NECESSITY OF COST CONTROL PROCESS (PRE- & POST - CONTRACT STAGE) IN CONSTRUCTION PROJECTS

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MASTER THESIS

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CONCEPTUAL FORMULATION

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Summary

Cost overruns can cause serious damages to the projects and its stakeholder reputation, thus it needs to be managed and controlled properly. The purpose of this research is to present cost control guidelines and management plan to define the methodology by which costs associated with any construction project will be developed and managed throughout the project i.e. from Pre-contract (Design stage) to Post-contract (Construction design) phases. To ensure the successful completion of the project within the allocated budget, this will set the format and standards by which the project costs are estimated, measured and controlled.

This research will focus on the importance and difficulties of cost control during a design phase, examines the causes of claims, delays, and cost overruns, investigate the contractual clauses that quoted in claims.

Objectives of the Study

- Define how the project cost, budget, and source of funding will be managed.
- Identify and examine the aspects of cost control task in pre-contract and post-contract stages.
- Define the various technique of cost control like BIM technology, Earned value management; Lean Construction, Value Engineering and Activity based cost management.
- Identify Developing procedures for improving the effectiveness of cost control for managing and controlling costs during pre-contract and post-contract stages.
- Identify procedures for improving the effectiveness of cost control.

The Master's Thesis project will start on March 1st, 2017 and will end 25th,August 2017.

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ABSTRACT

The purpose of this thesis is to apply and validate more detailed understanding and general practices adopted for cost management and control in pre-contract stage (budget or cost estimation) and in the post-contract stage (during construction stage) of a construction project. All stakeholders of a construction projects (clients, design consultants, cost consultants, contractors and sub-contractors) will benefit from this study, it shall discuss and provide a platform for overall project cost management plan as well as cost control guidelines. Additionally, this also develops common understanding of the concepts involved with classifying project cost estimates in different stages in conjunction with actual projects and the reasons of cost overruns with the solutions. The thesis will focus on the identification and examination of all the aspects of cost control task in pre-contract and post-contract stages.

The first part of the thesis discusses how literature reviews the topic of concept of cost control. Important and relevant publications, research articles and different course books will be thoroughly presented and discussed in a first step.

In the second step, discussions with big consulting firm’s project managers, design managers, quantity surveyors and cost estimators specialized in construction and consultancy works to provide general practice adopted during pre- & post-construction stages including cost control techniques based on the discussion and various available literatures.

Finally, to collect the data and discover the current trend of cost management & control in construction projects, a questionnaire survey was conducted with different professionals from the construction industry. The questionnaire was consists of six sections covering the most important cost issues such as cost estimation, cost control, cost overruns and cost efficiency. After the reply received from them, data analyses were used supported with information from the literature review in order to answer the research gaps and objectives. The final step was to discuss the findings in more practical way that benefits professionals with the same background for better cost control practices.

The recommendations are estimators should use BIM technologies to generate more accurate estimates and minimize conflicts between different professions. They should combine estimating methods at the same time as well. Risk management could help identifying not only risks but also opportunities, adding safety factor to estimate costs should be learned because it is very important in response to risks and uncertainties. Earned value management (EVM) method is highly recommended as the basis of cost control. Last but not the least, the approach for cost control process should proactive not reactive as it influences the final budget amount.

Keywords: Cost Management, Cost Control, Budget and Cost estimation, Project Management, Construction Projects, Pre-contract Stage, Post-Contract Stage.

DEDICATION

First of all I thank God for every turn, the hard one before the good one. I would like to dedicate this thesis to my family, especially my parents who raised me up to be who I am today.

Father, you have been there always for me in good days and hard days, including the support while I have been away from home and trying hard to overcome any kind of obstacles I have faced.

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Mohamed Abdelmageed

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ABBREVIATIONS AND ACRONYMS

VE	Value Engineering
ABC	Activity Based Cost
BOQ	Bill Of Quantity
SCRs	Site Clarification Reports
WBS	Work Breakdown Structure
PE	Project Estimator
PM	Project Manager
QS	Quantity Survivor
CE	Cost Estimator
GFA	Gross Floor Area
NFA	Net Floor Area
BIM	Building Information Modeling
ABCM	Activity Based Cost Management
EVM	Earned Value Management

CHAPTER 1

INTRODUCTION

1. CHAPTER ONE INTRODUCTION

1.1. Introduction

Engaging in construction projects represents a substantial financial commitment and therefore, requires serious consideration for any client at the same time, the estimated costs of a construction project, are a primary determining factor that influences both the client's ability and decision to build. A project which exceeds the designer's or cost consultant predicted cost and/or the client's stated project budget usually has to be re-evaluated, maybe redesigned or even abandoned altogether - involving the designers or cost consultant in additional expenses or financial loss. It may ultimately call into question the designers' and cost consultant professional judgment and his credibility.

Cost control is another important aspects during pre-contract (design) and post-contract (construction) stage of construction projects.

Therefore, effective cost management, which involve cost estimating, budgeting and controlling during design and construction stages are critical success factors for the outcomes of any project. It requires an objective focus, necessary skills, effort, consistent and effective communication and pre-defined process of cost estimation as well as continuous evaluation throughout the design and construction phases.

1.2. Problem Statement

In general, the success of an individual project depends on how it can achieve the project objectives, which are the completion of the project within the estimated budget, to the desired quality within the pre-determined timeframe. To achieve the project objectives, planning, monitoring and controlling are essential in both pre-contract (design) and post-contract (construction) stage. Cost overrun is a key problem encountered in almost every project, which contribute to secure lower profit margin for the client, developer, contractor and all stakeholder involved. There are numerous reasons for cost overruns; which can be categorized as internal and external. Internal reasons at pre-contract stage are the application of inappropriate processes and procedures followed during cost estimation, continuous changes in design, poorly drafted scope of works, lack of reliable cost data bank, inexperienced cost estimating team, lack of pro-active approach by design and execution team etc. To avoid all these problems and challenges, good practice of cost control techniques along with well-established cost estimating processes are essential from the inception up to the closing phase of the project.

1.3. Objective/Aim of Study

The objective/aims of this study are identified as follows:

- Outline the overall project cost management plan and cost control guidelines.
- Outline cost estimation methods during the development of design.
- Identify and examine the aspects of cost control task in pre-contract and post-contract stages.
- Outline construction process flow in pre-contract and post-contract phases.
- Explain various technique of cost control like BIM technology, Earned Value Management, Lean Construction, Value Engineering and Activity Based Cost Management.
- Identify who is responsible for managing and controlling costs during pre-contract and post-contract stages.
- Explain cost control process and its implementation in project life cycle.
- Developing procedures for improving the effectiveness of cost control.
- Identify the reporting formats and frequency of submission.
- Validate cost estimation, cost management and cost control through a questionnaire and reply received from construction industry experts.

1.4. Scope and Limitation of Study

This study focuses on project cost management plan and cost control guidelines used in construction projects for the development of cost estimating procedure generally applied by the design and cost consultants firms. However, the scope of this study is limited to the following:

- Cost estimating procedures, generally applied by the design and cost consultant globally.
- Construction projects designed and executed by main consultant and contractors working globally.

- Every aspects of cost management can’t be covered in this study, as this is a wide area of research.
- Some well-known and proven cost control techniques are presented in the study for the guidance and discussions. However, various other techniques are available and developed as per the project requirements for cost control.
- The questionnaire is limited to questions stated and different types of projects, which were design and executed recently.

1.5. Research Study Methodology

The proposed research study topic covers common cost estimation, cost control and management process adopted in some renowned construction projects. This study is carried out in three different steps.

In the first step- the theoretical part of this thesis – the author will define cost management and control and its significance. This elaborated definition will serve as the underlying concept for this thesis. The common factors that can improve or obstruct cost performance during design and construction stage of the projects will be highlighted. In this stage the researcher will review relevant literature like published journal, technical papers, books, publication of various construction cost data as well as websites of the most reliable consulting and construction firms working all around the globe.

Moving to the second part of this thesis, which puts the theory into practice, a detailed study will be conducted on a different construction projects. Subject matter expert (SME) like design team members, cost estimators, project managers, construction managers, project control team and contract managers from various cost and design consultants are contacted through e-mails regarding their experience and lesson learned about cost control processes in present or past projects

Finally in the last step, the researcher will derive conclusions and recommendation from the analysis and discussion; they will summarize all-important aspects of both, theoretical and practical part, highlight lessons learned of the whole process and provide some further thoughts and ideas on cost control in general.

1.6. Research Thesis Chronology

To sum up, this thesis consists of six chapters. Chapter one, state about objectives, the methodology as well as the scope and limitations of this thesis.

Chapter two deals with the principles of concept of cost control, aim of cost control, importance of cost control, general reasons of cost overruns in construction projects.

Chapter three presents costs estimates in various design stages i.e. from the feasibility to final stages of design works. In this chapter procedures generally used in cost estimate preparation, use of contingency in various design stages were included. Moreover, methodology of main processes and activities carried out by the quantity surveyor during pre-contract or the post-contract.

Chapter four concerned with various techniques used for the cost control during design and construction stages like Earned Value System, BIM Technology, Lean Construction, Value Engineering and Activity Based Cost (ABC).

In Chapter five, where the practical part take a part .A questionnaire was sent to 80 different professional. A detailed literature review and discussions with professionals in the construction field were also the basis of designing the questionnaire. As a result, the questionnaire consists of 25 important questions from the author's point of view. The aim of the questionnaire was to study the current general practice of cost management and control during design and construction phases on international level thorough getting respondents' opinions and experience in various projects.

Finally, Chapter six presents the conclusions and recommendations of the study. It highlights and suggests the findings gathered through the analysis of the questionnaire responses and discussions with various subject matter experts working in the field of construction.

CHAPTER 2

LITERATURE REVIEW

2. CHAPTER TWO LITERATURE REVIEW

2.1. Introduction-Concept of Cost Control

Cost control is the practice of identifying and reducing business expenses to increase profits, and it starts with the budgeting process. A business owner compares actual results to the budget expectations, and if actual costs are higher than planned, management takes action.

The main objective of cost control is to optimize the use of resources in the entire project life cycle and to provide maximum advantages to all the involved stakeholders. In these days of political and economic uncertainty, the majority of clients insisting on projects being designed and executed to give maximum value for money in the shortest possible time. Hence, cost estimators/quantity surveyors are employed during the early stage of design to advice the design team of all discipline on the probable cost implications of their design decisions. As projects become more complex and clients are more demanding nowadays in their requirements, it is essential to improve and refine the cost control tools. Decrease in oil price, increase in construction commodity prices, restrictions on the use of capital, economic and political crisis all around the globe and high interest rates have caused clients to demand from the cost team to proactively accept cost as a crucial element in design, and ensure suitably balanced costs throughout all parts of the project, as well as an accurately forecast and control overall cost.

2.2. Objectives/Aim of Cost Control

The objective of cost control is to manage the delivery of the project within the approved budget (Thomas Wong, 2015). Regular cost reporting will facilitate the best possible estimate of established project cost to date, anticipated final cost of the project and future cash flow. The objectives/aims of cost control can be generally identified as follows:

- To maximize the profit from the investment within the designated period and the stipulated budget.
- To optimize resources required for the project to gain the value for money during the design and construction stages.
- To limit the final project amount within the agreed amount by clients, established during the various design stages cost estimate prepared by the cost estimator/quantity surveyor. Moreover, create sense of responsibility among all stakeholders for strict cost discipline

throughout all design stages and execution to ensure that the agreed cost estimate, tender amount and final account sum all are in stipulated limit.

- To implement controlling measures exercise from the initiation to execution stages to ensure the total construction cost or the final amount does not exceed the client's approved budget.
- To achieve balanced design expenditure between the various elements of the project i.e. to give the client value-for-money project, which could be a perfect, blend of well-constructed, satisfactory appearance and well suited to perform all the necessary functions for which it is designed.
- To oblige the consideration of a total-cost approach of a project, considering life cycle cost of the project.
- To ensure that the cost of the project is a vital element of design process during the course of design and construction stage to achieve a suitably balanced costs throughout all parts of the project.

The client may stipulate the maximum initial cost expenditure, or provide a detailed scope of work to the design and cost team who will then determine the cost of the project. Most schemes are a combination of these two extremes.

2.3. Significance of Cost Control

Cost control is always a vital element of design and construction stages. However, in the recent years the significance of cost control is increased to manifold. There has been a great need for an understanding of construction economics and cost control by all the stakeholders of the project, particularly during the design stage of projects (Thomas Wong, 2015). The importance of this is due largely to the following:

- The project and client's requirements nowadays are more complex as compare to projects in earlier times. Therefore, a dynamic and more effective system for cost control is required from inception up to the completion of the project and further during the operational stage.
- The client and end users are unlikely to tolerate any delays caused by redesigning the project if the tenders received for the specified works are too high.
- The client (large organizations and financial institutions) reputations are at stack due to delay caused by mismanagement and improper cost control.

- Modern designs, new techniques, introduction of new materials and innovative methods of construction are bringing a wider range of products to choose from varieties in construction for designers. The traditional methods of estimating are unable to cope with these circumstances to achieve value for money and more balanced designs.
- Globally, contractors' markups have been reduced considerably during the past decade due to competitions, recession, overheads etc. This has resulted in their greater cost-awareness in an attempt to recover possible losses through effective cost control processes during construction stage.
- Natural resources, which are used in construction works directly or indirectly are required to be used in a sustainable way. Therefore, a move towards the elimination of waste, and a greater emphasis on the use of the world's scarce resources are developing. This has necessitated a desire for improved methods of forecasting and control of costs.
- Project costs are to be controlled not solely in the context of initial costs but in terms of life cycle costs, or total-cost appraisal, which includes operational cost.
- Economic recession in all over the world have a direct effect on the construction industry. This has led to a decrease in the availability of funds for capital purposes and construction in general. High inflation and interest charges are also resulting in the costs of construction soaring to high levels.
- Awareness about cost increase in later or developed design stages can cause more damage to the project cost and client's reputation. Therefore, cost control should be implemented from the inception of the project.

2.4. Reasons of Cost Overruns

Cost overrun and delay in project completion are integral part of most projects despite the availability of well-developed project management system supporting with advanced software. Physical and economic scales of the projects today are driven on either profit (for private organization) or national interest (for government projects). And, the degree of success of any endeavors can be defined within the famous triangle of cost, time, and scope or quality. Therefore, it is much appreciated to look general reasons of cost overrun in pre-contract and post-contract stages along with their mitigation plan, so as to increase the chances of project success.

2.4.1. Pre-Contract Stage (Design Stage)

Some of the reasons for cost overruns during the pre-contract stage (design stage) are listed as below:

Design Errors

One major factor that has been identified as reasons for cost overrun in most projects is design errors (Olawale, Y., and Sun M., 2010). Causes of design errors in most of the projects are inadequate field investigation, error in design and specifications, plan errors, design changes etc. Project designs are usually mapped out proper representation of client's technical and economical requirements. Thus any errors in design practically mean wrong or insufficient representation of project deliverables. Inappropriate design could also lead to error in project estimations and misrepresentation of project works, thereby leading to extra and abortive works, change order etc., thus resulting in delay and cost overrun.

If design errors unfold during execution stage it will lead to wrong application of techniques in achieving result and any attempt to correct it will lead to delay and cost overrun. Designs that are done without extensive investigation of site conditions could contain serious errors. Such designs could lead to additional work in form of re-design, revision of design and scope of work, and possibly contract revision. These will affect the overall project delivery time and cost.

In controlling project cost overrun and delay due to design errors, the basic thing to be considered is the involvement of professional skills, application of competent tools throughout the project, good communication with entire design team, integrating a design process that is properly planned, giving enough time for corrections, extensive investigation and reviews, an effective project planning, controlling and monitoring, proper site investigation and application of value management to obtain the best cost effective design options.

Estimation Methodology

The common methodology used by the estimator in the early stage of design is parametric method which is solely depends on the cost data of similar previous projects. However, as the design progresses estimator break down the total scope of the project into measurable elements i.e. in the form of bill of quantity BOQ (Himansu Bhaumik, 2010).

These conventional method use for estimation to work out the single point values of quantity, unit rate, and unit cost of individual elements and then combine the estimate for each element to arrive at the total estimated cost of the project. However, since it is very difficult to determine correct costs at this stage of design, these estimates are simply predictions of future values based on the information available during design stages.

Because of the inherent uncertainty associated with prediction of estimate, the cost is subject to change from the actual costs incurred during execution. Most of the projects are suffering from significant cost overrun due estimate uncertainty. So, it can be concluded that the early estimates may not have adequately cover all the factors contributing to the changes or cost increase. Therefore, serious efforts towards applying adequate methods and processes need to take to improve on the quality of the estimate and any discrepancies between estimates and actual costs.

Uncertainty Associated with Project Quantities

Once the project scope is defined, up-to-date levels of engineering knowledge, information and details are used to measure the project quantities (Himansu, Bhaumik 2010). Generally, the quantification done for the major work at an early stage of engineering is never accurate enough to match the final quantities, unless it's repletion of similar works. Eventually, this leads to claims, deviation and change order and subsequently the cost overrun.

Site work is best example for uncertainty associated with quantities. This consists of site clearing, stripping, grubbing, excavation & backfilling, soil stabilization, drainage, and roadwork. Basis of design is required to finalize the preliminary quantities in early stage of design. Since, these quantities are not engineered with sufficient details and are usually left to site verification during the execution stage, this results in significant variance between the estimated and actual quantities.

Some indirect cost elements need adequate attention for quantifications may include:

• Labour camp including health facility, food and accommodation.

• Transportation facilities for labours.

• Additional cost to cover rotational duty in remote areas.

• Construction offices set up and running.

• Enabling works including fencing, roads, construction power, sewage treatment, garbage disposal, lay down area, fuel supply, potable water supply, sanitary facilities etc.
• Training for staff.
• Construction equipment.
• Tools and consumables.

Uncertainty Associated with Unit Rate and Unit Cost

Unit rates are used to calculate productivity in terms of man-hours needed to complete a unit quantity of work. Reliable databases are available for productivity calculation by various agencies (RS Means, RICS etc.). Even some contracting firms and consultancy firms maintain their own in-house databases by using a standard productivity index. The uncertainty associated with the unit rates mainly concerns the assigning of an appropriate productivity index to suit an actual project condition. However, this can be more challenging for many countries where local productivity indexes are not available (Himansu Bhaumik, 2010).

Unit cost of a component is another important variable in the process of estimation. Appropriate unit costs when multiplied with concerned quantities and unit rates produce the calculated costs. Examples of unit costs included in the estimation process are as follows;
• Bulk commodity cost such as cost per ton of steel structures.
• Subcontract cost such as cost per cubic meter of concrete placed.
• Labor hour cost such as hourly pay roll cost.
• Construction equipment rental cost such as hourly rental cost of a 50-ton crane.
• Engineered equipment cost such as cost of a pump.

All of these unit costs are dictated by the law of supply and demand, local regulatory practices, and inflationary pressures, which are prevailing between the time the estimate is prepared and the time of commitment.

Escalation and Contingency

Escalation and contingency are normally addressed separately and included in the cost estimate as separate line items. Escalation is included to cover the change in price of labor, materials, and services due to inflation and other market conditions (Olawale, Y., and Sun M., 2010). It is normally not related with the degree of engineering completeness and as such can be estimated even during the early stage of the project. There are usually two parts to the process of estimating the escalation. The first part is to determine the point in time when a certain commitment of project expenditure is made. The second part is to predict the applicable escalation rate from the time the base estimate is prepared. There is, however, uncertainty associated in predicting both of these factors (Himansu Bhaumik, 2010).

Contingency is added to the estimate to cover uncertainties associated with estimation. Contingency is define as “an amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs” (AACE International). Many projects include this cost based on experience and find it to be inadequate while executing the project. It is recommended to estimate the contingency using statistical means through risk analysis and adopting range estimation techniques.

Other Miscellaneous Cost Elements

There are some costs elements those are not traditionally covered in quantification and these elements may cause cost overruns if not covered properly in the project estimate. Below is the list of such items (Himansu Bhaumik 2010):

- Freight cost and logistic.
- Financing cost and client’s cost.
- Start up and commissioning cost.
- Insurance cost.
- Social costs.
- Land acquisition cost.
- Operation ramp up cost.

2.4.2. Post Contract Stage (Construction Stage)

Reasons for cost overruns during the post-contract stage (construction stage) are defined as below:

Poorly defined Scope of Works

Poorly defined scope of works or poor project definition is the main source of cost overruns. It is generally discovered later when comparing the "as built" scope to the "as estimated" scope. The design project manager must perform a thorough study of the project scope at the beginning and get consent in writing from the client (Philip R, Moncrief, 2004).

Another source of cost overrun in project scope is not having the basic process set in the beginning of the project.

Unclear inapplicable, or incomplete project specifications, is another source of poor project scope of works. Regular changes in specification during execution stage source of higher cost in the construction industry.

Geographic, climactic, seismic, or soil conditions are not defined properly onset of the project. These are refined as the project progress. Similarly, administrative requirements of the client, local labor rules, requirements for local content, and local vendors supplying materials may cause project cost change, import regulations and taxes are often a source of cost "surprises" to the project and should be reviewed thoroughly at the start of the project and monitored constantly throughout the project for unanticipated differences.

Contract Formation Defects

Another major reason for cost overrun in project is inappropriate, vague, ambiguous, one sided and poorly drafted contract (Olawale, Y., and Sun M., 2010). Contracts should include every aspect of a project works and business relationship including payment terms, pricing, and service levels otherwise it may lead to dispute and long chains of negotiations, arbitration and/or mitigation, change work orders and the quest for reviewed contractual agreement with new budgets and schedule. Contract drafting defects like ambiguous contractual agreement with unclear clauses make contract incomplete, particularly in the areas of transfer of care, custody, control and start-up, warranties and performance tests.

Poor contractor selection, unethical selection criteria, contract bid amount, difference between the winning bid and second bid, difference between the winning bid and the engineer's estimate, payment schedule etc. are critical to the successful completion of any project. Thus poor selection of contractors due to low bids, with no technical capability will lead to cost overruns, schedule delays and poor quality. Therefore, all important potential dispute contract clauses should state in clear unambiguous terms. The use of generic contract conditions and templates should be avoided and “careful consideration should be done when forming the contract as per the specific project requirements. This will ensure that things are included in the contract documents that enable effective contract management (Philip R, Moncrief, 2004).

Client’s Action

Client actions like delay in approval, frequent changes in design and scope of work, delay in payments, prior approval of budget, short period for the project completion etc. can also cause cost overruns (Thomas Wong, 2015). Inexperienced team immature decisions of client project team members (inexperienced in projects in general or with the specific project type) are often a cause of increase cost. Delays in client decisions or late modifications are very common during design and construction stages, which increase costs through reduced productivity and necessary rework. If the client’s preferred vendor and subcontractor list is too limited or if unsuitable suppliers are included, poor quality materials or higher costs for the materials may be incurred. Sometimes client’s representative doesn’t have prior approval of budget or any budget for required modifications, which cause delay and give chance to contractor for additional claims.

Project Schedule

The detailed project schedule generated at the beginning of the project cannot be over stressed. Costs can be increased either through unrealistic schedules being created or imposed (by management or by the client) or through not meeting the agreed schedule. Areas of poor schedule performance that can contribute to increased costs include (Philip R, Moncrief, 2004):

- Late mobilization of personal and resources both in the engineering design office and the field.
- Late decisions by client not as specified in the schedule.
- Performing activities out of sequence (Ex: mobilization of subcontractors too early).
- Late revision of document by client after finishing all related activities.
- Delays in releasing purchase orders of vendors and consequently vendor drawings and data being issued late to the design team.
- Delays in issuing documents (shop drawings, site clarification reports (SCRs), request for information (RFIs)) to the job site.

- Late deliveries of materials to the job site, in particular, bulk materials or long lead items.
- Cascading effects of delays of one discipline in design and approval on another on the job site.

Home Office Support and Engineering Services (Design) Cost

Home office and engineering services costs can be overrun by a variety of causes, such as (Philip R, Moncrief, 2004):

- Late modifications and repetition of studies.
- Internal productivity problem caused by performing work out of sequence, rework, uncontrolled interfaces between disciplines and impact of changes by one discipline on the work of another.
- Excessive management reports and documents.
- Excessive costs for software, computers and information technology system.
- Underestimating the man-hours required for design works.
- Misunderstood the design scope of work.

Procurement and Subcontracting

Even the best procurement and subcontracting plans can run into cost difficulties. The market condition for purchasing and subcontracting can be different from those anticipated during estimating with inflation or lack of qualified and available suppliers causing increased costs (Thomas Wong, 2015). The workload of selected vendor can cause increasing prices and delay in delivery. If the purchase order documents are too voluminous or poorly structured or the term and conditions or specifications too strict or not complete enough (e.g. no agreed conditions for variations), the vendor can suffer increased costs that he will try to pass along. Spare parts not identified at the time of purchase will not normally be competitively priced after the purchase order has been placed. If any purchasing or subcontracting constraints are imposed by project financing and are not properly accounted for in the estimate, costs can increase.

Bidder provider with take-off of the expected quantities and types usually purchases bulk materials. If the quantities used for selected the vendor are not representative of the final requirements, even the most rigorous purchasing strategy may result in the wrong (not lowest cost) vendor being selected. If the types of materials given to the bidders are not inclusive of all requirements, the supplier may provide the additional types of materials at a non-competitive price.

Activities during Construction Stage

Increased costs can be incurred during construction from a number of causes. The impacts of these increased costs can be passed along to the client, the general contractor, or other depending on the contractual relationships. The project manager should be aware to the impacts and take the steps necessary to mitigate them. Construction costs can increase by poorly qualified or experienced construction supervision, slow manpower mobilization, and delays in initial site work which can impact the succeeding construction activities such as underground piping, slabs, foundations concrete structures, structural steel (Olawale, Y., and Sun M., 2010). Delays in delivery of drawing and materials can cause lower productivity, schedule delays, and rework. Poor manufacture inspection of fabricated equipment and materials can cause the field to rework the items or return them to the fabricator. Late modifications of construction document or late recognition or pre-commissioning and commissioning requirements can cause rework and increase costs. Failure of subcontractors to perform as planned or financial failure of a subcontractor can lead to increased costs and potentially large delays in construction performance.

Other sources of cost overruns during construction stage are the premature withdrawal of a key person from the project team with the resultant loss of knowledge and inertia and exchange rate risks.

Impact of Joint Venture Management

Joint ventures, either of client or contractors can lead to cost over runs from a variety of causes. Managing the interfaces in a joint venture can become a full time job for the project manager and he may need to add staff to monitor and manage them. Having a well-qualified management team to assure technical coordination (choice of and compliance with rules, standards, and specifications), coordination of technical interfaces, and control of all joint venture expenditures, at time of their commitment, can make the joint venture a success (Philip R, Moncrief, 2004).

Common sources of overruns in joint ventures are:

- Enforcing common methods in the joint venture rather than using each partner's normal work processes and tools.
- Coding systems for common materials and documents implemented late or poorly.
- Split of responsibilities or services that are vague and/or unsuitable.
- Lack of motivating provisions for each company to keep their own costs under control and to keep from generating any increased costs for their partners.
- Invoicing procedures to the joint venture being too complex and costly.

