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DEPARTMENT OF TRANSPORT

PROJECT COST ESTIMATING MANUAL

Document Number: AD-C-03
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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

GLOSSARY

"Base estimate" contains the total contract works and employer's costs (if advised by the Client) but does not include Project risk contingencies and escalation.

"Basis of estimate" describes the basis of an estimate and defines the information used in preparing the cost estimate. This document commonly includes a description of the scope, methodologies, references, defining deliverables, assumptions and exclusions, clarifications, adjustments, and level of uncertainty.

"Benchmark" means a standard that measures performance.

"Benchmarking" means collecting, organising, and analysing historical data for future use.

"Bill of quantities" means a list of work items; their measurement reference; and their quantities, including unit rates and the amount priced by the Bidder or the Contractor.

"Budget" means an approved amount of funding for the Project.

"Budgeting" is a process for allocating estimated costs of resource into cost accounts (*i.e.*, the cost budget) against which cost performance will be measured and assessed. Budgeting often considers time phasing in relation to a schedule or time-based financial requirements and constraints (Association for the Advancement of Cost Engineering, International [AACEI]).

"Cash flow" is the profile of total cost expenditure, or the Project estimate, including Project contingencies distributed across the financial years that the funds are expected to be spent.

"Change order (or variation)" is a requirement instructed by the Client directing the Contractor to make a change to the scope of the works.

"Conceptual design" describes how a concept will work and meet the mission, which requires a mission need as an input. Different concepts for meeting the mission needs are explored and alternatives are considered before arriving at the set of alternatives that are technically viable, affordable, and sustainable.

"Context-sensitive solutions" is an interdisciplinary approach that seeks effective transportation solutions by working with stakeholders to develop, build, and maintain cost-effective transportation facilities that fit into and reflect the Project's surroundings.

"Consultants" are specialist organisations, or a person, that gives expert advice or information. Consultants are normally external to the Client, but may also include internal parties.

"Contingency" is a provision derived from a structured evaluation of known and unknown risks, to cover a likely future condition or event, added to base to arrive at an expected estimate. This may also be referred to as an allowance included in the Project estimate to take care of unforeseen factors relating to the delivery of Project objectives.

"Contractor" means a person, organisation, department, division, or company that has a contract, agreement, or memorandum of understanding with the Client.

"Cost control" is a process of controlling changes to a project budget and forecast to completion.

"Cost estimate" is a statement of costs, properly documented, to be incurred to complete a project, or a defined part of a project; it also acts as a baseline for measuring performance.

"Cost estimating" is a process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project. As a predictive process, estimating must address risks and uncertainties. Estimating outputs are used primarily as input for budgeting, cost, or value analysis; decision making in business; asset and project planning; or project cost and schedule control (AACEI).

"Direct cost" are costs directly related to the Project, including materials, labour, and equipments.

"Discount rate" is the interest rate used in calculating the present value of expected yearly benefits and costs.

"Escalation" is the additional allowance that is used to cover the anticipated increase in the Project's costs over time, as a result of various factors; including inflation, market conditions, and supply constraints. Escalation addresses price increases caused by an increase in the cost of labour, material, or equipment necessary to perform the work.

"Historical cost information" is the documented database of similar information gathered from completed projects and normalised to some standard using cost indices, such as geographical data or time-based, etc., brought to current year data.

"Independent cost estimate" is an independent cost estimate that serves as a tool to crosscheck, validate, or analyse cost estimates developed by the Project's proponents.

"Indirect costs" are the costs incurred from common or joint objectives that are not directly attributable to a particular activity or work item. For construction activities, these costs usually include on-site overheads, including site supervision; and off-site overheads, such as the Contractor's corporate and business costs.

"Optimism bias" is the tendency for the people to be overly optimistic.

"Out-turn value" is the value of the works during the period when work will be executed. Estimates prepared at a particular date can be converted to out-turn value by applying the appropriate escalation rates to the Project's planned cash flow.

"Peer review" is a review of the Project estimates conducted by an independent, experienced Estimator within the organisation.

"Probabilistic estimating" is a technique of generating estimates that takes into consideration the quantities measured or allowed can change, rates assumed can vary, and risks with a probable outcome can occur.

"Project brief" is a statement of the objectives and functional and operational requirements of the finished Project. It enables the construction team to accomplish the detailed design and specification of the work and is therefore an essential reference for the construction team.

"Resources" are the consumables, other than time, required to accomplish an activity, including real or potential investment in strategic assets, like money, human, and physical resources. Resources become a cost when they are invested or consumed in an activity or project (AACEI).

"Risk management" is the act or practise of controlling risk. This organised process reduces the Project's risks or maximises the potential for success.

"Risk" is the chance of something happening that will have an impact upon the Project's objectives. Risk components are the probability or likelihood of failing to achieve a particular outcome, and the consequences and impacts of failing to achieve that outcome.

"Scope" is the sum of all that is to be done, or has been invested in and delivered by, an activity or project. In the Project planning, the scope is documented by the scope document, but it may be verbally or otherwise communicated and relied upon. Scope is generally limited to that which is agreed to by the stakeholders in an activity or project (*i.e.*, if not agreed to, it is out of scope). In contracting and procurement, scope includes all that an enterprise is contractually committed to perform or deliver (AACEI).

"Total completion cost" is an actual cost of a project.

"Total project cost" is the estimated total completion cost.

"Value management" is a structured, analytical process that seeks to achieve value for money by providing all the necessary functions at the lowest total cost consistent with required levels of quality and performance.

"Variation estimate" is an estimate prepared to support a request for variation in the approved scope of work.

"Work breakdown structure" is the way in which a project is divided by levels into discrete groups for programming, cost planning, and control purposes. Grouping of product-oriented Project elements organises and defines the total scope of the Project. Each descending level represents an increasingly detailed definition of a Project component. Components may be products or services.

ABBREVIATIONS AND ACRONYMS

AACE	Association for the Advancement of Cost Engineering
AACEI	Association for the Advancement of Cost Engineering, International
AC	Asphalt concrete
ADM	Abu Dhabi municipality
AED	Arab Emirates Dirham
AS/NZS	The Australian and New Zealand Standard
BCE	Budget cost estimate
BCU	Budget cost updates
BoQ	Bill of quantities
CBS	Cost breakdown structure
CE	Concept estimate
Const.	Construction
CP	Construction procurement phase
CPI	Cost performance index
CVE	Contract variation estimate
DDE	Detailed design estimate
DoT	Department of Transport, Abu Dhabi
ECT	Estimate for comparison of tenders
EE	Engineer’s estimate
FCA	Final cost analysis
Fe	Feasibility phase
Hr	Hours
JCB	Joseph Cyril Bamford
KMPH	Kilometres per hour
LCCA	Life-cycle cost analysis
MEP	mechanical, electrical, and plumbing
MSE	Mechanically stabilised earth
NOC	No objection certificate
OAE	Option analysis estimate
PCEM	Project Cost Estimating Manual
PD	Pre-tender design phase
P&DD	Preliminary and Detailed Design Phase
PDE	Preliminary design estimate
PF	Periodic forecasting
PI	Project initiation phase
PIE	Project initiation estimate
PIR	Project initiation report
PM	Project Manager
PPE	Project proposal estimate
PRMM	Project Risk Management Manual
PS	Procurement strategy phase
PV	Present value
QA	Quality assurance
QC	Quality control
ROW	Right-of-Way
SD	Standard Deviation

Abu Dhabi City Municipality

SAR	Scheme assessment report
SE	Strategic estimate
UAE	United Arab Emirates
WBS	Work breakdown structure

1 INTRODUCTION

1.1 Overview

In 2010, the Abu Dhabi Department of Transport commenced with the “Unifying and Standardizing of Road Engineering Practices” Project. The objective of the project was to enhance the management, planning, design, construction, maintenance and operation of all roads and related infrastructures in the Emirate and ensure a safe and uniform operational and structural capacity throughout the road network.

To achieve this objective a set of standards, specifications, guidelines and manuals were developed in consultation with all relevant authorities in the Abu Dhabi Emirate including the Department of Municipal Affairs (DMA) and Urban Planning Council (UPC). In future, all authorities or agencies involved in roads and road infrastructures in the Emirate shall exercise their functions and responsibilities in accordance with these documents. The pur[illegible]cability of each document are clearly indicated in each document.

Move (DoT) to where it appears the first and use DoT in rest of document.

It is recognized that there are already published documents with [illegible] contents prepared by other authorities. Such related publications are mentio[illegible]ment and are being superseded by the publication of the new document, except in cases where previously published documents are recognized and referenced in the new document.

1.2 Purpose and scope

An underlying principle within the Abu Dhabi Department of Transport (DoT) is to manage all work effectively and efficiently. This principle applies to all aspects of the DoT. To meet this requirement, in respect of cost estimation, it is required to develop and maintain accurate, reasonable, verifiable, and up-to-date cost estimates for all projects.

Project Cost Estimating Manual (PCEM) is developed to provide best practices and uniform guidance that describes the methods and procedures used for preparing cost estimates for new and redeveloped Abu Dhabi Emirate roads. Conformance to the provisions of this manual will result in consistent procedures, Emirate wide, and will support acceptance criterion for DoT reviewers.

This manual’s approach is consistent with the DoT’s objective to implement an emirate-wide unification and standardisation of highway engineering practises. Application of this manual is based on current best cost estimation practises that are modified and adapted for the conditions within the Abu Dhabi Emirate.

