)	96,836,589	122,982,467	26,145,878	0.26%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(3)	46,613,628	57,552,385	10,938,757	0.23%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(4)	42,506,626	65,460,205	22,953,579	0.54%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(5)	33,564,375	54,096,266	20,531,891	0.61%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(6)	22,849,099	34,923,385	12,074,286	0.53%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(7)	2,339,000	3,195,000	856,000	0.366%
The reasons that led to deviation	Increase prices(inflation			
case(8)	200,000	1,900,000	1,700,000	8.5%
The reasons that led to deviation	Inflation,corona virus, cash flow interruption, government low			
case(9)	5,250,000	28,650,000	23,400,000	4.46%
The reasons that led to deviation	Modify specification , Inflation, , delay in cash flow, government low			

case(10)	1,545,288	2,384,159	838,871	0.54%
The reasons that led to deviation	Modify specification , Inflation, , delay in cash flow, government low			
case(11)	968,750	7,604,600	6,635,850	6.85%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(12)	8,810,517	18,399,302	9,588,785	1.1%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			
case(13)	25,000,000	100,000,000	75,000,000	3%
The reasons that led to deviation	Inflation, corona virus, cash flow interruption, government low			

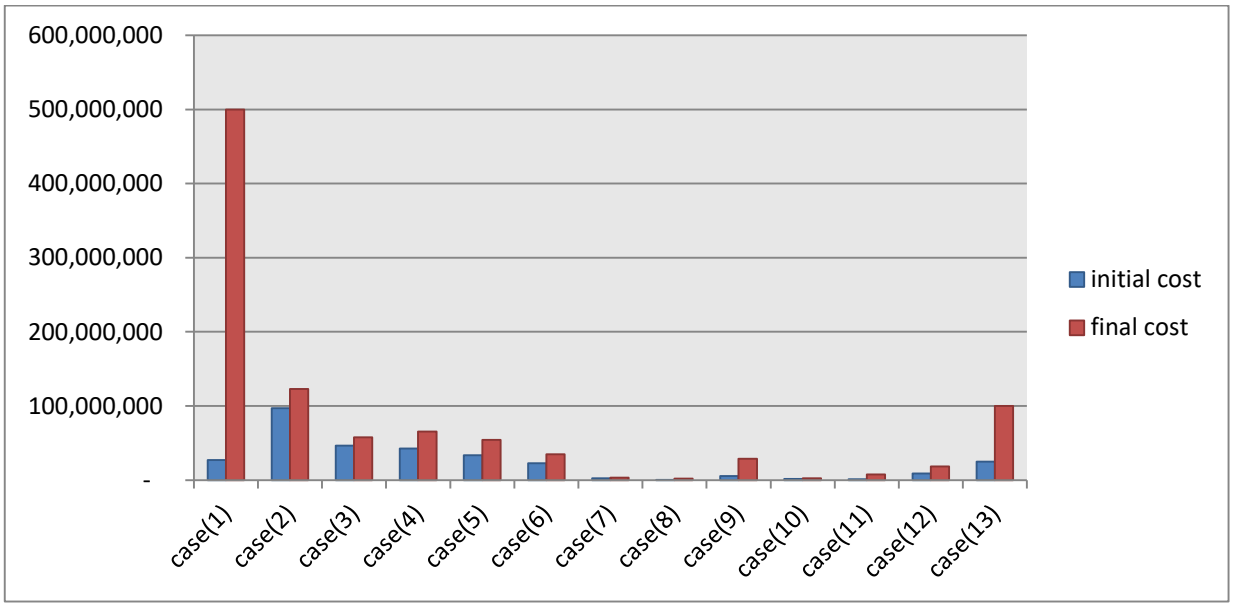


Figure (4.1) comparing between initial cost and final cost and final cost for study project

4.3The demographic variables of the study:

Table(4.2) demographic variables

General Information	Class	Frequency	Percent
What are your total years of the company experience within construction projects field?	Less than 5 years	27	33.8%
	Less than 10 years	20	25.0%
	From 10 to 20 years	19	23.8%
	More than 20 years	14	17.5%

	Total	80	100.0%
total years of experience	Less than 5 years	28	35.0%
	from 5 to 10 years	29	36.3%
	From 10 to 15 years	12	15.0%
	More than 15 years	11	13.8%
	Total	80	100.0%
What is your age	25-35	2	2.5%
	35-45	63	78.8%
	45-55	7	8.8%
	>55	8	10.0%
	Total	80	100.0%
highest academic degree	Bachelor’s degree	47	58.8%
	Higher Diploma Degree	5	6.3%
	Master’s degree	23	28.8%
	Doctorate degree	2	2.5%
	Others	3	3.8%
	Total	80	100.0%
what is te professional class	Graduate	49	61.3%
	specialist	14	17.5%
	Consultant	5	6.3%
	Others	12	15.0%
	Total	80	100.0%
What is the category of your current organization?	Projects Management	14	17.5%
	General Contractor’s	48	60.0%
	Specialized Contractors	3	3.8%
	General Engineering Consultants	15	18.8%
	Total	80	100.0%
What is the level of your current occupation?	Top manager	8	10.0%
	projects manager	14	17.5%
	Project manager	17	21.3%
	site engineering	23	28.8%
	Others	18	22.5%
	Total	80	100.0%