2.5. Summary

Project budget estimation is not only a task that design, cost and quantity surveying team carried out during project planning or pre-contract stage. The entire team would have to keep a close control on whether the costs remain close to the figures in the initial budget in the entire stage of design. It is advisable to constantly review the budget as well as the trends and other financial information. Cost status reports on project financials at regular intervals will also help keep track of the progress of the project. Regular check on project budget will ensure that overspending due to various reasons as mentioned in the previous sections does not take place, as client or higher management would not accept it when it is too late. The earlier the problem is identified, it is more easily and quickly to be fixed.

Similarly, cost management and control is equally vital in the post-contract stage. Regular changes from client, other stakeholder and deviation from the scope of work not only increase the cost but also off-track the project. The improvement of administrative process of change orders is very effective in decreasing the costs and the level of risk, for all the parties involved in the project persuades a better relationship that is built on trust.

CHAPTER 3

PROJECT BUDGET, COST MANAGEMENT & CONTROL

3. CHAPTER THREE PROJECT BUDGET, COST MANAGEMENT & CONTROL

Project budget and cost management is the process of ensuring that the project is completed within the approved budget (Thomas Wong, 2015). It includes cost planning, cost estimating, the setting of realistic budgets and controlling actual costs against those budgets. The Project must be completed within the triple constraints of time, cost, and quality. Budget and cost management is one of these essential elements; it deals with the financial aspects of the project. The client and the project manager are committed to ensuring that the project complies with its financial requirements. The objective of the budget and cost management process is to ensure that the project is completed within the approved budget.

Cost Management Plan

The purpose of cost management plan is to define and establish the methodology by which costs associated with project will be managed throughout the project lifecycle i.e. from inception to completion. To ensure the successful completion of the project within the allotted budget, this plan sets the format and standards by which the project costs are measured, reported and controlled. Several cost components are associated with any project. Metrics, cost variance considerations, and reporting activities will be outlined in this plan. To complete any project successfully, all key project members and stakeholders must adhere to and work within cost management plan and the overall project plan it supports.

The cost management plan will:

- Outline the overall project cost management approach; outline how the project cost, budget and source of funding will be determined.
- Identify who is responsible for managing and controlling costs, including who has the authority to take decisions, approve changes to the project, its budget or sources of funding.
- Identify the methods to be used for quantitatively measuring and reporting on cost performance; identify the reporting formats, frequency and to whom they are presented.

  The cost management plan is prepared taking into account the following inputs from the project.

- Work breakdown structure (WBS) for cost estimation and management, which is a hierarchical breakdown of the project into sub-elements, phases, deliverables, and work packages. A work breakdown structure is a key project deliverable that organizes the team's work into manageable sections.
- External/other factors-Specific factors that may influence the cost management such as political policies, currency exchange, location and requirements of the projects etc.
- Historical information of projects with similar characteristics.

Budget and Cost Management Strategy

The strategy for achieving the budget and cost management objective is for the PM and the client to establish an accurate and realistic budget for the Project in accordance with the approved project work breakdown structure (WBS). It then falls to the PM to control and monitor project costs against the budget. This strategy requires that the project budget and cost management functions be integrated with schedule management processes and procedures. Both the project budget and the master baseline schedule will be developed utilizing a common WBS. The project baseline master schedule will be used to time-phase all project costs. Budget and cost management software will be adopted and linked with the baseline master schedule software to prepare budget and cost reports. The Project budget, along with the baseline master schedule, will be monitored and updated throughout the project to report actual progress and to forecast project costs (AACE International, 2012).

The budget and cost management strategy includes the following processes:

- Estimating the costs of different project elements to create an overall project budget.
- Creating monthly project cash flow requirements to determine project-funding requirements.
- Reporting costs to date and forecasting total project costs based on the percentage completed and project trends.
- Cost management and control occurs at three levels in the project; budget summary (at the project level), contract budget (at the contract level) and progress payments (at the contract level).

Budget and Cost Management Methodology

The following table summarizes the budget and cost management methodology and provides an overview of the various action items associated with the management of the budget and cost aspects for typical construction or consultant services packages. The responsibilities of the various parties (generally) directly involved with the budget and cost aspects of the project are indicated.

Table 3.1: Responsibility Matrix

Sr. No.	Party / Organization	The Client Activity	Project Management Consultant to the Client	Design Consultant to Project Management Consultant	Contractor to Project Management Consultant
1	Work Breakdown / Packages	Approve	Establish		
2	Existing Budget Estimates	Provide data to Consultant	Review and report	Advise	
3	Cost Estimates (Excluding Changes)	Review	Review and report	Prepare	
4	Cost Budgets	Approve	Review and Recommend		
5	Cost of Design Alternatives	Approve	Recommend	Prepare	Advise
6	Variation Orders	Approve	Prepare, Review, Clarify, Check, Monitor and Recommend	Comment or Prepare	Propose
7	Waivers/Concessions	Approve	Review and Recommend		
8	Claims (From Contractors)	Approve / Reject	Notify, Review, Check, Recommend	Comment	Notify and Submit
9	Monthly Cot Report and Final Forecasts	Review, Comment Report	Prepare and Report	Review and Submit	Report
10	Processing Interim Payments	Review, Agree/ Accept	Review, Certify, Check, Monitor and Recommend	Review and Submit	Submit
11	Processing of Certificates	Review, Agree/ Accept	Review, Certify, Check, Monitor and Recommend	Review and Submit	Submit

The detailed processes and procedures for budget and cost management on the project are included in the following sections.

Budget Determination

Consultant will prepare detailed budget to ensure that allocated budget for the projects is sufficient and suitable to meet clients' goals and objectives (Project Cost Estimating Manual 2015). The budget is prepared to cover the following:

- Design fees.
- Construction supervision fees.
- Project management fees.
- Construction costs.
- Contingency sums.

Similar to the conceptual estimate preparation, the budget prepared by consultant considers the following:

- The overall built-area or unit of measurement of each component.
- The unit rate as per the applicable unit of measurement.
- The market prevailing prices and the estimated prices at the time of execution of each component in view of the forecasted rates of inflation in economy and price fluctuation.
- The comparison with available historical data for similar projects or data.
- Suitability to the proposed bid strategies and time schedules.
- Risk analysis and its effect on the budget allocated for each component.
- Allocated contingencies and sufficiency to cover the design, construction and price changes.
- Updates covering any new events or factors that may affect the basis of the allocated Budget.

3.1. Pre-Contract Stage (Design Stage)

The purpose of this study is to present a set of procedures, requirements, rules and guidelines for the purpose of establishing general standard structure and mandatory approach in the preparation, production, communication and review of construction cost estimates for building projects, throughout the design phases and construction phase (AACE International, 2012). This study also provides:

- A standard form and procedure for post contract analysis of final design and actual tender construction costs, for the purpose of developing an historical construction cost database for use in budget estimating and cost planning future projects.
- A standard method and rules for measurement of buildings, and terminology to be adopted and used by design personnel whenever building areas - Net and Gross Floor Areas - (NFA and GFA) or building volumes, are required to be calculated, expressed or communicated with in consultant or to clients, in connection with project design space programs or cost estimates.

Applicability of Study

The study can be applicable to and shall be followed by all design and construction personnel like managers, architects, engineers, quantity surveyors and estimators; involved in or contributing to the preparation, and production of cost data and construction cost estimates for any construction projects.

Preparation of Cost Estimate

Cost estimate shall be prepared at such time as directed by the project manager in conjunction with the knowledge, support and co-operation of the assigned design team.

- Cost estimates shall whenever possible be based on 'quantification' of the proposed works with each unit of work priced according to the current market price for that unit. Where 'quantification' is not possible, historical cost data should be utilized (either elemental cost/m2 of floor area and/or parametric unit cost data). The preference shall be the option that contains superiority in cost reliability.
- Cost estimates shall reflect those works shown on drawings and specifications and/or that, which can be reasonably inferred, as necessary.
- Cost estimate submittals to clients shall be prepared under the management and direct supervision of a professional quantity surveyor/cost estimator whose primary duty is that of cost management estimating.
- Design department cost estimates shall be prepared by architects, engineers or quantity surveyors, with estimating experience and a broad understanding of construction work

costing techniques and management objectives, and who are familiar with UNIFORMAT and the provisions of this manual.

Performance Standards

Cost estimate submittal must meet the following standards:

- Balance: Among the various design-construction elements and systems which make up the proposed project works, there must be a proportional estimating effort by each respective design discipline, in relation to the department's cost contribution to the cost of the project as a whole, including specialist sub consultants.
- Completeness: For an estimate to be acceptable, it must incorporate and make provision for all components of the proposed project works together with all modifications, regardless of the stage of design, including specialist sub consultants (if any).
- Accuracy: To be credible, a quality departmental estimate should be as accurate as the design stage information and experience makes possible.

Estimates must be quantified and unit rate priced to the greatest extent possible and unsupported lump sum amounts must be held to an absolute minimum. The level of cost detail and back-up information is to be appropriate to the level of detail and data provided in the documents at each design stage of the project.

Estimates Structure and Format

Cost estimate submittals and back-up data shall be structured, organized, formatted and reported in accordance with CSI "UNIFORMAT - A uniform classification of construction systems and assemblies". Refer to Appendix 1. By definition, elements are the major components and systems, common to most buildings, which perform a particular function regardless of the design specification, construction method, or materials used. UNIFORMAT classification provides a practical and consistent reference for analysis, evaluation, control and management, and may be used effectively as a basis for:

- Developing design - construction programmers.
- Structuring costs for economic evaluation early in the design process.
- Estimating and controlling costs during planning, design and construction.

- Conducting value-engineering workshops.
- Performing risk analysis.
- Coding and referencing standard details in CAD design systems.
- Structuring preliminary project descriptions.
- Structuring cost databases and BOQ documents.

UNIFORMAT comprises three principal hierarchical levels: Major group elements (level 1), group elements (level 2), and individual elements (level 3). Sub element levels 4, 5 and 6 comprise subordinate sub-components and systems in successive degrees of specific detail - Level 6 constitutes and equates to individual construction work items similar to those used in a BOQ documents.

Pricing

All pricing and unit rates used in cost estimates, shall be current as at the date of submission, providing for all Contractors' mark-ups and margins, but excluding any projection allowances to cover the anticipated contract time for completion, and/or any contingency cost allowances.

Contingencies

The Project estimator shall be solely responsible for anticipating and allowing appropriate contingency factors in each cost estimate; including provision for on-going design development (design contingencies) and any anticipated market cost fluctuations between the date of the estimate and the predicted date of contract award (increased cost contingencies). These contingencies shall be identified individually and expressed as percentage cost allowances in the executive summaries.

As design development advances and the date of contract award can be more accurately predicted, then contingency cost factors should be progressively reduced in each successive cost estimate submittal until generally eliminated and finally expressed at zero in the tender price estimate.

Assumptions, Exclusions and Qualifications

The cost estimate shall include all the exclusions and any significant assumptions and important qualifications concerning the estimates that should be brought to the attention of the client for his due consideration in relation to the overall cost of the project. It is imperative that all design trades exclusions, assumptions or qualifications relating to their design should clearly mention in cost estimate.

Requirement of Specialist Sub-Consultants

External specialist sub-consultants, participating in the project should be familiar with the requirement of the project and provide cost estimates relating to their specialty. Generally, the cost information produce is of such a specialized nature that it may be impossible for project cost estimator to verify its accuracy. (Examples are: - Interior Design, (Fixed Decor). Loose furniture, fittings and fabrics. Kitchen & laundry equipment, hotel management systems, sign writing, audio vision systems and landscaping, etc.

Definitions

The following definitions apply to the various design stages. The percentage of design shown against each stage of design is only indicative.

Design Stages (Generally)	% of design
Inception. Appointment of Design Team and general approach defined)	
Feasibility. Testing to establish whether Client's Requirements can be met in terms of planning, accommodation, costs, etc.	
Out/in Proposals. (Conceptual) General approach identified together with critical dimensions, main space location and uses: budget identification.	10-20%
Scheme Design (Preliminary) Basic form determined and Cost Plan (budget verification).	40-50%
Detail Design (Fundamental) Design developed to the point where detailing is complete and the building 'works'. Cost checking against Budget.	60-75%
Production Information (Final) Working drawings prepared for Contract Documents. Fair Priced (Tender) Cost Estimate	95-100%

Frequency of Cost Reports

The frequency of cost estimate reports, are aligned to each design stage. This frequency may not be a requirement of the Service Agreement. Each subsequent cost report shall however follow the same principle of ascending refinement and accuracy, parallel with design development.

Inherent Factors Influencing Building Costs

Cost estimators/ designers are only minimal control over construction elements like client's selection of his Site, requirements for a particular building type and required completion date for the project. The majority of construction costs are already inherent within his development. Designers must identify these costs at the earliest and control them as the design evolves.

1. Project Location

Project location selection cannot control by the cost unit or design team. They are inherent within any design. Site, city, and country in which the development will occur will select by the client, and this selection is subject to local building codes and standards. The project site is also influenced by the climatic and geographic conditions of the area. Consequently the clients' selection of a site, has already incurred major costs influencing his development, over which the designer has little control.

2. Proposed use of the Development.

The client requires that his development will be of a particular type (residential, commercial, etc.). Consequently, the client's selection of the function of the project type has already incurred cost parameters on the design and the cost unit or design team can only marginally influence construction costs. With the client's selection of the building type, the following is identified: -

- The hotel must have adequate capacity to generate income from paying guests to render the project viable (feasible). Consequently this will identify the building capacity. This capacity must be contained within the site area (Plan area) and as such is inflexible. Flexibility occurs only with building height (either below or above ground). Height is subject to local regulations.
- As buildings increase in area, generally unit costs of construction reduce. This maxim only applies to low and medium rise buildings. High-rise buildings are more expensive to construct, due to additional loading and less efficient use of non-usable space.
- The greater the story height between floors, the greater the construction cost. The vertical elements of buildings can account for 25-35% of the total construction cost. A 10% reduction in story height may reduce costs by 2.5 -3.5%.

- The Buildings built up area contains dead space (non-usable or non-income generating space) Example, circulation, toilets, electro/mechanical plant room areas, ducts and the like. The designer can minimize these dead spaces.

Consequently the client's selection of his site and the function of the project type, has already incurred cost parameters on the design and the designer can only marginally influence construction costs.

3. Quality

The quality of construction relates to the purpose intended for the development. They are inherent in the design and are subject to marginal cost control by the cost unit or design team. There is a direct relationship between quality and cost. Quality may be influenced by local regulations, particularly by the building and the purpose intended. Moreover, the location of the site will have an impact on the construction cost depending on the source of supply of materials (whether they are locally produced or are imported).

4. Contractual Matters

These relate to the clients' requirements in respect to risk, and the contract-selected form influences them. They are not design orientated, but contractual orientated cost matters. The General Contract Forms (FIDIC) apportion risk sharing between client and contractor on an equal basis. If clients' wish to reduce their exposure to contractual risk, they must increase the contractor's risk. In this eventuality, the client must be prepared to pay a premium to the contractor (higher cost) for this benefit.

5. Time Factors

Clients require income from the completed development; in the shortest possible time (clients make no money during construction, only on completion, by trading/sale of the completed development). The client may elect to introduce an accelerate construction programme, to realize this benefit from the completed project at an earlier date. Consequently, he must pay a premium (higher cost) to the contractor for this benefit. These additional costs are beyond the control of the designer and are based on the client's own requirements. The above represent the prime fundamentals influencing the construction cost of a project and the designer's ability to reduce construction costs is limited once the client has selected his Site.

Costs Estimates in Various Design Stages

Cost estimation is a process that provides progressively more accurate information as a project moves from conceptual through final design and construction award. Therefore, cost estimates must be reviewed during the whole project. The cost management plan -documents the methods to be used to manage and control the cost components.

A 'bottom-up' approach will be used for preparing a detailed cost estimate of each cost component involved with each project activity. Costs estimates will be prepared using the best information available at the time of estimation. The basis for the estimate must be fully documented so that if better information becomes available at a later time in the project, the cost estimate can be adjusted. The cost estimate will follow the same principle of ascending refinement and accuracy concurrently with the design development. Design consultant/cost consultant will prepare the cost estimate at each of the concept, preliminary, detailed and final design stages through its quantity surveyors, cost engineers, economists, and qualified professional engineers and by employing its established cost planning guidelines.

The usual practice followed in preparing cost estimate in various stages of design depends on the size & type of the project and the time availability. It also depends on the requirements of the clients for instance how to develop project design.

The primary objective of preparing cost estimates in various stages of design is to produce the element of certainty of cost to the maximum with the level of design information available at the time. The ability to increase this element of certainty is parallel with design development.

The following sections shows the different estimate stages based on the project design stages (AACE International Recommended Practice No. 17R-97):

3.1.1. Feasibility Stage: Indicative Cost Estimate

The details available at this stage of design are nominal i.e. only shape, form, and function. The method, to the accessed project cost, is by historical costs data applied to the total enclosed floor area or volume. Moreover, historical parametric unit costs can apply to the defined components of the project if design information is sufficient. These historical costs are available from the cost data bank and must relate to a previously completed project, similar in type and location to that proposed. While preparing cost estimate in this stage, adjustments to cost data must be made to suit the uniqueness of the proposed project, including its time of construction, contract form and the economic conditions prevailing in the project country. Cost estimate at this stage of design is indicative cost estimate or the order of magnitude.

Scope

- The client must inform the PM of his full requirements as it is these requirements that provide the cost parameters for the preparation of the indicative cost estimate.
- Design information to be provided by the PM to the Project Estimator (PE).
- Indicative cost estimate to be complied by PE to PM.

Design Data

The PM will provide to the PE with:

1. A copy of the client's requirements, illustrated in general layout drawings clearly showing the shape and form of the proposed development.
2. Schedule of built up area proposed (Gross Floor Area) and all other available information (site Investigation results, brief out line specification) if known.
3. Construction proposals (if known) comprising any packaging and phase requirements, form and type of construction contract, anticipated dates for commencement and completion.

Indicative Cost Estimate

The PE will prepare an indicative cost estimate based on historical cost/ m^2 applied to the gross-floor area, or where permitting, parametric unit cost based on the defined building components/systems. This information shall be based on a cost model obtained from the cost data bank. The proposed development and the cost model(s), used shall be similar in type, characteristics and location as far as possible. As no two projects are similar, the PE shall isolate those factors, which are not common to both developments, and he shall make a professional judgment in terms of cost and include them within his indicative cost estimate. During his assessment of the indicative cost, the PE should communicate with the respective design trades as appropriate.

The indicative cost estimate shall be prepared and summarized on the executive summary and submitted to the PM including any supplementary back up sheets as deemed necessary by the PE. Contingencies of 15% project cost shall be included in this indicative cost estimate unless otherwise decided by PE. The adequacy of the first project cost estimate is critical as it sets the financial framework for the project cost and all subsequent cost estimates. Consequently considerable care must be taken during its preparation and it should be reviewed by the PM and PE prior to issue to the client.

Clients Budget: Indicative Cost Estimate

Where the client has already indicated his project target budget, the PE shall compare the Indicative cost estimate against the clients' target budget and report any difference to the PM. The PM and PE will jointly investigate whether cost economies could be achieved of sufficient magnitude to eliminate any cost over-run against the clients target budget. These recommendations will be made by the PM after discussions and agreement with the higher management for client's approval. Where Project cost under-runs is indicated against client's target budget, the PM and the PE shall verify the adequacy of the indicative cost estimate, prior to advising the client.

Submittal Package

The indicative cost estimate package shall be produced and prepared by the PE. It shall be bound in a suitably sectioned and arranged document, and following final review and approval by the PM, shall be transmitted to the PM for distribution.

The package shall include the following:

• Cover sheet with project title, job number, and date: indicative cost estimate and marked confidential.

• Table of contents, executive summary (Level 2) and cost summary (Level 3) if appropriate.

• Space allocation program including Net Floor to Gross Floor Area ratio calculations. Etc., as far as this is possible.

•Listing of all relevant sketch design documents, drawings and reference data used in compiling the cost estimate and back up cost estimate data from design trades, if any.

3.1.2. Conceptual Stage: Conceptual (Budget) Cost Estimate

This cost estimate will be prepared with accuracy and appropriate details. This estimate will help clients to make basis for business decisions including asset development strategies as well as committing resources for further project development. The estimate is mainly prepared on the basis of a single-parameter quantitative definition (e.g. cost per square meter) and also considers several factors such as the location, inflation, the proposed bid strategies and time schedules, and contingencies. To prepare the estimate, consultant will employ its established cost estimation manual and cost indices that were developed by utilizing its wide experience in the construction market and the region.

The design information developed at this stage is approximately 10-20%; still it is insufficient for quantification. However, some individual building elements detail available from Concept design report like built-up area, site area, type of finishes internal and external, floors and ceiling finishes, the area of the external enclosure, the area of windows, type of foundation, partitions type, etc. Consequently, the measurement of the prime elements is simplified to the minimum and unit rates can be applied to these indicative quantities from the parametric cost analysis. This parametric cost analysis is available from the cost data bank, and its' use must be restricted in the same way as historical costs/m2, including a subsequent modification to reflect differing conditions. Cost estimate at this stage of design is conceptual (budget) cost estimate. The design information at concept stage is limited and will not be sufficient for detailed quantification. Accordingly, consultant will provide the cost estimate in costs/m^2 based on the unit area of the different elements of the project. The costs/m^2 of the different elements will be provided from the database for projects of similar types.

Scope

This section describes:

• Design information to be provided by the PM to the PE.

• Design information to be provided by the PE to the design trades.

• Cost data and departmental cost estimates to be provided by design trades to the PE.

• Budget (conceptual) cost estimate to be collated and produced by the PE for submittal to the PM.

Conceptual Design Data

The PM will provide the PE with a copy of the following design information:

- Design drawings, including drawing schedule showing the totality of all drawings to be prepared. Drawings (to a measurable scale) showing: Site plan, floor layouts, and elevations and sections in sufficient detail to enable the works to be approximately quantified. Where the design development between differing departments is not parallel, historical costs/ m^2 and/or parametric elemental costs can be used in lieu of quantification. However, where the works can be quantified, this must have priority.
- Preliminary project descriptions (outline specifications) - preliminary project descriptions, structured and organized according to UNIFORMAT Levels 2 and 3, incorporating and describing the outline specifications included in the conceptual design report.
- Space Allocation Program- space analysis schedule for each separate building and for each separate floor culminating in both gross and net floor areas.
- Conceptual Design Report-where the PM agrees that the budget (conceptual) cost estimate is to be delayed in its issue after submission of the conceptual design report; the PM will provide a copy of that Report to the PE for his general information.
- Construction proposals and any variation to construction proposals. The PE shall circulate all of the above information to design trades.

Conceptual (Budget) Cost Estimate

Based on the concept design information provided by the PM, and using historical cost date and /or elemental cost estimates produced and submitted to him by the respective design trades, the PE will have had prepared a partial quantified and priced cost estimate for the totality of the Works and PE shall compile a cost estimate. Summary should show the total cost, total cost equated to cost/m2 of GFA and total cost equated to cost/functional unit.

In addition, cost summary provide for design engineering cost parameters expressed in the units shown in the form and these unit cost parameters shall be completed as far as reasonably possible. (e.g. foundation footprint area, basement volume, exterior wall area, air conditioning tonnage, numbers of sprinkler heads and sanitary fixtures, electrical load, etc.) together with their corresponding unit costs. Contingencies shall be included at 10% of project development costs unless PE decides otherwise.

Level of Details

The minimum level of detail in design trades cost estimates shall be UNIFORMAT Level 3. Additional detail shall be provided as back up to support one or more of the cost elements (e .g.) a listing of: "D2040-Special Mechanical Systems".

Back-up estimating data shall be produced by design trades on standard estimate forms supported and supplemented by appropriate calculations, sketches, annotations, assumptions and exclusions, etc., as prescribed by the PE. Design trades estimates are to be UNIFORMAT coded, arithmetically checked, summarized and submitted to the PE under cover of a signed transmittal.

Indicative Cost Estimate: Conceptual (Budget) Cost Estimate

Where the conceptual (budget) cost estimate exceeds or is less than the indicative cost estimate, PE shall compare the conceptual cost estimate with the indicative cost estimate to isolate the differences and report such differences to the PM. The PM and PE shall jointly investigate whether cost economies could be achieved of sufficient magnitude to eliminate any cost 'overrun' against the indicative cost estimate. These recommendations will be made by the PM after discussions and agreement with the higher management for client's approval. Where project cost 'Under-Runs' are indicated against clients' target budgets, the PM and the PE shall verify the adequacy of the conceptual cost estimate prior to advising the client.

Submittal Package

The conceptual (budget) cost estimate package shall be produced and prepared by the PE. It shall be bound in a suitably sectioned and arranged document, and following final review and approval by the PM, shall be transmitted to the PM for distribution.

The package shall include the following in the order listed:

- Cover sheet with project title, job number and date: concept design - conceptual (budget) cost estimate and marked confidential.
- Table of contents; executive summary (Level 2) and cost summary (Level 3).
- Over-view of project cost development from indicative cost estimate.
- Space allocation program and analysis data, including Net Floor to Gross Floor Area ratio calculations, etc.
- Listing of all relevant concept design documents, drawings and reference data used in compiling the cost estimate.
- Cost saving suggestions and comments.
- Appendices containing such additional information deemed necessary by the PE to validate, clarify and amplify the conceptual cost estimate.

3.1.3. Preliminary Design: Preliminary Cost Estimate

Following to having the preliminary drawings and outline specifications ready, consultant will prepare preliminary engineering estimates. These estimates identify engineering systems and subsystems and are calculated based on a quantitative analysis of these subsystems. In addition to their comprehensiveness, preliminary engineering estimates main feature is their presentation in a manner easily recognizable by the designer in order to avoid overlapping in design documentation and to exercise control over expenditures during the design phase.

Preliminary cost estimate & cost plan- a detailed preliminary cost estimate & cost plan will be submitted based on preliminary design BOQs which shall be realistic in the comparison with the budget.

The design has developed sufficiently (in the range of 40-50%) to prepare an elemental cost plan. An approximate quantification of the works by elements priced at relative market prices. Cost estimate at this stage of design is preliminary cost estimate.

Scope

This section describes:

- Design information to be provided to the PE by the PM.

- Design-cost data and cost estimates to be provided to the PE by design trades.
- Preliminary cost estimate to be prepared and produced by the PE for submittal to the PM.

Preliminary Design Data

The PM will provide the PE with a copy of the following design information.