1.3 Guidelines versus standards

Standards presented throughout this manual shall be the required cost estimation practices for DoT projects. Guidelines presented will provide the estimator opportunities for flexibility. In areas where it is not clearly expressed as a standard or guideline, the following language usages will help the estimator understand the degree of flexibility in the estimation process:

- Standard: Look for the words “shall” or “shall not,” and “must” or “must not.” Additionally, look for the words “is required” or “are required.”

deciding on the work scope. Project cost estimation is also a vital tool for financial planning, the selection of various possible design alternatives, Project scheduling, evolving Project specifications, cost planning, and cost control.

This manual envelops the preparation of estimates in support of the identification, selection, development, implementation, and finalisation of projects. Objectives of this manual include the following:

- Developing a better understanding as to what prerequisite information each agency is required to prepare to meet DoT expectations at each phase;
- Providing guidance to agencies with appropriate processes and procedures to meet DoT standards;
- Providing guidance to DoT staff to better understand what underlies the estimate for engaging in constructive discussion; and,
- Assisting the DoT in taking a leadership role in aligning industry standards nationally for cost estimating of infrastructure projects.

Reliable cost estimate information will assist in the following:

- Justification of a project concept case, for example, cost and benefit analysis;
- Comparison of various tenders received;
- Estimation of alternative Project completion options; and,
- Cost control during Project concept, development, and implementation phases.

Total Project cost estimates must include the costs of all components that become increasingly significant in the overall Project cost. This manual provides information on a range of processes and techniques to suit the varying circumstances under which estimates develop.

Larger, more complex projects should go through an alternative, more extensive analysis as they contain more risk elements than other projects. Traditional estimating methods are not always appropriate. Guidance provided in this manual is intended to assist Clients, and other agencies, in ensuring that all Project cost estimates are prepared using sound practises that result in logical and realistic initial estimated Project costs — providing a more stable cost estimate throughout the Project continuum.

Compliance with this manual is mandatory for all cost estimates prepared for DoT infrastructure projects. Project Managers (PM), Engineers, Technical Officers, and external service providers shall follow these procedures when preparing cost estimates at any point in the Project cycle. This manual is the basis for review of all cost estimates submitted to the DoT for its review, acceptance, or approval.

Each project is unique; therefore, the Estimator shall accurately develop an estimate of the construction costs for each project.

1.5 How to use this manual

Estimators shall follow the guidelines included in Chapters 2, 3, and 4, for developing an estimate in accordance with different phases in a project life cycle. This process should be completed prior to quality assurance (QA), as provided in Chapter 5. Presentation of the estimate and reporting shall be in accordance with the guidelines as provided in Chapter 6.

It is important to bring to the Estimator's attention that these guidelines do not provide actual figures or values of different elements. Rather, it provides information based on standard, commercial estimating practises and processes to meet DoT requirements. Using associated checklists and templates will ensure that the initial submittals are complete and require minimal revision after DoT review.

1.6 Content and format

This PCEM is structured to provide a detailed level of information as the reader progresses. Initial sections provide overviews of the estimating functions and requirements with detailed explanations in the remaining sections.

The manual covers sections dealing with the cost estimation process, cost estimating methodology, cost estimating or Project development levels, cost estimating training, document and basis of estimate, cost estimating data, independent estimate and estimate review, and resources. Detailed guidelines are given for cost estimating methodology.

This PCEM is divided into seven chapters with various appendices. Chapter 1 defines the purpose and scope of the manual, which is to provide a consistent engineering approach for cost estimation management of DoT infrastructure projects. It also discusses an industry perspective on current practises. Chapter 2 defines the estimates involved during the different phases of a project life cycle and the tools and techniques available to aid in estimate development.

Chapter 3 discusses the generic estimating process followed by a description of the estimate document structure. This is foundational knowledge for any estimate on any type of project. This chapter also details the development processes for each estimate document, which are arranged in order of the sequence of estimate stages. Chapter 4 describes the estimate development process in different phases of the Project development.

Chapter 5 includes processes and guidelines to assist in achieving reliable Project cost estimate performance. Each subject [illegible] hmarking, including peer review. Chapter 6 establishes methods for the p[illegible]s, which are supported by templates.

why 'italics' while in many places this abbreviation is not 'italics'/ Consistency please with all styles and formats.

Chapter 7 provides a link [illegible] ing and infrastructure project management methodology, because estima[illegible] of the cost management process within project management.

Additional sections provide a glossary of terms and abbreviations; a list of references referred to within the *PCEM*; an index of where to find key subjects; and appendices, which include standard templates for cost estimation reports and the specific reports referred to in each chapter.

1.7 Industry perspective – current practise

Estimating in the emirate is carried out by a wide range of personnel who subscribe to protocols that are broadly understood, but are not consistently well documented. Approaches to estimating usually vary between the Contractor's, service providers', and Client's organisation; and is not reflected in a documented or accepted industry standard. Estimators perform work creating relatively minor differences in practice between each Client organisation, which are absorbed in the process allowing inconsistencies to continue to prevail.

Government agencies, as well as public and private companies, require reliability in the estimation of Project costs to achieve their objectives. Numerous industry sectors draw upon the specialist resources of estimating personnel. In recent years, with strong economic growth, there has been a chronic shortage of specialised personnel to carry out project cost estimating work.

Industry sectors are broadly divided into the building and engineering infrastructure sectors.

Estimating functions in the building sector are served by the quantity surveying profession, which subscribes to standards set out by the relevant professional institution. Hence, stakeholders in that broad sector understand the processes that support project estimating.

Covering a wide range of project types, including the roads, rail, marine, process, power, and water sectors, the engineering infrastructure sector is arguably more diverse. Skills required to estimate infrastructure projects rely heavily on technical knowledge and experience in a particular sector. Estimators in any sector typically have an engineering background and have gained their skills from years of experience in a particular project type.

There is limited formal training support available from local institutions for the education of Estimators, who normally gain training on the job. Training in estimating is an issue that the emirate engineering and infrastructure industry should consider, given the strong demand in infrastructure and resource development.

In summary, by commissioning this manual, DoT has recognised the need for improvements in the cost estimation of infrastructure projects and is providing valuable leadership in establishing a benchmark standard. Setting a standard will assist the process of alignment of work practises and the training of new staff, allowing the on-going development of best practises in cost estimation to become more effective. This manual can be used by other project owners across the emirate with suitable modifications to suit their structure and standards.

2 COST ESTIMATING

2.1 Overview

This chapter provides an overview of the estimating process. It discusses the purpose of different estimates through the various phases of the Project's life cycle and the roles and responsibilities of the different personnel involved in Project acquisitions, which are arranged according to the sequence of estimate stages.

This chapter also considers what needs to be taken into account when adjusting unit bid price and lists the tools and techniques available to aid in an estimate development.

Figure 2-1: General cost estimation process

Important Note

Throughout the *Project Cost Estimating Manual,* there are boxes containing important notes that emphasise suggested practices that may not be well known but that may be beneficial for future reference.

Why now full title if you created an abbreviation.

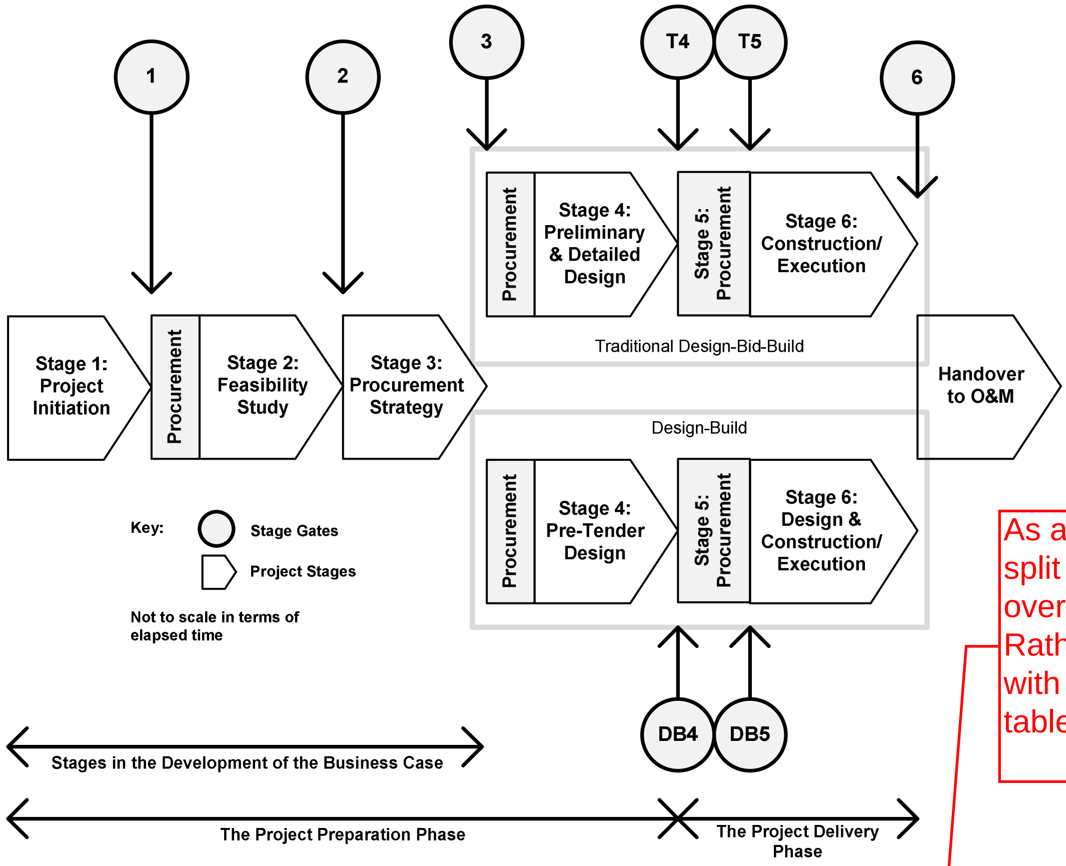
2.2 Project life cycle

During the life of project development, cost estimates and related documents are developed to facilitate the acquisition and to document the Project planning, development, and changes required throughout the process. Estimates are typically produced for each development phase of a project.