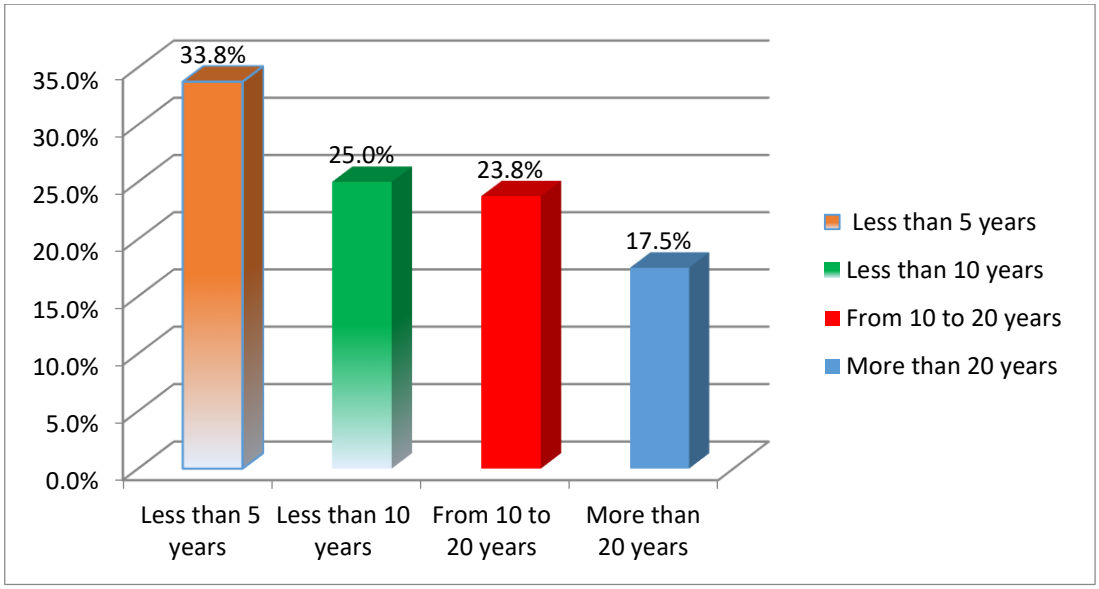


Figure (4.2) Distribution of the sample according Gender

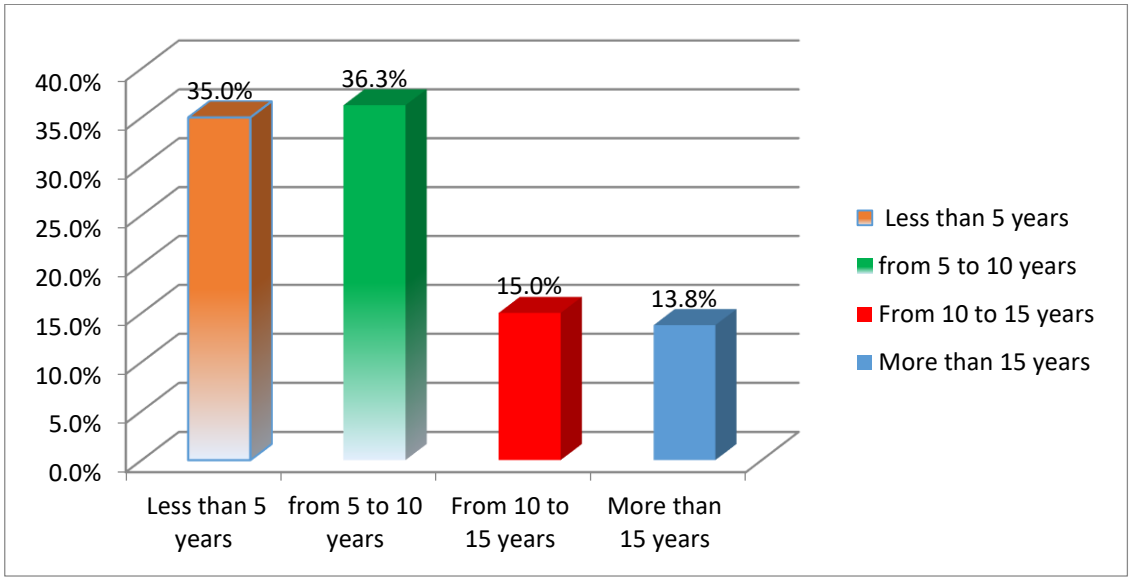


Figure (4.3) Distribution of the sample according Certificate

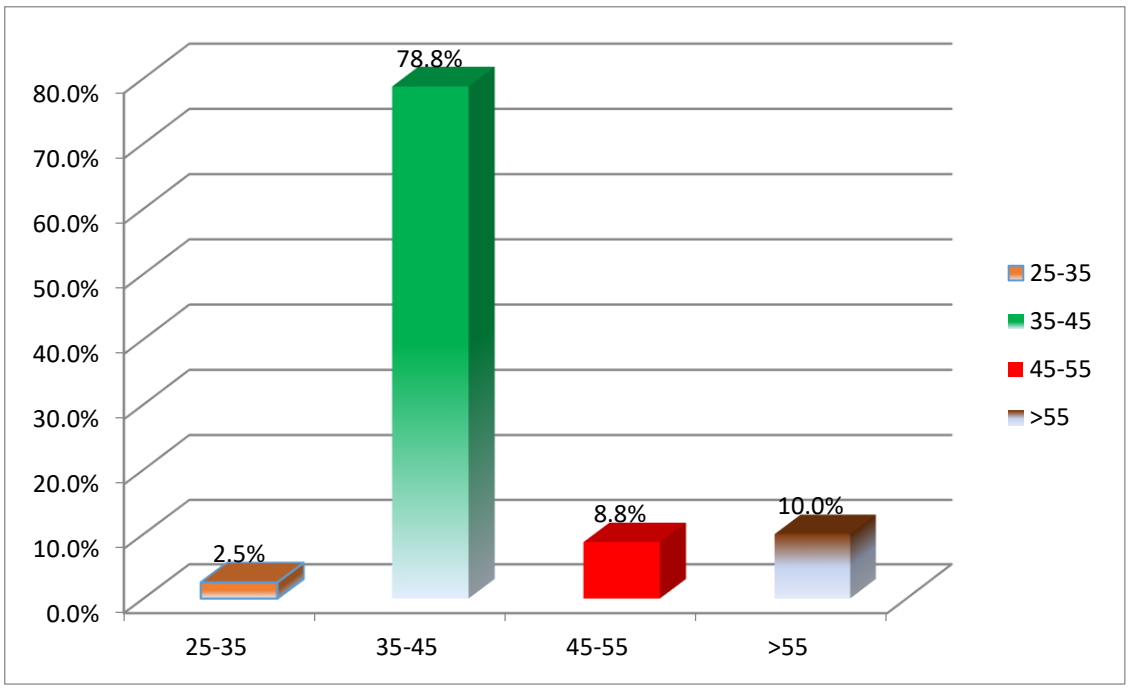
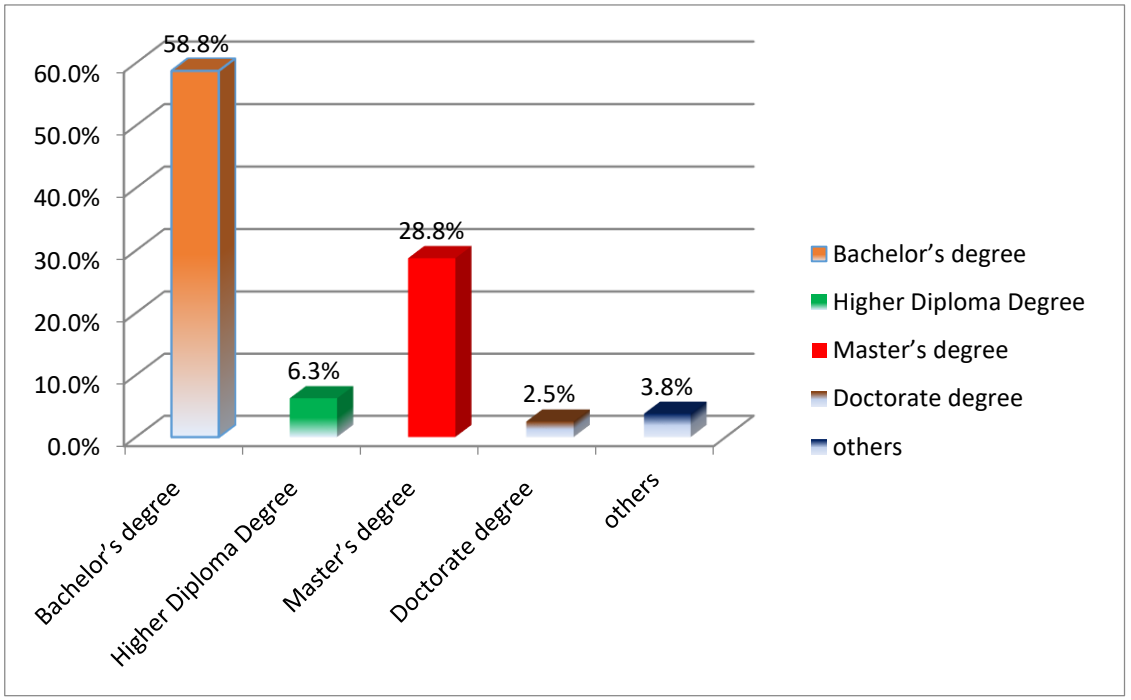
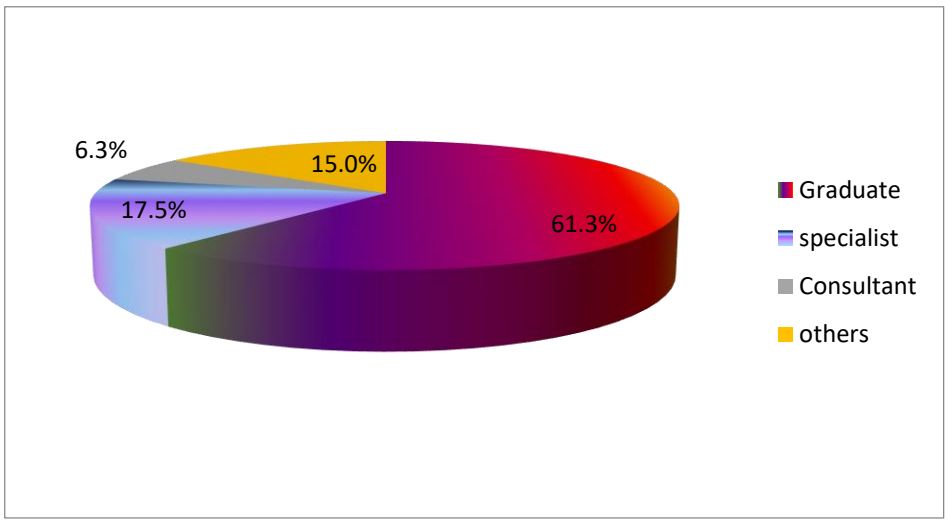


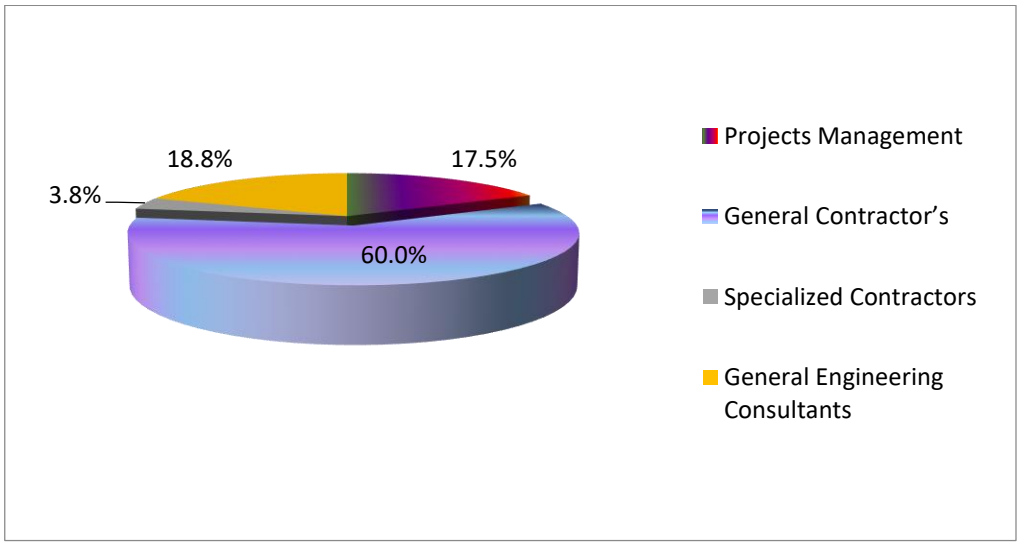
Figure (4.4) Distribution of the sample according Job Experience



Figure(4.5) Distribution of the sample according occupation



Figure(4.6) Distribution of the sample according occupation



Figure(4.7) Distribution of the sample according occupation

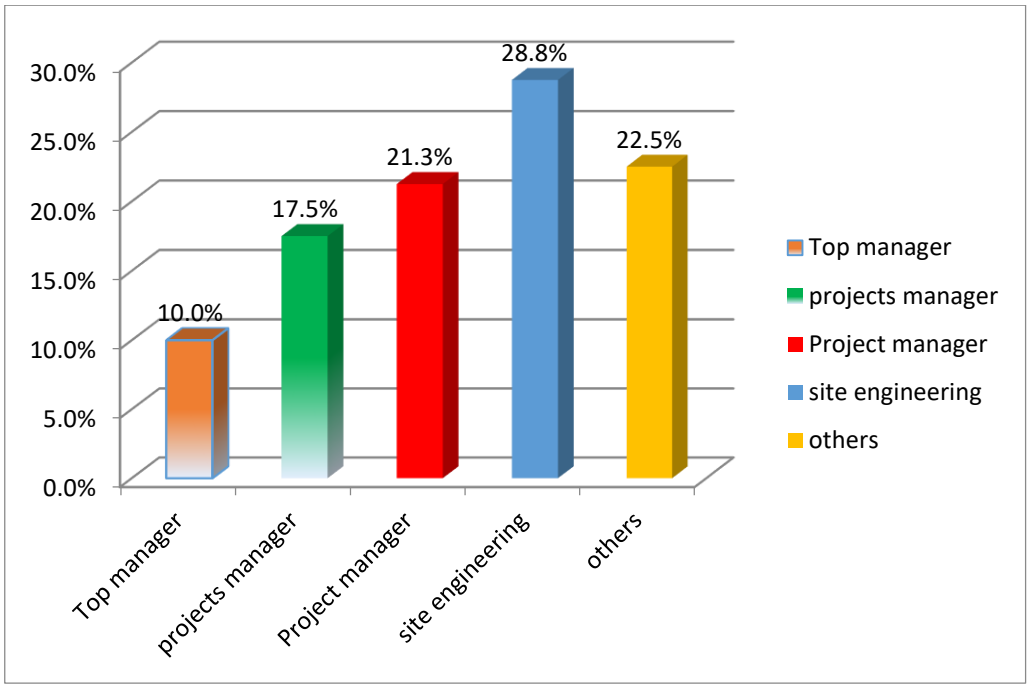


Figure (4.8) Distribution of the sample according occupation

4.4: Frequency Distribution of the sample

1-Economic reasons and their impact on changing cost in construction project site in Sudan:

-This table (4.3) show the result of Frequency Distribution of the sample according to level of Agree where that (44.3%) sample of research are (Agree), and (36.7%) of them (Strongly agree),also we find (12.8%) sample of research are (Neutral), and (5.6%) of them (Disagree),beside that (6%) of them (Strongly disagree totally).

In addition to that we found Total Economic reasons and their impact on changing cost in construction project site in Sudan obtained for total mean equal (4.11) that means most of sample of research are (Agree) for this partion from variables according to fifth likert measure .

Table (4.3) Distribution of the sample according Economic reasons and their impact on changing cost in construction project site in Sudan

N	Items	Strongly disagree totally	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D	level of Agree
		N	N	N	N	N			
		%	%	%	%	%			
1	feasibility study is aimed to identify the best possible investment options between competitive orders on material, human and resources available	0 0.0%	0 0.0 %	5 6.3 %	41 51.3 %	34 42.5 %	4.36	0.601	Strongly agree
2	Acceptance or rejection of project by evaluating the economic feasibility study by comparing investment options.	0 0.0%	2 2.5 %	9 11.3 %	50 62.5 %	19 23.8 %	4.08	0.671	Agree
3	Successful economic analysis techniques must deal with concept of time value of money because the money in future less than present	1 1.3%	1 1.3 %	6 7.5 %	34 42.5 %	38 47.5 %	4.34	0.779	Strongly agree
4	Inflation rate that leads to change the cost of the projects result of government actions(exchange rate, governmental	0 0.0%	4 5.0 %	16 20.0 %	22 27.5 %	38 47.5 %	4.18	0.925	Agree

	regulations, governmental safety laws)								
5	Inflation occurs as result of the lack of productivity elements (human and physical resource).	1	7	13	42	17	3.84	0.906	Agree
		1.3%	8.8%	16.3%	52.5%	21.3%			
6	Purchase of the most offered resources to increase their inflationary prices reduces a cost change	0	11	13	36	20	3.81	0.969	Agree
		0.0%	13.8%	16.3%	45.0%	25.0%			
7	An escalation items help protect the supplier and buyer from unexpected cost changes	0	3	14	43	20	4.00	0.763	Agree
		0.0%	3.8%	17.5%	53.8%	25.0%			
8	An escalation item must be included in the contract to accommodate its prices or decrease to ensure the conservation of profits and continued work	0	2	6	34	38	4.35	0.731	Strongly agree
		0.0%	2.5%	7.5%	42.5%	47.5%			
9	Currency Variation affect the profits of companies and spoke over the cost	0	3	8	37	32	4.23	0.779	Strongly agree
		0.0%	3.8%	10.0%	46.3%	40.0%			
10	Tax policies, tax rates and depreciation rules affect cost changes in construction projects	0	13	16	31	20	3.73	1.018	Agree
		0.0%	16.3%	20.0%	38.8%	25.0%			
11	To ensure that costs are not changed to	3	3	7	20	47	4.31	1.038	Strongly
		3.8%	3.8	8.8	25.0	58.8			

	construction projects in Sudan, contracts should be signed at fair currency prices as Dollar		%	%	%	%			agree
	Total : Economic reasons and their impact on changing cost in construction project site in Sudan	5	49	113	390	323	4.11	0.384	Agree
		0.6%	5.6 %	12.8 %	44.3 %	36.7 %			

2- Cost management in construction project site in Sudan has included :

This table (4.4) show the result of Frequency Distribution of the sample according to level of practice where that (55.5%) sample of research are (Always), and (40.3%) of them (sometime),also we find 4.3%) sample of research are (Never).

In addition to that we found Total Cost management in construction project site in Sudan has included obtained for total mean equal (2.51) that means most of sample of research are (Always) for this part ion from variables according to third likert measure.

Table (4.4) Distribution accordingto item of Cost management in construct-ion project site in Sudan has included

N	Items	Never	some time	Always	Mean	Std. D	level of practice
		N	N	N			
		%	%	%			
1	Cost in construction projects has great importance in reducing cost and implementation of the project in specified time	1	26	53	2.65	0.506	Always
		1.3%	32.5 %	66.3 %			
2	The success of the project is the ability to manage and assess its financial needs	2	24	54	2.65	0.530	Always
		2.5%	30.0 %	67.5 %			
3	Lack of knowledge of the concept and objectives of project cost management in construction projects in Sudan	6	45	29	2.29	0.599	Always
		7.5%	56.3 %	36.3 %			
4	Estimation of the total cost of the project and establish tables for the	4	28	48	2.55	0.593	Always
		5.0%	35.0	60.0			

	implementation of the necessary cash flows and provide funding in accordance with the stages of implementation		%	%			
5	Comparing the actual values of planned values to know the causes of problems and find solutions	2 2.5%	35 43.8 %	43 53.8 %	2.51	0.551	Always
6	A decrease occurs in the size and impact of project changes when the project is implemented by exact planning cost management.	5 6.3%	27 33.8 %	48 60.0 %	2.54	0.615	Always
7	Lack of interest from top manager in construction institutions by applying the concept of cost management	3 3.8%	39 48.8 %	38 47.5 %	2.44	0.570	Always
8	The preparation of the budget is the basic step for costs and resource rationalization	1 1.3%	15 18.8 %	64 80.0 %	2.79	0.441	Always
9	Weak efficiency of administrative staff in the field of project cost planning in Sudan	5 6.3%	41 51.3 %	34 42.5 %	2.36	0.601	Always
10	Do not know the different methods for cost estimates and apply for accurate estimates in construction projects in Sudan	5 6.3%	42 52.5 %	33 41.3 %	2.35	0.597	Always
	Total : Cost management in construction project site in Sudan has included	34 4.3%	322 40.3 %	444 55.5 %	2.51	0.251	Always

3- Technologies and methodologies for costs management and planning:

This table (4.5) show the result of Frequency Distribution of the sample according to level of practice where that 31.6%) sample of research are (Always), and (53.1%) of them (sometime),also we find 15.3%) sample of research are (Never).

In addition to that we found Total Technologies and methodologies for costs management and planning obtained for total mean equal (2.16) that means most of sample of research are (sometime) for this part ion from variables according to third likert measure .

Table (4.5) Distribution of the sample according to item of Technologies and methodologies for costs management and planning

N	Items	Never	sometime	Always	Mean	Std. D	level of practice
		N	N	N			
		%	%	%			
1	Your organization uses modern methods in his management and controlling cost	11	44	25	2.18	0.652	sometime
		13.8%	55.0%	31.3%			
2	Used by Earned value method in your organization because it is the most successful method of monitoring projects, controlling cost and predicting what they will be like in the future	16	41	23	2.09	0.697	sometime
		20.0%	51.3%	28.8%			
3	Do not use earned value method in your organization because the beneficiaries do not require it and do not pay for it.	22	40	18	1.95	0.710	sometime
		27.5%	50.0%	22.5%			
4	Variance analysis(Cost and schedule) the most frequently analyzed measurements.	12	41	27	2.19	0.677	sometime
		15.0%	51.3%	33.8%			
5	For projects not using formal earned value analysis, similar variance analyses is done by comparing planned cost against actual cost.	8	45	27	2.24	0.621	sometime
		10.0%	56.3%	33.8%			
6	An important aspect of project cost control includes determining the cause and degree of variance relative to the cost baseline	7	46	27	2.25	0.606	sometime
		8.8%	57.5%	33.8%			

7	The reason of the variance and process that must be changed can be identified by the root case analysis in your organization.	10	50	20	2.13	0.603	sometime
		12.5 %	62.5%	25.0 %			
8	The cost performance index It is considered the most critical EVA metric and measures the cost efficiency for the work completed	1	43	36	2.44	0.524	Always
		1.3%	53.8%	45.0 %			
9	During cost control, reserve analysis is used to monitor the status of contingency	14	39	27	2.16	0.702	sometime
		17.5 %	48.8%	33.8 %			
10	Trend analysis studies performance of the project if it improves or decorating and compares the future performance objectives in the form of budget at completion do you use your organization this technique.	21	36	23	2.03	0.746	Always
		26.3 %	45.0%	28.8 %			
	Total : Technologies and methodologies for costs management and planning	122	425	253	2.16	0.394	Always
		15.3 %	53.1%	31.6 %			

4- Follow-up processes, control and control of construction

This table (4.6) show the result of Frequency Distribution of the sample according to level of Agreewhere that (46.6%) sample of research are (Agree), and (38.5%) of them (Strongly agree),also we find (11.4%) sample of research are (Neutral), and (2.8%) of them (Disagree),beside that (0.7%) of them (Strongly disagree totally).