- A review statement identifying any significant project design changes or supplementary proposals which have been introduced since submittal of the concept design report, and specifically:
- Design drawings
- Updated drawing schedule showing the totality of all drawings to be prepared.
- Updated drawings (to measurable scale) showing: - site plan, floor layouts.
- Elevations and sections in sufficient detail that the works can be approximately quantified by design trades. Where the design development between the differing departments is not parallel historical costs/m2 and or parametric component costs can be used in lieu of quantification. However, where the works can be quantified, this must have priority.
- Preliminary project description (outline specification)-updated preliminary project description structured and organized according to UNIFORMAT Level 3 and 4 incorporating and describing the outline.
- Specification included in the preliminary design report.
- Update space allocation programme for each separate building and for each separate floor culminating in both gross and net floor areas.
- Conceptual design report-where the PM aggress that the preliminary cost estimate is to be delayed in its issue after submission of the preliminary design report, the PM will provide a copy of that report to the PE for his general information.
- Update construction proposals including: packaging and phase requirements, if any; form and type of construction contract(s) envisaged; anticipated date(s) of contract award and corresponding construction period(s), etc.
- Circulation of design information: the PE shall circulate all of the above information to design trades.

Preliminary Cost Estimate

Based on the preliminary design information provided and using the elemental cost plan estimates produced and submitted by the respective design trades, the PE will arrange to have prepared a qualified and priced elemental cost plan using market prices and PE shall compile a cost estimate summary and an executive summary showing the data total cost equated to cost/ m^2 (GFA) and total cost equated to cost/unit of function.

In addition, the forms provide for design /engineering parameter costs expressed in the units shown in the forms and these costs parameters shall be reviewed and updated to accord with the elemental costs identified by the elemental cost plan (e.g.: cost of foundations; footprint area: cost of basement walls: wall area: exterior wall area: air conditioning tonnage: number of sprinkler heads: sanitary fixtures: electrical loads etc.). Contingencies shall be included at 5% of the project development costs unless otherwise decided by PE.

Level of Details

The minimum level of detail in design trades cost estimates shall be UNIFORMAT Level 3 although the cost plan may relate to Level 4. Back-up estimating data shall be produced by design trades on standard estimate forms, supported and supplemented by appropriate calculations, sketches, annotations, assumptions and exclusions, etc., and as prescribed by the PE. Design trades estimates are to be UNIFORMAT coded, arithmetically checked, summarized, and submitted to the PE under cover of a signed transmittal.

Market Surveys

If the Preliminary design includes or proposes to use any products, materials, equipment or systems, which in PE experience are unusual, costly, difficult to obtain, the PE shall be notified by the responsible design trades. PE shall authorize design trades or may himself conduct a market survey to establish: - sources, availability costs, and the like relevant matters.

Conceptual (Budget) Cost Estimate: Preliminary Cost Estimate

Where the preliminary cost estimate exceeds or is less than the conceptual cost estimate, the PE shall compare the preliminary cost estimate with the conceptual cost estimate to isolate the difference and he shall report such difference to the PM. The PM and PE shall jointly investigate whether cost economies could be effected of sufficient magnitude to eliminate any cost overruns against the conceptual cost estimate. These recommendations shall be made by the PM after discussion and agreement with the higher management for client's approval. Where project cost under-runs are indicated against client's target budgets, the PM and the PE shall verify the adequacy of the preliminary cost estimate prior to advising the client. The PE shall produce at level 2, a running cost estimate comparison summary for incorporation into the Preliminary cost report.

Submittal Package

The preliminary cost estimate package shall be produced and prepared by the PE. It shall be bound in a suitably sectioned and paginated document and following final review and approval by the PM shall be transmitted to the PM for distribution.

The package shall include the following in the order listed:

- Cover sheet with project title, job number and date: preliminary design - preliminary cost estimate and marked confidential.
- Table of contents.
- Over-view of project cost development from conceptual cost estimate.
- Executive summary (Level 2) and cost summary (Level 3).
- Running cost estimate comparison summary (Level 2).
- Update space allocation program and analysis data, including Net Floor to Gross Floor Area ratio calculations, etc.
- Listing of all relevant preliminary design documents, drawings and reference data used in compiling the cost estimate (by reference to preliminary design report if appropriate).
- Cost saving suggestions and comments (if any).
- Appendices containing such additional information deemed necessary by PE to validate clarify and amplify the preliminary cost estimate.

3.1.4. Detailed Design: Detailed Design Cost Estimate:

The elemental cost plan prepared under preliminary design must be reviewed, updated, expanded and modified to accord strictly with the greater design detail available. In effect at this stage, a mini-BOQ is produced. Cost estimate at this stage of design is fundamental cost estimate. The design has developed sufficiently (in the range of 60-75%) to prepare an elemental cost plan.

Scope

This section describes:

• Design information should be provided to the PE by the PM.

• Design information should be provided by PE to design trades.

• Cost data and cost estimates to be provided to the PE by design trades.

• Final cost estimate to be collated and produced by the PE for the PM.

Detailed Design Data (Fundamental)

The PM will provide the PE with a copy of the following design information:

• A review statement identifying any significant project design changes or supplementary proposals occurring or introduced since preparation of the preliminary design report; and specifically design drawings.

• Updated drawings schedule shows the totality of all drawings to be prepared.

• Fundamental drawings (to measurable scale) showing: - site plan, floor layouts, elevations and sections in sufficient detail that the works can be approximately quantified by design trades.

Fundamental project description (specification)-specification index scheduling all specification sections anticipated being included in the final specification document.

• Space allocation programme: updated space analysis schedule for each separate building and for each separate floor culminating in both gross and net floor areas, the difference between gross and net shall be that area required by the external walls.

• Fundamental design report- where the PM agrees that the final cost estimate shall be delayed in its issue after submission of the fundamental design report; the PM shall provide a copy of that report to the PE for his general information.

• Update construction proposals including packaging and phase requirements, if any; form and type of construction contract(s) envisaged; anticipated date(s) of contract award and corresponding construction period(s), etc.

• Circulation of design information- the PE shall circulate all of the above design information to design trades.

Detailed Design Cost Estimate

Based on the fundamental design information provided and using elemental cost plan estimates produced and submitted by respective design trades, the PE will arrange to have prepared, by design trades an updated quantified and priced elemental cost plan using market prices and PE shall compile a cost estimate summary and an executive summary showing the data total cost, total cost equated to cost/m2 (GFA), total cost equated to cost/unit of function. In addition, the forms provide for design engineering parameter costs expressed in the units shown in the forms and these costs parameters shall be reviewed and updated to accord with the elemental costs identified by the elemental cost plan (e.g.: cost of foundations; footprint area: cost of basement walls: wall area: exterior wall area: air conditioning tonnage: number of sprinkler heads: sanitary fixtures: electrical loads, etc.). Contingencies shall be included at 2.5% of the project development costs unless otherwise decided by PE.

Level of Details

The minimum level of detail in design trades cost estimates shall be UNIFORMAT Level 3 although the cost plan analysis may relate to level 4. Back-up estimating data shall be produced by design trades on standard estimate forms supported and supplemented by appropriate calculations, sketches, annotations, assumptions and exclusions, etc., and as prescribed by the PE, design trades estimates are to be UNIFORMAT coded, arithmetically checked, summarized, and submitted to the PE under cover of a signed transmittal.

Market Surveys

If the fundamental design includes or proposes to use any products, materials, equipment or systems, which in PE's experience are unusual costly and difficult to obtain, the PE shall be notified by the responsible design trades and PE shall authorize design trades, or may himself conduct a market survey to establish sources, availability, costs, and the like relevant matters.

Detailed Design Cost Estimate

Where the cost estimate exceeds or is less than the preliminary cost estimate, the PE shall compare the detailed design cost estimate with the preliminary cost estimate to isolate the difference and he shall report such difference to the PM. The PM and PE shall jointly investigate whether cost economies could be effected of sufficient magnitude to eliminate any cost over-runs against the preliminary cost estimate. These recommendations shall be made by the PM after discussion and agreement with the PO for clients' approval. Where project cost under-runs are indicated against client's target budget, the PM and the PE shall verify the adequacy of the final cost estimate prior to advising the client. The PE shall produce level 2 a running cost estimate comparison summary for incorporation into the final cost report.

Submittal Package

The final cost estimate shall be produced and prepared by the PE. It shall be bound in a suitably sectioned and paginated document and (allowing final review and approval by the PM shall be transmitted to the PM for distribution.

The package shall include the following in the order listed:

• Cover sheet with project title, job number and date: fundamental design - final cost estimate and marked confidential.

• Table of contents.

• Over-view of project cost development from preliminary cost estimate.

• Executive summary (level 2) and cost summary (level 3).

• Running cost estimate comparison summary (level 2).

• Update space allocation program and analysis data, including Net Floor to Gross Floor Area ratio calculations.

• Listing of all relevant preliminary design documents, drawings and reference data used in compiling the cost estimate (by reference to fundamental design report if appropriate).

• Cost saving suggestions and comments, (if any).

• Appendices containing such additional information deemed necessary by PE to validate, clarify and amplify the final cost estimate.

3.1.5. Final Design Cost Estimates:

Towards the end of the design phase, consultant will prepare reliable detailed engineering estimates that determine the fair cost estimate of the project. QS shall prepare these estimates and qualified professional engineers and employs latest quantity takeoff software. To prepare these estimates, consultant will perform the quantity take-off for all the project components with higher level of accuracy and the unit pricing for each of the BOQ items. The unit pricing will be performed taking into consideration the estimated cost of materials, equipment, labour, and average overhead and profit of contractors.

Final cost estimate and cost plan, a detailed final cost estimate (BOQ) and cost plan will be submitted based on final design drawings and details, which shall be realistic in comparison with the approved budget.

The design has completed sufficiently (in the range of 95-100%) at this stage, final copy of project documents is to be reviewed by client before issuing to the tenderer. Cost estimate at this stage of design is well supported by detailed priced bill of quantities. Cost estimate at this stage of design is final cost estimate.

Tender design- the final bill of quantities, issued for tender is priced using relevant market prices. Later this final cost estimate or fair price estimate will be used for negotiation, justification, and comparison of tenderer prices. Cost estimate at this stage design is tender cost estimate or fair price estimate.

The level of available details and contingency varies in different projects. However, the general percentage is as provided in below Table-1. Contingency percentage (progressively reduced) should be adjusted (increase or decrease) as per the followings:

- Type of Project
- Level of Details available
- Availability and quality of historical cost data
- Market Conditions

Scope

This section describes:

- Design information to be provided by PM to the PE.
- Design information to be provided by the PE to the design trades.
- Tender price estimate to be prepared and produced by the design trades to the PE.
- Tender price estimates to be collated and produced by the PE for the PM.

Final Documents

The PM will provide the PE with an un-priced final bill of quantities (as approved for tender issue) together with a project-drawing list, a table of contents index to the final specification. (PE will circulate the relevant copies of this design information to the design trades).

Tender Price Estimate

The design trades shall provide the PE with extracts from the bill of quantities, relevant to their own design department input, with all quantities priced at unit rates to reflect anticipated construction costs in accordance with the construction schedule established for the contract, including any supplementary information as the PE may prescribe. All BOQ priced line items shall be UNIFORMAT level 4 coded, (unless the BOO deviates from this prescribed format). All pricing finally reviewed, arithmetically checked, summarized, and submitted to the PE under cover of a signed transmittal.

The PE will collate the design trades tender price estimates reassemble and reproduce the bill of quantities into a fully priced and summarized document, and based on this will prepare and produce a cost estimate summary. Design contingencies shall be included at 0.00%.

Format

The PE shall summarize and report the tender price estimate on cost summary (level 3) and produce a corresponding executive summary (level 2).

Final cost - tender price estimate comparison- the PE shall compare the tender price estimate with the final cost estimate on the running cost estimate comparison summary (level 2), in order to track design development cost variations and ensure target design costs have been maintained.

If the tender price estimate significantly exceeds the final cost estimate, the PE shall immediately notify and submit a brief report to the PM. The PM will initiate appropriate actions and advise the higher management.

Submittal package - the tender price estimate package shall be produced and prepared by the PE. It shall be bound together, in a suitably sectioned and paginated document and following final review and approval by the PM shall be transmitted to the client.

The package shall include the following: -

• Cover sheet with project title, job number and date: final documents - tender price estimate, and marked confidential.

• Table of contents.

• Over-view of project costs development from final cost estimate.

• Executive summary (level 2) and cost summary (level 3)

• Update space allocation program arid analysis data, including Net Floor to Gross Floor Area ratio calculations, etc., if any.

• Listing of all relevant design documents, drawings and reference data used in compiling the cost estimate (by reference to tender documents if appropriate).

• Appendices containing the priced bill of quantities and any such additional information deemed necessary by the PE to validate, clarify and amplify the tender priced estimate.

Between Final Cost Estimate and Tender Priced Estimate

There should be no design changes or supplementary provisions occurring or introduced between the submittal of the final cost estimate and the preparation of the tender priced estimate. If design changes or supplementary provisions occur after submission of the final cost estimate, they must be immediately reviewed by the PM and PE and the cost implications (if any) conveyed to the client irrespective of the design stage (AACE International Recommended Practice No. 17R-97).

Table 3.2: Percentage Design Completion in Various Design Stages

Design Stage Name	Design Stages Details	Design Percentage/Level of Details*	Contingency to be included
Feasibility	Testing to establish whether client's requirements can be met regarding planning, accommodation, costs, etc.	0-2%	15%
Conceptual Design	General approach identified together with critical dimensions, primary space location and uses, budget identification.	10-20%	10%
Preliminary Design (Schematic)	Basic form determined and cost plan (budget verification).	40-50%	7.5%

Detail Design (Fundamental)	Design developed to the point where detailing is complete and the building 'works'. Cost is checking against budget.	60-75%	5%
Final Design	Design completes for the final review and comments by client. Final cost is checking against budget.	95-100%	2.5%
Tender Design	Production Information (Final) Working drawings prepared for contract documents. Fair Priced (Tender) cost Estimate	100%	0%

3.1.6. Post Contract: Project Data-Cost Analysis

Scope

This section describes:

• Contract information to be provided by the PM to the PE.

• Design-cost data and assistance to be provided by the design trades to the PE.

• Project data-cost analysis be prepared and produced by the PE for the purpose of contributing to in-house cost data bank containing historical design-cost data for use in cost planning and budget estimating for future projects, and finalizing project cost estimating records.

Contract Price Data

Within 30 days after the award of a construction contract, the PM will provide the PE a copy of the tender analysis report and copy of the successful contractor's priced tender BOQ (together with any agreed or negotiated post tender adjustments), comprising the make-up for the contract price, together with copies of all important post tender issue documents: drawings, addenda, notices, minutes of meetings, correspondence, etc., and the letter of acceptance.

Project Data-Cost Analysis

After the receipt of the contract price data, the PE with the assistance of design trades (if necessary), shall prepare an analysis of the contract price, utilizing all available project design-cost data in order to check and confirm design/ engineering elemental parameter and building area unit quantities, and allocate contract price costs accordingly. From this analysis the PE shall prepare and produce:

• Comparison between the estimate tender price and the contract price.
• Elemental cost analysis showing the individual elemental total costs, costs/m2 and percentage of that element to the total.
• Cost summary (level 3), providing an elemental analysis of the contract price, and a final statement of actual design/engineering parametric unit costs, building area (GFA) unit costs and element percentage costs.
• Project data analysis summary providing a synopsis of the project scope and characteristics: building type, space plan, efficiency and quality factors, and the like to clearly categorize the building type.

3.2. Post-Contract Stage (Construction Stage)

The purpose of this section is to describe the methodology and main processes and activities carried out by the QS during construction stage of the project.

This section aims at providing guidelines and processes for monitoring and overseeing the management of the project costs during construction in order to keep them within the original contract sum, plus any agreed additional sums. Cost control allows administering all aspects of the construction supervision that are of a commercial nature or that have input upon costs.

Accomplishing this task entails providing services such as

- Measuring construction progress.
- Processing and certifying the interim payments to the employer, and also monitoring the cash-flow estimate.
- Performance measurement analysis in order to forecast the project cost at completion.
- Preparing, processing, valuating and controlling the variation orders / change requests
- Updating cost baseline in order to have control over the total project cost.

3.2.1. Payment System for Contractors

a) Objective-the objective of having a payment system is to oversee, monitor and check the contractors' interim payment certificates (IPCs) by QS.

b) Tools and techniques- the QS to check the contractors' payment applications and review and issue the related IPCs in compliance with the conditions of contract for the construction Works.

The contractor's submissions of their payment applications at the end of each month showing the sums to the end of the preceding month in respect of:

- Completed milestones and any other items in accordance with the contract.
- The value of permanent works executed on site and forming part of the works according to rates in the project BOQ.
- The value of any other item in the BOQ'S (temporary works, insurance, bonds, etc.).
- Any other sums or charges to which the contractor may consider himself entitled to under the terms of contract.

On receipt of the contractors' applications for payment, the QS will check and verify the rates and prices therein.

The quantity surveyor's verification and preparation of certificate for the amount due and payable to the contractors in accordance with the terms of the contract will take the following into consideration:

Completed Milestones	Claims
Amounts Vs. Progress	Retention (attention to limit)
Applied Payment Mode	Recovery of Advance Payments
Over-run in Quantities	Deduction
New Items	Tax Requirements
Variations	Previous certified amounts
Minimum amount of payments	

- At the substantial completion of works, the contractor will submit to the engineer, a statement at completion with supporting documents showing in detail, in an approved form, a final value of all work done in accordance with the contract up to the date stated in taking-over-certificate, and include any further amounts which the contractor considers to be due to him under the contract. The quantity surveyor will assist the engineer in verifying and certifying the contractor's statement at completion and recommending it to client for payment.

- After expiry of the defects liability period, the contractor will submit to the resident engineer after the issue of the defects liability certificate for the whole of the works, a statement of final account showing in detail, and in an approved form, the value of all amounts he considers due to him under the contract. This statement of final account will be checked and verified by the quantity surveyor, who will prepare the contractor's final payment certificate accordingly and forward it to the resident engineer. The quantity surveyor will check and confirm the veracity of the final payment certificate and issue this, together with a recommendation to client for payment.

The quantity surveyor will examine the final account and prepare the final certificate in accordance with contract requirements and within the time period quoted in the contract.

3.2.2. Performance Measurement Analysis and Forecasting

Objectives can be considered as the followings:

- To assess the magnitude of variances occurring between the planned and the actual status of activities.
- To determine the causes of such variances.
- To decide the corrective actions.
- To prepare cash flow and trend reports.
- To anticipate and report potential problems and provide cost recovery recommendations.

The quantity surveyor will perform the performance measurement analysis and forecast in accordance with recognized practice and will then update the baseline cost based on this analysis for approval by client. The quantity surveyor will prepare a forecast of the project cost at completion.

3.2.3. Managing Variation Orders / Change Requests

Managing variation orders / change requests will be in coordination with the project stakeholders such as client, resident engineer, and the contractor and will be based on the processes defined herein and taking regards to the scope management procedures of the project management plan.

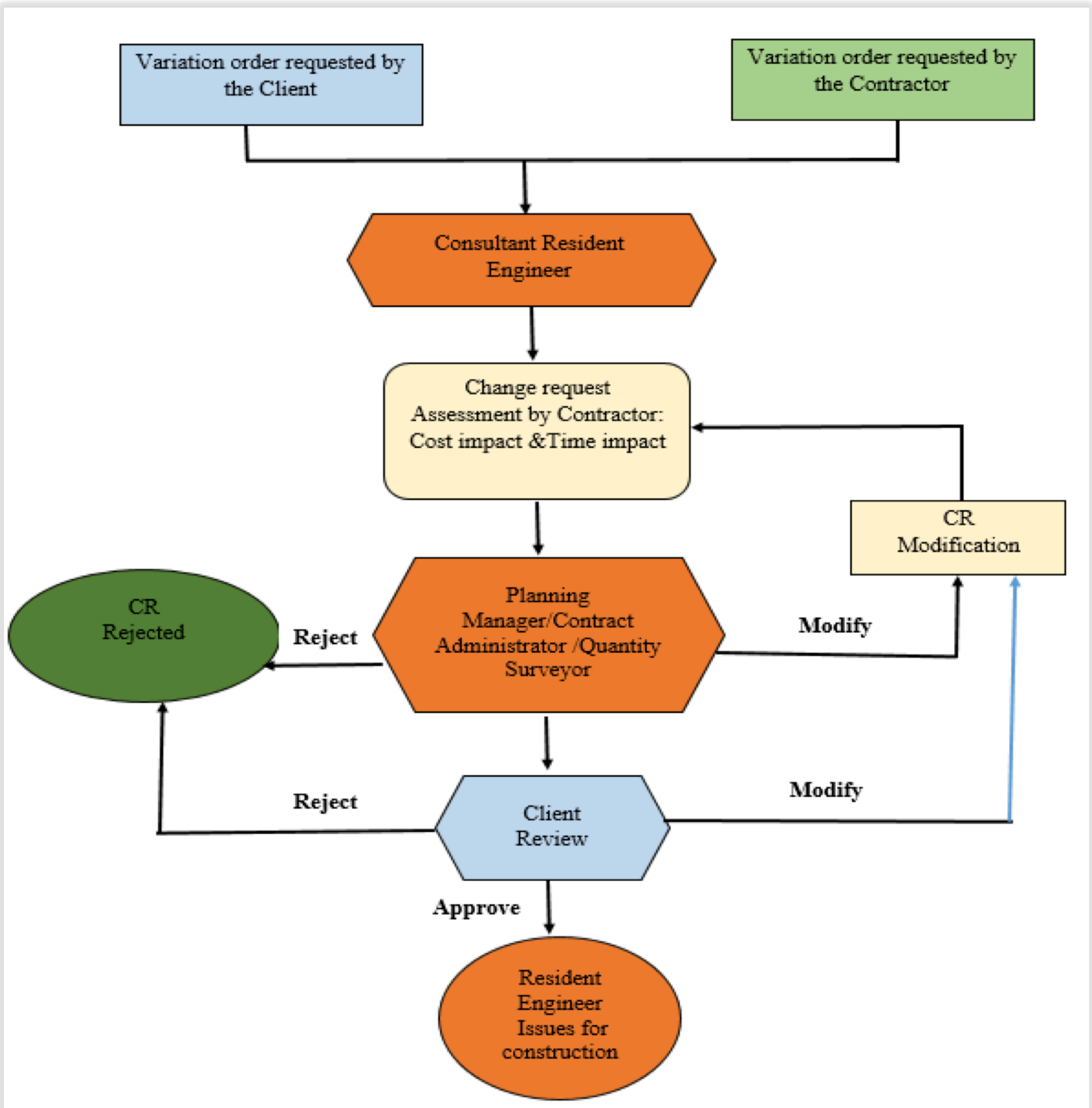


Figure3.1: Change Order Flow Chart

The change identified by client, contractor, or engineer.

1. The change request is registered in the standard log for tracking.
2. Request information on the cost and time impact of the requested change from the contractor.
3. The planning engineer and the quantity surveyor evaluate the time and cost impact respectively and if need be conduct negotiation and discussions with the contractor.
4. The resident engineer issues the initiated variation order form including the explanations of the estimated time and cost impact to client for his review and approval.
5. Upon client approval, the resident engineer issues the variation order form to the contractor with copy to the employer and the registry will be updated.

Close control will be maintained to reduce the financial effects of the changes to a minimum. Whenever a change is deemed necessary, assessments on the time and cost impacts thereof, will be prepared by the contract administrator who will make a report, with recommendation for approval or otherwise, to client in accordance with the stipulated procedures

In processing a change request, the contract administrator will ensure that:

1. A variation order report is prepared.
2. The approved changes are incorporated into the design process.
3. The contractor is compensated for additional costs incurred, or the amount of saving is applied in accordance with the contract conditions.
4. Variations scope, additional costs/savings, time and quality impact analysis are defined and reported in timely manner to client.
5. No work is started on a variation until client has approved that a variation be implemented.
6. The relevant clauses in the conditions of contract are considered and respected.

3.2.4. Cost Baseline Update

a) Objectives- the quantity surveyor will update the cost baseline in order to have control over the total project cost allowing the following:

- A realistic benchmark against which actual costs are compared.

- A correct picture of the project financial status in order to ensure that client has continuous access to actual data, thus enabling proper involvement whenever warranted.

b) Tools and Techniques- the quantity surveyor will update the cost baseline taking the following into consideration:

- Variances between actual and budgeted costs, which entail exceeding or varying projected costs and estimates. If client approves these cost changes, the cost baseline is updated accordingly.
- Approved construction variation orders.

3.2.5. Cost Claim Management

a) Objective- prevent claims and minimize them, and ensure proper evaluation of any claims that may be submitted by the contractor, and always in line with the contract stipulations and procedures

b) Tools and Techniques:

i. Preventing / Minimizing Cost Claims

The resident engineer, with the help of his site team, in order to minimize or prevent cost claims, take all necessary actions included but not limited to the below:

- Control that the construction activities are executed in accordance with the specifications, and other contract documents, and that no additional requirements are implemented without the prior approval of the employer.
- Ensure that any conflict in the contract documents is properly analyzed and resolved in line with the stipulations of the contract, so as to exclude any unjustified claims.
- Control the quality of works at site in systematic manner to avoid quality problems and subsequent abortive works.
- Ensure that employer’s requirements and instructions for change are implemented within the works, in full compliance with the necessary specifications.
- Carry out proper evaluation of payments and variations in timely manner and in accordance with the contract requirements in order to prevent any subsequent claims.
- Identify any risk that may arise at the site during construction, and log the same into the risk register, and ensure proper treatment and management of the risk in order to minimize

subsequent cost claims.

- Control that authorities requirements are met during the construction; in order to avoid any related abortive works.
- Ensure project requirements and construction procedures are set at the commencement of the project and distributed to all concerned so as to allow for the necessary information to reach all involved parties / persons.
- Address all contract administration aspects in full compliance with the contract stipulation, and advise the employer in line with the same.
- Highlight and track any critical or urgent correspondence that may require action of any of the parties.

ii. Procedure for Cost Claims Management

The Sr. quantity surveyor implements a claim management plan, that entails the following procedures:

Stage-1: Claim Submission by contractor and logging

Once the contractor submits a claim, the engineer logs the claim in a systematic Log.

Stage-2: Claim Evaluation and Determination

The claim documentation is dispatched to the Sr. quantity surveyor, who carries out the evaluation and determination of cost claims, in due consultation with the contractor & the employer, as enumerated below:

The contract administrator identifies the referred contractual basis, lists them and thereafter validates against the conditions of contract. Moreover, the contractor's claim will be verified against the following.

- Contract conditions (among others, the time for notification and submission of claim should be respected).
- Specifications.
- Contract drawings

- BOQ and method of measurement.
- Notices and addenda.
- Other contract documents (Agreement, Resolutions. etc.)
- Any agreements subsequent to contract.

The contract administrator also identifies the factual basis vs. statement of facts, dates, reference letters, site documents etc., documents them and checks their accuracy. The following checks are ensured/complied with.

- Statements/events are accurate and factual
- Check any hidden background etc.

The factual data is filtered to consider only valid claims, and thereafter a cost assessment Analysis is conducted in conjunction with the quantity surveyor taking into consideration the following.

a) Basis of the Rates

- Refer and compare to contract rates.
- Determine proper and applicable rates.
- Check authenticity and applicability of submitted quotations and invoices.

b) Quantities

- Verify accuracy of quantities (theoretical/executed)
- Check method of measurement/ Breakdown of cost.

Once the cost assessment is established, the determination of the claim is submitted in the form of claim evaluation report, by addressing the contractual & factual Basis, to the resident engineer.