Section 2.2.1 explains the stages involved in DoT's project development and corresponding phases in the development of cost estimates. These stages are specific to DoT structure; Estimators of other client's referring this manual should suitably align these stages to suit their structure.

2.2.1 DoT's project development procedure

The DoT's *Project Development Procedures Manual* defines the procedure under which the DoT delivers its capital projects. Under this procedure, the DoT's capital projects are developed within well-defined stages (Project Development Stages). The end of each Project Development Stage represents an important decision point (Stage Gate) in the project's development at which the Project is subject to higher-level review and approval. Figure 2-2 illustrates the Project Development Stages and the Stage Gates that follow each of them, whilst Table 2-1 describes the purpose of each stage.



As a rule: try not to split the same table over two pages. Rather fill this space with text and start table on next page.

Figure 2-2: DoT's Project development procedure

Table 2-1: DoT's Project Development Stages

Project Development Stage	Purpose
Stage 1: Project Initiation	Define the Project concept, evaluate the need for the Project in the form of a Prefeasibility Study, and detail the scope and funding requirements for the Feasibility Study to support a request for funding for the Feasibility Study stage.
Stage 2: Feasibility Study	Confirm the optimal technical scope and composition of the Project (through a concept options development and design process) and its overall economic feasibility to support a request for funding for the design and/or subsequent stages of the Project.

Project Development Stage	Purpose
Stage 3: Procurement Strategy	Evaluate and compare alternative project delivery models to identify a Preferred Delivery Model to provide the complete information required to support a request for funding for the design and/or subsequent stages of the Project.
Stage 4: Preliminary & Detailed Design	Define existing conditions and requirements and identify the application of relevant design standards, criteria, and guidelines to develop a preliminary engineering design. For construction detailing of the preliminary design, and definition of the construction responsibilities and risks to be transferred to the Contractor, prepare the construction tender documents.
Stage 5: Construction Procurement	Procure the Construction Contractor in accordance with the Department's Procurement and Contracts Division procedures.
Stage 6: Construction Execution	Construct the works in accordance with the detail design drawings and tender documents.

2.2.2 Estimate development phases

Project estimates are developed in the following six different phases, which correspond to DoT's Project Development Stages:

- Project initiation phase (PI), which includes the following:
    - Project initiation estimate (PIE) (Strategic estimate [SE])
- Feasibility phase (Fe), which includes the following:
    - Project proposal estimate (PPE)
    - Option analysis estimate (OAE)
- Procurement strategy phase (PS), which includes the following:
    - Concept estimate (CE)
- Preliminary and detailed design phase (P&DD), which includes the following:
    - Preliminary design estimate (PDE)
    - Detailed design estimate (DDE)
- Construction procurement phase (CP), which includes the following:
    - Engineer's estimate/estimate for comparison of tenders (EE/ECT)
    - Budget cost estimate (BCE)
- Construction phase, which includes the following:
    - Budget cost updates (BCU)

- Periodic forecasting (PF)
- Contract variation estimate (CVE)

Each project has one live estimate that is updated progressively as the Project develops. This estimate is given different names depending on the Project phase, or the hold point to which it relates. During the earliest phases of the Project, multiple option analysis estimates may be prepared to allow for a number of potential solutions for the Project.

2.3 Project initiation phase

In the pre-Project phase, a study is conducted to check the feasibility of a Project. The phase concludes with the production of a Project initiation report (PIR) and an associated Project initiation estimate, which is usually developed with limited Project knowledge.

2.4 Feasibility phase

During the feasibility phase a nominated project receives sufficient priority to win funding. Investigations and studies are conducted to compile essential information. This phase includes the development of a Project proposal estimate; a scoping report, if required; and a scheme assessment report (SAR). Scoping reports summarise the various options and includes option analysis estimates for each proposed option; however, a scoping report is not always required.

2.5 Procurement strategy phase

This stage includes the development of a concept estimate based on a selected estimate from the nomination and will function as a benchmark against which all future estimates are compared. This estimate is the pre--design estimate that the Abu Dhabi Department of Transport (DoT) will use to secure funding for the design phase.

no need to write full name again - use only abbreviation. Check this for all abbreviations / acronyms in whole of document.

2.6 Preliminary and detailed design phase

This design stage consists of the preliminary design estimate and detailed design estimate. The aim of the preliminary design estimate is to ensure that the proj[illegible] design, ensuring that the estimate aligns with the concept case. [illegible] greater detail, permitting the design process to proceed with the de[illegible]

Approved concepts and the supporting documentation prepared for [illegible] form the basis of the detailed design estimate. Detailed design incorporates all the restudy and redesign work, the final specifications and drawings for bids from Contractors, and the construction cost estimate — along with analyses of health and safety factors. Moreover, the coordination of all design elements and local and government agencies is also included.

2.7 Construction procurement phase

Detailed design estimate is used to prepare the most accurate estimate (estimate for comparison of tenders [ECT]) possible prior to competitive bidding and construction. ECTs secure construction-phase funding and allow the design to be tendered out to the market. After the receipt of tenders and before the contract is awarded, the estimate will be revised to a budget cost estimate, which the PM and the Consultant will then manage until Project completion.

2.8 Construction phase

Construction phase consists of construction activities. This is the time during which actual work and operations are performed. Live working estimates are required throughout the life of the Project construction for cost control. These estimates reflect the most recent cost and data design available, the estimated cost to complete the Project, the allowance for contingency, the detailed contingency analysis, and the uncertainties remaining in the Project. This phase includes budget cost updates, periodic forecasting, and a contract variation estimate.

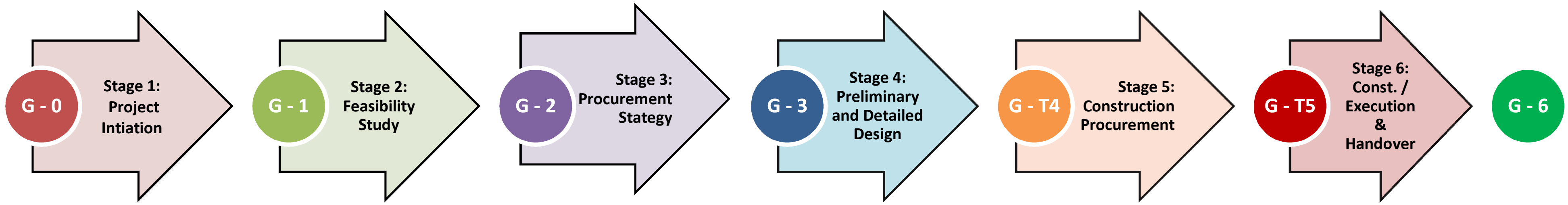
Finally, after the Project is completed, the information (cost) from the Project is analysed through a final cost analysis (FCA) for future reference and to measure estimating performance. This analysed information is passed on to the DoT, and the estimating lessons learned and outcomes are documented.

Figure 2-3 shows the comparison of phases between the PCEM and *Project Development Procedures Manual*.

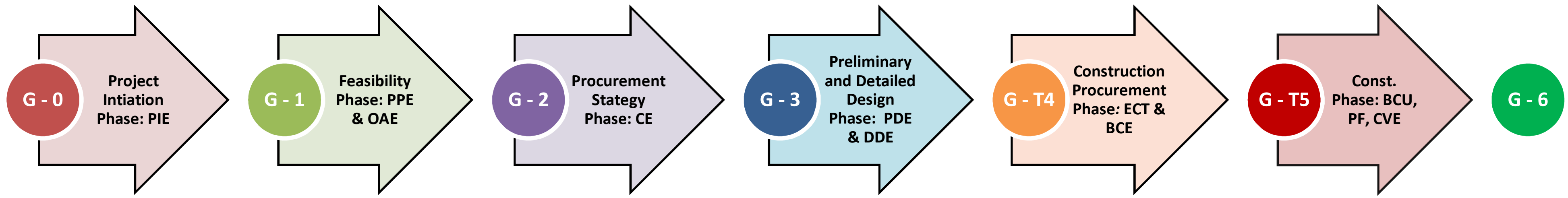
If you refer to another document, provide it with a reference number and include the full name and publishing details of that document of that document in list of 'Cited References'.
Apply this troughout document.

Figure 2-3: Stages comparison between DoT's *Project Development Procedures Manual* and PCEM

DoT's Project Development Procedures Manual Stages



Corresponding PCEM Phases (Gateways from *Project Development Procedures Manual* used for comparison)



PIE – Project initiation estimate
PPE – Project proposal estimate
OAE – Option analysis estimate
CE – Concept estimate
PDE – Preliminary design estimate
DDE – Detailed design estimate
ECT – Estimate for comparison of tenders
BCE – Budget construction estimate
BCU – Budget cost updates
PF – Periodic forecast
CVE – Contract variation estimate

2.9 Design and build

Principles for estimating a project under the design and build path is the same as that under the traditional design-bid-build path. Estimators should follow the guidelines as provided under this manual and make adjustments as appropriate to the Project's procurement path.