In addition to that we found Total Follow-up processes, control and control of construction obtained for total mean equal (4.19) that means most of sample of research are (Agree) for this part ion from variables according to fifth likert measure .

Table (4.6)Distribution of the sample according to item of Follow-up processes, control and control of construction

N	Items	Strongly disagree totally	Disagree	Neutral	Agree	Strongly agree	Mean	Std. D	level of Agree
		N	N	N	N	N			
		%	%	%	%	%			
1	The cost and control of the cost is an essential factor in the success of the project	0	1	3	23	53	4.60	0.628	Agree
		0.0%	1.3%	3.8 %	28.8 %	66.3 %			
2	The censorship and control process helps construction institutions to achieve greater profit	0	1	5	28	46	4.49	0.675	Agree
		0.0%	1.3%	6.3 %	35.0 %	57.5 %			
3	Problems of deviation of cost in construction projects return to the effective application for cost control procedures	0	3	9	47	21	4.08	0.725	Agree
		0.0%	3.8%	11.3 %	58.8 %	26.3 %			
4	The cost adjustment is more effective whenever used at an early stage	0	1	5	29	45	4.48	0.675	Agree
		0.0%	1.3%	6.3 %	36.3 %	56.3 %			
5	Cost control gives the owner logical value for the construction cost	0	0	5	39	36	4.39	0.606	Agree
		0.0%	0.0%	6.3 %	48.8 %	45.0 %			
6	The cost is set through the effect of factors that changes in the approved reference line for cost.	0	2	12	38	28	4.15	0.765	Agree
		0.0%	2.5%	15.0 %	47.5 %	35.0 %			
7	The lack of enough knowledge of the management of the company on how to apply control and	0	7	22	36	15	3.74	0.868	Agree
		0.0%	8.8%	27.5 %	45.0 %	18.8 %			

	control the cost								
8	Deviation and cost control are corrected by project resource management	0	1	7	51	21	4.16	0.608	Agree
		0.0%	1.3%	8.8 %	63.8 %	26.3 %			
9	The accuracy of appreciation and control of the cost is largely based on the degree of detail and project area	0	0	9	45	26	4.21	0.630	Agree
		0.0%	0.0%	11.3 %	56.3 %	32.5 %			
10	The control and control process aimed to adjust the project expenditure from the beginning until the end of the project	1	0	7	33	39	4.36	0.750	Agree
		1.3%	0.0%	8.8 %	41.3 %	48.8 %			
11	There are no qualified people who are able to apply and control the cost	3	7	14	40	16	3.76	0.990	Agree
		3.8%	8.8%	17.5 %	50.0 %	20.0 %			
12	Cost adjusted is an actions for reducing losses when achieving unwanted results in the project	3	5	12	37	23	3.90	1.014	Agree
		3.8%	6.3%	15.0 %	46.3 %	28.8 %			
	Total : Follow-up processes, control and control of construction	7	27	109	446	369	4.19	0.440	Agree
		0.7%	2.8%	11.4 %	46.6 %	38.5 %			

4.5 One-Sample Statistics:

To know about Cost management in construction projects under Critical economic condition we need to answer this axis below:

Economic reasons and their impact on changing cost in construction project site in Sudan

T-test of all item which making first axis their P value (0.000)< α=0.05 that mean , There is a statistically significant between answer of study (Economic reasons and their impact on changing cost in construction project site in Sudan) .

Table(4.7)One-Sample Test of item of Economic reasons and their impact on changing cost in construction project site in Sudan

No	Item	t	df	Sig. (2-tailed)	Relative Percent	Result
1	feasibility study is aimed to identify the best possible investment options between competitive orders on material, human and resources available	64.978	79	0.000	87.3%	statistically significant
2	Acceptance or rejection of project by evaluating the economic feasibility study by comparing investment options.	54.333	79	0.000	81.5%	statistically significant
3	Successful economic analysis techniques must deal with concept of time value of money because the money in future less than present	49.830	79	0.000	86.8%	statistically significant
4	Inflation rate that leads to change the cost of the projects result of government actions(exchange rate, governmental regulations, governmental safety laws)	40.383	79	0.000	83.5%	statistically significant
5	Inflation occurs as result of the lack of productivity elements (human and physical resource).	37.873	79	0.000	76.8%	statistically significant
6	Purchase of the most offered resources to increase their inflationary prices reduces a	35.189	79	0.000	76.3%	statistically significant

	cost change					
7	An escalation items help protect the supplier and buyer from unexpected cost changes	46.886	79	0.000	80.0%	statistically significant
8	An escalation item must be included in the contract to accommodate its prices or decrease to ensure the conservation of profits and continued	53.234	79	0.000	87.0%	statistically significant
9	Currency Variation affect the profits of companies and spoke over the cost	48.505	79	0.000	84.5%	statistically significant
10	Tax policies, tax rates and depreciation rules affect cost changes in construction projects	32.712	79	0.000	74.5%	statistically significant
11	To ensure that costs are not changed to construction projects in Sudan, contracts should be signed at fair currency prices as Dollar	37.145	79	0.000	86.3%	statistically significant

2. the Cost management in construction project site in Sudan has included:

T-test of all item which making second axis their P value (0.000)< α=0.05 that mean , There is a statistically significant between answer of study (the Cost management in construction project site in Sudan has included)

Table (4.8) One-Sample Test of item of Cost management in construction project site in Sudan has included

No	item	T	df	Sig. (2-tailed)	Relative Percent	Result
1	Cost in construction projects has great importance in redu-cing	46.874	79	0.000	88.3 %	statistically significant

	cost and implementation of the project in specified time					
2	The success of the project is the ability to manage and ass-ess its financial needs	44.712	79	0.000	88.3 %	statistically significant
3	Lack of knowledge of the con-cept and objectives of project cost management in construc-tion projects in Sudan	34.132	79	0.000	76.3 %	statistically significant
4	Estimation of the total cost of the project and establish tables for the implementation of the necessary cash flows and pro-vide funding in accordance with the stages of implement-tation	38.448	79	0.000	85.0 %	statistically significant
5	Comparing the actual values of planned values to know the causes of problems and find solutions	40.782	79	0.000	83.8 %	statistically significant
6	A decrease occurs in the size and impact of project changes when the project is implement-ted by exact planning cost management.	36.899	79	0.000	84.6 %	statistically significant
7	Lack of interest from top man-ager in construction institu-tions by applying the concept of cost management	38.233	79	0.000	81.3 %	statistically significant
8	The preparation of the budget is the basic step for costs and resource rationalization	56.492	79	0.000	92.9 %	statistically significant
9	Weak efficiency of administra-tive staff in the field of project cost planning in Sudan	35.189	79	0.000	78.8 %	statistically significant
10	Do not know the different me-thods for cost estimates and	35.180	79	0.000	78.3 %	statistically significant

	apply for accurate estimates in construction projects in Sudan					

3. Technologies and methodologies for costs management and planning

T-test of all item which making third axis their P value (0.000)< α=0.05 that mean , There is a statistically significant between answer of study (Technologies and methodologies for costs management and planning)

Table(4.9)One-Sample Test of item of Technologies and methodologies for costs management and planning

No	Item	t	df	Sig. (2-tailed)	Relative Percent	Result
1	Your organization uses modern methods in his management and controlling cost	29.852	79	0.000	72.5%	statistically significant
2	Used by Earned value method in your organization because it is the most successful method of monitoring projects, controlling cost and predicting what they will be like in the future	26.785	79	0.000	69.6%	statistically significant
3	Do not use earned value method in your organization because the beneficiaries do not require it and do not pay for it.	24.573	79	0.000	65.0%	statistically significant
4	Variance analysis(Cost and schedule) the most frequently analyzed measurements.	28.909	79	0.000	72.9%	statistically significant
5	For projects not using formal earned value analysis, similar variance analyses is done by comparing planned cost against actual cost.	32.215	79	0.000	74.6%	statistically significant
6	An important aspect of project cost control includes determining the cause and degree of variance relative to the cost baseline	33.216	79	0.000	75.0%	statistically significant

7	The reason of the variance and process that must be changed can be identified by the root case analysis in your organization.	31.506	79	0.000	70.8%	statistically significant
8	The cost performance index It is considered the most critical EVA metric and measures the cost efficiency for the work completed	41.610	79	0.000	81.3%	statistically significant
9	During cost control, reserve analysis is used to monitor the status of contingency	27.568	79	0.000	72.1%	statistically significant
10	Trend analysis studies performance of the project if it improves or decorating and compares the future performance objectives in the form of budget at completion do you use your organization this technique.	24.283	79	0.000	67.5%	statistically significant

4- follow-up processes, control and control of construction

T-test of all item which making fourth axis their P value (0.000)< α=0.05 that mean , There is a statistically significant between answer of study (follow-up processes, control and control of construction) .