Stage-3: Claim Determination Review

The resident engineer reviews the draft claim determination and thereafter-related consultation would be carried out with the employer.

Stage-4: Determination by the Engineer

When the claim determination is finalized, the engineer, for the determined cost, issues a letter to the contractor.

Stage-5: Determination Disputed

In case the Determination is disputed then it would be processed based on the stipulated conditions of Contract.

CHAPTER 4

COST CONTROL TECHNIQUES

4. CHAPTER FOUR COST CONTROL TECHNIQUES

Introduction of new technology is changing construction market very rapidly. All stakeholders anticipations in the investment process, in terms of quality of works, efficiency, and cost optimization related to the project and value of their investment are also growing up. All these expectations oblige investors, contractors and designers toward the use of new technologies and changing approaches to the investment process. Improve communication among all stakeholders and integration of the investment process is a new development for the successful completion of any project.

Different Methods of Cost Control

It is necessary to decide the type of control method in the beginning of any the project and the extent of detailing is to be required to enter in the construction stage. Different companies use various cost control methods to retain the initial approved cost of the project. Moreover, the cost itself is a main difficult part in operating a detailed cost control system. It is an expensive process for a large contract to carry out a detailed cost control system. Several techniques and technologies are available, as listed below, but not limited to, for cost estimation and cost control;

- BIM Technology
- Earned Value System
- Lean Construction
- Value Engineering
- Activity Based Cost Management (ABCM)

The above mentioned methods can be used either as a standalone system or these can be used in combination with each other as per the project requirements. There are many different cost control techniques are available but due to the effectiveness of the process, thesis works are limited to the aforementioned techniques.

4.1. BIM Technology

Building Information Modeling (BIM) is nowadays one of the most reliable developments which the design and construction industries have achieved in the past few years. BIM is used to construct virtual models of a building and services digitally. These computer-generated models contain precise geometrical data of the building components and other necessary data needed to support the fabrication, construction and procurement activities. BIM also contains several of the functions required to model the lifecycle of a building, providing the platform for new design and construction capabilities. Efficient utilization of all BIM features produce more integrated design and construction process which results in high quality project deliverables at reduced duration and lower cost.

The building information model (BIM) - “A BIM is a set of information that structured in such a way that the data can be shared. It is a digital model of a building in which information about a project is stored. It can be 3D, 4D (integrating time) and 5D (integrating cost) – right up to ‘nD’ (n term covers any other information).”

BIM aims at improving relationship between the entire stakeholders figure 4.1, reducing the time needed for documentation of the project and producing more predictable project outcomes. BIM has immense potential and versatility as a receptacle for project information.

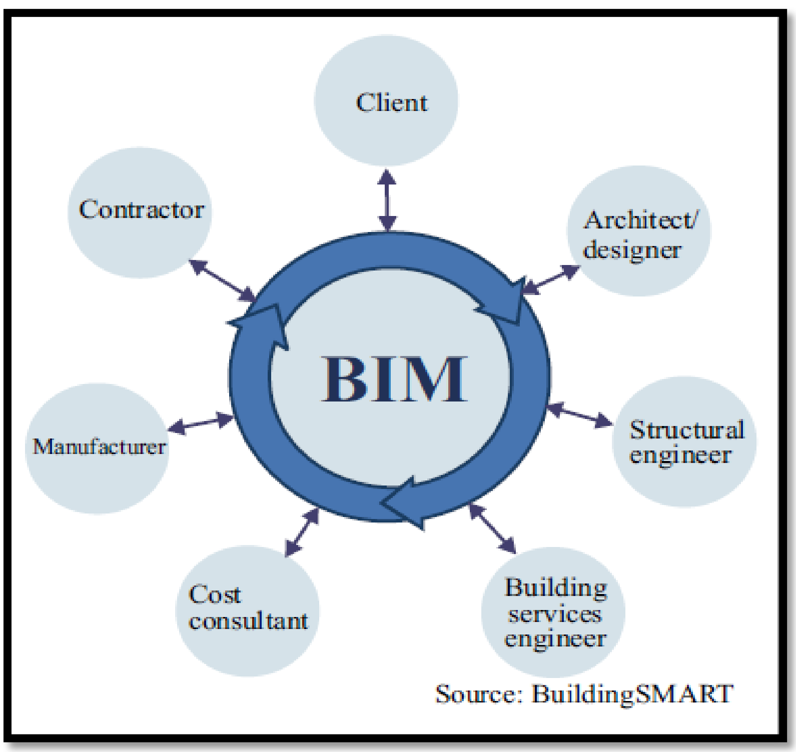


Figure 4.1: Major stakeholders in BIM

Benefits of BIM technology:

There are numerous advantages of using BIM for any project (Xinan Jiang 2011). However, key benefits of using BIM technologies are as listed below (BIMestiMate):

- Fast Access- All type of information used in different stages of project development process can be access quickly through BIM technology.
- Time Saving- It reduces the optional analysis process from the output model to the final result. It allows effectively enter innovative solutions into the project design and execution.
- Cost Control- it provides cost control from inception to close out of the project i.e. in the entire life cycle of the project. Therefore, costs are more predictable and better calculated with minimum deviation.
- Better Quality Project – Based on the model complete tests and simulation can be done. This in result allows for maximum design optimization and minimizes the risks associated with the execution and construction stage.
- Data Use- Any digital data in the project model presented by designers or BIM team may be used as the design progresses. These data can be used even when building or project in operation and in buildings management systems (BMS).
- Accurate and Automatic Visualization- BIM allows client, investors, management team and project team to know how well construction works is progressing (concept of the project and any related technical solutions). It improves the quality of customer service and customer satisfaction.

Functions of BIM

A fully functional BIM can be integrated with several functions as shown in Figure 4.2. Different projects can use BIM for a set of desired functions according to the needs and nature of the project. Each of the BIM function can bring much to the share knowledge pool and a lot can be gained from it. BIM can be used from the starting phase of a project, in the planning approval process and in checking whether the project conforms to the regulations till various design stages of a project. Different BIM software packages can ease the working of architectures, building services engineers and structural engineers and enhance their performance. 3D visualizations are also possible by the applicability of BIM to see the project alive before it is built. BIM allows different checks and function to be performed to improve the design and cost data can also be extracted by the utilization of BIM. In addition to this, a time dimension can also be added to the BIM to assist with scheduling, planning and construction management and after the completion of the project. BIM can be used by the different managers like facility managers for instance to support the operation and maintenance activities.

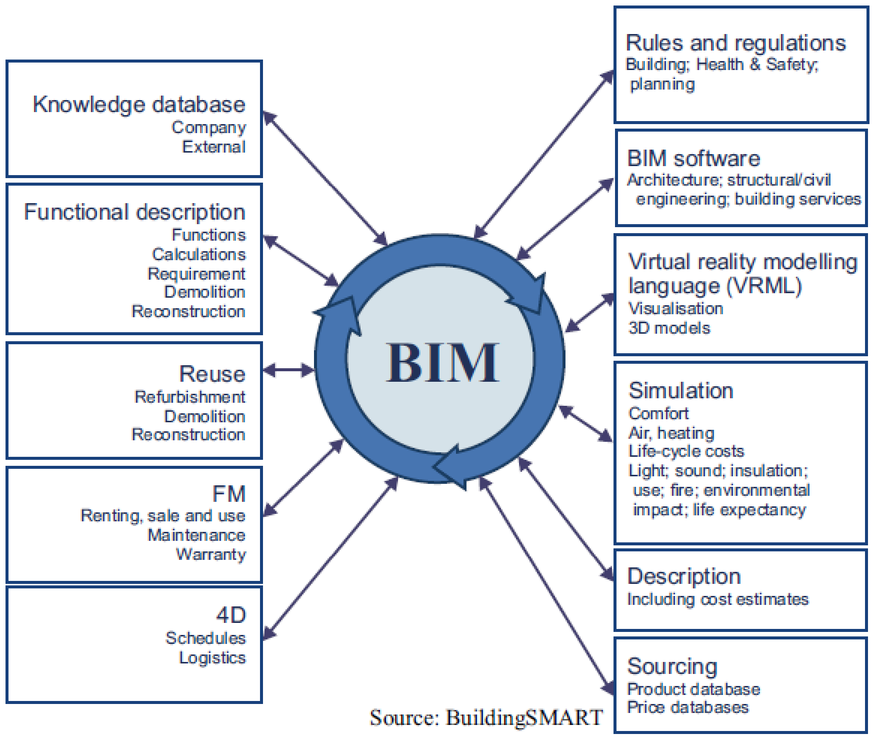


Figure 4.2: Functions of BIM

BIM Dimensions

The availability of the information regarding the project and its connectedness characterizes BIM dimensionally, that is, 3D, 4D and 5D, where 3D is three-dimensional space; 4D adds time as a dimension; and 5D includes cost as a dimension. An illustration of different dimensions of BIM is represented in Figure 4.3.

3Dimension BIM

All the spatial relationships, geographic information and geometry contain in 3D BIM e.g. length, width, and height of the building components. By the usage of virtual 3D building model, design errors due to inconsistent 2D drawing are identified and eliminated. In addition to this, models from different disciplines like Architecture, Structure, Electrical, and Mechanical, can be superimpose together and compared to check for any conflicts (Clash detection) and constructability problems before they are identified on the execution stage or in construction site. Clash detection allows for the effective identification, inspection and reporting of interferences in 3D project model. By the implementation of 3D model the coordination among different project participants is improved and likelihood of design errors are significantly reduced. This leads to an efficient construction process with reduced cost and minimized likelihood of legal disputes among stakeholders.

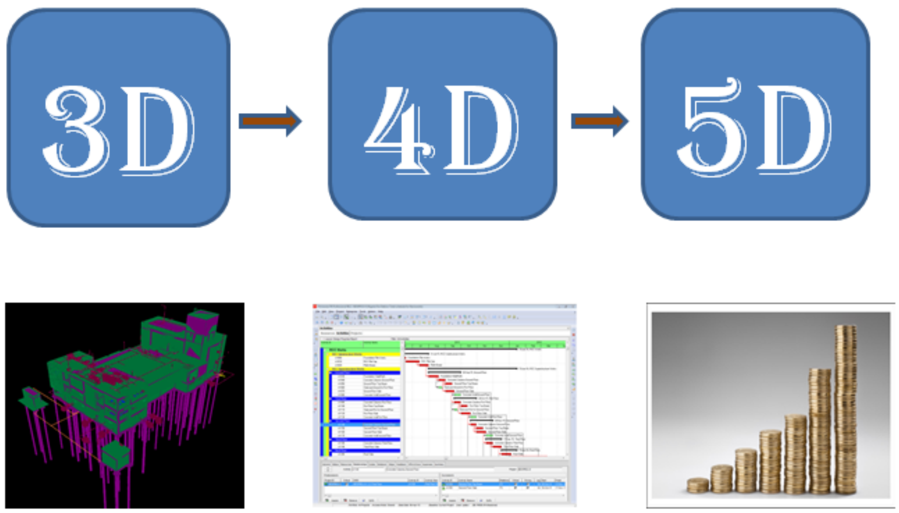


Figure 4.3: Dimensions of BIM

4Dimension BIM

In 4D BIM construction schedule is requires link to the 3D model, which makes possible to visualize how the building and site would look like at any particular construction stage by simulation the construction process. 4D tools allow planning team to visually communicate and plan activities in the context of time and space. This makes possible the adoption of alternative methods to site layout, enabling works, phasing of works, deployment of different trades personnel, scheduling and crane placement etc. during the construction stage. The productivity rate information can also be contained in the model, which will permit lines of balance schedule analysis. This allows the efficient configuration of the tasks based on their productivity rate and location in the project. A significant improvement in the efficiency of a project can be made by making enhancements in productivity rates and repetitive tasks.

5Dimension BIM

In 5D BIM requires project cost to be integrated with the 3D model of the building making it possible to forecast and track the project cost throughout all the phases of construction. It is very helpful in the initial stages of the project to establish budget. With the gradual progress of the model, cost estimation can be refined with the increased level of model detail. The cost implementations of different design alternatives can be estimated at any stage of design phase. The cost data extracted from the 5D model can also be utilized to measure the financial performance of the project during the actual construction phase to check the progress of the project work.

Quantification

Quantification supports integration of three-dimensional (3D) design data. We can combine multiple sources of 3D files and create quantity takeoff. Quantity take-off an entire building information model (BIM) and create coordinated project views that combine information from BIM tools such as AutoCAD and Revit software together with geometry, images, and data from other tools. Virtual takeoff can also carry out for items with no associated model geometry or properties. After that quantity take-off data can be exported to excel file for further analysis and shared with all project design team members for enhanced collaboration.

Quantity take-off can measure and count building elements quantities associated with all trades like;

- Civil works (earthwork, roadwork, drainage)
- Architecture works (doors, walls, windows, flooring, ceiling)
- Structural works (concrete works, reinforcement)
- MEP works (mechanical, electrical, plumbing)

The following measurements units can be quantify:

- Length, Width, Thickness, Height
- Area & Volume
- Weight, Diameter, Perimeter

Navisworks used mostly in construction design works to complement 3D design (such as AutoCAD, Autodesk Revit and Micro-Station). It allows users to open and combine 3D models, navigate around them in real-time and review the model using tools like comments, redlining, viewpoint, and measurements.

Navisworks has a feature that will change the way of working and bring intelligence to information packed models. Model based quantification is not new thing, however combining it with building information models from multiple file formats, measures quantities directly from the building information model. Then run change analysis as the model changes is an important part of streamlining, this is generally time consuming and lengthy process. Navisworks is used to bring together different design trades into a single combined model. Once this model is ready, take-off of all building elements can be done to constructible items, which may contain resources such as materials, labor, etc., this will then combine the quantity take-off data into a reporting format which can be exported into a spreadsheet or an API connection can be built for use in an estimating system so the project manager, estimator and design team can then start looking to the project cost directly from the BIM. In case of any change in the model, Change Analysis process can be run to get the latest correct quantities and can quickly find any new or deleted items from takeoff. These features takes the BIM to a new group of people those who never works more than hard copies, paper drawings or a 2D plan of the model and been detached from the process of modifications and instant and quick refinements of the design.

Navisworks is set up to support quantities from Revit and AutoCAD, DWF files; these would include length, width, thickness, height, perimeter, diameter, area, volume and weight and counts of the items take-off if available in the properties. These properties are in models; in below example the volume, area and length are available in the element tab of the properties window.

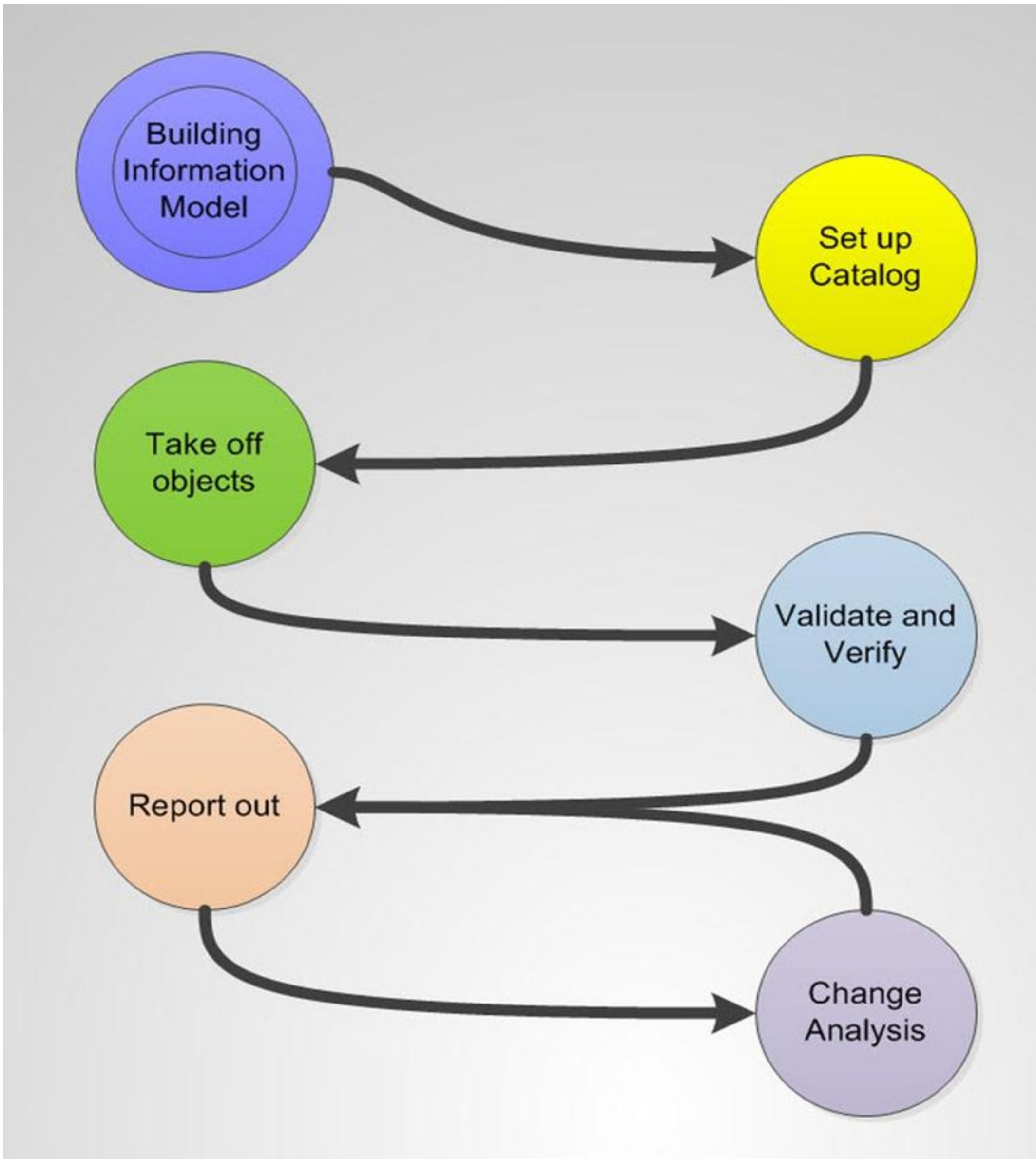
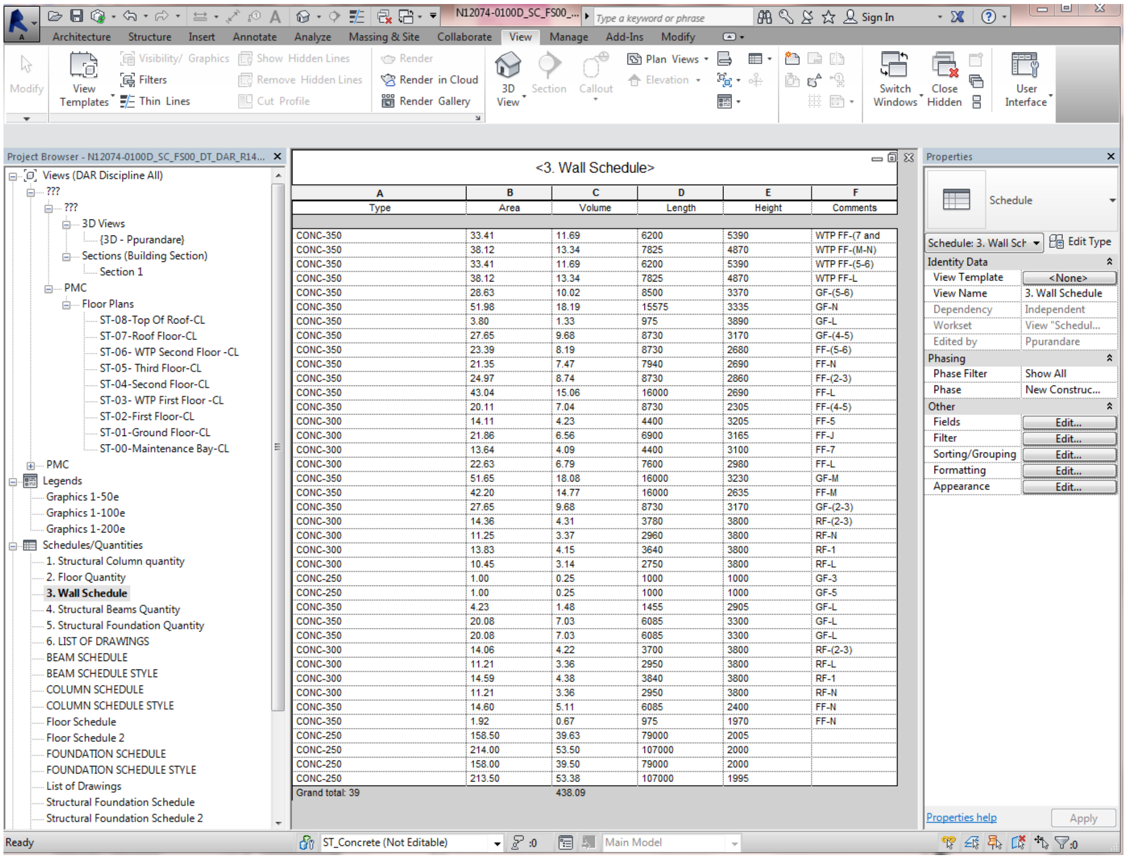


Figure 4.4: Navisworks Model

Resources can be added to items, to build up a picture of the quantities of materials or labor of an item and use formulas to calculate facts based on properties. Figure 4.5 above shows the walls schedule in the project are made up of several different components and the applicable quantities are measured based on the area of the wall.

We can then export these quantities to an excel spreadsheet, which we can then use in estimating software.



<3. Wall Schedule>

A	B	C	D	E	F
Type	Area	Volume	Length	Height	Comments
CONC-350	33.41	11.69	6200	5390	WTP FF-(7 and
CONC-350	38.12	13.34	7825	4870	WTP FF-(M-N)
CONC-350	33.41	11.69	6200	5390	WTP FF-(5-6)
CONC-350	38.12	13.34	7825	4870	WTP FF-L
CONC-350	28.63	10.02	8500	3370	GF-(5-6)
CONC-350	51.98	18.19	15575	3335	GF-N
CONC-350	3.80	1.33	975	3890	GF-L
CONC-350	27.65	9.68	8730	3170	GF-(4-5)
CONC-350	23.39	8.19	8730	2680	FF-(5-6)
CONC-350	21.35	7.47	7940	2690	FF-N
CONC-350	24.97	8.74	8730	2860	FF-(2-3)
CONC-350	43.04	15.06	16000	2690	FF-L
CONC-350	20.11	7.04	8730	2305	FF-(4-5)
CONC-300	14.11	4.23	4400	3205	FF-5
CONC-300	21.86	6.56	6900	3165	FF-J
CONC-300	13.64	4.09	4400	3100	FF-7
CONC-300	22.63	6.79	7600	2980	FF-L
CONC-350	51.65	18.08	16000	3230	GF-M
CONC-350	42.20	14.77	16000	2635	FF-M
CONC-350	27.65	9.68	8730	3170	GF-(2-3)
CONC-300	14.36	4.31	3780	3800	RF-(2-3)
CONC-300	11.25	3.37	2960	3800	RF-N
CONC-300	13.83	4.15	3640	3800	RF-1
CONC-300	10.45	3.14	2750	3800	RF-L
CONC-250	1.00	0.25	1000	1000	GF-3
CONC-250	1.00	0.25	1000	1000	GF-5
CONC-350	4.23	1.48	1455	2905	GF-L
CONC-350	20.08	7.03	6085	3300	GF-L
CONC-350	20.08	7.03	6085	3300	GF-L
CONC-300	14.06	4.22	3700	3800	RF-(2-3)
CONC-300	11.21	3.36	2950	3800	RF-L
CONC-300	14.59	4.38	3840	3800	RF-1
CONC-300	11.21	3.36	2950	3800	RF-N
CONC-350	14.60	5.11	6085	2400	FF-N
CONC-350	1.92	0.67	975	1970	FF-N
CONC-250	158.50	39.63	79000	2005	
CONC-250	214.00	53.50	107000	2000	
CONC-250	158.00	39.50	79000	2000	
CONC-250	213.50	53.38	107000	1995	
Grand total: 39		438.09			

Figure 4.5: Wall Schedule using Navisworks

When there are changes in the model we can again run change analysis to see what has changed, why this change and how, with callouts detailing the change details to allow to verify that the change is an expected one.

Cost Estimation, Monitoring and Control for Building Construction

Cost estimate, cost monitor and cost control are vital for the success of construction projects. Starting from initial design to project completion, these are progressively becomes more intricate and challenging (Emad Elbeltagi, 2014). However, visualization adds new features to cost estimation, cost monitor and cost control where any deviations can be visually noticed and analyzed. Still, literature related to visualization in construction and incorporating it with cost monitoring and control is relatively in undeveloped stage.

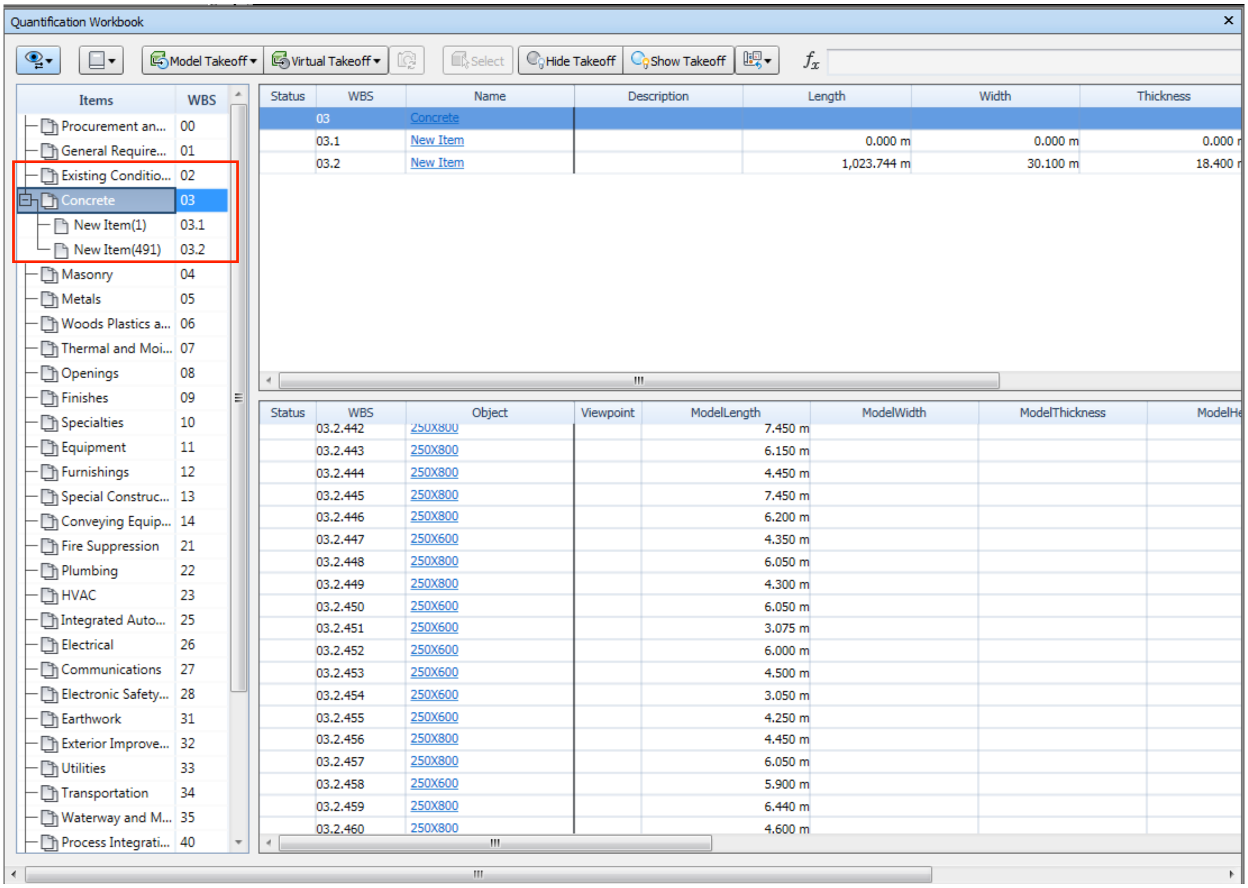


Figure 4.6: Change Analysis

Building information modeling can have promising impact in this area. The BIM has a capabilities to provide the user of visually see actual cost expended in different building elements and compare it with that client's approved budgeted at different design and construction stages. It provides designers and construction team with vital data that can help in them taking timely and appropriate corrective actions in case of any deviation from the approved budget (Su-Ling Fan, 2015).