Project phases, from inception to completion for traditional and design-build procurement models, are shown in the following figure of timelines, which also shows how estimates fit into the life cycle.

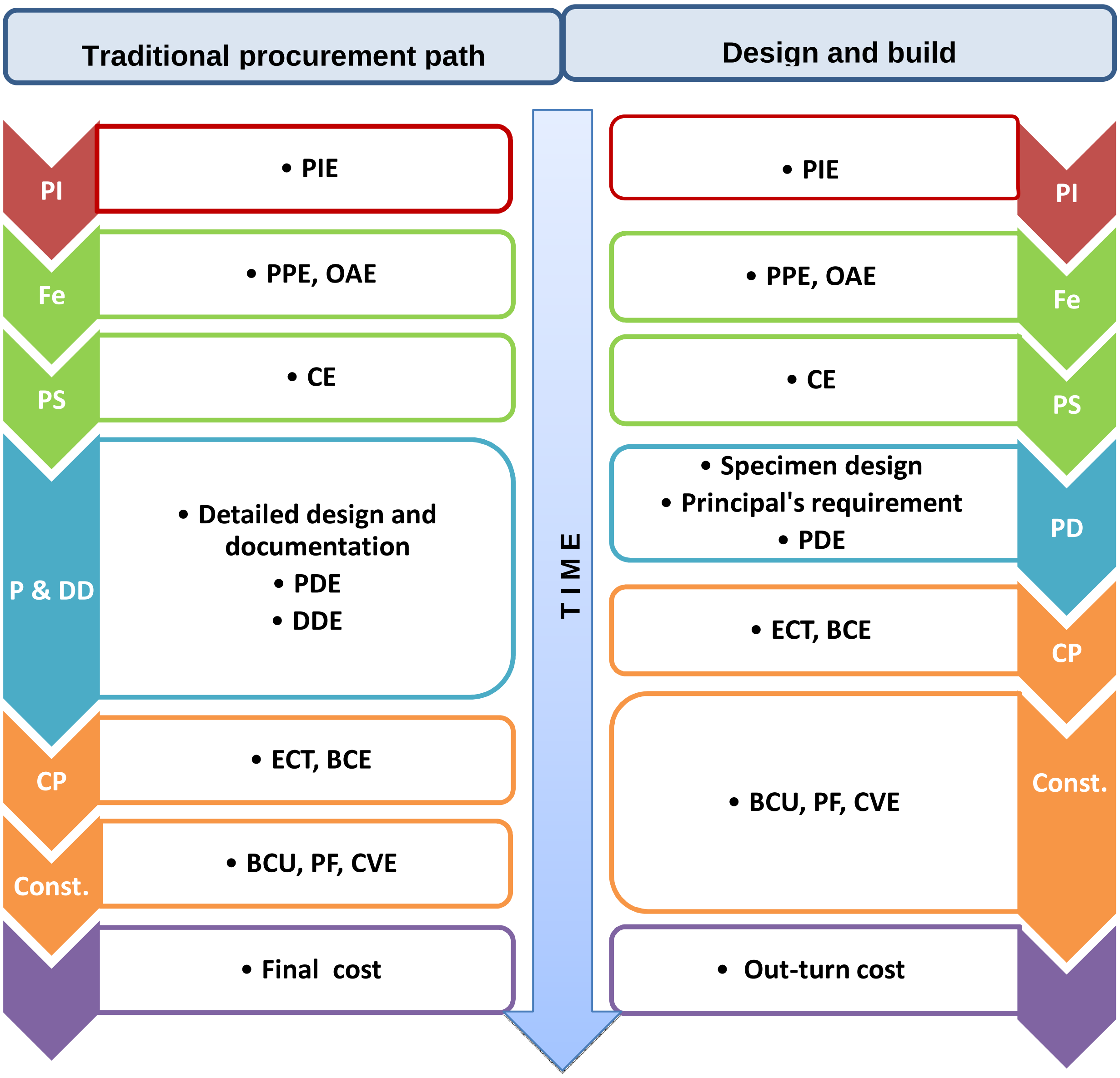


Figure 2-4: Traditional and design-build contract delivery timeline with estimate deliverables

2.10 Estimate definitions

2.10.1 Estimate

An estimate is a quantitative assessment of a likely outcome. It is a document elaborating the cost prediction to undertake a specific work prepared in a systematic manner appropriate to the size and complexity of the work, and to a level of accuracy commensurate with the available information and the intended use of the information developed. It may include some prior expenditure. It is usually applied to resources, project costs, durations, and similar variables, and it should always include some indication of accuracy (*e.g.*, + or - x percent).

2.10.2 Base cost estimate

A base cost estimate is the total sum that makes up an estimate, including provisional sums, but not including a contingency. For example, in physical works, it is the sum of the calculated quantities from a drawing multiplied by the current market rates for each work item. The base cost represents the cost that can reasonably be expected if the project materialises as planned. Typically, a variance is associated with the base cost.

Note: Base cost estimates are to be prepared by the project estimator relative to the current year value and will exclude future cost escalation.

2.10.3 Cost-based estimate

A cost-based estimate is a cost estimate prepared based on estimating the cost of each component (labour, materials, equipment, including contractor and subcontractor mark-ups), and then adding a sufficient amount for a contractor's overhead and profit.

2.10.4 Historical bid-based estimate

Historical bid-based estimate is a straightforward count or measure of units of items multiplied by unit costs. These unit costs are developed from historical project data and may be modified to reflect Project-specific conditions.

2.10.5 Parametric estimate

A parametric estimate is a method to estimate the cost of a project or a part of a project based on one or more project parameters. Historical bid data is usually used to define the cost. For example, a typical infrastructure Project cost estimate could be prepared by using parameters such as cost per lane kilometre, cost per interchange, or cost per square metre. These methods are often used early in the estimating stage, such as during the planning phase.

2.10.6 Project initiation estimate (strategic estimate)

Project initiation estimate is produced during the Project initiation phase, normally as part of a Project initiation report. This estimate provides budgets for forward programming.

Note: To produce a more reliable estimate, investigation beyond a traditional approach may be undertaken in the Project initiation phase. Generally, these estimates are prepared using elemental costs. Major risks must be identified and their impact on the out-turn cost shall be assessed and included in the estimate.

2.10.7 Option analysis estimate

Option analysis estimate is prepared during the concept phase and compare project options. Such estimate is based on a preliminary brief, limited general and site information, and the scope of work. All possible risks must be identified and included in the estimate.

2.10.8 Preliminary design estimate

Preliminary design estimate is prepared based on an advanced design. It provides a check on the position between the approved scope/budget and the Project estimate and occurs immediately prior to the detailed design stage. It is expressed in out-turn value.

2.10.9 Detailed design estimate

Detailed design estimate includes all components of a project prepared prior to seeking construction funding and the tendering of the physical works. It is based on detailed design documentation, which includes final design drawings, specifications, the schedule of prices, and all consent conditions. It is expressed in out-turn value.

2.10.10 Estimate for comparison of tenders

Typically, the estimate for comparison of tenders (ECT) is the final estimate prior to bid opening. An ECT for each work package is derived from the detailed design estimate prior to issuing the tender documents and reflects the expected tender price. Prior to the invitation of the tenders, the Project should have a complete ECT; however, during the bid period, addenda that change the scope of the work may require a revised ECT or reconciliation of the changed value to serve as part of the justification for award.

2.10.11 Budget Cost estimate

Budget cost estimate (BCE) is prepared during the tender evaluation period and updated (at least) quarterly during the construction phase until project completion. It is based on the tendered price of selected tender and is used to confirm that construction funding allocations are sufficient. The BCE also includes escalation and information received during the tender process. All risks must be reviewed, based on the preferred tender and any new issues that arise from the selection of the tenderer. It should also include change orders provided during the construction stage.

2.11 Estimating strategy

This section is specific to DoT; Estimators of other clients referring this manual should suitably align this section to suit their clients' requirements.

2.11.1 Estimating strategy background

DoT's development of investment strategies is based on the Abu Dhabi Emirate's strategic transport needs to ensure consistent outcomes are delivered in accordance with government priorities and objectives. Identifying and funding the highest-priority works to meet these needs, and delivering them through an efficient roads programme, is critical to realising the benefits of these outcomes for the community and achieving the DoT's primary purpose.

These processes rely on sound Project cost estimates and cost control to ensure decision integrity regarding conformance with government priorities, Project justification and authorisations, and the operation of road infrastructure programming.

2.11.2 Estimating strategy issues

Inaccurate estimates can result in negative perceptions of the DoT's professionalism, budgetary shortfalls, and delays in Project funding and approval.

2.11.3 DoT estimating programme

Through the development of these standard practises and procedures, the DoT needs to maintain a system for Project cost estimating in support of road infrastructure projects that will ensure a high level of confidence in Project cost estimates and reduce the incidences of cost variations.

This cost-estimating programme addresses not only the need for good governance but also the need to maintain consistency with internal and external demands, such as the standardisation of road infrastructure frameworks, by introducing standards to different elements of infrastructure works, including a road drainage manual, pavement design manual, standard bill of quantities (BoQ), road landscaping manual, and many more.