Table 4.10 One-Sample Test of item of follow-up processes, control and control of construction

No	Item	t	df	Sig. (2-tailed)	Relative Percent	Result
1	The cost and control of the cost is an essential factor in the success of the project	65.470	79	0.000	92.0%	statistically significant
2	The censorship and control process helps construction institutions to achieve greater profit	59.469	79	0.000	89.8%	statistically significant
3	Problems of deviation of cost in construction projects return to the	50.257	79	0.000	81.5%	statistically significant

	effective application for cost control procedures					
4	The cost adjustment is more effective whenever used at an early stage	59.334	79	0.000	89.5%	statistically significant
5	Cost control gives the owner logical value for the construction cost	64.784	79	0.000	87.8%	statistically significant
6	The cost is set through the effect of factors that changes in the approved reference line for cost.	48.538	79	0.000	83.0%	statistically significant
7	The lack of enough knowledge of the management of the company on how to apply control and control the cost	38.524	79	0.000	74.8%	statistically significant
8	Deviation and cost control are corrected by project resource management	60.852	78	0.000	83.3%	statistically significant
9	The accuracy of appreciation and control of the cost is largely based on the degree of detail and project area	59.775	79	0.000	84.3%	statistically significant
10	The control and control process aimed to adjust the project expenditure from the beginning until the end of the project	51.997	79	0.000	87.3%	statistically significant
11	There are no qualified people who are able to apply and control the cost	33.756	78	0.000	75.2%	statistically significant
12	Cost adjusted is an actions for reducing losses when achieving unwanted results in the project	34.407	79	0.000	78.0%	statistically significant

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATIONS

5. 1Introduction:

This chapter includes the Conclusion of the results and discussion and number of recommendations and Recommendation for future studies

5 .2 Conclusions:

We conclude from the analysis that was based on the results of the questionnaire as follows:

T-test of all item which making first axis their P value (0.000)< α=0.05 that means accepting the hypothesis that (Economic reasons and their impact on changing cost in construction project site in Sudan).this is for the following reasons:

1-feasibility study is aimed to identify the best possible investment options between competitive orders on material, human and resources available has Ratio of acceptable93.8%.

2- An escalation item must be included in the contract to accommodate its prices or decrease to ensure the conservation of profits and continued work Ratioof acceptable72%

3- Successful economic analysis techniques must deal with concept of time value of money because the money in future less than present Ratio of acceptable89.5.8%

4- To ensure that costs are not changed to construction projects in Sudan, contracts should be signed at fair currency prices as Dollar Ratio of acceptable 83.8%

5- Currency Variation affects the profits of companies and spoke over the cost Ratio of acceptable94%

6- Inflation rate that leads to change the cost of the projects result of government actions (exchange rate, governmental regulations, governmental safety laws Ratio of acceptable75%

7- Acceptance or rejection of project by evaluating the economic feasibility study by comparing investment options Ratio of acceptable86.3%

8-An escalation items help protect the supplier and buyer from unexpected cost changes Ratio of acceptable78.8%

-Inflation occurs as result of the lack of productivity elements in construction project (human and physical resource) 73.8

Application of Cost management include (planning and estimating and controlling the cost through the life of project)in construction project site in Sudan and their impact of changing cost:

1- Cost management in construction projects has great importance in reducing cost and implementation of the project in specified time98.8

2-weakof knowledge of the concept and objectives of project cost management in construction projects in Sudan92.6

3- Weak efficiency of administrative staff in the field of project cost planning in Sudan93.8

4-Your organization uses modern methods in his management and controlling cost86.3

5-Used by Earned value method in your organization because it is the most successful method of monitoring projects, controlling cost and predicting what they will be like in the future80.1

6- Problems of deviation of cost in construction projects return to the effective application for cost control procedures85.1.

7- weak of enough knowledge of the management of the company on how to apply control and control the cost63.8

5.3Recommendation:

The researcher reached number of recommendations which are summarized as :

- To determine the best investment options you should pay attention to doing feasibility study.
- Must apply techniques of economic analysis that deal with the concept of the time value of money.
- Contracts should be signed at fair currency prices as Dollar in countries with instable economy.
- On institutions conducting feasibility study for all projects by specialists.
- An escalation item must be included in the contract to accommodate its prices or decrease to ensure the conservation of profits and continued work
- Urging governments to reduce inflation because government actions (exchange rate, governmental regulations, and governmental safety laws) led to inflation.
- Must take care of productivity elements in construction project (human resource and physical resource)
- The top manager of organization should be interested in applying the concept of cost management and spreading this concept to all those interested.
- Follow the right ways in the management of construction project.
- Following modern and effective ways of controlling cost management in construction project.
- Attention to train, incentive and develop the team work and use the and improve the working environment**.**

5.4Recommendation for future studies:

The management and control of cost in construction projects in Sudan is important to maintain costs in construction projects and maintain competitive advantage of companies. Must study and learn the impact of all the factors of the surrounding the theoretical project and which change are required by specialists.

The modern and accurate ways must be applying in construction project and control of the cost and knowledge of the problem and their causes in timely basis to make true decision.

-the importance of using earned value because it is the most effective to monitoring the project.

-know the root case of the problem using root case analysis in time to solve it.

Reference:

Dr. Makarand Hastak, PE CCP, Editor"Skills and Knowledge of Cost Engineering"2015

Wayne J. Del Pico "Project Control"Integrating Cost and Schedule in Construction", CPE"2013.

Weisheng Lu Chi Cheung LaiTung Tse" BIM and Big Data for Construction Cost Management"2019.

PMBOK® GUIDE "A Guide to the PROJECT MANAGEMENT BODY OF KNOWLEDGE,Sixth Edition

Eur Ing Albert Lester, CEng, FICE, FIMechE, FIStructE, FAPM "Project Planning and Control"2003.

John Wiley & Sons, Inc "COST REDUCTION AND CONTROL BEST PRACTICES'2006

Terra Vanzant Stern, PhD "Lean and Agile Project Management"2017

WaynE j. DEL PiCo "Estimating Building Costs"2012

Len Holm "Cost Accounting and Financial Management for Construction Project Managers"2019

William G.SULLIVAN Elin M .WICKS C PARTICK KOELLING"ENGINEERING ECONOMY"2014

Keith Potts "Construction Cost Management"2008

Keith Potts and Nii Ankrah "Construction Cost Management Second edition"2013

Alnoor Bhimani Charles T. Horngren Srikant M. Datar Madhav Rajan"MANAGEMENT AND COST ACCOUNTING"2014

Colin Drury "MANAGEMENT AND COST ACCOUNTING"2018

Parviz F. Rad "PROJECT ESTIMATING AND COST MANAGEMENT"2002

Richard E. Westney, P.E. "The Engineer's Cost Handbook Tools for Managing Project Costs"1997

-BANDI, S.H. Collaborative Usage of ICT DBMS in Construction Cost Control :The Post Contract Perspective .Thesis Master, University of Technology, Malaysia, 2008,132

- Ibusuki U., and Kaminski P. C., " Product development process with focus on value engineering and target-costing: A case study in an automotive company". International Journal of Production Economics, Vol. 105, Issue 2, February 2004, pp. 459–474

-Kelly,T.A System Design Formwork for Project Cost Control in the Irish Construction Industry. Thesis Master , DublinInsttute of Technology,Irelanda,2001,171

المراجع باللغة العربية:

الدكتور عبد الحميد عبد المجيد البلداوي " أساليب البحث العلمي والتحليل الإحصائي التخطيط للبحث وجمع وتحليل البيانات يدويا وإستخدام برنامج SPSS" 2007 م .

أسامة محمد المرضي سليمان خيال " كتاب التحليل الإقتصادي الهندسي " 2018م .

صباح اصطفيان كجه جي " إعداد دراسات الجدوى و الجدوى الإقتصادية لمشاريع التنمية 2008م.

دكتور بديع الدين ريشو"اداره التكاليف" 2009م

عماد محمد عبد العزيز حسن حسين أحمد "إدارة المشروعات"

الدليل المعرفي لإدارة المشروعات الطبعة السادسه 2017

حسن إبارهيم بلوط، إدارة المشاريع ودارسة جدواها الاقتصادية، دار النهضة العربية بيروت لبنان م .(2002م) الطبعة الأولى 2008م

حسين محمد جمعة , إدارة تنفيذ المشروعات الإنشائية ,طبعة 2005م إدارة المشروعات ، الدار الجامعية للنشر والتوزيع ، الأسكندرية

سعد صادق م، إدارة العقود الهندسية وعقود التشييد ، الكتاب الخامس تسوية 2002م

سامي فرج ,النازعات الطبعة الثانية دار الرضاء للنشر, .الإدارة الحديثة للمشاريع باستخدام القيمة المكتسبة 2012م .

شعبان محمد حسن ,المفهوم والتطبيق الإدارة العامة, مركز البحوث, الرياض

-عبد الستار محمد العلي، إدارة المشروعات العامة، الطبعة الأولى، دار المسيرة للنشر والتوزيع والطباعة،عمان 2009م الأردن

فلاح حسن الحسيني، إدارة المشروعات الصغيرة، الطبعة الأولى، دار الشروق للنشر والتوزيع،عمان الأردن 2006م

قاسم ناجي حمندي، أسس إعداد دارسات الجدوى وتقييم المشروعات، الطبعة الأولى ، 2008م دار المناهج للنشر والتوزيع عمان.

المجلات والرسائل الجامعيه

زهير مخاييل ساكو مرفت رزاق ولي"مجله الهندسه اداره وتخطيط التكلفه في مشروعات التشييد"كانون الاول 2019م

-مجله الاداره دور ادوات اداره التكلفه بتسعير المنتجات الحكوميه

إسماعيل، نازنين علي،"التخطيط للمشروع الهندسي دارسة تطبيقية في المنظمات الاستشارية في .- العراق"،

رسالة ماجستير مقدمة إلى قسم الهندسة المعمارية،في عام 1996م الجامعة التكنولوجية ، م ، إستهداف السعر كأساس 2007م.