Framework of Cost Estimate and Monitoring with BIM **(**Emad Elbeltagi, 2014)

Cost estimate and monitoring framework consists of three interacting modules; cost estimate and schedule module, cost monitoring/control module, and BIM module. These three modules interact together as shown in the figure through the interconnected areas of these modules

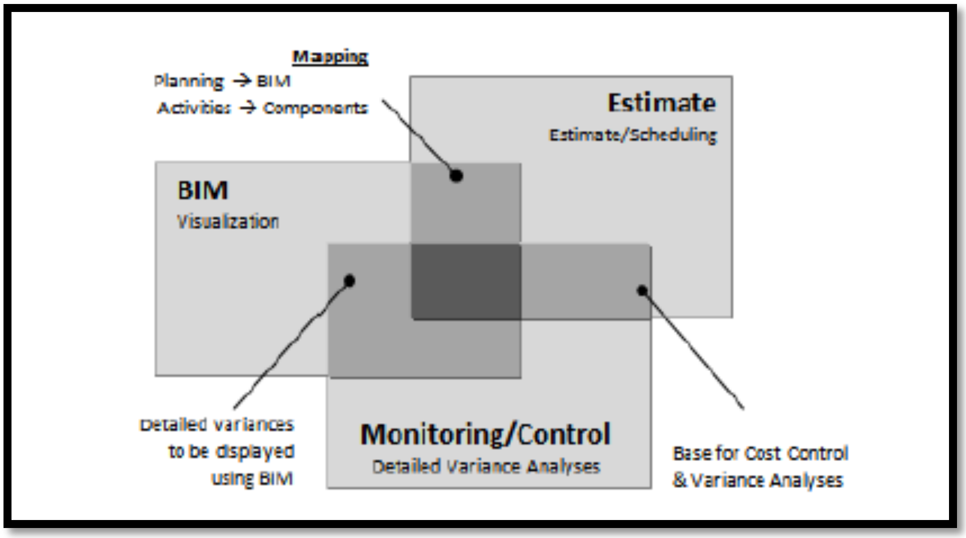


Figure 4.7: Proposed BIM based Cost Estimate / Monitoring Framework

. The Work breakdown Structure (WBS) of project is used to link the estimate/scheduling (planning) with the BIM where the project was broken down into different activities that are recorded to their corresponding building components. During construction, the actual cost (AC) for each resource/activity is compared with its equivalent planned value (PV) and the Earned Value (EV).

Figure 4.8 shows the main processes framework. Developing a reasonable work breakdown structure (WBS) is the first step for application. The WBS is the initial base for developing a custom Building Information Model (BIM) representing the building. Moreover, the WBS is also used in preparing the initial project plan/schedule on any project management software (e.g., MS Project, Primavera etc.).

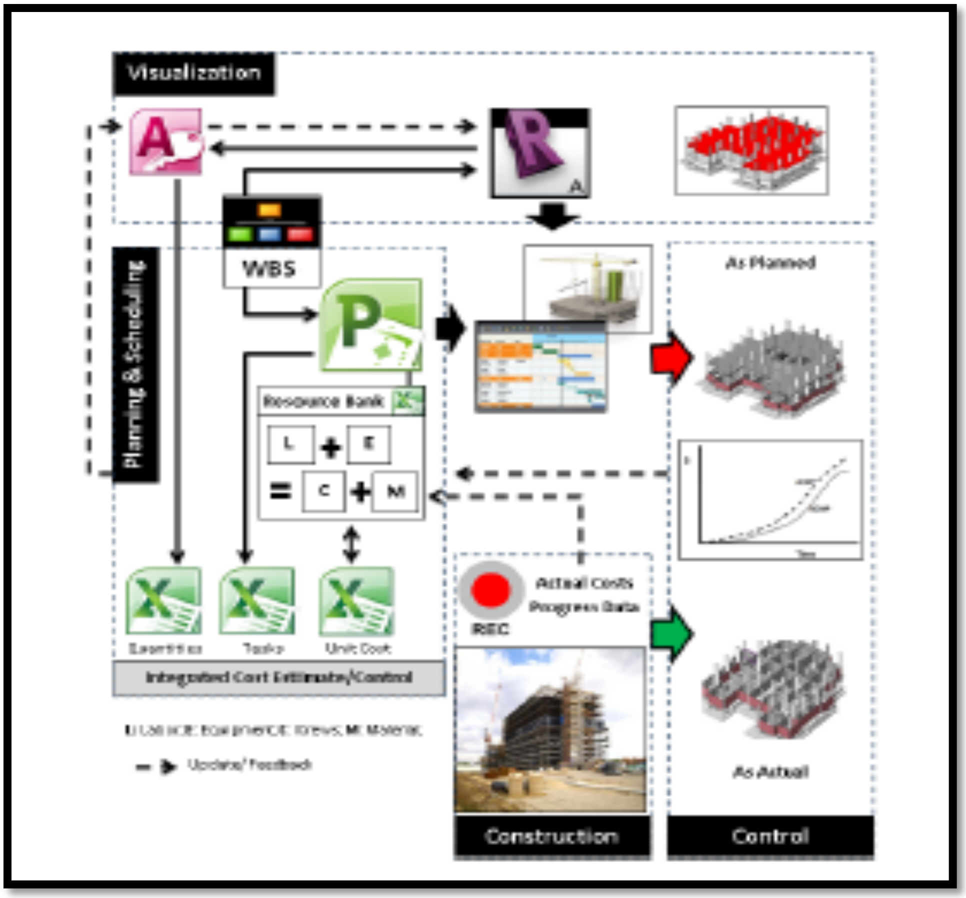


Figure 4.8: Framework of Main Process

Visualization Platform

The purpose of using advances in the building information modeling (BIM) is to visualize construction projects from the design phase with project cost estimate and control. In developing a visualized model, first a three dimensional (3D) model is to be prepared in a BIM environment (Rivet). Building the model in Revit does not only represent a 3D model but also extends it to nD modeling because each object (e.g. walls, roofs, ceiling etc.) has a database containing all information relating to that object. Project objects data can be exported from the BIM environment (Revit) to the central access database. All information related to project cost estimate and implementing cost control models in excel spreadsheets is exported to the central database. Accordingly, all project elements information in access is regularly updated by the cost estimate and control data. The project data stored in the database system could be exported to BIM and automatically linked to their corresponding objects. A query can be done to visualize the project components based on the imported data from access. Project objects in

Revit, which corresponds to project activities, now are stored in Revit with their cost estimate and cost variances data. By using Revit filter command the user can visualize the project objects that have unacceptable cost difference and those that have acceptable cost difference in color-coding. Figure 4.9 below explain the work progress. It can be noticed from the figure that the first and second floor slabs were over budget while other elements of buildings were either on budget or under budget.

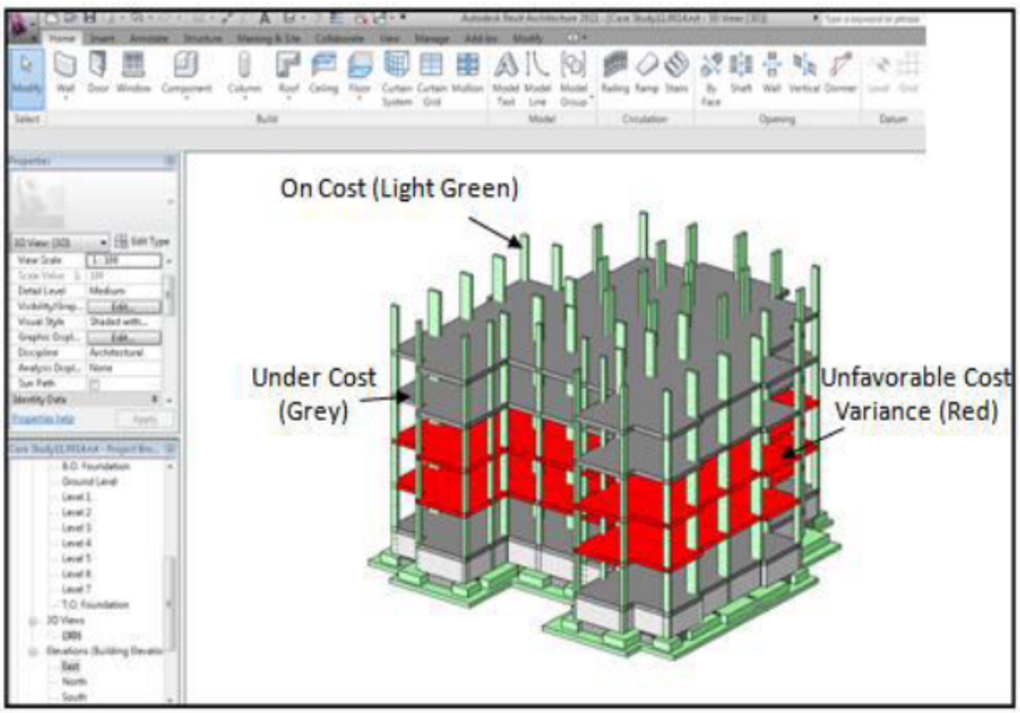


Figure 4.9: Work Progress

Summary & Recommendations

It is prominent that 5D, modeling is beneficial for the forecast and track the construction project cost. Further study can be carried out for "how much beneficial is 5D modeling for the construction cost of the project, that is, if it is highly effective or not"? However, if it is highly effective then why it is not yet accepted in the construction industry? These subjects need separate study; hence it is advised as to be a topic of research for future studies. In future conducting practical interviews or surveys with construction project stakeholders and industry peers and project managers should increase research, the validity and reliability of the study. Moreover, applying 5D modeling on ongoing projects of a construction firm could be very beneficial for collecting actual data and information to determining the effectiveness of 5D modeling. Such experience will reinforce the statement of findings and discussion, it will develop a broader and holistic perception of 5D cost modeling in construction projects as well.

4.2. Earned Value Management

Earned value management (EVM) - It is a project management and control technique which objectively measures and track project performance and progress of works.

Earned value management (EVM) is an effective tool & technique for tracking, monitoring and controlling costs and examining project expenditures relative to completed work. Main strength of EVM is that it studies cost, time, and task completion within the scope of the project simultaneously, whereas other control techniques track cost and time without considering scope of work. It uses WBS and budget created during the design development stage, but tracks these metrics during the implementation stage of a project life cycle (Yicheng Shen, 2014).

Earned Value Management Measures

Below are the lists of key EVM terms:

- Planned Value (PV): PV is initial budgeted value or cost. This is the approved budget allocated for the given activity (or any WBS component). This value is distributed over the entire duration of phase or project. This is also referred to as Budgeted Cost of Work Scheduled (BCWS) (Sherif Mohamed Hafez, 2015).

PV = Planned % Complete x BAC

- Actual Cost (AC): Actual expenditures at measured points in the project. This is the actual amount of budget expended in carrying out the work on any given activity (or any WBS component) at any given point in time. Actual cost is also referred as Actual Cost of Work Performed (ACWP) (Sherif Mohamed Hafez, 2015).
- Earned Value (EV): EV is value of work accomplished at a certain point in the project. EV is the actual value of work completed /performed on any given activity or WBS component at any specified/reporting date. This is expressed in terms of approved budget for that activity. Earned value is also termed as to as Budgeted Cost of Work Performed (BCWP) (Yicheng Shen, 2014).

EV = Actual task unit Complete x BAC

EV=Baseline Cost x % complete actual

- Performance Measurement Baseline (PMB): is total planned value of work. PMB is the time-phased budget plan for completing work, against which contract performance is measured. PMB does not contain any management reserve (Sherif Mohamed Hafez, 2015).

- Budget at Completion (BAC): This is the total planned value for all activities (or WBS components) over the entire project. Alternatively, this is the planned amount required to spend on project work when the project ends. It is referred as 'planned' because BAC is calculated during planning period, which is much ahead of project completion time (Sherif Mohamed Hafez, 2015).

- Estimate at Completion (EAC) - This is calculated at a specified time based on how much of work on an activity (or WBS component) is complete. This is a measure of expected cost of task or WBS component or the project when it finally completes.

EAC=AC+ETC

- Estimate to Completion (ETC): ETC is the anticipated cost of the project, as the project progresses. It's a management estimate of costs from a certain point in the project schedule, necessary to complete the project.

ETC= EAC-AC

- To-Complete Performance Index (TCPI) - It is the cost performance to be achieved on remaining work to complete project goal such as completing project on schedule.

- Total Allocated Budget (TAB) – Also known as Total project funds. This can be calculated as a sum of all activity-level budget on the project performance management baseline (PMB) and management reserve.
- Variance at completion (VAC) - It is the variance on the total budget at the end of the project. This can be calculated as difference between what the project was originally expected (baseline budget) to cost and what it is now expected to cost.

VAC=BAC-EAC

Value means planned or accomplished "work" based on planned tasks and costs—expressed in dollars (actual monetary expenditures or labor time converted to a monetary amount)

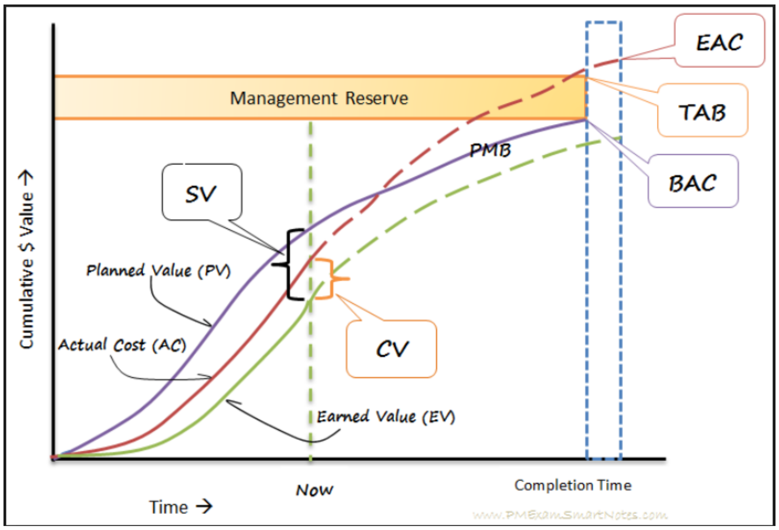


Figure 4.10: Earned Value Management (EVM) Concepts

A summary of important EVM project performance measures is provided in Table 4.1 below (Yicheng Shen, 2014).

Table 4.1: A summary of important EVM project performance measures

Performance Measure	Formula	Description
Schedule Variance (SV)	EV-PV	Indicates the difference between the earned value and the planned value of work completed at a given point in the project. A positive SV number indicate that project is ahead of schedule and negative value indicates project is behind schedule.
Cost Variance (CV)	EV-AC	Indicates the difference between the earned value and the actual cost at a point in the project. A positive CV number indicates that project expenditures are less than expected.
Cost Performance Index (CPI)	EV/AC	CPI is an index showing the efficiency of the utilization of the resources on the project. It compares expenditures to actual value at a point in the project. CPI values above 1 indicate project team is very efficient in use of resources allocated to the project and value below 1 indicates project team is less efficient in utilizing the resources of the project.
Schedule Performance Index (SPI)	EV/PV	SPI is an index showing the efficiency of the time utilized on the project. It compares the planned work and project progress at a point in the project to the actual value of work achieved. SPI values above 1 indicate project team is very efficient in utilizing the time allocated to the project and value below 1 indicates project team is less efficient in utilizing the tie allocated to the project.

Summary

Earned Value Management is a powerful and useful methodology that helps management, executive, project manager, program manager and other stakeholders of the project to manage the project more effectively (Yicheng Shen, 2014). Major benefits of using EVMS are:

1. It provides reliable and consistent data on project performance.
2. It integrates scope, schedule, and cost using a work breakdown structure (WBS).
3. The connected database of completed projects is useful for comparative analysis.
4. The cumulative cost performance index (CPI) and schedule performance index (SPI) provides an early indication of any deviation from the planned value.

5. It uses an index–based method to forecast the final cost of the project. The CPI is a forecaster for the final cost of the project. The periodic (weekly or monthly) CPI and SPI is a benchmark, which can be used to measure the project performance in later stage.
6. The to-complete performance index allows evaluation of the anticipated cost at the end of the project.

4.3. Lean Construction

Lean construction is a technique to design the systems to minimize waste of materials, time and effort in construction process to create the maximum possible amount of value. The prime objective of lean construction is optimizing efforts, minimizing costs and time, waste reduction and creating value.

Philosophy behind lean construction is a based on the concepts of lean manufacturing. It is about managing and improving the construction process, from design to execution, to profitably delivers what is the customer actual need. Since lean construction is an idea, it can be followed through a number of different methods.

Figure 4.11: The Lean Principles (www.constructingexcellence.org.uk)

The Lean Principles

Lean construction is based on the following principles:

- The first and foremost important principle is to eliminate waste.
- Value is to be precisely specified from the perspective of the ultimate customer.
- Process should be clearly identified that delivers what the customer values and eliminate all steps, which are having no value.
- Managing the interfaces between different steps to make the remaining value adding steps flow without interruption.
- Don't make anything unless it is required, and if required then make it quickly.
- Continuous improvement is key for success.

Lean construction is all about right designing and execution and follows the right process and having the right systems, resources and measures to deliver right things in first time. The most important in this process is the elimination of waste – material, activities and processes that consume resources but no value addition. Waste in design works can include mistakes in design, abortive works, repetitive works, working without coordination with all trades, redundant activity and movement, delayed or premature inputs, and products or services that don't meet client's requirements. The primary focus is on precisely understand the process and deliver a design product that clients really want, identifying the waste within it, and eliminating it by progressive improvement.

Lean production and management principles

Lean is primarily focused on value addition, more than on cost, and seeks to remove all non-value adding components and processes and at the same time including activities those improving or adding value. It aims to define value in customer terms, identifying key points in the development and production process where that value can be added or enhanced. The objective is to provide unified integrated design processes, which fulfill the client's requirement.

Lean philosophy is based on doing things "Right" in first time. 'Right' in this context means making it so that there is no chance of it goes wrong. Doing things right first time approach involves a really hard searching, analysis of every detail of product development and production, looking for continuously efforts to find out the source of problems. By eliminating the cause at source remove the possibility of occurrence of the same error.

Lean manufacturers have developed systems for product development, which first identify the right product as per the customer needs, and then design it correctly so that it can be manufactured efficiently.

Design works in Lean are concerned with the development and integration of different elements, systems and components into logical, efficient and buildable products, not just the showcasing of the exterior look, this task is often carry out by external agencies. Various tools have been developed to capture and analyze customer opinions and requirements for design product, its quality and performance. Design development targets include reductions in design changes and process iterations with all trades.

Applying lean thinking to Construction

The lean principles can only be applied fully and effectively in construction process (in design and execution both) by concentrating on continuously improving the complete process. Therefore, all parties and stakeholders involved have to be committed and work to overcome any obstacles that may arise from traditional contractual arrangements. The lean principle can be applied in various stages of construction process. These are listed below:

In Design Development

- Utilization of modern techniques- Visual techniques such as Building Information Modeling (BIM), Revit, Virtual Reality and 3D CAD to fully explain the actual design requirements from the customer's viewpoint.
- Value analysis- it is required to achieve more understanding and focus on client value and necessity.
- Cooperation among all stakeholders- integrated design and build arrangements are required to develop and used, including partnering to encourage cooperation between designers, planners, contractors, sub-contractors, manufacturers, and specialist suppliers.
- Standard Design and Pre-assembly – Both of these processes can achieve higher quality and cost and timesaving.

In Project Planning Process

- Benchmarking – It is to establish ‘best in class’ methods and get best outputs in all design and construction process.
- Project programme – Development of a sound and stable project programme, with clear identification of critical path, long lead items etc.
- Risk management – It is to identify, analyze and manage risks during designing and construction the project.

In Procurement Process

- Selecting the right team- right team selection, which includes contractor, sub-contractor and suppliers, can only deliver project as per the client requirement.
- Supply chain management- supply chain management and justification of the supply chain to integrate all parties who contribute to the overall customer value into a unified integrated process.
- Transparency of costs - the elimination of all kind of waste in both processes and activities requires a clear and complete understanding of costs to confirm decisions related to customer value can be taken and managed.
- Partnering for common goal- the development of concept of partnering can involve all parties contributing to a common goal for the successful completion of the project.

In Logistics

- Just-in-time techniques- delivery of materials to the point of use at the right time eliminates the need for on-site storage and double handling.

In Construction Process

- Project Plan- Clear communication of project plans to all involved parties will help to do the things right in first attempt.
- Teamwork training- Teamwork training to all the concerns is needed to achieve good results and it also develop multi-skilling of team.

- Reporting- Daily, weekly and monthly progress reporting of the construction works is required to arrange and improvement meetings.
- Motivation- A well-motivated, well trained, flexible and fully engaged workforce can produce better results.

Summary

Lean construction is relatively new techniques, which integrates various other effective cost control techniques. Lean design and construction are having various advantageous over other traditional project management and control techniques and these are listed below:

- The concept of control is redefined from just monitoring the results to making things happen with a measured and improved planning process to assure reliable workflow and predictable project outcomes.
- Maximizing value and minimizing waste at project level is key objective of lean construction which makes if different from the traditional practice of make an attempt to optimize each individual activity.
- Throughout the life of the project, value to the customer is defined, created and ultimately delivered, while in traditional practice attempt for defining requirements at the beginning of the project and delivery at the end, despite changing markets, new technology and improved business practices.
- Coordinating action with all project participants and continuous flow of all information and decision is the foremost important function of lean process, whereas the traditional method, schedule-driven push which generally depends on central authority and project schedules to manage resources of the project and coordinate work.
- Decision-making is decentralized in lean process. It gives transparency and authorization to all project participants with ample information to take action for better results and success.

4.4. Value Engineering

Nowadays, every client wants value for money. Governmental organizations and private clients identifying and developing value and innovation through a process known as the Value

Engineering (VE). It is also known as by different terms like value methodology, value analysis, and value management. The VM process can be very effective tool to optimize projects, processes, and product development in significant ways. By adopting this process, companies and government agencies regularly reduce costs, increase profits, improve quality and performance, and enhance customer satisfaction (Senay Atabay, 2013).

Value Engineering (VE) is a continuous improvement process with systematic approach to analysis & improves the value within certain performance. It is a professional, function oriented, creative and systematic team management approach, used to analyze and improve value. It encourages correlation between design and construction. It differs from other cost saving and control technique. The main difference between VE and other techniques is function. It involves a search analysis of the function of a product as opposed to just seeking lower costs in processes to produce the same product (Senay Atabay, 2013).

Value engineering is a balance between cost and quality in order to achieve the desired function (Sherif Mohamed Hafez, 2015).

V: f (P and C)

V- Value

P- Performance or Quality

C- Cost

Value Engineering is "Minimum" and "Maximum" proactive approach i.e. minimum cost & maximum performance.

The question is why construction project need Value Engineering? And the answer is:

- It is required to maximize performance (quality, safety, time, etc.)
- To maximize value addition in any particular activities and entire project.
- Minimize cost without affecting the value of the project.
- Add good communication management among all stakeholders.
- It also provides effective project management information system (PMIS).
- And last but not least Good team approach with coordinated efforts.

What is the value?

"Value" is the measurement of how well an item fulfills its function, considering:

- Function or performance level.
- Quality level.
- Safety level.
- Unused capacity.
- Revenue, etc.

"Function" is the attribute of an item, which meets the need, or requirements of the end user or client (Sherif Mohamed Hafez, 2015).

- Basic function - The feature or characteristic which is the primary reason for the existence of an item, from the client or user's point of view.
- Secondary function- A feature which supports the basic function. It may make the item "sell" better or work better i.e. it does not contribute directly to the accomplishment of a basic function.

Hence, the Value Engineering process determines possible ways of eliminating unnecessary expenses, while assuring that the quality, reliability, performance, consistency and other critical factors will meet the client's or end user's satisfaction.

The Value Methodology Job Plan

The value methodology job plan (SAVE international) covers three major progressive steps of activity: Pre-study, the Value Study, and Post-study. All phases and steps of the job plan are performed sequentially. As a value study progresses further, new data and information may cause the study team to return to earlier phases or steps within a phase on an iterative basis. On the other hand, phases or steps within phases are not skipped. Below are the steps involved in the three major activities (SAVE international):

I. PRESTUDY- It is a preparation tasks which involve six areas

- Collect user/customer attitudes.
- Complete data file.
- Determine evaluation factors.

- Scope the study.
- Build data models.
- Determine team composition.

II. **VALUE STUDY-** The value study is where the primary Value Methodology is applied. These effort is composed of six phases;

i. **Information Phase**
  - Complete data package.
  - Modify scope.

ii. **Function Analysis Phase**
  - Identify functions.
  - Classify functions.
  - Develop function models.
  - Establish function worth.
  - Cost functions
  - Establish value index
  - Select functions for study

iii. **Creative Phase**
  - Create quantity of ideas by function

iv. **Evaluation Phase**
  - Rank and rate alternative ideas
  - Select ideas for development

v. **Development Phase**
  - Conduct benefit analysis
  - Complete technical data package
  - Create implementation plan
  - Prepare final proposals

vi. **Presentation Phase**
  - Present Oral Report
  - Prepare Written Report
  - Obtain Commitments for

- Implementation

III. **POST-STUDY-** The objective of post-study activities is to make assure the implementation of the approved value study change recommendations. Assignments are made either to individuals within the VM study team, or by management to other individuals, to complete the tasks associated with the approved implementation plan.

- Complete changes
- Implement changes
- Monitor status

Value Engineering Significance and Use

Perform VE during the planning, design, and final phases of a project. The most effective application of VE is during early design phase of a project. Any changes or redirection in the design works can be accommodated without extensive re-design at this point, thereby saving the client's or end user time and money (Del L. Younker, 2004).