2.11.4 Estimating strategy principles

Key principles of the DoT's estimating strategy include the following:

- All estimates prepared should be on an "unlikely to be exceeded but not excessively conservative" basis at various stages of the Project life cycle, which will provide confidence in the processes of project priority, affordability, and strategic fit.
- Estimates are subject to a review and approval process based on consistent and clear lines of responsibility and accountability (as discussed in the next section) to ensure that costing standards and control apply to any budget information that is to be released.
- Regular project and system reviews should be conducted to encourage and facilitate continuous improvement.
- Sharing lessons learned on past projects increases corporate knowledge.

2.11.5 Estimating rationale

DoT's cost estimating rationale must be exercised in the broader context of a project to provide assurance that estimate values are continually dependable. Estimating forms an integral part of a system of co-dependent core inputs, such as scope, time, cost, and quality. Projects are inherently uncertain, and therefore, irrespective of the stage of a project, there will be incomplete scope information on which to base the Project's completed-as estimate. The aim of this manual is to establish a set of Project parameters, apply a risk assessment process to allocate contingencies to cover probable eventualities, and convey meaningful information concerning the reliability of the figures provided.

Estimators are required to verify that projects are defined for the life of the Project using the standard project cost breakdown structure (CBS), at least. To improve the accuracy of an estimate, end-of-stage reviews must be conducted. Lessons learned in each stage should be captured for the PM's completion report. Each estimate shall be presented using a standard estimate structure format, as provided in this manual, and shall incorporate a report that defines the scope and assumptions on which the estimate has been based. This will facilitate the rapid review and update of estimates. Estimates shall be reported in out-turn value and shall be based on an assumed construction date and escalation rate to aide in programme management. Systematic reviews, and approval processes based on clearly defined accountabilities, will improve the reliability of an estimate.

2.11.6 Strategy implications and estimating stages

Estimates will be developed throughout the Project's life cycle in support of management needs. Pre-project estimates can be in current, or clearly specified, values and dated; but projects and nominated projects shall consist of out-turn dirhams.

Table 2-2 indicates the definition and alignment of estimate documents and stages. DoT's communicated Project cost estimates should commensurate with the level of information and time available to create an estimate. Preferred content to communicate an estimated cost includes the following:

- Cost ranges with the higher pessimistic out-turn cost and lower optimistic out-turn cost;
- Indication of the most likely out-turned cost; and,
- Estimate categories and completion dates.

Table 2-2: Estimate stages and documents

Estimate stages	Estimate documents
Initiation	Initiation/strategic estimate
Feasibility	Project proposal estimate
	Option analysis estimate
Procurement strategy	Concept estimate
Preliminary and detailed design	Preliminary design estimate
	Detailed design estimate
Construction procurement	Estimate for comparison of tenders
	Budget cost estimate
Construction	Updated budget cost
	Budget forecast
	Contract variation estimate

2.11.7 Estimate classes

Table 2-3 indicates the six defined estimate classes. Class 1 indicates the least amount of information available and/or time to analyse data. Class 6 indicates a highly detailed analysis and a review of detailed information from a well-defined scope.

Table 2-3: Class descriptors

	Class 1	Class2	Class 3	Class 4	Class 5	Class 6
Project stage	Project initiation	Proposal	Concept	Preliminary design	Detailed design	Construction

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	Class 1	Class2	Class 3	Class 4	Class 5	Class 6
Estimate basis	No formal scope	Simple scope/ strategy	Agreed scope/ preferred option	Schematic design	Developed design	Contract details
Input to	Initial budget	Project budget	Detailed budget	Basic cost management	Detailed cost management	Construction budget and cost control
Confidence	Very low	Low	Low to medium	Medium	Medium to high	High
End usage	Feasibility	Concept/budget	Budget/ control	Budget/ control	Authorisation, check tender	Cost control

Estimates may be described as any of the above classes, as appropriate. More likely, estimates will move from Category 1 through Category 6, as a project matures during its life cycle.

2.11.8 Estimate development

This section outlines the general estimate development process. Chapter 3 provides a more detailed description of the general process, and phase-specific details are documented in Chapter 4. Estimators should persistently, and continually, pursue scope clarification and definition — as the accuracy of an estimate highly depends on a well-defined scope. Information should be gathered concerning all aspects of the Project as its scope evolves; including, but not limited to, functions to be provided, design, constructability, work practises, constraints, assumptions, risks, latest prices, and development strategy. Analyses of the cost of construction and the employer's costs should then be carried out.

When combined, these items form the base estimate. Risk assessment and contingency figures are analysed and determined at the risk assessment workshop. Base estimates with contingencies represent the total Project cost in current value. Further analysis is carried out to determine the likely cash flow and the impact of escalation factors over the life of the Project. Total project cost is recorded in out-turn value, nominating the year of completion. Throughout the development of the estimate checks, reviews and approvals to proceed occur.

2.11.9 Estimate structure

Major work areas in managing and producing project deliverables are highlighted in the estimate structure, which also outlines the necessity to account for risks and escalation. Please refer to Section 3.5 for more details.

2.11.10 P90 estimating for projects

DoT's estimating strategy requires project estimates from the concept case to have a 90 percent level of confidence of not being exceeded. Estimates prepared before the concept case, including the Project proposal and options analysis, should not be expressed with any percentage of likelihood of not being exceeded.

In all circumstances, the PM is responsible for preparing a high confidence estimate for the Project. The Project Manager is responsible for the overall completeness of the estimate in accordance with the DoT's typical project estimate structure, outlined in Figure 3-3 (that is, construction contractor work costs, employer's costs, risk and contingencies, and escalation). Traditionally, a P90 estimate is prepared using a quantitative approach to estimating, which includes the use of tools, techniques, and templates.

Section 2.13.15 mentions the Monte Carlo method, which can be used for expressing confidence. Additionally, Section 2.13.16 provides a rough method of expressing the confidence level without using Monte Carlo, or other simulation techniques.

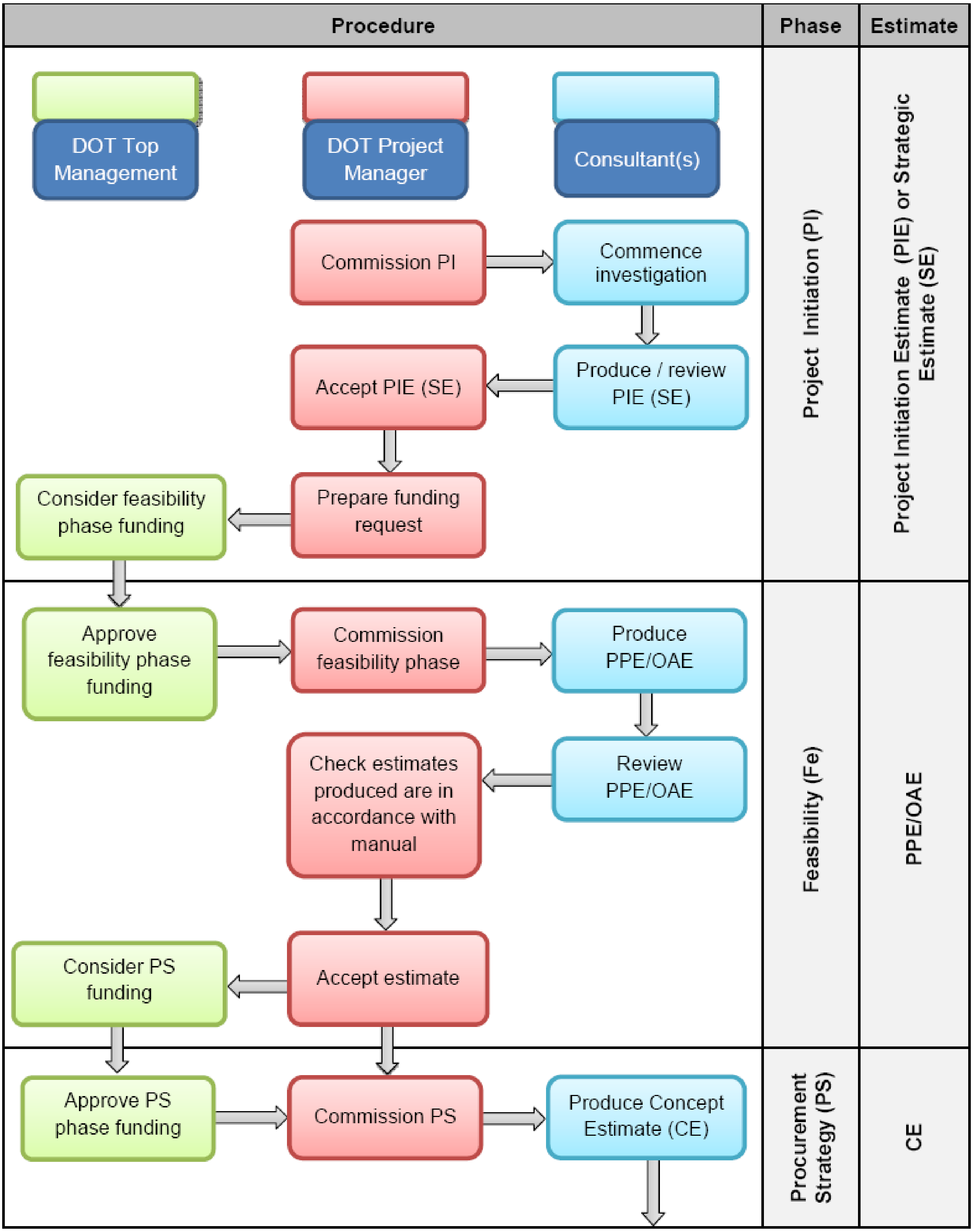
2.12 Estimate management

This manual is intended to be used by the Clients and Cost Estimators, Project Directors, PMs, and other personnel involved in Project acquisition.