جليلة عيدان الذهبي، ثائر صري الغبان، (لتحقيق تقنية التكلفة المستهدفة للوحدات الاقتصادية العاملة في بيئة الأعمال ، كلية الإدارة 13 ، المجلد 48 الحديثة ، مجلة العلوم الإقتصادية والإدارية ، العدد والإقتصاد ، جامعة بغداد) إنتاجية العمال 2005م .
حسون , لبني ، خير الله, الجلالي , نصر الدين , محمد (في صناعة التشييد في سوريا .مجلة جامعة دمشق للعلوم الهندسية ,سوريا,المجلد 2005م، العدد الثاني، 21
-علاء الدين علي الديري، إدارة وتخطيط المشاريع الإنشائية،دارسة استكمال .لمتطلبات الدكتواره في إدارة المشاريع،الأكاديمية العربية للتعليم العالي.
عبد القادر محمد الاحوج"مجله الجامعه الاسمريه للعلوم الاساسيه التقييم المالي واداره التكلفه في المشاريع" المعهد العالي للمهن الهندسية زليتن 2017م .
دلال بدر الدين ستوت"استخدام شبكات بيرت في تخفيض التكاليف"رساله ماجستيرمقدمه الي قسم المحاسبه كلية الاقتصاد جامعه حلب2016 "

APPENDICES

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

Sudan University of science &Technology

College of graduate Studies

Questionnaire about:

Cost management in construction projects under Critical economic condition

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.

Kindly help us by filling our questioner to find solutions for the research problems.

***Note: This questionnaire is for the purpose of scientific research, and all data will remain strictly confidential**

Questionnaire

First axis:General Information

Please choose the most appropriate answer in your opinion.

1. Name

……..

2. What is the name of your company?

…….

3. What are your total years of the company experience within construction projects field? *Check only one

☐ Less than 5 years ☐ Less than 10 years

☐From 10 to 20 years ☐ More than 20 years

4. What are your total years of experience within construction projects field? *Check only one square.

☐ Less than 5 years ☐ from 5 to 10 years

☐From 10 to 15 years ☐ More than 15 years

5. What is your age? *Check only one square.

☐ 25-35 ☐> 35-45

☐>45-55 ☐>55

6.What is the highest academic degree you have completed? *Check only one square.

☐ Bachelor's degree ☐ Higher Diploma Degree

☐ Master's degree ☐ Doctorate degree

☐others

7-what is the professional class? *Check only one square

☐Graduate ☐specialist

☐Consultant ☐others

8. What is the category of your current organization? *Check only one square.

☐ Projects Management ☐ General Contractor's

☐ Specialized Contractors ☐ General Engineering Consultants

9-What is the level of your current occupation? *Check only one square.

☐ Top manager ☐projects manager

☐Project manager ☐site engineering

<u>The second axis:</u> Economic reasons and their impact on changing cost in construction project site in Sudan:

Please choose the most appropriate answer in your opinion (√)

NO		Strongly agree	Agree	Uncertain / not applicable	Strongly Dis agree	DIS agree
1	feasibility study is aimed to identify the best possible investment options between competitive orders on material, human and resources available					
2	Acceptance or rejection of project by evaluating the economic feasibility study by comparing investment options.					
3	Successful economic analysis techniques must deal with concept of time value of money because the money in future less than present					
4	Inflation rate that leads to change the cost of the projects result of government actions(exchange rate, governmental regulations, governmental safety laws)					
5	Inflation occurs as result of the lack of productivity elements (human and physical resource).					
6	Purchase of the most offered resources to increase their inflationary prices reduces a cost change					
7	An escalation items help protect the supplier and buyer from unexpected cost changes					
8	An escalation item must be included in the contract to accommodate its prices or decrease to ensure the conservation of profits and continued work					
9	Currency Variation affect the profits of companies and spoke over the cost					
10	Tax policies, tax rates and depreciation rules affect cost changes in construction projects					
11	To ensure that costs are not changed to construction projects in Sudan, contracts should be signed at fair currency prices as Dollar					

The thirdaxis:

About the Cost management in construction project site in Sudan has included: -

Please choose the most appropriate answer in your opinion (√)

NO		Always	sometime	Never
1	Cost in construction projects has great importance in reducing cost and implementation of the project in specified time			
2	The success of the project is the ability to manage and assess its financial needs			
3	Lack of knowledge of the concept and objectives of project cost management in construction projects in Sudan			
4	Estimation of the total cost of the project and establish tables for the implementation of the necessary cash flows and provide funding in accordance with the stages of implementation			
5	Comparing the actual values of planned values to know the causes of problems and find solutions			
6	A decrease occurs in the size and impact of project changes when the project is implemented by exact planningcost management.			
7	Lack of interest from top manager in construction institutions by applying the concept of cost management			
8	The preparation of the budget is the basic step for costs and resource rationalization			
9	Weak efficiency of administrative staff in the field of project cost planning in Sudan			
10	Do not know the different methods for cost estimates and apply for accurate estimates in construction projects in Sudan			

Fourth Axis :Technologies and methodologies for costs management and planning Please choose the most appropriate answer in your opinion (√)

NO		Always	sometime	Never
1	Your organization uses modern methods in his management and controlling cost			
2	Used by Earned value method in your organization because it is the most successful method of monitoring projects, controlling cost and predicting what they will be like in the future			
3	Do not use earned value method in your organization because the beneficiaries do not require it and do not pay for it.			
4	Variance analysis(Cost and schedule) the most frequently analyzed measurements.			
5	For projects not using formal earned value analysis, similar variance analyses is done by comparing planned cost against actual cost.			
6	An important aspect of project cost control includes determining the cause and degree of variance relative to the cost baseline			
7	The reason of the variance and process that must be changed can be identified by the root case analysis in your organization.			
8	The cost performance index It is considered the most critical EVA metric and measures the cost efficiency for the work completed			
9	During cost control, reserve analysis is used to monitor the status of contingency			
10	Trend analysis studies performance of the project if it improves or decorating and compares the future performance objectives in the form of budget at completion do you use your organization this technique.			

<u>The fifth axis:</u> follow-up processes, control and control of construction.

Please choose the most appropriate answer in your opinion (√)

NO		Strongly agree	Agree	Uncertain/ not applicable	Strongly Dis agree	DIS agree
1	The cost and control of the cost is an essential factor in the success of the project					
2	The censorship and control process helps construction institutions to achieve greater profit					
3	Problems of deviation of cost in construction projects return to the effective application for cost control procedures					
4	The cost adjustment is more effective whenever used at an early stage					
5	Cost control gives the owner logical value for the construction cost					
6	The cost is set through the effect of factors that changes in the approved reference line for cost.					
7	The lack of enough knowledge of the management of the company on how to apply control and control the cost					
8	Deviation and cost control are corrected by project resource management					
9	The accuracy of appreciation and control of the cost is largely based on the degree of detail and project area					
10	The control and control process aimed to adjust					

	the project expenditure from the beginning until the end of the project					
11	**There are no qualified people who are able to apply and control the cost**					
12	**Cost adjusted is an actions for reducing losses when achieving unwanted results in the project**					

Thanks for your patience...

The Researcher

جامعه السودان للعلوم والتكنلوجيا

كليه الدراسات العليا

مدرسه الهندسه المدنيه

استبيان حول

ادارة التكلفه في مشروعات التشييد في ظل الظروف الاقتصاديه الحرجه

تعتبر ادارة التكلفه الوظيفه الاساسيه لمديرى المشاريع عند التكامل مع النطاق والجودة وادارة الوقت حيث هذه الوظائف الثلاث جوهر ادارة المشروع .

يرجي مساعدتنا بملء هذا الاستبيان لايجاد حلول لمشاكل البحث .

***ملاحظه:**

هذا الاستبيان لغرض البحث العلمي وستبقي جميع البيانات في سريه تامه

الإستبيان

القسم الأول: معلومات عامة عن الشخص الذي سيقوم بتعبئة الاستبيان والمؤسسة التي يعمل لديها

1- الاسم (اختياري) : .....-

2-اسم الشركة التي تعمل بها:.....

3- ما هو المسمى الوظيفي لك في الشركة : ..... -

4-كم عدد سنوات تواجد الشركة في مجال التشييد

اقل من خمس سنوات { } اقل من 10سنوات { }

من 10سنة واقل من20 سنة { } أكثر من 20 { }

5- كم عدد سنوات تواجدك في مجال التشييد

اقل من خمس سنوات { } من خمس سنوات وأقل من 10{ }

من 10 سنوات واقل من 15 سنة { } اكثر من 15 سنه { }

6- العمر

اقل من 25 سنة { } من25 سنه الي35 سنه{ }

من35 سنه الي 45 سنه { } اكثر من45 سنه { }

7- الدرجة الأكاديمية :

بكالوريوس{ } دبلوم عالي { }

ماجستير { } دكتواره { }

خرى (اذكرها) . اذكر مؤهلك .....

8 - الدرجة المهنية

خريج { } أخصائي { }

مستشار { } أخرى (اذكرها) واذكر درجتك المهنية

.....