Value engineering during the earliest stages of design is termed as value planning. Use the set procedure to analyze predesign documents like program documents and planning documents. At the pre-design stage, perform VE to define the project's functions, and to achieve agreement on the project's direction and approach by the all project team. By participating in this early VE exercise, members of the project team communicate their needs to other team members and identify those needs in the common language of functions. By expressing the project in these terms early in the design process, the project team minimizes miscommunication and redesign, which are costly in both work hours expenditures of design team and possible schedule delays of design works (Del L. Younker, 2004).

Perform VE during schematic design when design works reach or completed up to 15-20 percent, design development when design works completed up to 45-50 percent, and completion documents when design is almost completed up to 100 percent. Conduct VE studies at each stage of design completion to define or confirm project functions, to verify technical and management approaches, to analyze selection of system, equipment and materials, and to assess the project's economics and technical feasibility. Perform VE studies concurrently with the user/owner's design review schedules to maintain the project schedule. Through the schematic design and design development stages, the VE team analyzes the drawings and specifications from each technical discipline. During the construction completion documents stage, the VE team analyzes the design drawings and specifications, as well as the details and equipment selection, which are more clearly defined at this later stage (Del L. Younker, 2004).

A Value Engineering study performed at final design stage i.e. almost 90 to 100 percent completion stage or just prior to bidding, mainly concentrates on constructability, economics and technical feasibility of project. Consider methods of construction, phasing of construction, packaging of project works and procurement. The goals at this stage of design are to minimize costs and maximize value; reduce the potential for claims may arises from the contractor after the contract award; analyze management and administration of the project; and final review the design, equipment and materials used for the project (Del L. Younker, 2004).

During construction stage of project, analyze value analysis and change proposals submitted by the contractor. Value analysis and change proposals reduce the cost or duration of construction or present alternative methods of construction, without reducing performance, acceptance, or quality of works. At this stage, design and supervision team analyzes the alternatives presented to the Client. To encourage the contractor to propose valuable value engineering and change proposal, the client's and the contractor share the resultant savings with mutual agreement and/or if permitted by contract.

The numbering and timing of VE studies varies for every project. The client, the design professional, and the value analyst determine the best approach jointly. A complex or expensive facility or a design that will be used repeatedly warrants a minimum of two VE studies performed at the predesign and design development stages (Del L. Younker, 2004).

Summary

In conclusion, value engineering is an important part of competing in today's marketplace. The value improvement process takes shape by following the SAVE International recommended job plan, consisting of information, function analysis, creative, evaluation, development, and presentation/reporting.

The main benefit from conducting such VE studies on a project is that the managers of value improvement programs have a valuable tool in value analysis for managing the value objectives for which they have control and are expected to produce. The managers' goals are to produce the best product with the greatest amount of value improvement in the timeframe, allowed and within or under budget according to the customer's expectations. VE is only one effective tool to help the manager meet and exceed the project goals. Side benefits from conducting the study are numerous, including better team relations and better project identification and understanding of the customer's goals, as well as more improved group dynamics and cohesiveness focused on managing value objectives.

4.5. Activity Based Cost Management (ABCM)

Activity Based Cost Management is a comparatively new innovation and technique in cost accounting field (Sherif Mohamed Hafez, 2015). Activity Based Costing is a costing approach that assigns resource costs to cost objects such as products, services, or customers based on activities performed for the cost objects.

Various government and private organizations are now adopting this technique due to its usefulness as compare to traditional cost accounting. ABCM is a useful approach to understand an order of activities, distinguish between value and non-value activities, and eliminate non-value adding or wasteful activities. ABCM is a systematic and objective practice to identify costs to products in any situations when it is difficult for traditional methods (Abhishek C Ayachit).

Activity-based cost management determines the cost of individual activities and allocate costs to cost objectives on the basis of use.

"Activity Based Costing is a management accounting approach which allocate all direct and indirect (overhead) costs to cost object (product and services) in order to help management understand critical business information. ABC allocates direct and indirect costs to product and services based on the level of activities used to create, and deliver those product and services.

Overhead Expenses are Displacing Direct Costs

The primary and foremost cause for the shift is the continuing proliferation in products and service lines. Organizations have been increasingly offering a vast variety of projects, products and services as well as using more types of distribution and sales channels over the last few decades. Moreover, organizations have been serving more and different types of client and customers. Introducing greater variation and diversity into an organization creates more complexity, and increasing complexity results in more overhead expenses to manage it. The secondary cause for the shift is use of modern technology, advance equipment, automation, or computer generated process. In other words, organizations are more relying on automation rather than involving manual process and jobs. (Gary Cokins)

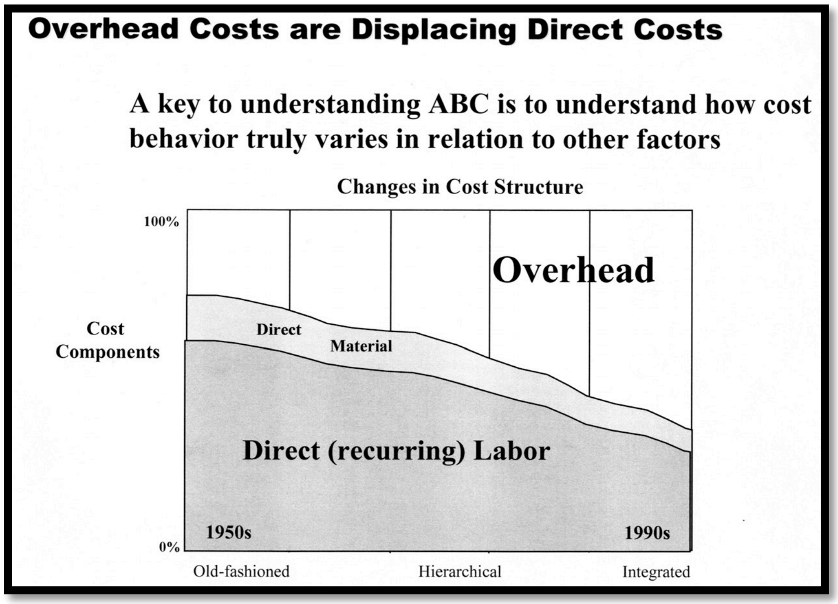


Figure 4.12: Overhead Expenses

So the fact that the overhead component of expense is displacing the repeated labor expense, but it does not automatically mean that an organization is becoming inefficient or inflexible. It simply means that the company is offering more variety and different types to their client and customers. It shows, the shift to overhead displacing direct labor reveals the cost of complexity (Gary Cokins). ABCM does not fix or simplify complexity; the complexity is a result of other things. But what ABCM offers is point out where the complexity is and where it comes from.

ABCM uses cost drivers to assign the costs of resources to activities and unit cost as a way of measuring an output. There are four steps to implementing ABCM:

1. Identify activities.
2. Assign resource costs to the identified activities-Direct costs, indirect costs, general and administration costs.
3. Identify outputs.

4. Assign activity costs to outputs.

Comparison between Traditional and ABCM Allocation

- Traditional method is easier to set up and use. This method is usually better for the preparation of cost estimates.
- ABC is more accurate when process is in operation. Though, ABC is more costly but provides more information for cost analysis and decision-making.
- Traditional and ABCM methods complement each other. Traditional is good for cost estimation and allocation and ABC is better for cost tracking and cost control.

Summary

Costing accuracy in the product generation process is the primary benefit of activity-based costing. Organizations assign cost only to the products that require the activity for production. This method eliminates allocating irrelevant costs to a product. Moreover, other benefits of activity-based cost management include an easy understanding of cost for team and internal management, the ability to allow benchmarking with other cost data and a more clear and sound understanding of overhead costs. However, implementing an activity-based cost management system within any organization requires considerable resources which itself consume time and cost. This can be a disadvantage for organization with limited funds. Another disadvantage of using activity-based costing is that some users easily misjudge it. So far, ABCM have not been highly diffused among practitioners and project team and that is why practitioners are having doubts in terms of replacing traditional technique.

Overall Summary about the cost control Techniques

It is mentioned above that using various cost reduction techniques by multidisciplinary team, value and economy are improved through study of alternative design concepts, material and construction methods without compromising functional requirement and quality. Cost effective construction techniques, material and different management strategies during the execution of project plays important role in saving time as well as cost of construction. Thus, cost reduction techniques assure best cost, value will be obtained over life cycle of the building or structure.

CHAPTER 5

DATA COLLECTION & DISCUSSION OF RESULTS AND FINDINGS

5. CHAPTER FIVE DATA COLLECTION & DISCUSSION OF RESULTS AND FINDINGS

5.1. Data Collection

5.1.1. Introduction

The data collection for this research is a very crucial part. There are two common approaches to collect data, these are: questionnaires and /or case studies.

In this thesis, questionnaires are used to investigate the construction expert's opinion with regards to cost management and control. They also serve as a guide for the interviewers so that every respondent replies on exactly the same questions. A mix of qualitative and quantitative methods was used to analyze the data. The questionnaire was distributed using direct contact through e-mails with the respondents also with the help of the online service " server monkey ". The questionnaire was sent to 80 experts in the construction industry (project managers, cost consultant, construction managers, cost control & estimators, etc.)

5.1.2. Questionnaire Design

The aim of questionnaire design includes the study of research question to cover cost management and control with cost estimation methods as stated in chapter one and two. Designing the questionnaire took a lot of effort and brainstorming sessions; meetings with construction professionals were organized to point out and introduce all the appropriate questions clearly in a format that is open to only one interpretation. Questionnaire design itself took considerable time to rephrase questions in an easy way to be understood by all the respondents.

5.1.3. Contents of the Questionnaire and Measure

The questionnaire aims to cover the cost management and control with cost estimation. A detailed literature review and discussions with professionals in the construction field were the basis for the design of the questionnaire. Brainstorming sessions and discussions with construction professionals were organized to identify and introduce all necessary and required questions, which are clear, straight to the point and in a format that is open to only one interpretation. The questionnaire design itself took considerable time and effort as well as some piloting to adapt questions so that all the respondents will understand the questions. As a result, the author developed a questionnaire consisting of 25 questions. The aim of the questionnaire is to study the current general practice of cost management and control during design and construction phases on international level through getting respondent's opinions and behaviors inside their organizations.

The questionnaire was divided into six sections. Each section belongs to different category or stage as follows:

Section A provides data about the respondent's information such as position, experience, which stakeholder he/she works with, type of client they are handling, if he/she experienced cost control responsibility in the past. The aim of this section is to have an overview about respondents' backgrounds and to be satisfied about the reliability of the information to some extent. This section in total has five questions.

Section B provides data about the company's background such as its industry and the size of the company. The aim of this section is to make sure that most of the organizations are connected with construction industry. In total, this section has three questions.

Section C discusses the respondents' opinions regarding how satisfied they are for their organization's performances in achieving the planned costs, quality, and milestones. Moreover, it asks for their opinions about important details required to achieve accurate initial cost estimation and the method used for cost estimates. This section in total has three questions.

Section D discusses the respondents' behaviors inside their organizations regarding cost control practices. Important information are presented in this section such as the stage and frequency of conducting cost control, techniques used for cost control, and the frequency of issuing cost control reports. In addition, this section asks respondents about their satisfaction regarding the used techniques and programs. This section in total has five questions.

Section E discusses Costs overrun factors and how to mitigate them. The aim of this section is to rate several factors so that finally the reader will know the five most important reasons that lead to costs overruns. This section is one question in tabular form.

Section F discusses reason for high cost of labors, materials, plant, and sub-contractors and how does the land cost influence the cost in construction industries. The aim of this section is to figure out the most common practices to decrease costs and improve efficiency. This section in total has eight questions.

The questionnaire was administered and sent directly to 80 different specified respondents. The returned questionnaire responses in total were 60 where 18 were answered by conducted on contractors/sub-contractor, 22 by consultants and architects, 4 by clients, 14 by cost consultant & project management service as well as 2 other disciplines. The response rate was thus75%. The complete questionnaire can be found in appendix C of this thesis.

5.2. Results and Findings

The author analyzed and interpreted all 25 questions answered by the respondents. The main objectives of the analysis are:

- To study the nature of the respondents and their companies,
- To discuss the most used practices in costs estimation,
- To study the importance of generating accurate estimates,
- To discuss the problems faced during cost controlling,
- To highlight the main causes of cost overruns,
- And finally to investigate used practices in minimizing the planned costs and work in a more efficient way

A. Respondent's Background

1. Title of Respondent

The respondents worked in construction industry and faced issues related to cost management and cost control in design and construction stages. Table 5.1 & chart 5.1 shows the title level of the respondents Responses were received from design managers, team leaders, cost estimators, site managers/engineers and quantity surveyors. This strengthens the fact that the results are based on experienced professionals who are handling these issues in their projects and expected to provide precise answers.

Table 5.1: Title of Respondent

Title of Respondent	No.	%
Directors	2	3%
Project Managers	10	17%
Design Manager	12	20%
Team leader	10	17%

Construction Managers	2	3%
Site Managers/Engineers	6	10%
Cost Estimators/Quantity Surveyors	10	17%
Cost Control Managers/Planner	8	13%
Total	60	100%

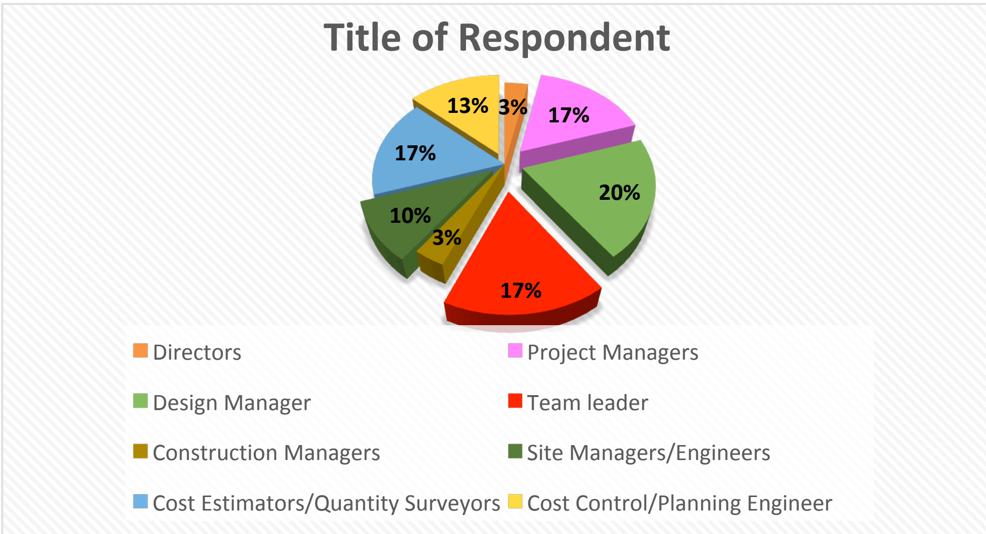


Chart. 5.1: Title of Respondent

2. Experience in Construction Industry

Chart 5.2 shows the number of years of professional experience of the respondents. Based on the chart, 40% of respondents have between 10 to 15 years of professional experience in construction. 27% have 5 to 10 years of professional experience. 17% of the respondents have between 15 to 20 years of experience. The respondents who have less than 5 years of experience are 10%. Lastly, 7% of the respondents have more than 20 years of experience. This strengthens the fact that the responses are based on extensive professional experiences with most of the respondents having professional experiences in construction of more than 5 years.

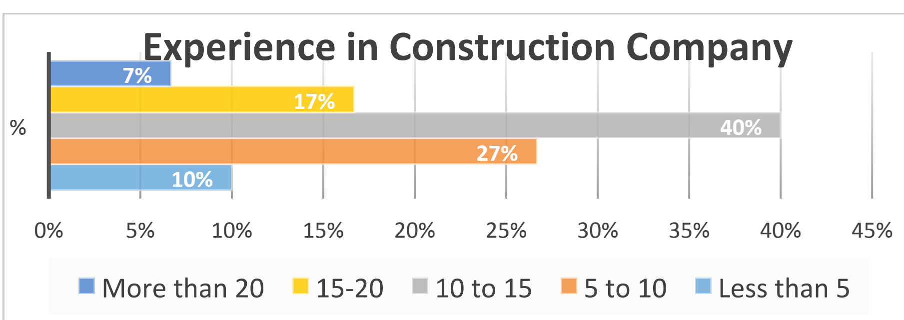


Chart. 5.2: Experience in Construction Industry

3. Stakeholder, you are working for

Chart 5.3 shows that 60 out of 80 respondents who answered the questionnaire are working for the different stakeholder. Most respondents are from design consultant/ architectural firm, main contractor and cost consultant & project management services. This strengthens the fact that the responses are based on the opinion of different stakeholder working in various environments and facing different challenges in construction projects.

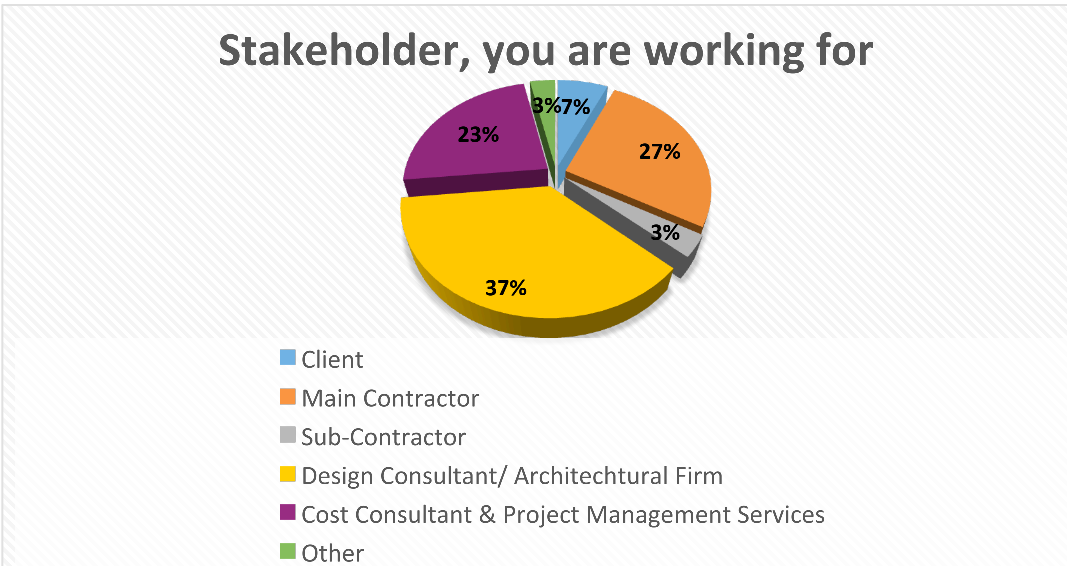


Chart 5.3: Stakeholder, you are working for

4. Type of Client in project

Table 5.2 shows the respondents are working for different clients. The clients most respondents are government agencies (20%), private organizations (14%) and developers (16%). Each client has a different background, approach and expectations towards the project. This reinforces the fact that the results are based on varied client database and requirements.

Table 5.2: Type of Client in project

Type of Client in your project	**No.**	**%**
Government Organization	20	33%
Developer	16	27%
Oil & Gas Company	4	7%
Private Organization	14	23%
Other (please specify)	6	10%
Total	60	100%

5. Percentage of respondents who have cost control experience

Table 5.3 shows how many respondents were actually responsible for cost control during their careers. This enables the author to write a reliable research with data that is based on professionally experienced respondents with cost control background. All of them are having experience in cost control (72% directly involved and 28% indirectly involved).

Table 5.3: Percentage of respondents who have cost control experience

Percentage of respondents who have cost control experience	%
Yes	100
a) Directly	72
b) Indirectly	28

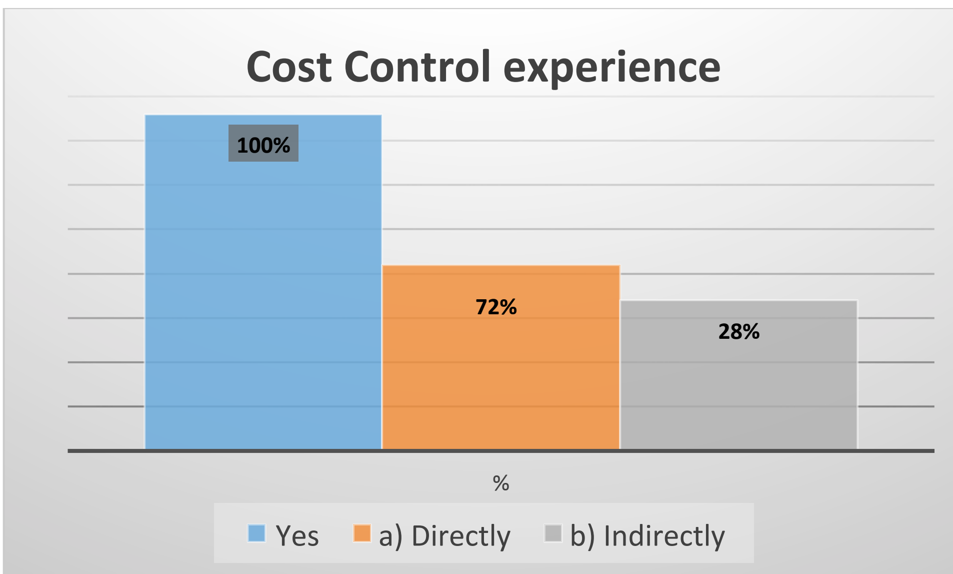


Chart 5.4: Stakeholder who have cost control experience

B. Company's Details

6. Type of construction industry

Table 5.4 shows the type of industry where respondents are employed. This enables the author to grasp the cost issues related problems in various construction industries. It also enables the author to generalize some issues and list cost control problems as per specific industry.

Table 5.4: Type of Industry

Construction Industry, your company belongs to	Responses	
	No	%
Building construction (commercial or residential)	26	43%
Heavy civil engineering	6	10%
Roads and infrastructure	12	20%
MEP services	6	10%
Water and sanitary	6	10%
Industrial buildings	4	7%
Total	60	100%

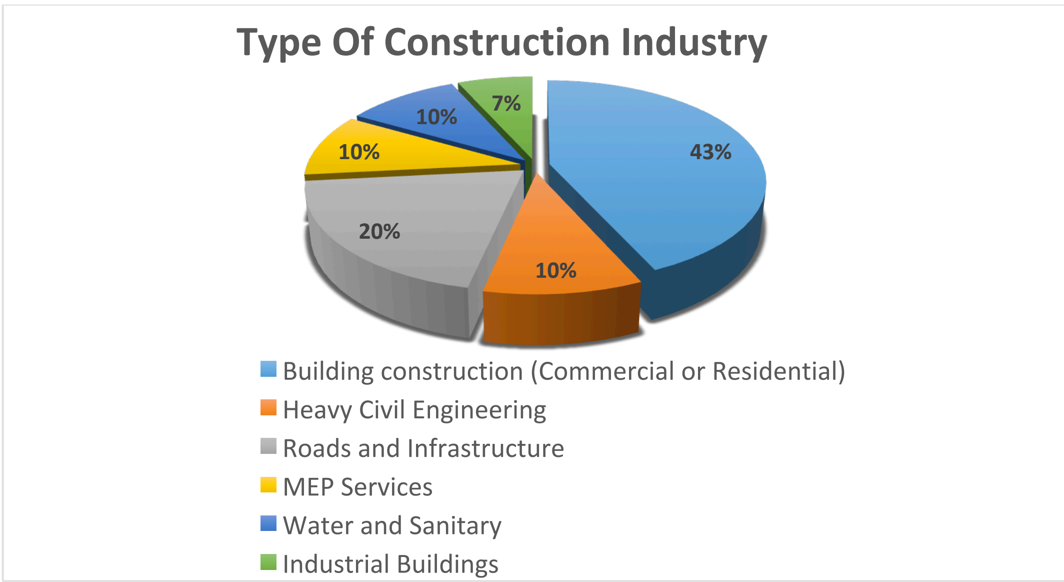


Chart 5.5: Type of Construction Industry

7. Region of your company

Table 5.5 shows the presence of the respondents' companies in the various regions of the world. This enables the author to get more insight in the region-wise issues or problems that construction industry is facing. These also enable the author to seek information related to labor, material, plants, geographical and political issues.

Table 5.5: Project region of respondent company

In which Region your company is working?	No	%
Middle East	26	43%

North African Country	16	27%
South-East Asia	12	20%
European	6	10%
Total	60	100%

8. Turn-over of your Company

Table 5.6 shows the turn-over rate of the companies the respondents are working in. This enables the author to judge the project size that company is handling.

Table 5.6: Turnover of your Company

What is the yearly turnover of your company?	Responses	
	No	%
Less than 50 Million USD	12	20%
Between 50-200 Million USD	30	50%
Between 200-500 Million USD	12	20%
More than 500 Million USD	6	10%
	60	100%

C. <u>Cost Estimation</u>

This section is divided into three parts. First, respondents' answers are presented followed by an analysis of the data. Second, a full explanation of successful practices used for costs estimating is presented. Lastly, the best practices used for preparing budgets for construction projects are presented.

9. Current Status of the Project

Data Analysis

Table 5.7 shows the respondents' opinions about "to what degree their organizations have achieved the planned costs, schedule, quality and objective of project". In the first question, a maximum number of respondents show dissatisfaction about their company's approach to complete the project within approved budget. 57% of the respondents reported a serious mismatch between actual completed costs and approved budget. In the second question, the relation between cost and schedule progress is closer. 43% of the respondents are having difficulties in achieving the baseline milestones. This finding is also supported by Olawale and Sun, 2010) whose research found that the top factors hindering cost control and the top factors constraining time control are almost the same. In the third question, respondents reported a general satisfaction regarding the achieved quality in their projects comparing to previous projects.

In question four most of the respondents only (3%) reported that the SOW never deviates from the initially agreed SOW

In the fifth question, again there is a general satisfaction on the achieved objectives of respondents' projects. In the sixth and last question, a high percentage of respondents emphasized the importance of applying BIM tools in estimating costs for construction projects. 43% of them answered that it is very important to use BIM technologies in estimating costs.

Table 5.7: "Respondents" opinions

Questionnaire	Always	Sometimes	Rarely	Not at all	Total
To what degree the costs of completed project are well-matched with approved budget of the project during design stage in your project	3%	27%	57%	13%	100%
To what degree that your project completed on time	7%	27%	43%	23%	100%
To what degree that the quality of your project has been acceptable in your project	17%	53%	20%	10%	100%
To what degree the scope of works deviate from the initially agreed SOW	27%	33%	37%	3%	100%
To what degree that the project objectives are achieved	17%	40%	37%	7%	100%
To what degree do you think that building information technologies (BIM) improves cost estimation processes?	43%	30%	27%	0%	100%

10. Methods for Estimation

Chart 5.6 and table 5.8 show the used methods for estimating costs in construction projects. The results show that traditional methods are still governing; project comparison with previous projects (Analogous Estimating), unit cost estimating (Parametric Estimating), and square and cubic foot estimating. The results show an increasing use of BIM technologies in estimating. However, still its use are limited despite it is known that BIM technologies give more accurate results. BIM tools are still new techniques and in this research are the benefits from using BIM tools in construction projects. The respondents that use estimation methods also depend on the design stage and the time available for the preparation of the estimate. This was explained in more detail in chapter 2 of this thesis.