Although this guide does not provide explicit how-to information, it is expected that the Clients and its agencies use it to obtain a working knowledge of cost estimating and analysis — including how cost estimates are used throughout the planning and execution. Each project shall have the following management structure:

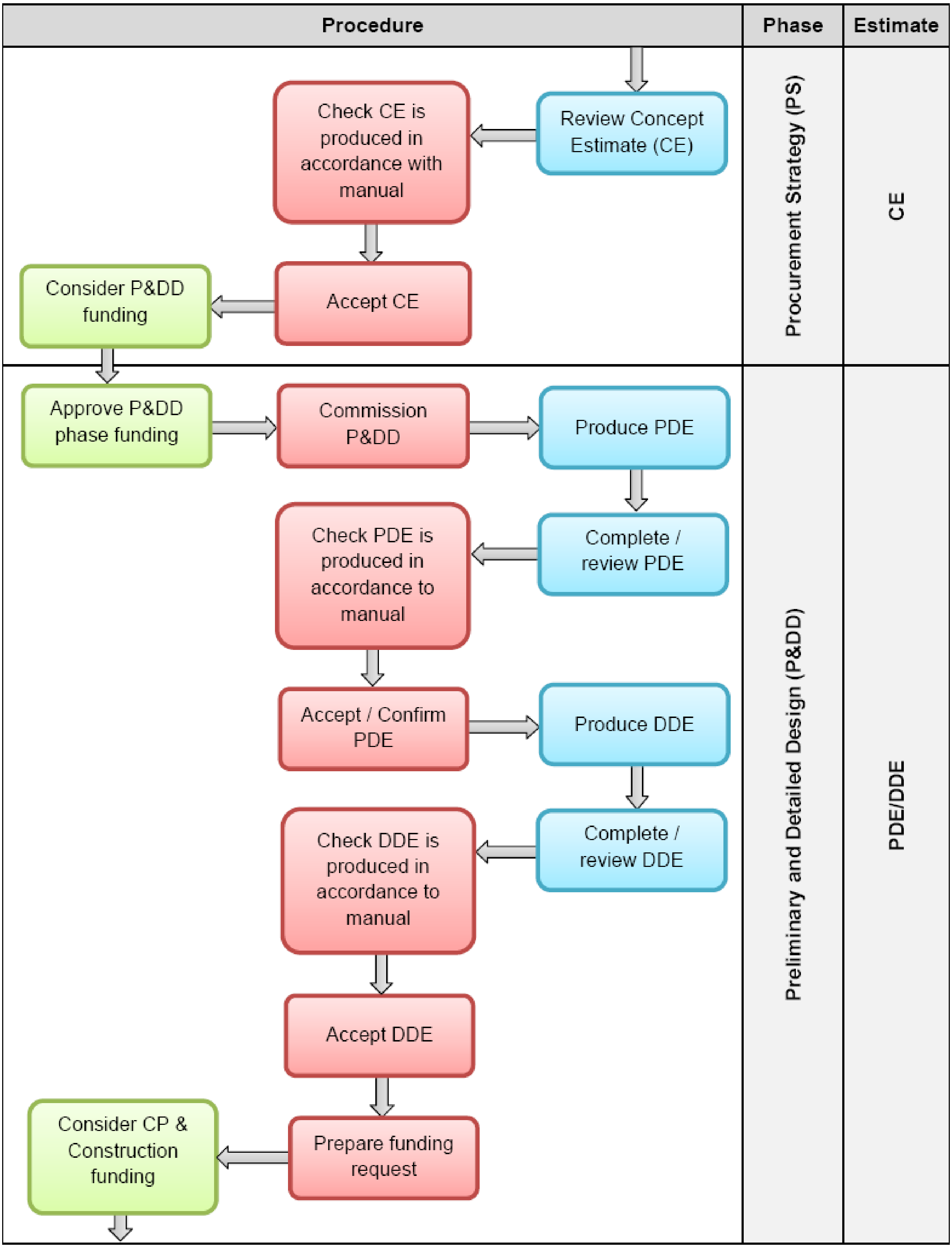
- The PM's responsibilities include the following:
  - Providing a project brief to the Consultant;
  - Checking and ensuring that the estimate prepared has been produced in accordance with the guidelines provided in this manual;
  - Implementing peer reviews;
  - Providing cost information for the Client-managed costs on previous projects; and,
  - Benchmarking estimates as required.
- The Consultant Team Leader's responsibilities include the following:
  - Establishing the scope of work from the Project brief in consultation with the Client's PM;
  - Preparing the estimate in accordance with the guidelines provided in this manual;
  - Collating estimate elements;
  - Checking the estimate for its consistency with the scope of works;
  - Checking the estimate for its compliance with the guidelines provided in this manual;
  - Conducting internal peer reviewing estimates; and,
  - Reconciling differences with a Peer Reviewer and Estimator.

Refer to Figure 2-5 through Figure 2-7 for a flow chart of the complete Project management estimate structure of a typical project from Project initiation to completion. These figures are specific to DoT; other clients referring this manual should suitably modify these figures to suit their structure.



*Flow chart continues on the next page

Figure 2-5: Project management estimate structure flow chart – part 1*



*Flow chart continues on the next page

Figure 2-6: Project management estimate structure flow chart – part 2*

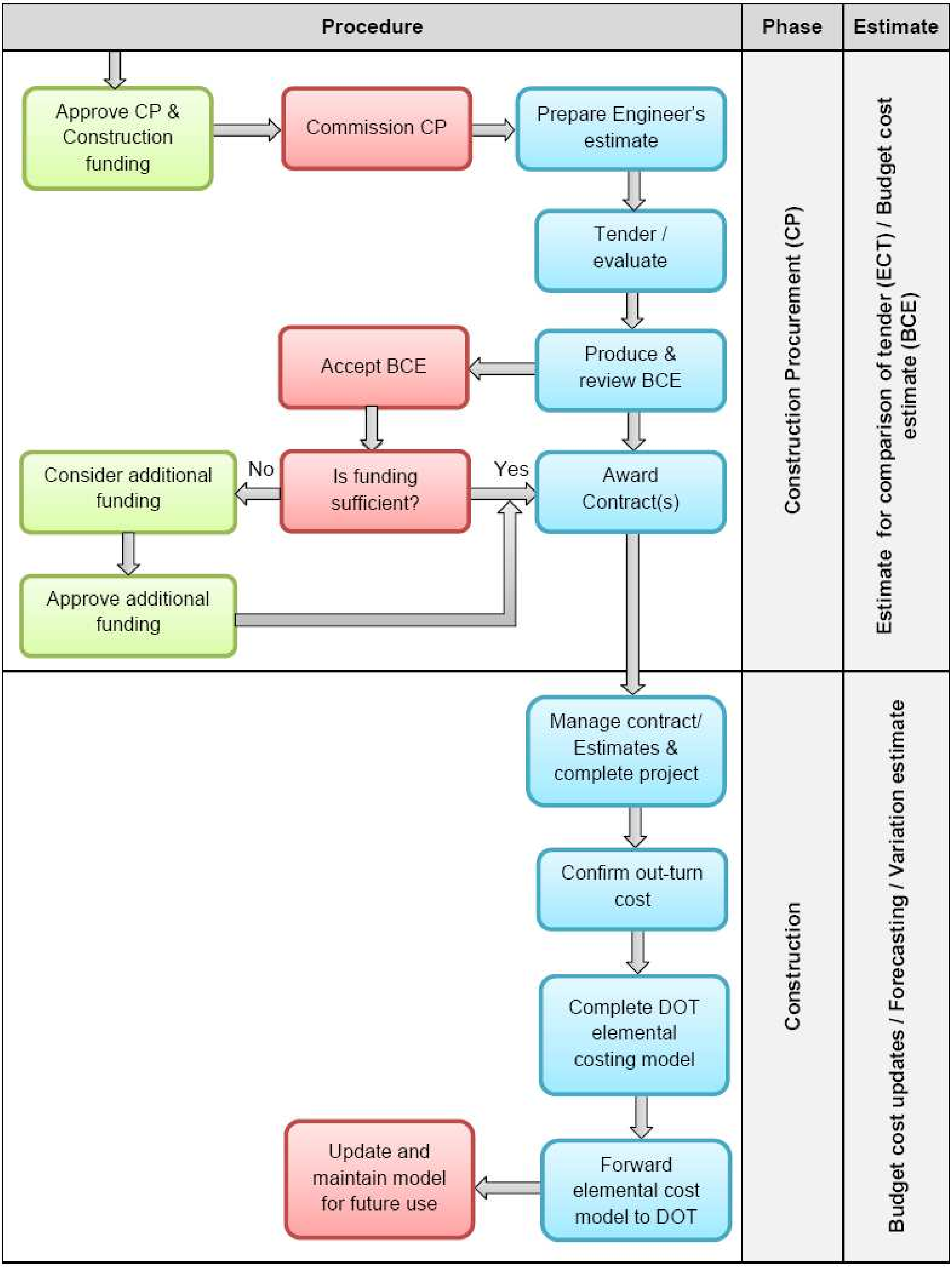


Figure 2-7: Project management estimate structure flow chart – part 3

2.13 Introduction to estimating tools and techniques

2.13.1 Estimating methods

Main differences between the different methods used in estimating are the degree of elements into which a project is divided and the method utilised to apply rates and other costs; the more rigorous the process used, the greater the certainty of the estimate.