9 - صفة المؤسسة

منفذة { } مشرفة { }

استشارية { } أخرى (اذكرها) اذكر درجتك المهنية

المحور الثاني : العوامل الاقتصاديه واثرها علي تغيير التكلفه

فيما يلي من أسئلة يرجى اختيار إجابة واحدة فقط بوضع علامة

الرقم		اوافق بشده	اوافق	محاد	لا اوافق	لا اوافق بشده
1	تهدف دراسه الجدوي لتمكين المستثمر او الاستشاري الاقتصادي من تحديد افضل الخيارات الاستثماريه الممكنه بين الطلبات المتنافسه علي الموارد الماديه والبشريه					
2	يتم قبول او رفض المشروع في ضوء تقييم دراسه الجدوي الاقتصاديه من خلال مقارنه خيارات الاستثمار .					
3	تقنيات التحليل الاقتصادي الناجحه يجب ان تتعامل مع مفهوم القيمه الزمنيه للاموال لان المال في المستقبل له قيمه اقل من الحاضر					
4	معدلات التضخم التي تؤدي لتغيير تكلفه المشروع ناتجه من الاجراءات الحكوميه (اسعار الصرف واللوائح الحكوميه واجراءات الحظر وقوانين السلامه)					
5	يحدث التضخم نتيجه لعدم توفر وارتفاع تكلفة عناصر الانتاجيه (الموارد البشريه والماديه)					
6	شراء الموارد الاكثر عرضه لزياده الاسعار التضخميه يقلل من حدوث تغيير في التكلفه					
7	تساعد صياغه بنود التصعيد في العقد حمايه المورد والمشتري من تغييرات التكلفه غير المتوقعه					
8	يجب تضمين بند التصعيد في العقد لاستيعاب زياده الاسعار او نقصانها لضمان المحافظه علي الارباح واستمرار العمل					
9	تغييرات العمله واجراءات العمله تؤثر علي ارباح الشركات وتحدث تغغير في التكلفه					
10	لضمان عدم تغيير التكاليف بمشروعات التشييد في السودان يجب توقيع العقودات باسعار عملات ثابته كالدولار					
11	اعداد تقرير التدفق النقدي يعتبر التقييم الدقيق لكتفة النفقات الماليه للمشروع وهو من اهم اسباب نجاح الشركات					

المحور الثالث :اداره التكلفه في مشروعات التشييد في السودان:

فيما يلي من أسئلة يرجى اختيار إجابة واحدة فقط بوضع علامة

الرقم		اوافق بشده	اوافق	محاد	لا اوافق	لا اوافق بشده
اهميه اداره التكلفه في مشروعات التشييد						
1	اداره التكلفه في مشاريع التشييد لها اهميه كبيره في خفض التكلفه وتنفيذ المشروع في الزمن المحدد					
2	نجاح المشروع يتمثل في قدرة إدارته في تحديد وتقدير احتياجاته المالية					
3	عدم معرفة مفهوم وأهداف إدارة تكاليف المشروع في مشاريع البناء في السودان					
4	تقدير التكلفة الإجمالية للمشروع ومن ثم إنشاء جداول لتنفيذ التدفقات النقدية اللازمة وتوفير التمويل اللازم وفقا لمراحل التنفيذ من خلال ادارة التكلفه					
5	مقارنة القيم الفعلية للقيم المخطط لها لمعرفه اسباب المشكلات وايجاد الحلول لها					
6	يحدث انخفاض في حجم وتأثير تغييرات المشروع عندما يتم تنفيذ المشروع بالتخطيط الدقيق للتكلفة .					
7	عدم اهتمام الإداارت العليا في مؤسسات التشييد بتطبيق مفهوم إدارة التكلفة					
8	إعداد الموازنة هو الخطوة الأساسية لعملية الرقابة على التكاليف وترشيد الموارد					
9	ضعف كفاءة الكادر الإداري في مجال تخطيط تكلفة المشاريع في السودان					
10	عدم معرفه الطرق المختلفه لتقديرات التكلفه وتطبيقها للحصول علي تقديرات دقيقه في مشروعات التشييد في السودان					

المحور الرابع : التقنيات والمنهجيات المتبعة في إدارة وتخطيط التكلفة

فيما يلي من أسئلة يرجى اختيار إجابة واحدة فقط بوضع علامة

الرقم		دائما	احيانا	ابدا
1	تستخدم مؤسستكم الأساليب الحديثة في إدارة وضبط التكلفة			
2	تستخدم طريقه القيمه المكتسبه لانها من أنحج طرق مراقبة المشروعات والتحكم في التكاليف والتنبؤ بما سيكون علية مستقبلا			
3	لا تستخدم ادارة القيمة المكتسبة في موسستكم لان الجهات المستفيده لا تطلبها			
4	تحليل التباين الفروق بين التكلفه والجدول الزمني هي من اكثر القياسات التي تم تحليلها بشكل متكرر في موسستكم			
5	بالنسبه للمشاريع التي لا تستخدم تحليل القيمه المكتسبه الرسميه يتم اجؤاء تحليل التباين من خلال مقارنه التكلفه المخططه ضد التكلفه الفعليه لتحديد الفروق بين تكلفه خط الاساس والاداء الفعلي			
6	يتضمن جانبا مهما لمراقبه تكلفه المشروع وتحديد سبب التباين بالنسبه الي خط الاساس			
7	يتم تحديد سبب التباين والعمليات التي يجب تغييرها من خلال تحليل السبب الجذري			
8	موشر اداء التكلفه يعتبر المقياس الاكثر اهميه ويقيس تكاليف العمل المنجز			
9	اثناء التحكم في التكاليف يساخدم تحليل الاحتياطي لمراقبه حاله احتياطات الطوارئ			
10	هل تستخدم موسستكمتحليل الاتجاه (يدرس اداء المشروع اذا كان يتحسن او يتدهور ويقارن بين اهداف الاداء المستقبليه في شكل موازنه عند الاكتمال حيث يتم عرضه في اشكال بيانيه).			

المحور الخامس : عمليات المتابعة،الرقابة والسيطرة على الكلفة الإنشائية

فيما يلي من أسئلة يرجى اختيار إجابة واحدة فقط بوضع علامة

الرقم		اوافق بشده	اوافق	محايد	لا اوافق	لا اوافق بشده
1	تشكل الرقابه والسيطرة علي التكلفة عاملا أساسيا في نجاح المشروع					
2	عملية الرقابة والسيطرة علي التكلفة يساعد مؤسسات التشييد إلي تحقيق الربح الأعظم					
3	مشاكل انحراف التكلفة الحاصل في مشاريع التشييد يعود إلي التطبيق غير الفعال لاجارءا ت ضبط التكلفة					
4	ضبط التكلفة يكون أكثر فعالية كلما استخدم في مرحلة مبكرة					
5	ضبط ورقابة التكلفة يعطي المالك قيمة منطقية لتكلفة البناء					
6	يتم ضبط التكلفه خلال من خلال التاثير علي العوامل التي تحدث تغييرات في الخط المرجعي المعتمد للتكلفه					
7	عدم وجود معرفة كافية لدى إدارة الشركة عن كيفية تطبيق الرقابة والسيطرة علي التكلفة					
8	تتم تصحيح الانحارف والرقابة للتكلفة عن طريق إدارة موارد المشروع					
9	تعتمد دقة التقدير والرقابة علي التكلفة بشكل كبير علي درجة التفصيل وتحديد مجال المشروع					
10	تسعي عملية الرقابة والسيطرة علي الكلفة إلي ضبط نفقات المشروع من البداية حتى نهاية المشروع					
11	عدم وجود أشخاص مؤهلين قادرين على تطبيق ضبط والسيطرة علي التكلفة .					
12	ضبط الكلفة عبارة عن أعمال موجهة لتقليل الخسائر عند تحقيق نتائج غير مرغوبة في المشروع					

شكرا لمساعدة الباحثه

Data Collection Form

Cost Management in construction project under critical condition

Project name	
location	
The scope of work	
the owner	
The contractor	
The consultant	
No of floor	
Built area	
Project delay method	
Type of contract	
Date of contract signing	
Date of commencement	
Contract duration	
Date of actual finish	
Contract price	
Actual cost of project	
Contract increase	

The reason that lead to cost deviation

....

.....

فروقات اسعار مشروع بربر-المرحله الثانيه

المعادله المستخدمه:

P=

$$X+ a(\frac{CE}{CE0}) +b\ (\frac{RS}{RS0}) +c(\frac{ST}{ST0})+d(\frac{SA}{SA0})+e(\frac{Agg}{Agg0})+f(\frac{acc}{acc0})+g(\frac{sal}{sal0})+h(\frac{fu}{fu0})+i(\frac{man}{man0})$$

X: عباره عن المصروفات الاداريه والارباح بوزن 0.15 من قيمه المشروع

A: عباره عن وزن بند الاسمنت من قيمه المشروع

CE@CE0:عباره عن تكلفتي الاسمنت عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

b:وزن حديد التسليح

RS&RS0:تكلفه حديد التسليح عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

C: عباره عن وزن بند الحجر من قيمه المشروع

ST0&ST: عباره عن تكلفه الحجر عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

d:عباره عن وزن بند الرمل من قيمه المشروع

Sa &Sa0: عباره عن تكلفه الرمل الحجر عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

e:وزن الخرسانه من قيمه المشروع

ASS0&Agg: عباره عن تكلفه الخرسانه عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

f: عباره عن وزن الاعاشات من قيمه المشروع

Acc0/acc: عباره عن تكلفه الاعاشات عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

g:عباره عن وزن المرتبات من قيمه المشروع

Sal0&sal: عباره عن تكلفه المرتبات عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

h : عباره عن وزن الوقود من قيمه المشروع

fu0&fu: عباره عن تكلفه الوقود عند تقديم المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

I: عباره عن وزن الاسبيرات والصيانه من قيمه المشروع

Man &man0: عباره عن تكلفه الاسبيرات والصيانه عند تقديم المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

وجد ان اوزان البنود علي النحو التالي:

البند	الوزن
X= وزن المصروفات الاداريه والارباح	0.15 معطي
A= وزن الاسمنت	0.001
b= وزن حديد التسليح	0.0043
C=وزن الحجر	0.0095
d = وزن الرمل	0.0003
e =وزن الخرسانه	0.0008
F = وزن الاعاشات	0.03
g = وزن المرتبات	0.11
h =وزن الوقود	0.47
i = وزن الصيانه والاسبيرات	0.23
المجموع	1.00

التباين في اسعار البنود وفقا للتكلفه التعاقديه والتكلفه الحاليه حسب المستندات والفواتير المرفقه :

CE0=	1,900	CE=	5000
RS0=	13,250	RS=	3400
ST0=	600	ST=	900
Sa0=	2,000	Sa=	4000
Agg0=	3,000	Agg=	5000
Acc0=	28	Acc=	40
Sal0=	508	Sal=	508333
Fu0=	18.5	Fu=	25.5
Man0=	12483680	Man=	15729437

- **ملحوظه في بند الصيانه والاسبيرات وجد ان نسبه الزياده في عدد 3 عينات عشوائيه تتراوح بين (42%و31%و26%) وتم اعتماد اقل نسبه زياده موجوده من بين النسب اعلاه وهي 26%.**