Table 5.8 Estimation Method

How do you calculate Project budget cost?	Responses	
	No	%
Analogous/parametric estimating	24	40%
Square & cubic meter estimates	16	27%
Bottom-up estimating	6	10%
Three-points estimates	4	3%
BIM technologies	10	20%
Total	60	100%

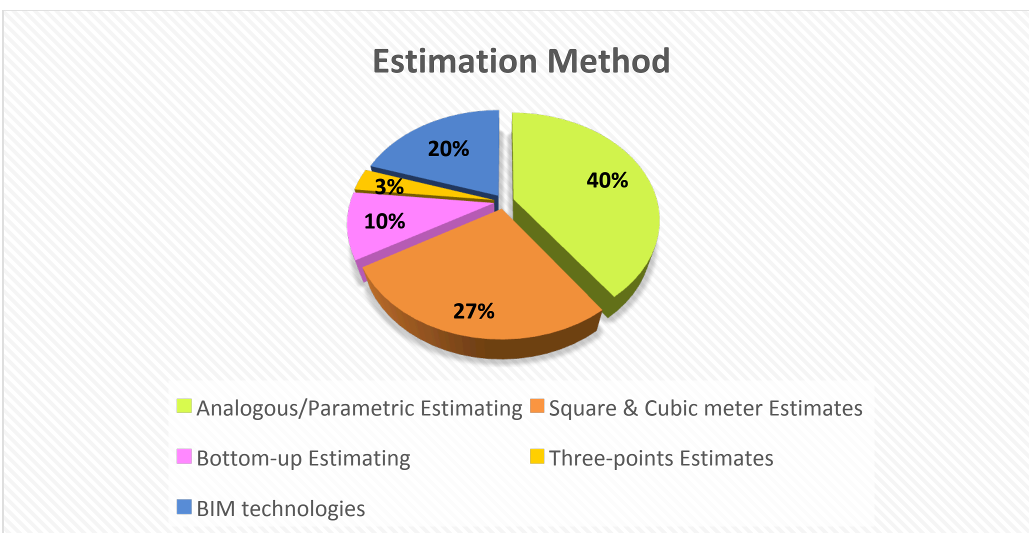


Chart 5.6: Estimation Method

11. Details required for preparation of cost estimate

Table 5.9 shows respondents' selections of various parameters, which are required for the generation of accurate cost estimates. The author analyzed the respondent's replies between "Strongly agree" and "Agree". The results show that cost data bank, materials cost knowledge, labor cost knowledge, type and intent of development, inflation, qualifications, exclusions and inclusions, estimating technique or software and currency fluctuation in that region etc. are all necessary to generate accurate estimations. Responses clearly show that all the parameters in the below table are vital and cannot be ignored for the correct cost estimate

Table 5.9: Details required for Preparation of Cost Estimate

Following details are required	Strongly agree	Agree	Not sure	Disagree	Strongly disagree	Total
Cost Data Bank	53%	30%	13%	3%	0%	100%
	32	18	8	2		60
Locally availability of material	47%	33%	13%	7%	0%	100%
	28	20	8	4		60
Type and intent of development	43%	30%	20%	7%	0%	100%
	26	18	12	4		60
Labour cost knowledge and its availability	47%	33%	13%	7%	0%	100%
	28	20	8	4		60
Availability of equipment	43%	37%	17%	3%	0%	100%
	26	22	10	2		60
Electro-mechanical cost	30%	43%	17%	7%	3%	100%
	18	26	10	4	2	60
Overhead costs	27%	47%	20%	3%	3%	100%
	16	28	12	2	2	60
Use of contingency for risk and uncertainty	40%	40%	17%	3%	0%	100%
	24	24	10	2		60
Qualifications, exclusions and inclusions	53%	40%	7%	0%	0%	100%
	32	24	4	0	0	60
Inflation and currency fluctuation in that region	50%	33%	13%	3%	0%	100%
	30	20	8	2		60
Estimating technique or software	23%	50%	20%	7%	0%	100%
	14	30	12	4		60
Work methodology of an activity	17%	37%	30%	10%	7%	100%

	10	22	18	6	4	60

D. Cost Control

12. Best stage is for cost control

Table 5.10 shows the respondents' reply to apply cost control measures in pre- and post-contract stages. The findings show that most of the respondents agree to apply cost control measures in the design stage itself (40%). However some of the respondents also said it should be applied in all stages of the project (23%). This reinforces that an early start of cost control will change cost considerably.

Table 5.10: Best stage is for cost control

In your opinion, which stage is best for Cost Control?	Responses	
	No	%
Initial stage of design	24	40%
During mid stage of design	12	20%
Tendering stage	6	10%
Construction stages	4	7%
All the time	14	23%
	60	100%

13. Construction stages cost Control

Table 5.11 shows the respondents' reply to implement cost control systems during the construction stage. The findings show that respondents agree to apply it all the time – with 60% of the respondents saying cost control should be carried out all the time - as this will control the cost overrun in the development of the project. Respondents provided feedback that a dedicated team is doing a continuous effort during construction.

Table 5.11: Cost control in construction Stage

Do you carry out cost control system during the construction stage?	Responses	
	No	%
All the time	36	60%
Most of the time	16	27%

Sometimes	6	10%
Rarely	2	3%
Never	0	0%
Total	60	100%

14. Cost control techniques

Table 5.12 and chart 5.7 show the respondents ‘'reply about the use of techniques their companies are applying to control cost in various stages of the project. The result shows that respondents are using Project-Cost Value Reconciliation (24%), which is an in-house development by their company. This shows that most of the companies are customizing their cost control techniques to their own needs and project requirements

Table 5.12: Cost Control Techniques

What techniques does your company use to control cost?	**Responses**	
	No	**%**
Project-Cost Value Reconciliation	24	40%
Earned value Analysis	16	27%
Labor /Plant/Mechanical (actual verses forecast reconciliation)	8	13%
Lean Construction	6	10%
Unit Rate costing	2	3%
Overall Profit or loss	2	3%
Others	2	3%
Total	60	100%

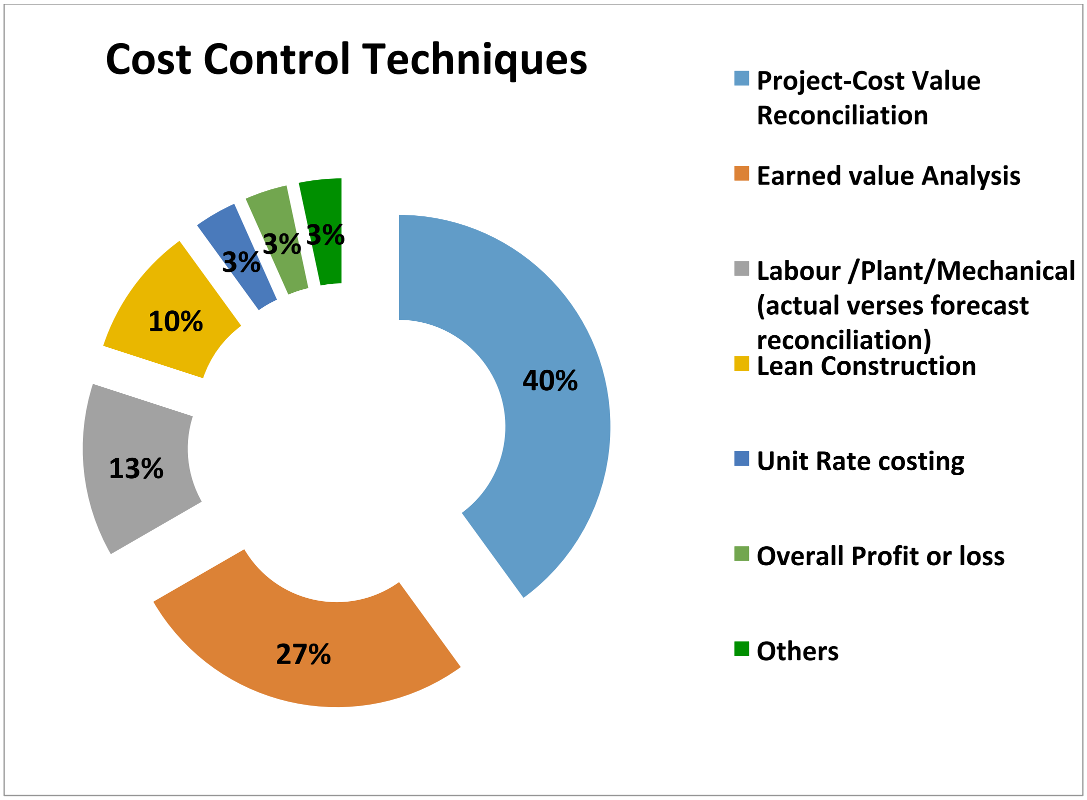


Chart 5.7: Cost Control Techniques

15. Satisfaction Level by Using Cost Control Techniques

Most of the respondents are satisfied with the in-house techniques they developed as this can be customized according to the project requirements. The respondents mentioned that clients sometimes require using particular techniques for a specific project.

16. Submission frequency of cost control report

Chart 5.8 shows that most of the companies prefer to submit cost control reports on a bi-weekly (17%) and monthly (43%) basis. However, all respondents confirm that the report should not be prepared yearly (0%) or even quarterly (7%). Some respondents mentioned that weekly reporting is also a burden for a team when the project is in the fast pace and it may also cause errors and inefficient work.

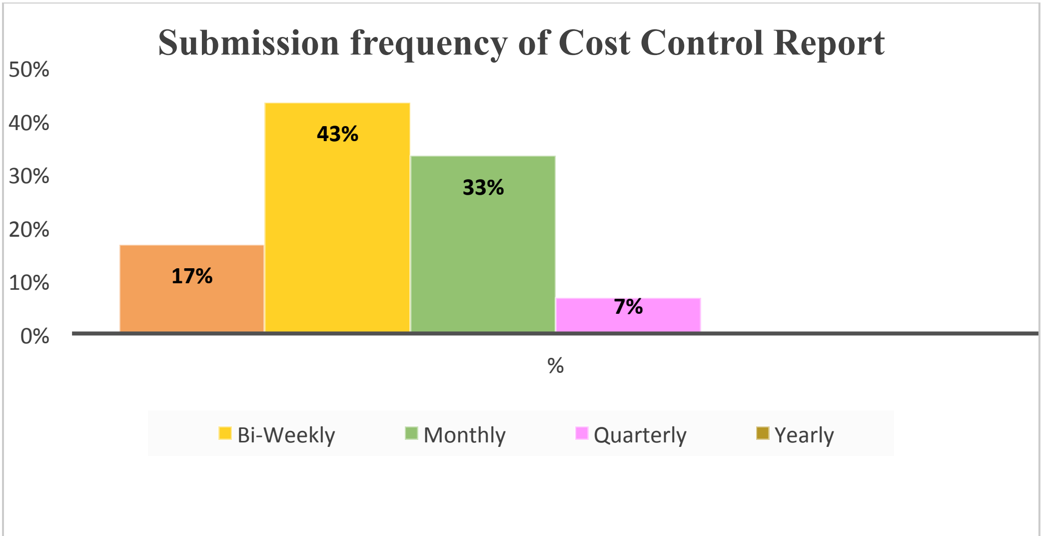


Chart 5.8: Submission frequency of Cost Control Report

E. Cost Overrun

17. Cost Overrun Cause

Data Analysis

Respondents were asked to state the percentage of their projects that have faced cost overruns according to each reason listed. The author used a coding method for the percentages for later analysis as follows:

1- (75% - 100%) of the projects, with code 1.

2- (50% - 75%) of the projects, with code 2.

3- (25% - 50%) of the projects, with code 3.

4- (0% - 25%) of the projects, with code 4.

The codes are used to calculate the weighted average for each factor. The factor with the least weighted average is considered as the top factors causing cost overruns. Several researches were done in the same way before, yet this research will give the most up-to-date information regarding cost overruns from different international opinions. Table 5.13 shows the different factors contributing to cost overruns, the corresponding reported as well as the weighted average for each factor.

Table 5.13: Cost Overrun Cause

	75-100 %	50-75%	25-50%	0-25%	Total	Weighted Ave.
Inaccurate evaluation of project's duration	27%	30%	20%	23%	100%	2.40
	16	18	12	14	60	
Design changes/scope changes	17%	43%	23%	17%	100%	2.40
	10	26	14	10	60	
Risk and uncertainties associated with projects	17%	27%	40%	17%	100%	2.57
	10	16	24	10	60	
Financial management	17%	33%	27%	23%	100%	2.57
	10	20	16	14	60	
Nonperformance of sub-contractors and nominated suppliers	17%	27%	37%	20%	100%	2.60
	10	16	22	12	60	
Inaccurate estimation of project's cost (Labour, material & plant)	13%	30%	37%	20%	100%	2.63
	8	18	22	12	60	
Inflation of Prices	10%	30%	40%	20%	100%	2.70
	6	18	24	12	60	
Client Interference	13%	23%	43%	20%	100%	2.70
	8	14	26	12	60	
Lack of appropriate technique or software	13%	20%	47%	20%	100%	2.73
	8	12	28	12	60	
Specification interpretation	10%	23%	47%	20%	100%	2.77
	6	14	28	12	60	
Contract administration	17%	13%	40%	30%	100%	2.83
	10	8	24	18	60	

The above table shows the top contributing factors to cost overruns. The top five factors that will be discussed are as follows:

- Inaccurate evaluation of project duration.
- Design changes.
- Risks and uncertainties associated with projects.
- Financial management.
- Non-performance of sub-contractors and nominated suppliers.

F. Decrease Construction Costs & Improve Efficiency

Last part of the questionnaire is particularly about discussing the possibility of achieving cost efficiency or cost engineering at construction sites. Engineers conduct cost efficiency practices in order to maximize the profit margins by dealing with each activity or category separately and applying efficiency practices on it.

18. Major reason for high cost of Labour

Table 5.14 & chart 5.9 show the various reasons for high cost of labour encountered in the construction industries. The respondents' replies show that inflation is a major reason for the higher labor cost (46%). The second important reason is continuous change in government policies (27%). This reinforces the fact that the labour cost knowledge is essential for cost estimation (Question no. 11) and this may also cause cost overrun (Question no. 17).

Table 5.14: Major reason for high cost of Labour

In your view what is the Major reason for high cost of labour in the construction industries?	**Responses**	
	No	**%**
Unrealistic demand by labour unions	6	10%
Government decision- review on wages, fringe benefits	16	27%
Inflation	28	46%
Scarcity of skilled labour	10	17%
Total	60	100%

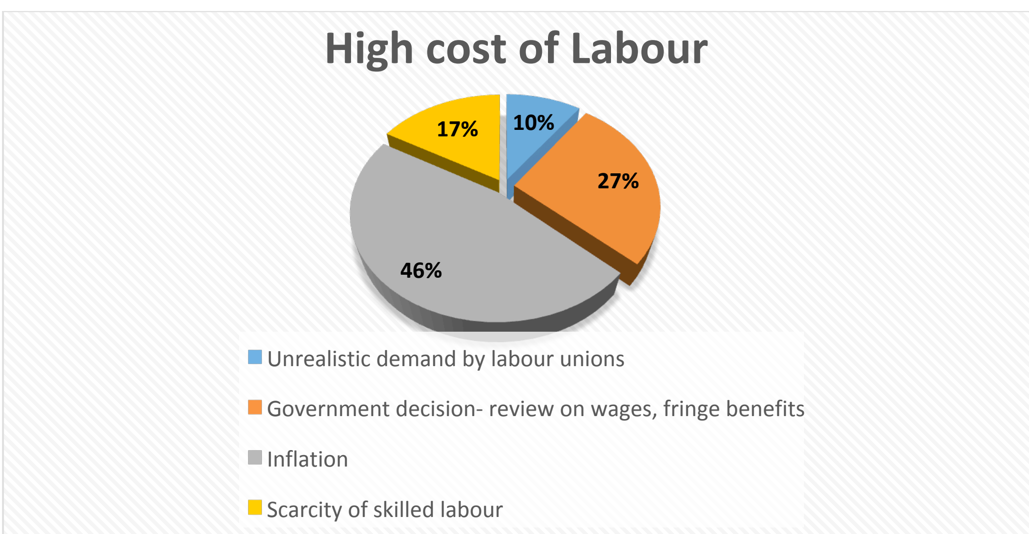


Chart 5.9: Major reason for high cost of labour

19. High cost of construction material

Table 5.15 & chart 5.10 shows the various reasons for high cost of material encountered in the construction industries. The most common reason of high cost of material identified by the respondents is high production cost (57%). High production cost is also related to high labor cost (please also refer to question 18).

The second most important reason is scarcity of materials (27%). This reinforces the fact that knowledge about the costs of locally available material is essential for cost estimation (please also refer to question 11) and this may also cause cost overrun (please also refer to question 17).

Table 5.15: High cost of construction material

What is the major reason for high cost of construction material in the construction industries?	**Responses**	
	No	**%**
Profiteering by various supplier	4	6%
Competitive high demand	6	10%
Scarcity of materials	16	27%
High production cost	34	57%
Total	60	100%

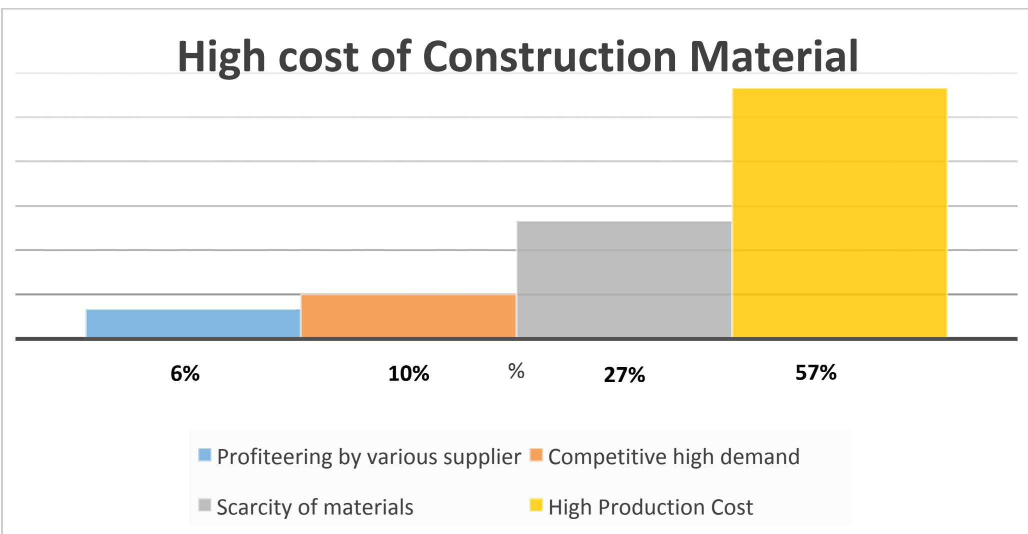


Chart 5.10: High cost of construction material

20. High cost of Plant charges

Table 5.16 & chart 5.11 shows the various reasons for high cost of plant and equipment encountered in the construction industries. The most common reason of high cost of plant stated by the respondents is higher maintenance cost (40%). The second biggest reason is fuel rates, lubricant and unavailability of spare parts (23%). This reinforces the fact that the available of equipment is to be checked in the project reason is essential for cost estimation (please refer to question 11) and this may also cause cost overrun (please refer to question 17).

Table 5.16: High cost of Plant charges

In your view, what is the major reason for increase of plant charges in the construction industries?	Responses	
	No	%
Devaluation/Fluctuation of currency	10	17%
Increase in fuel rates, lubricant etc.	14	23%
Unavailability of spare parts	12	20%
High Cost of Maintenance	24	40%
	60	100%

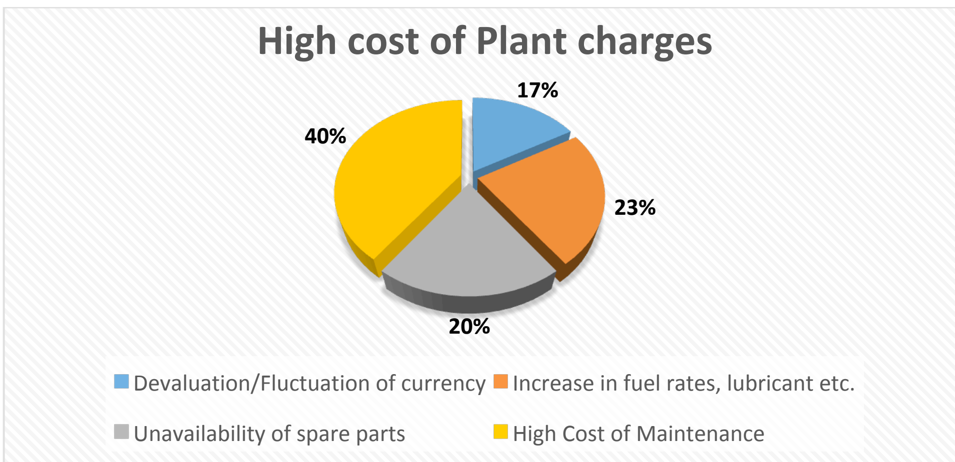


Chart 5.11: High cost of plant charges

21. Increasing cost by Sub-contractors

Table 5.17 & chart 5.12 show the various reasons for high cost encountered by sub-contractors in the construction industries. The respondents rated high bank interest rates on loans and overhead (47%) and high import cost of material, labour and plant (37%) as most important factors to increase the cost of sub-contractors (please also refer to questions. 18, 19 & 20). The responses also falsify the common assumption that sub-contractors tend to overestimate – only 3% of the respondents agreed to this reason. This also reinforces the idea that the construction market is going towards more competitiveness.

Table 5.17: Increasing cost by Sub-contractors

What is the major reason for increasing cost by sub-contractors in the construction industries?	**Responses**	
	No	**%**
Overestimation	2	3%
High import cost of material, labour and plant	22	37%
Delay and short period for the completion of project	8	13%
High bank interest rates on loans and overhead	28	47%
	60	100%

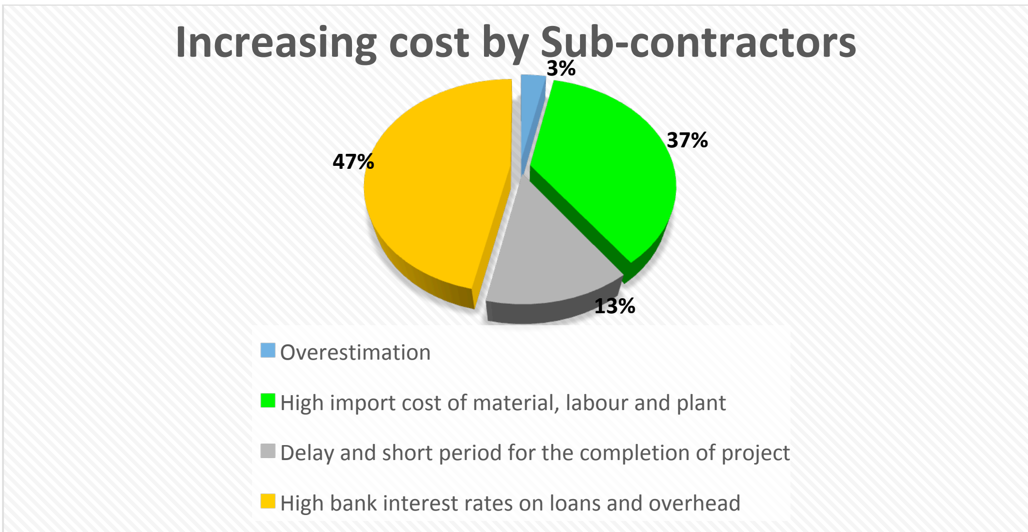


Chart 5.12: Increasing cost by Sub-contractors

22. Land cost Influence

Table 5.18 & chart 5.13 suggest various reasons for high cost of land. Major reason for that is increasing development of the area and other reason as per the respondent are substantial payment for compensation, and private ownership. However, 17% of the respondents think that land cost has little effect on high cost of construction.

Table 5.18: Land cost influence

How does the land cost influence the cost in construction industries?	**Responses**	
	No	**%**
Increasing development of the area	28	47%
Private ownership	10	17%

Little effect on high cost of construction	12	20%
Substantial payment for compensation	10	17%
Total	60	100%

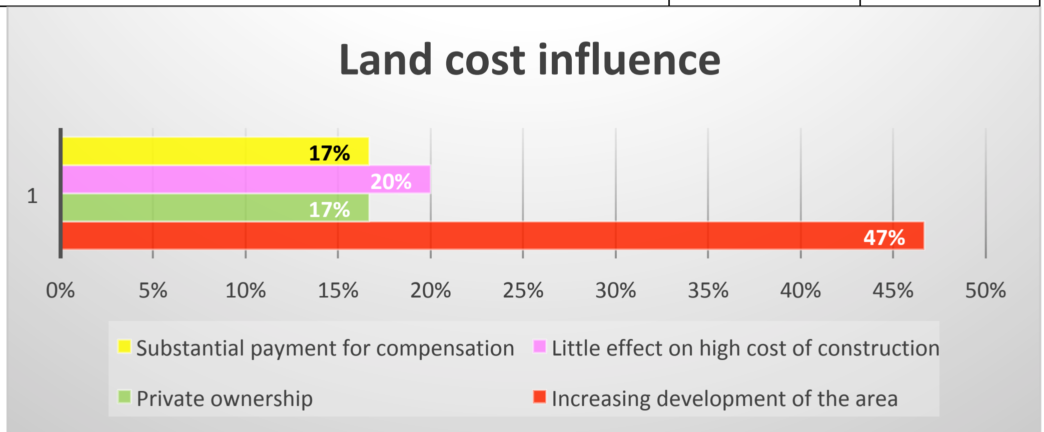


Chart 5.13: Land Cost Influence

23. Projects in which construction costs lower than the specified costs

Chart 5.14 shows that 63% of the respondents report that most of the projects are not completing with construction costs lower than the specified costs. Whereas, only 23% of the respondents have witnessed cases where costs were less than the planned ones at the end of their projects. 13% of respondents are not sure because their projects are still in progress.

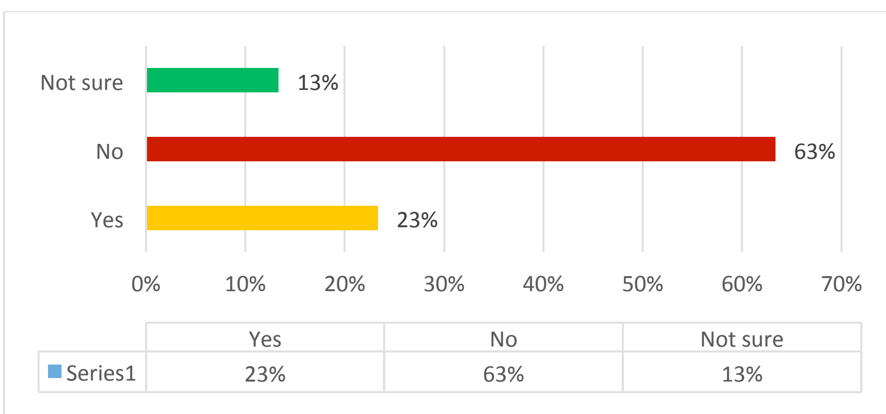


Chart 5.14: Construction costs lower than the specified costs

24. Minimization of wastage in labor, material, time, and energy

Chart 5.15 shows the maximum companies are not very efficient in minimization of wastage in labour, material, time, and energy. This shows that the cost of the resources are wasting for many unproductive things and increasing the cost of the project. There is a lack of waste management practices and non-application of lean construction technique (Question no. 15 also confirm as only 10% are using this technique for cost control) during construction phase.