Various methods used in estimating are listed below:

- Global estimate;
- Unit rate estimate;
- First principle estimate;
- Hybrid estimate;
- Expert opinion;
- Trend analysis;
- Estimating lump-sum items; and,
- Estimating unique items.

2.13.2 Global estimate

Global estimating is an approximate method of estimating that involves using global composite rates. With this method, the Project consists of one or a few estimating elements on which the estimate is prepared. Examples include bridge costs per square metre of deck area; underpass costs per square metre, including closed and open sections; or road costs per kilometre.

Global estimating techniques are used when little, other than basic parameters, is known about the Project. This estimate requires using cost estimating relationships, which are developed from historical data. Whilst using the rates, it is necessary to carefully analyse the unit costs of a number of recently completed projects of the same type and make allowances for the major project dissimilarities.

Please refer to Table 2-5 for guidance on using this method during the different estimate development phases.

Important Note

Global estimates are best used when the design basis has provided very little detail but the overall parameters have been established. Global estimating must not be used for budgeting purposes or for media releases.

2.13.3 Unit rate estimate

Unit rate estimates are based on the historical bid price approach and are aided by sound engineering judgement, which can be used for estimating the cost of each element of the Project by multiplying the quantity of work with historical unit rates. Total project cost will be determined by the sum of all elemental costs. Unit rates are usually determined from a careful analysis of the unit costs of a number of recently completed projects of the same type, with allowances being made for Project dissimilarities.

It is important to recognise that the rates may include indirect costs, such as the Contractor's management, risk, overheads, and margins; which must be adjusted when converting a unit rate to the direct cost rate. Please refer to Table 2-5 for guidance on using this method during the different phases on the estimate development.

Some items that cannot be estimated using the historical bid approach include the following:

2.13.3.1 Lump-sum items

Most lump-sum items differ from one project to another, except for mobilisation and the Contractor testing. Refer to Section 2.13.10 for guidance on estimating lump-sum items.

2.13.3.2 Unique items

Minimal availability of historical data for unique items often leads to inaccurate unit prices. Refer to Section 2.13.11 for guidance on estimating unique items.

2.13.4 Historical bid-based estimating considerations

In the absence of any standard cost management data, the consider the bids received for like items on project built under similar conditions within the past two years that fairly represent the Contractor's cost plus a reasonable profit. Average unit prices from the lowest three bidders shall be used to verify that the low-bid unit price is reasonable and consistent. Unit prices shall be modified to fit the Project conditions and adjusted for increases in the overall cost of construction over time using an inflation index. Historical unit bud prices shall be inflated from the bid date to the current year. Appendix C includes a detailed example of how to inflate the prices.

Whilst adjustments are made, the following considerations should be taken in account:

- Inflation;
- Site conditions, such as mountainous or flat terrain;
- Market conditions;
- On- and off-site overheads and profit;
- Scale of works, including large or small quantities;
- Site location, such as urban or remote;
- Design complexity, such as unique or routine;
- Risk profile ground type;
- Construction methods, such as specialised or conventional; and,
- Material and finish specifications, which include architectural or plain finish.

Section 2.13.12 discusses the detailed considerations generally applicable to all methods. Historical bid-based unit rate estimating is a relatively quick method of estimating; however, it lacks precision, especially in the interpretation of what the unit rate exactly provides. Emphasis on scope, which is reflected in a comprehensive schedule of work items that is unique to the Project, is required for the accuracy of an estimate. Unit rates can vary from project to project, but the use of the historical unit rate, adjusted by an experienced Estimator and applied to a detailed schedule, produces a more accurate estimate than a global estimate does.

With a sufficient level of information in terms of the scope of the Project, the work breakdown, quantities, and careful selection of appropriate historical rates, the unit rate method of estimating con produce estimates suitable for all Project stages through to detailed design.

Important Note

Sometimes historical costs can be misleading, as they do not represent the current market rates; therefore, caution needs to be exercised in the absence of a controlled set of historical cost information. Historical costs should be used only as a reference indicator for an item.

2.13.5 Cost-based estimating (first principle estimating)

A cost-based approach, aided by sound engineering judgement, is the most definitive of the estimate techniques and uses information down to the lowest level of detail available. This method is most understood and is commonly utilised by Contractors to price projects. Accuracy of the estimate depends on the accuracy of available information.

Foundation of cost-based estimating, sometimes referred to as first principle estimating, is the calculation of project-specific costs based on a detailed study of the resources, such as labour hours, material costs, equipment costs, and subcontract costs, or other unit-cost-type items, required to accomplish each activity of work contained in the Project work breakdown structure (WBS). Indirect costs, overhead costs, contingency, and escalation are then added — as necessary. Drawings, specifications, and work statements can be used to identify activities that make up the Project. Quantities are objective, discrete, and measurable; and, an adequate allowance for items not properly documented is made and included in the estimate schedule.

Whilst using cost-based estimating to estimate construction costs, if an Estimator does not have experience or knowledge of the Contractor's production rates to obtain the correct information, the Estimator shall seek assistance from those who do. Consideration needs to be given regarding the site conditions likely to be encountered; the programme of work; the work methods to be employed, including alternatives; resource availability; the productivity of labour and the Contractor's equipment; the procurement of plants, materials, and Subcontractors; and the risks likely to be encountered during the course of the Project. Please refer to Table 2-5 for guidance on using this method during the different phases on the estimate development.

2.13.6 Sources of cost-based estimating data

Sources of information used to develop cost-based unit prices are discussed in the following subsections.

2.13.6.1 Production rates

Estimators can refer to some standard books providing guidelines for production rates, such as *RS Means Heavy Construction Cost Data*, *Means Heavy Construction Handbook*, and *Spon's Middle East Construction Price Book*. General production rates shall be adjusted to fit Project-specific requirements.

2.13.6.2 Equipment

Equipment costs include expenses to cover depreciation, repairs, taxes, fuel, and storage. Equipment costs may also be estimated by using historical bid prices.

2.13.6.3 *Labour*

Obtain estimated labour rates from the prevailing wage rates or estimate using historical bid prices. Apply the appropriate overheads and profit.

2.13.6.4 *Material*

Obtain the quotes by contacting the suppliers directly. The material price should include all the expenditures, including but not limited to royalties, crushing costs, and vendor profit. Hauling costs are to be estimated based on haul distance, truck capacity, loading and unloading time, driver wages, and truck expense.

2.13.6.5 *Overheads and profit*

Estimate overheads at 10 percent and profit at 8 percent. Profit applies to all costs (*i.e.* labour, equipment and materials).

2.13.6.6 *Cost-based estimating methods*

Appendix D shows an example of a cost-based unit price. Estimators can refer to some standard books providing guidelines for calculating cost data, such as *RS Means Heavy Construction Cost Data*, *Means Heavy Construction Handbook*, and *Spon's Middle East Construction Price Book*.

2.13.7 Hybrid (unit rate/cost-based) estimate

Hybrid method uses some features of the unit rate method and some of the cost-based method, thereby increasing estimating accuracy above that of the unit rate method. This estimate is completed in a similar manner to the cost-based estimate through the application of typical percentages for on- and off-site overheads and profit to a direct job cost estimate compiled using a direct cost unit rate method and cost-based unit method.

For example, for the CE with limited project development detail, use first principle for high-value, high-risk items and unit rates for low-risk items. Alternatively, using the cost-based method for estimating major items to work that contribute to about 80 percent of the Project cost and remaining by unit rate method will increase the level of accuracy above that of unit rate method.

A weakness of the method is that it relies on the availability of direct-cost unit rates (*i.e.*, rates which are equivalent to the direct job costs component of the cost-based method before the distribution of indirect costs). These are not normally available from industry resources unless the organisation itself carries out basic cost estimating. Given the correct information, experienced Estimators can make an adequate analysis of a Contractor's tender schedule and bring the costs back to a direct-cost level.

2.13.8 Expert opinion

Expert opinion is an estimating technique wherein specialists are consulted and a consensus is formed regarding task, activity, project, or programme. Data is collected from the specialist and a cost estimate is developed. This technique may be used for activities for which there is no other sound basis and is most appropriate in the early stages of a project (*i.e.,* prior to preliminary and detailed estimate phase) These cost estimates should include a list of the experts consulted, their relevant experience, and the basis of their opinion.

2.13.9 Trend analysis

This estimating technique is used for in-progress, current work. A trend is first established by comparing originally planned costs (or schedules) against actual costs (or schedules) for work performed to date. Derived cost/schedule indices are then used to adjust the estimate of work not yet completed. This technique can be used to update cost estimates developed using other techniques.

2.13.10 Estimating lump sum items

For less commonly used lump sum items, first quantify the work included in the lump sum item. Use historical bid data to come up with costs on the quantified work within the lump sum item, and make any necessary project-specific adjustments to determine a lump sum estimated cost. Also refer to *"Lump sum items"* under Section 2.13.12.