- **عند تطبيق المعالجه وجد ان :**

$$P=0.15+(0.001*(\frac{5000}{1900}))+(0.0043*(\frac{34000}{13250}))+(0.0095*(\frac{900}{600}))+(0.0003*(\frac{4000}{2000}))+(0.0008*(\frac{5000}{3000}))+(0.03*(\frac{40}{28}))+(0.11*(\frac{508.333}{508.333}))+(0.47*(\frac{25.5}{18.5}))+(0.023*(\frac{15,729,37}{12,488,680})=1.27$$

بناء عليه وجد ان نسبه الزياده في العقد تبلغ 27% اي مبلغ 26,145,878 لتصبح القيمه الجديده 122,982,467

فروقات اسعار مشروع تنفيذ 29 بئر بولايات كسلا القضارف والبحر الاحمر :

المعادله المستخدمه:

P=

$$X+ a\frac{CE}{CE0})+b(\frac{RS}{RS0})+c(\frac{ST}{ST0})+d(\frac{Sa}{Sa0})+e(\frac{Agg}{Agg0})+f(\frac{acc}{acc0})+g(\frac{sal}{sal0})+h(\frac{fu}{fu0})+i(\frac{man}{man0})$$

X:عباره عن المصروفات الاداريه والارباح بوزن 0.15 من قيمه المشروع

a: عباره عن وزن بند الاسمنت من قيمه المشروع

CE@CE0:عباره عن تكلفتي الاسمنت عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

b:وزن البونتنايت من قيمه المشروع

BE0&BE :تكلفه البونتنايت التسليح عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

C: عباره عن وزن بند المواسير من قيمه المشروع

Pi0&Pi: عباره عن تكلفه المواسير عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

d:عباره عن وزن بند الفلتر من قيمه المشروع

Fi0&fi: عباره عن تكلفه الفلتر عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

e:وزن الاعاشات من قيمه المشروع

Acc0&acc:عباره عن تكلفه الاعاشات عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

f: عباره عن وزن المرتبات من قيمه المشروع

Sal0/sal:عباره عن تكلفه المرتبات عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

g:عباره عن وزن الاسبيرات من قيمه المشروع

Man0&man:عباره عن تكلفه الاسبيرات عند تقديم العرض المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

h : عباره عن وزن الاسبيرات من قيمه المشروع

fu0&fu: عباره عن تكلفه الوقود عند تقديم المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

I: عباره عن وزن الخزان من قيمه المشروع

ET0&ET: عباره عن تكلفه الخزان عند تقديم المالي وعند تاريخ حساب فروقات الاسعار علي التوالي

J: عباره عن وزن ضخ الشمسيه من قيمه المشروع

SP0&SP= عباره عن تكلفه وحده ضخ الشمسيه عند تقديم العرض المالي وعند تقديم فروقات الاسعار علي التوالي.

K: عباره عن وزن السورمن قيمه المشروع

Fe0&Fe: عباره عن تكلفه السور عند تقديم العرض المالي وعند تقديم حسابات فروقات الاسعار علي التوالي .

- **ولايه كسلا:**

وجد ان اوزان البنود علي النحو التالي:

البند	الوزن
X= وزن المصروفات الاداريه والارباح	0.15 معطي
a = وزن الاسمنت	0.017
b= وزن البونتنايت	0.003
C=وزن المواسير	0.018
d = وزن الفلتر	0.006
e =وزن الاعاشات	0.003
F = وزن المرتبات	0.041
g = وزن الوقود	0.135
h =وزن الصيانه والاسبيرات	0.048
i = وزن عن وزن الخزان	0.177
J=وزن وحده الضخ الشمسيه	0.364
K=وزن السور	0.37
المجموع	1.00

التباين في اسعار البنود وفقا للتكلفه التعاقديه والتكلفه الحاليه حسب المستندات والفواتير المرفقه :

CE0/Ton=	2050	CE/Ton=	5000
BE0/Ton=	2212	BE/Ton=	17500
PI0/Nr=	1499.18	PI/Nr=	1499

FI0/Nr=	2378.54	FI/Nr=	18500
ACC0/day=	375	ACC/day=	600
Sal0/month=	148084	Sal/month=	192510
Fu0/Gallon=	15.75	Fu/Gallon=	21
Man0/well=	162588	Man/well=	328880
ET0/Set=	215496	ET/Set=	682404
Spo/set=	443445	Sp/set=	1404244
Fe0/j0b	44796	Fe/j0b	141855

- ملحوظه في بند الصيانه والاسبيرات وجد ان نسبه الزياده في عدد 3 عينات عشوائيه تتراوح بين (118%314%286%) وتم اعتماد اقل نسبه زياده موجوده من بين النسب اعلاه وهي 218%.
- عند تطبيق المعالجه وجد ان :

$$P=0.15+(0.017*(\frac{5000}{2050}))+(0.003*(\frac{17500}{2212}))+(0.018*(\frac{1499}{1499}))+(0.006*(\frac{18500}{2378}))+(0.003*(\frac{600}{375}))+(0.041*(\frac{192272}{147901}))+(0.135*(\frac{21}{15.75}))+(0.048*(\frac{283485.7}{215496}))+(0.364*(\frac{1404244.875}{443445.75}))+(0.037*(\frac{141855}{44796}))=2.45$$

ولايه القضارف:

وجد ان اوزان البنود علي النحو التالي:

البند	الوزن
X= وزن المصروفات الاداريه والارباح	0.15 معطي
a = وزن الاسمنت	0.017
b= وزن البونتنايت	0.008
C=وزن المواسير	0.029
d = وزن الفلتر	0.005
e =وزن الاعاشات	0.007
F = وزن المرتبات	0.094
g = وزن الوقود	0.091
h =وزن الصيانه والاسبيرات	0.064
i = وزن عن وزن الخزان	0.164
J=وزن وحده الضخ الشمسيه	0.337
K=وزن السور	0.34
المجموع	1.00

التباين في اسعار البنود وفقا للتكلفه التعاقديه والتكلفه الحاليه حسب المستندات والفواتير المرفقه :

CE0/Ton=	2050	CE/Ton=	5000

BE0/Ton=	2212	BE/Ton=	17500
PI0/Nr=	1499.18	PI/Nr=	1499
FI0/Nr=	2378.54	FI/Nr=	18500
ACC0/day=	375	ACC/day=	600
Sal0/month=	148084	Sal/month=	192510
Fu0/Gallon=	15.75	Fu/Gallon=	21.24
Man0/well=	162588	Man/well=	328880
ET0/Set=	215496	ET/Set=	682404
Spo/set=	443445	Sp/set=	1404244
Fe0/j0b	44796	Fe/j0b	141855

- **عند تطبيق المعالجه وجد ان :**

$$P=0.15+(0.017*(\frac{5000}{2050}))+(0.008*(\frac{17500}{2212}))+(0.029*(\frac{1499}{1499}))+(0.005*(\frac{18500}{2378}))+(0.007*(\frac{600}{375}))+(0.094*(\frac{192272}{147901}))+(0.091*(\frac{21}{15.75}))+(0.064*(\frac{328880}{162588}))+(0.164*(\frac{682404}{2154}))+(0.037*(\frac{140244}{443445}))+(0.34*(\frac{141855}{44796}))=2.41$$

ولايه البحر الاحمر:

- **وجد ان اوزان البنود علي النحو التالي:**

البند	الوزن
X= وزن المصروفات الاداريه والارباح	0.15 معطي
a = وزن الاسمنت	0.014
b= وزن البونتونايت	0.003
C=وزن المواسير	0.020
d = وزن الفلتر	0.006
e =وزن الاعاشات	0.004
F = وزن المرتبات	0.051
g = وزن الوقود	0.216
h =وزن الصيانه والاسبيرات	0.049
i = وزن عن وزن الخزان	0.149
J=وزن وحده الضخ الشمسيه	0.307
K=وزن السور	0.031
المجموع	1.00

التباين في اسعار البنود وفقا للتكلفه التعاقديه والتكلفه الحاليه حسب المستندات والفواتير المرفقه :

CE0/Ton=	2050	CE/Ton=	5000
BE0/Ton=	2212	BE/Ton=	17500
PI0/Nr=	1454	PI/Nr=	2400
FI0/Nr=	1594	FI/Nr=	2600
ACC0/day=	375	ACC/day=	600
Sal0/month=	148210	Sal/month=	192673
Fu0/Gallon=	15.75	Fu/Gallon=	21
Man0/well=	167152	Man/well=	355886
ET0/Set=	215496	ET/Set=	682404
Spo/set=	443445	Sp/set=	1404244
Fe0/j0b	44796	Fe/j0b	141855

وعند تطبيق المعادله وجد ان:

P=

$$0.15+(0.014*(\frac{5000}{2050}))+(0.0039*(\frac{17500}{2212}))+(0.02*(\frac{2400}{1451}))+(0.004*(\frac{600}{375})+(0.051*(\frac{192673}{148210}))+(0.216*(\frac{21}{15.75})+(0.049*(\frac{355886}{167152})+(0.149*(\frac{682404}{215496}))+(0.307*(\frac{1404244}{44344})+(0.031*(\frac{141855}{44796}))=2.26$$

Applying Earned Value : Case study No(2)

EV= 23,000,000

PV=0.625*96,836,588= 60,522,867

AC=1.27*23,000,000=29,210,000

CV=EV-AC=23,000,000-29,210,000=-6,210,000

CPI=EV/AC=(23,000,000/29,210,000)= 0.787

CPI<1

SV= EV-PV=23,000,000-60,000,000=-34,522,867

SPI=EV/PV=(23000000/60522867)=0.38

SPI<1

EAC=29,210,000+0.763*96836588*1.27= 122,184,744