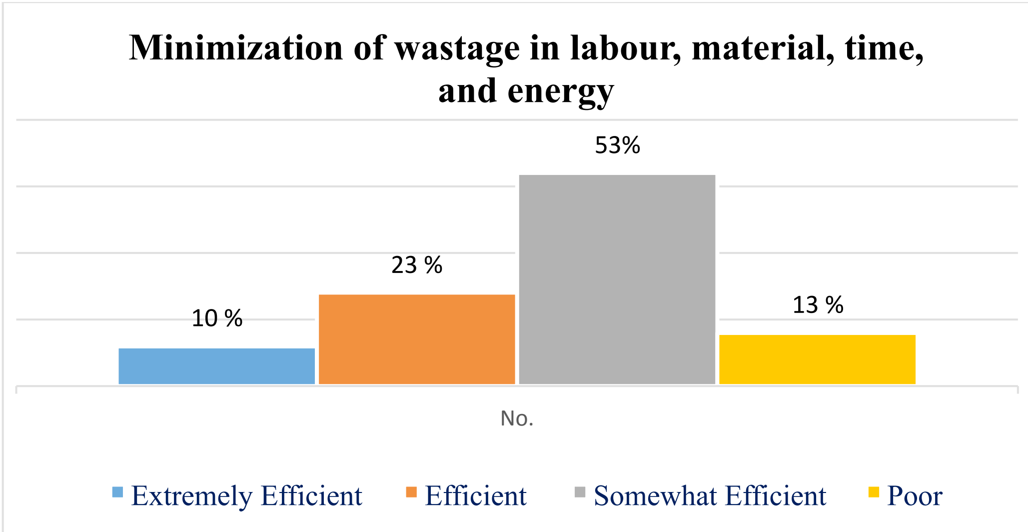


Chart5.15: Minimization of wastage in labour, material, time, and energy

25. Actions to be taken in order to lower construction costs

According to the literature review and the answers of the respondents ,the, following actions are the proposed action which should be considered for cost control in any project:

- All decisions taken during design and construction stage should be based on a proper estimate of the cost impact of the alternatives proposed, and any decisions with possible additional cost implications will require detailed investigation and justification.
- Encourage the project team to update the cost at all stages and follow the variation/change and design development control procedures established for the project.
- Establish value analysis process, which should be carried out in each stage of design in pre-contract stage and in construction stage with client and contractor.
- Apply BIM technology (Revit Model) for design development, which entails better scope, cost control and time.
- Prepare cost estimates during design stage with a consideration of any published construction cost data from government or any other reliable source, well documented cost data bank, perform construction cost market survey, detailed study of locally available

materials and imported materials, labor productivity data and reliable published data for inflation. Emphasize more on local material and labors (Question no. 11).

- Develop each design stage cost estimate accompanied by base date, log of design changes, basis of estimate, qualification and exclusions, etc. (Question no. 11)
- Regularly update and reissue the cost plan and variation orders causing any alterations to the approved design. Also adjust the cash flow plan to reflect alterations in the target cost, the master schedule or the forecast of inflation. (Question no. 16)
- Develop the cost plan in liaison with the project team as design and construction progress. Develop the cost pan also involves adding details as more information about the work was assembled, replacing cost forecasts with more accurate forecasts or actual costs whenever better information can be obtained.
- Review contingency and risk allowances at regular intervals and reporting the assessments should be an essential part of risk management procedures. (Question no. 11)
- Check that the agreed change management process is strictly followed in all stages of the project design and construction.
- Make arrangement for the contractor to provide the correct information at the correct time in order to minimize claims (cost and time). Any anticipated or expected claims should be reported to the client and included in the regular cost reports.
- Contingency provisions should be based on a detailed evaluation of the risks and are available to pay for events, which are unexpected. It should not be used to cover changes in the specification, changes in the client's requirements or variations resulting from errors or omissions.
- Submit regular, up-to-date and accurate cost reports to keep the client well informed of the current budgetary and cost situation. Ensure that the project costs are always reported back against the original approved budget. Any subsequent variations to the budget must be clearly indicated in the cost reports.
- Prepare reconciliation report showing reasons and justification of changes from previous cost estimate. This report is essential to list out the reasons of changes; whether it is by client, design enhancement, authority requirement, error in design etc.

- Introduction of just in-time techniques for materials procurement during construction stage i.e. to reduce the inventories, exact materials quantities needed are delivered whenever required.

5.3. Summary

Client reputation and budget was the main constraint for any mixed-use development project. Thus, the consultant has to perfectly balance between required quality, predetermined time and approved budget to achieve the project objectives. The consultant should advise the client to establish cost control measures processes from the beginning of design stage so that costs can be monitored and controlled throughout the design and construction stages. This proactive and objective approach helps all stakeholders involved (client, consultant contractor and sub-contractors) to know their roles and responsibilities.

The project budget should be continuously refined as the design progresses by adopting most updated cost control techniques like Value Engineering and BIM (Revit model). Regular workshops for design enhancement and value engineering are to be conducted to update the cost plan involving design team, project management & cost control team and client representatives.

Establishing a cost control approach is to be followed in construction stage as well. In this stage the consultant should suggest and implement innovative approaches and techniques with the main contractor as well as sub-contractors, like effective site management process, JIT technique, Earned Value Management for progress reporting, use of latest project management software Primavera, Vico and MS project etc.

The afore described pro-active cost control methodology will help to keep the client's expenditure within the agreed amount and additionally will provide reasonable profit as well as a value-for-money project. However, the consultants set procedure for cost control should be further re-examined as the project progressed.

CHAPTER 6

CONCLUSIONS & RECOMMENDATIONS

6. CHAPTER SIX CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary

The study was analyzed and divided into six chapters. Chapter one introduces the study, emphasizing the importance of cost control and management in construction projects, objectives, scope, and the limitations. It also gives a brief explanation about research thesis methodology and chronology adopted in the study.

Chapter two present concept of cost control along with objectives/aim of cost control, significance of cost control and reasons of cost overruns in Pre-Contract and Post Contract stages. Causes of cost overruns are listed in this section, which are very common in design and execution stages.

Chapter three explains the cost management and control process used in Pre-Contract and Post Contract Stages in details. It outline the overall project cost management approach, estimation stages from inception to closing.

Chapter four is related to various techniques used for the Cost control during design and construction stages like Earned Value System, BIM Technology, Lean Construction, Value Engineering and Activity Based Cost (ABC).

In Chapter five, questionnaire was sent to construction professional. The aim of the questionnaire was to study the current general practice of cost management and control during design and construction phase’s thorough getting respondents’ opinions and behaviors inside their organizations.

6.2. Conclusions

This study has briefly introduced and reviewed the key concepts of cost control and management in construction projects in order to identify a suitable approach for pre and post-contract stage with the help of on the literature review and data analysis.

The cost control and management systems should allow clients and project managers to detect additional expenditure or cost overruns as early as possible so that appropriate actions can be considered and /or taken in a shorter time period. Ideally, each cost estimate should be a logical development of its previous stage cost estimate reflecting the increased level of detail available.

Estimates should not be single figures, implying a degree of accuracy that does not exist; they should rather be a range of figures within stated parameters.

In the periods between revisions of cost estimates and cost plans, the development of designs and the progress of procurement and commitment must be controlled. It is necessary to mention qualifications, exclusions, inclusions and assumptions clearly.

A major factor in the management of costs is the early identification and proper management of the risks. Risks are associated with the unknown and uncertainty. Therefore, as a project progresses from inception through design, construction and use, the unknown elements should diminish and the risk allowance reduced accordingly.

All estimates will require the estimator to assess the risks for the project, which can be considered in construction projects. Traditionally, contractors have sought to shift these risks onto subcontractors through the use of harsh conditions of subcontracts. The initiative for the application of risk management lies with the client and their professional advisers, particularly the project manager and cost manager.

Furthermore, in the past, many contractors were selected on the basis of the lowest bids. These low bids might have been developed based on innovative working methods or alternative designs but might also have been a result of the contractor's misunderstanding or underestimating of risks in the project. This traditional approach often resulted in an adversarial position being taken by both the client and the contractor.

The analysis of the questionnaire responses demonstrated that real benefits and cost savings could be secured by implementing a value engineering approach and use of some latest technology like BIM technology.

6.3. Recommendations

The problem of cost control does actually not lay in the techniques being used (as explained in chapter 4) , but rather in the poor management of the techniques and the negligence in supervision during design and execution stage. It is therefore strongly recommended that designers, cost estimators, construction professionals and contractors should constantly update themselves with latest and effective cost control techniques and methodologies. Generally, it can be observed that in most of the projects, design teams are not aware of the performance targets or the cost limit. This indicates that there is lack of knowledge and communication among all stakeholders involved in the project. The best way of controlling the construction cost is to start and control it right from the first stage of design. According to the findings discussed in the different chapters of this thesis, the conclusion listed above, and review of various literature mentioned in the references, the following key issues should be taken into consideration.

- A cost plan should be developed in consultation and agreement with the all project team members and stakeholders. The design teams should work as per the cost plan at all stages and follow the variation/change and design development control procedures for the project. It is important to higlight that the all team members should be aware that no one has the authority to increase costs by adding element of the work without prior approval from the deciding authority (client , developer and consultant).
- Regularly update and issue the cost plan and design variations to inform all the team members. The cash flow should be adjusted and updated to reflect changes in the target project cost and the baseline schedule.
- Any decisions taken during design and construction stage by client and consultant should be based on cost implications and impact on approved budget, alternative should only be considered which will bring best value to the project.
- Change management processes agreed during the start of the project should be strictly followed at all stages of the project any deviation msut be recorded in the project status report.
- Objectives and scopes of work of the project should be finalized during the initial stage of the project; frequent changes or alteration should be avoided (specially from the client side).
- Contingency allocation should be based on a detailed risk evaluation and to be used for actions, which are unforeseen and unforeseeable. It should not be used to cover changes in the specification, changes of client's requirements or variations resulting from errors or omissions in quantities. Contingency and risk allowances should be reviewed regularly and should be assessed and report in risk management procedures.
- Team roles and responsibilities should be clearly defined and understood by everyone, including a clear communication plan. Client's senior management leadership and commitment are needed from the beginning of the project.

- The design should take constructability, functionality, appropriate build quality health and safety issues as well as any adverse impact on the environment into consideration.
- The selection of the lowest tender price should be avoided. The contract should be awarded to the firms who can bring best value for money.
- Correct information should be provided at correct time by the client and design consultant to the contractor in order to minimize claims during the construction stage. Any anticipated or expected claims should be reported to the client and included in the regular cost status reports with details of variations, justification and its cost implications with impact on the original approved budget etc.

The deficiency of this thesis and necessity of further research

Cost control and management in construction projects is a very extensive topic, which includes numerous sub-topics, processes, technology and techniques. It is impossible to cover it with full details in one single study.. However, with full dedication and interest I tried to cover the cost control and management broadly. It is worth noticing that this thesis do not provide a full view of the said topic; some ideas presented in the study are based on the assumption of ideal conditions which can be rarely found in daily work life.. Therefore, this thesis further needs vast study at micro level in future to cover and clarify many related topic.

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APPENDIX

APPENDIX-A: UNIFORMAT

1. COST SUMMARY – UNIFORMAT LEVEL 1

Project Name:	GSA - Gross Site Area (m2):
Job No:	FPA - Footprint Area (m2):
Location:	NFA - Net Floor Area (m2):
Estimate Date:	GFA - Gross Floor Area (m2):

Code	Description	Unit	Qty.	Rate	Amount
A	SUBSTRUCTURE				
B	SHELL				
C	INTERIORS				
D	SERVICES				
E	EQUIPMENT & FURNISHINGS				
F	SPECIAL CONSTRUCTION & DEMOLITION				
G	BUILDING SITEWORK				
M	MISCELLANEOUS ITEMS				
Z	GENERAL (COC & GRs)				
Z10	Conditions & General Requirements				
Z20	CONTINGENCIES				
	PROJECT - TOTAL CONSTRUCTION COST				

2. COST SUMMARY – UNIFORMAT LEVEL 2

Project Name:	GSA - Gross Site Area (m2):
Job No:	FPA - Footprint Area (m2):
Location:	NFA - Net Floor Area (m2):
Estimate Date:	GFA - Gross Floor Area (m2):

Code	Description	Unit	Qty.	Rate	Amount
A	SUBSTRUCTURE				
A10	FOUNDATIONS				
A20	BASEMENT CONSTRUCTION				
B	SHELL				
B10	SUPERSTRUCTURE				
B20	EXTERIOR ENCLOSURE				
B30	ROOFING				
C	INTERIORS				
C10	INTERIOR CONSTRUCTION				
C20	STAIRS				

C30	INTERIOR FINISHES				
D	SERVICES				
D10	CONVEYING				
D20	PLUMBING				
D30	HVAC				
D40	FIRE PROTECTION				
D50	ELECTRICAL				
E	EQUIPMENT & FURNISHINGS				
E10	EQUIPMENT				
E20	FURNISHINGS				
F	SPECIAL CONSTRUCTION & DEMOLITION				
F10	SPECIAL CONSTRUCTION				
F20	SELECTIVE BUILDING DEMOLITION				
G	BUILDING SITEWORK				
G10	SITE PREPARATION				
G20	SITE IMPROVEMENTS				
G30	SITE CIVIL/MECHANICAL UTILITIES				
G40	SITE ELECTRICAL UTILITIES				
G90	OTHER SITE CONSTRUCTION				
M	MISCELLANEOUS ITEMS				
M01	MISCELLANIES ITEMS				
Z	GENERAL (COC & GRs)				
Z10	Conditions & General Requirements				
Z20	CONTINGENCIES				
	PROJECT - TOTAL CONSTRUCTION COST				

3. COST SUMMARY - UNIFORMAT LEVEL 3

Project Name:
Job No:
Estimate Date:
Design Stage:

GSA - Gross Site Area (m2):
FPA - Footprint Area (m2):
NFA - Net Floor Area (m2):
GFA - Gross Floor Area (m2):

	GROUP ELEMENT Individual Element	ELEMENT			Amount	Cost per Unit GFA	Gross Bldg. Cost %	Notes
		Qty.	Unit	Rate				
	BUILDING							
A	SUBSTRUCTURE							
A10	FOUNDATIONS							
A1010	Standard Foundations							
A1020	Special Foundations							
A1030	Slabs on Grade							
A20	BASEMENT CONSTRUCTION							
A2010	Basement Excavation							
A2020	Basement Walls							

B	SHELL							
B10	SUPERSTRUCTURE							
B1010	Floor Construction							
B1020	Roof Construction							
B20	EXTERIOR ENCLOSURE							
B2010	Exterior Walls							
B2020	Exterior Windows							
B2030	Exterior Doors and Entrance							
B30	ROOFING							
B3010	Roof Coverings							
B3020	Roof Openings							
C	INTERIORS							
C10	INTERIOR CONSTRUCTION							
C1010	Partitions							
C1020	Interior Doors							
C1030	Fittings							
C20	STAIRS							
C2010	Stair Construction							
C2020	Stair Finishes							
C30	INTERIOR FINISHES							
C3010	Wall Finishes							
C3020	Floor Finishes							
C3030	Ceiling Finishes							
D	SERVICES							
D10	CONVEYING							
D1010	Elevators and Lifts							
D1020	Escalators and Moving Walks							
D1030	Material Handling Systems							
D1090	Other Conveying Systems							
D20	PLUMBING							
D2010	Plumbing Fixtures							
D2020	Domestic Water Distribution							
D2030	Sanitary Waste							
D2040	Rain Water Drainage							
D2050	Other Plumbing Systems							
D2090	Other Plumbing Systems							
D30	HVAC (Heating, Ventilation, and Air Conditioning)							
D3010	Energy Supply							
D3020	Heat Generation Systems							
D3030	Refrigeration (Cooling Generating systems)							
D3040	HVAC Distribution Systems							
D3050	Terminal and Packaged Units							
D3060	HVAC Instrumentation and Controls							
D3070	Testing, Adjusting, and Balancing							
D3090	Other HVAC Systems and Equipment							
D40	FIRE PROTECTION							
D4010	Sprinklers Systems							
D4020	Standpipes							
D4030	Fire Protection Specialties							
D4090	Other Fire Protection Systems							

D50	ELECTRICAL							
D5010 D5020	Electrical Service and Distribution Lighting and Branch Wiring							
D5030	Communication and Security							
D5040	Electrical Systems Testing							
D5090	Other Electrical Systems							
	BUILDING - NET COST							
E	EQUIPMENT & FURNISHINGS							
E10	EQUIPMENT							
E1010	Commercial Equipment							
E1020	Institutional Equipment							
E1030	Vehicular Equipment							
E1090	Other Equipment							
E20	FURNISHINGS							
E2010	Fixed Furnishings							
E2020	Moveable Furnishings							
F	SPECIAL CONSTRUCTION & DEMOLITION							
F10	SPECIAL CONSTRUCTION							
F1010	Special Structures							
F1020	Integrated Construction							
F1030	Special Construction Systems							
F1040	Special Facilities							
F1050	Special Controls and Instrumentation							
F20	SELECTIVE BUILDING DEMOLITION							
F2010	Building Elements Demolition							
F2020	Hazardous Components Abatement							
	BUILDING - GROSS COST							
G	BUILDING SITEWORK							
G10	SITE PREPARATION							
G1010	Site Clearing							
G1020	Site Demolition and Relocations							
G1030	Site Earthwork							
G1040	Hazardous Waste Remediation							
G20	SITE IMPROVEMENTS							
G2010	Roadways							
G2020	Parking Lots							
G2030	Pedestrian Paving							
G2040	Site Development							
G2050	Landscaping							
G30	SITE CIVIL/MECHANICAL UTILITIES							
G3010	Water Supply and Distribution Systems							
G3020	Sanitary Sewer							
G3030	Storm Sewer							
G3040	Heating Distribution							
G3050	Cooling Distribution							
G3060	Fuel Distribution							
G3070	Site Systems Testing and Balancing							
G3090	Other Site Mechanical Utilities							

G40	SITE ELECTRICAL UTILITIES							
G4010	Electrical Distribution							
G4020	Site Lighting							
G4030	Site Communications and Security							
G4040	Site Electrical Systems Testing							
G4090	Other Site Electrical Utilities							
G90	OTHER SITE CONSTRUCTION							
G9010	Service Tunnels							
G9090	Other Site Systems							
M	MISCELLANEOUS ITEMS							
M01	MISCELLANIES ITEMS							
M0101	External Fence							
Z	GENERAL							
Z10	GENERAL (Conditions & General Requirements)							
Z1010	Administration							
Z1020	Quality Requirements							
Z1030	Temporary Facilities							
Z1040	Project Closeout							
Z1050	Permits, Insurance, and Bonds							
Z20	CONTINGENCIES							
Z2010	Design Contingencies							
Z2020	Cost Fluctuation Contingencies							
Z2030	Construction Contingencies							
	PROJECT - TOTAL CONSTRUCTION COST			US$				

APPENDIX-B: SURVEY LETTER

Dear Sir/Madam,

With reference to my master thesis at HTW University for Applied Sciences Berlin, intended to investigate the cost control practices inside consultant and construction firms during pre-contract (design) and post-contract (construction) stage, importance of costs estimation, various cost overruns factors and mitigate techniques, and use of cost control techniques and software's for that. Your responses will enable me to obtain as full understanding of this vital issue.

I am sending this questionnaire to Directors, Project Managers, Design Manager, Team leader, Construction Managers, Site Managers/Engineers, Quantity Surveyors, Cost estimators, Procurement Managers/Engineers, Cost Control Managers/Engineers, Planners, etc. who have worked in construction projects and are in positions to control costs of the projects.

The questionnaire consists of six small sections, which will take few minutes to complete it. The answers of the questionnaire will be used as the main data set for my research project for my thesis research.

Your early response to this questionnaire will help me to analyze the process of cost management and control along different stages of construction projects.

Looking forward to hearing from you.

Yours faithfully

Ahmed Abobakr

APPENDIX-C: QUESTIONNAIRE

G. <u>Respondent's Background</u>

1. Type of Respondent
   - ○ Directors
   - ○ Project Managers
   - ○ Design Manager
   - ○ Team leader
   - ○ Construction Managers
   - ○ Site Managers/Engineers
   - ○ Cost estimators/ Quantity Surveyors
   - ○ Cost Control Managers/Planner
2. Experience in Construction Industry?
   - ○ Less than 5
   - ○ 5-10
   - ○ 10-15
   - ○ 15-20
   - ○ More than 20
3. Stakeholder, you are working for?
   - ○ Client
   - ○ Main Contractor
   - ○ Sub-contractor
   - ○ Design Consultant/Architectural Firm
   - ○ Cost Consultant & Project Management Service
   - ○ Other (please specify)
4. Type of Client in project?
   - ○ Government Organization
   - ○ Developer
   - ○ Oil & Gas Company

- ○ Private Organization
- ○ Other (please specify)

5. Have you responsible for Cost Management & Control, Cost Estimating or budgeting during your career?
   - ○ Yes
     a) Directly
     b) Indirectly
   - ○ No

H. <u>Company's Details</u>

6. What industry does your company belongs to?
   - ○ Building construction (Commercial or Residential)
   - ○ Heavy Civil Engineering
   - ○ Roads and Infrastructure
   - ○ MEP Services
   - ○ Water and Sanitary
   - ○ Other (please specify)

7. In which country your company is working?
   - ○ Middle East
   - ○ African Countries
   - ○ South-East Asia
   - ○ Europe

8. What is the turn-over of your Company?
   - ○ Less than 50 Million USD
   - ○ Between 50-200 Million USD
   - ○ Between 200-500 Million USD
   - ○ More than 500 Million USD

I. <u>Cost Estimation</u>

9. Please tick mark in the appropriate section in below table.

	Always	Most of the Times	Sometime	Not at all
To what degree the costs of completed project are well-matched with approved budget of the project during design stage in your project	○	○	○	○
To what degree that your project completed on time	○	○	○	○
To what degree that the quality of your project has been acceptable in your project	○	○	○	○
To what degree the Scope of Works deviate from the initially agreed SOW	○	○	○	○
To what degree that the project objectives are achieved	○	○	○	○
To what degree do you think that building information technologies (BIM) improves cost estimation processes?	○	○	○	○

10. How do you calculate Project Budget Cost?

○ Analogous/Parametric Estimating

○ Square & Cubic meter Estimates

○ Bottom-up Estimating

○ Three-points Estimates

○ BIM Technologies

○ Other (please specify)

11. Below questionnaire is for the preparation of Cost Estimate. Please tick mark in the appropriate section in below table.

Following details are required	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Cost Data Bank	○	○	○	○	○
Locally availability of Material	○	○	○	○	○
Type and intent of Development	○	○	○	○	○
Labor Cost knowledge and its availability	○	○	○	○	○
Availability of Equipment	○	○	○	○	○
Electro-Mechanical Cost	○	○	○	○	○
Overhead Costs	○	○	○	○	○
Use of Contingency for risk and uncertainty	○	○	○	○	○
Qualifications, Exclusions and Inclusions	○	○	○	○	○
Inflation and Currency Fluctuation in that region	○	○	○	○	○
Estimating Technique or software	○	○	○	○	○
Work Methodology of an activity	○	○	○	○	○

J. Cost Control

12. In your opinion, which stage is best for cost control?

○ Initial Stage of Design

○ During mid Stage of Design

○ Tendering Stage

○ Construction Stages

○ All the time

13. Do you carry out the cost control system during the construction stages?

○ All the time

○ Most of the time

- Sometimes
- Rarely
- Never

14. What techniques does your company use to control costs?

- Project-cost value Reconciliation
- Earned value Analysis
- Labour /Plant/Mechanical (actual verses forecast reconciliation)
- Lean Construction
- Unit rate costing
- Overall Profit or loss
- Others (Please specify)

15. How satisfied you are with your cost control technique?

- Extremely satisfied
- Very satisfied
- Somewhat satisfied
- Not so satisfied
- Not at all satisfied

16. How often does your company prepare cost control report?

- Weekly
- Bi-Weekly
- Monthly
- Quarterly
- Yearly
- Other (please specify)

K. Cost Overrun

17. Please tick the percentage of projects that experienced cost overruns because of the following factors?

	75-100 %	50-75%	25-50%	0-25%
Design Changes/Scope Changes	○	○	○	○
Risk and uncertainties associated with projects	○	○	○	○
Client Interference	○	○	○	○
Inaccurate evaluation of project's duration	○	○	○	○
Inaccurate estimation of project's cost (Labour, material & plant)	○	○	○	○
Nonperformance of sub-contractors and nominated suppliers	○	○	○	○
Contract Administration	○	○	○	○
Specification interpretation	○	○	○	○
Inflation of Prices	○	○	○	○
Financial Management	○	○	○	○
Lack of appropriate technique or software	○	○	○	○

L. Decrease Construction Costs & Improve Efficiency

Addressing actions that could be taken to lower construction costs, Increase efficiency, and increase productivity

18. In your view what is the major reason for high cost of labour encountered in the construction industries?

○ Unrealistic demand by labour unions

○ Government decision- review on wages, fringe benefits

○ Inflation

○ Scarcity of skilled labour

19. What is the major reason for high cost of construction material in the construction industries?

    - ○ Profiteering by various supplier
    - ○ Competitive high demand
    - ○ Scarcity of materials
    - ○ High Cost of Production

20. In your view, what is the major reason for increase of plant charges in the construction industries?

    - ○ Devaluation/Fluctuation of currency
    - ○ Increase in fuel rates, lubricant etc.
    - ○ Unavailability of spare parts
    - ○ High Cost of Maintenance

21. What is the major reason for increasing cost by sub-contractors in the construction industries?

    - ○ Overestimation
    - ○ High import cost of material, labour and plant
    - ○ Delay and short period for the completion of project
    - ○ High bank interest rates on loans and overhead

22. How does the land cost influence the cost in construction industries?

    - ○ Increasing development of the area
    - ○ Private ownership
    - ○ Little effect on high cost of construction
    - ○ Substantial payment for compensation

23. Have you worked on projects and experienced construction costs lower than the specified costs?

    - ○ Yes, please explain
    - ○ No

○ Not sure

24. How efficient your company is for the minimization of wastage in labor, material, time, and energy?

○ Extremely Efficient

○ Efficient

○ Somewhat Efficient

○ Poor

25. What actions to be taken in order to decrease or lower construction costs during the Design, Tendering and Construction stage?