Important Note

Limit the use of lump-sum pay items as much as possible. Using lump-sum pay items typically transfers risk to a Contractor, and the Contractor will increase its bid prices to account for this risk.

2.13.11 Estimating unique items

Sometimes, items of work that have no or little historical data to assist in establishing unit prices are included in a project. For such unique items, look for similar items that may provide some guidance on cost. Care should be observed whilst considering its scope of work. In addition, gather information from others who may be familiar with the item, including other government agencies and suppliers. Add appropriate overhead and profit to the estimated cost. Also refer to "Experimental and research items", Specialty work" and "First time used" under Sections 2.13.12.

2.13.12 General considerations

When adjusting unit bid prices, the Estimator shall consider the following:

Project size

Project sizes can affect the unit cost of constructing. This is not simply an issue of supply and demand it is also an issue of production efficiency and economy of scale. Generally, the unit price for smaller quantities of a given material will be more than that for larger quantities. Suppliers usually offer discounts for larger quantity orders. Mobilisation and overhead, such as site and head office costs, are all spread out over a larger quantity, thus reducing their effect on each unit. Wastage, to some extent, is also spread over a larger quantity, thereby having a smaller effect on each unit.

However, sometimes very large projects with very large quantities of certain materials may actually cause an increase to the unit bid price. For example, a project with huge reinforced concrete work may be affected by the market in terms of the availability of a particular type of steel or the availability of cement.

Large amounts of specialist work also tend to increase the unit price, as these items are frequently subcontracted. This practise increases a Contractor's overhead and usually results in the application of a mark-up to those items.

Additionally, small quantities of items of work are usually less cost-effective to construct, and therefore lead to higher unit prices. Not only will suppliers charge more for smaller purchases but, in some instances, the minimum amount that has to be purchased is greater than the needed quantity. Small quantities also do not allow for high production rates or other efficiencies, and thus cause higher unit costs.

Geographic location

Geographic considerations can have a considerable effect on the selection of unit bid prices. The project location, whether in a densely populated area (urban) or sparsely populated (rural) area, should be considered in establishing bid prices. A suitable cost relating to a project's location may be accounted for relative to the Project being in a populated area with, for example, greater traffic volumes, confined working spaces (limited right-of-way [ROW]), and limited hours of operation (especially in residential areas) and nighttime work. However, some of these factors may be balanced by the availability of local contractors, materials, equipment, and personnel.

Projects located in rural areas have their own factors that affect unit bid prices. Whilst construction operations may have less restricted work areas, lower traffic volumes, and additional hours to complete the work, all factors that increase productivity, a project in a rural location generally requires that materials, equipment, and personnel be brought in from elsewhere, which may increase costs related to transportation, support, and wages.

On projects that require large quantities of earthwork and aggregates, whether for base or surfacing, the location of material sources and disposal sites may have a large impact on costs. Nearby material sources or disposal sites reduce hauling costs. The location of a material source may also have an impact on the cost of the Project. For a rural project with long material hauls and no concrete batching or commercial asphalt plants available, unit bid prices most likely will be higher than an urban project, where these facilities are readily available.

Groundwater conditions may vary greatly and need to be investigated to determine the extent of dewatering required for foundations and other structures.

Contracting method

Type of contracting method, such as design-build or cost-plus bidding, should be taken into consideration when preparing the estimate. Design-build contracts and contracts with performance-based specifications or warranties impose a higher risk on the Contractor and may increase a Contractor's bid.

Market conditions

Estimators should take into account market conditions whilst developing a cost estimate. If the economy is experiencing a downturn and there is more competition for projects, Contractors will bid competitively with less profit. Conversely, if the market is booming and more projects are advertised, Contractors will bid projects with higher mark-ups.

Contract provisions for price adjustment (indexing)

Most of the construction materials in the region are being imported from other parts of the world. Volatility of construction material and supply prices can result in significant problems for

Contractors preparing bids. In some cases, material suppliers and Subcontractors do not give firm price quotes for the duration of the Project. This leads to price speculation and inflated bid prices to protect against possible price increases. If price adjustment provisions are used in the contract to respond to this price volatility, a portion of the risk will then be transferred to the Client. This will result in lower bids; however, because agencies may have to pay for an increase in prices to the Contractor, a reserve amount must be set aside and included in the overall cost estimate (refer to Appendix C for additional information).

Traffic conditions

Projects with complex sequences of work and high traffic volumes reduce the productivity of the works carried out, and therefore will have higher prices than uncomplicated projects with low traffic volumes.

Context-sensitive solutions

Context-sensitive solutions implemented into a major project may have an impact on the programme cost estimate. All context-sensitive solutions need to be included in the cost estimate.

Construction season/duration

The part of the year during which the Project is to be awarded for contract and the time estimated for completion may have a significant influence in price selection. Factors such as a restriction on working hours during the summer and major holidays, shortened work periods during Ramadan, and suspension or delay due to inclement weather will have an effect on bid prices. Accelerated or compressed construction schedules can potentially increase costs. These factors should be considered when establishing the price or construction schedule for each project.

Projects requiring long periods of construction are likely to reflect higher bid prices for the items that must be purchased from suppliers, especially when large quantities of expensive items are constructed at the later stages of the Project. Whilst suppliers guarantee prices for a limited period, and usually are unwilling to guarantee prices for longer duration of time. For security against any increase in prices, Contractors typically account for such risk in their bid on this type of item, resulting in higher prices than in projects with shorter completion times.

Accessibility

Accessibility to the existing terrain and work area is an important factor. For example, works that may be easy to accomplish on level terrain or gentle slopes can be difficult or almost impossible on steep slopes. Mountainous terrain and steep grades normally reduce production rates, which leads to increased costs, whereas level terrain and straight roadways will generally have the opposite effect.

Lump-sum items

Lump-sum items are usually used when an item of work can be defined only in general terms, such as the finished product is defined but not all of the components or details can be easily determined. This can make estimating lump-sum items difficult for the Estimator. Though lump-sum items can reduce administrative costs during contract administration, they tend to transfer the risk of quantities and performance to the contractor, for which the contractor would price higher.

Wherever possible, if the work item to be performed can be quantified, then a payment method that includes a quantity should be used; the more information or breakdown of a lump-sum item that is available to an Estimator, the greater the likelihood of the development of an accurate lump-sum estimate. By breaking out a lump-sum item into smaller items of work that have historical data, and then applying reasonable estimated prices to those subunits, the Estimator can accurately establish a price for the overall lump-sum item.

As stated above, using lump-sum items typically transfers risk to a Contractor, and the Contractor may increase its price to accommodate this risk. Lump-sum items are therefore bid at higher costs than component costs due to the transfer of risk from the Client to the Contractor. Therefore, the use of lump-sum items should be used with great care and should only be used when the following conditions apply:

- When no appropriate alternative of a standard item is available for use;
- When the final product is known, but the construction techniques or other components are unknown or are difficult to determine; and,
- Complex items with many components — although it is encouraged to break down items if possible.

Using a lump-sum item must be justified and the work breakdown documented in the estimate file.

Restrictive conditions/limitations

Restricting working hours during the summer or the method of work on a project can have a great effect on prices.

Limitations imposed by DoT agencies (ROW, Traffic) should be reviewed with the PM for discussion with the respective DoT agency. Flexibility in requirements or incentives to complete the operations in a timely manner can impact the estimated costs.

Availability of materials

Materials that are commonly used, or are readily available, are generally less expensive. Stringent specification requirements or material shortages can cause construction delays, which will increase construction costs.

Materials that are in short supply are more expensive and should be considered when establishing the unit price. Large quantities of materials required in a short period may also result in a temporary shortfall in product availability and a potential cost increase or delay.

Site constraints/difficult construction

Site constraints and/or difficult construction will increase the unit cost of construction for a Contractor. Working close to historical buildings that are possibly fragile, placing piles under water, working near active railroads, constructing on or near environmentally hazardous or culturally important sites, and limited ROW to construct are all examples of constraints that should be considered.

Timing of advertisement

Usually, Contractors have a certain time of year that is busier than others. This is normally directly correlated with the weather and occurs when the conditions are the most conducive for construction activities (such as asphalt paving). The peak season for most highway projects is from October through May. The best time to advertise a project is several months before the work season for that type of work to allow time for contract execution and for the Contractor to mobilise its resources in time to take full advantage of the work season.

Estimators preparing estimate for comparison of tenders needs to be aware of the timing of the advertisement and account for any expected fluctuations in bid prices due to the season, such as lower production during temperature extremes, additional protections for weather-sensitive materials, and so forth.

Bidder competition

Similar style?

A lack of competition often leads to higher bid prices. Generally, projects that are tendered during a period of time when a large number of contractors are available are bid more competitively.

Multiple contracts

Multiple projects, when advertised simultaneously, can influence the bid prices in almost the same way as the lack of competition and availability. For large projects, a Contractor may not have enough resources to develop bids or to construct more than one project at a time. In such cases, care should be taken to manage the programme for the tendering of projects to ensure that this does not influence the bids. If this cannot be prevented, then the estimate needs to account for this factor.

Usually, with three or more bidders at a time, the effect on the bid amount is negligible. Estimators should therefore consider to what extent the reduction below the normal number of bidders will influence the bid amount. Another factor to consider in adjacent to multiple contract environments is whether multiple active projects will create conflicts in an area. These can include traffic control, labour issues, direct coordination issues, and other similar issues. These conflicts need to be considered in the calculation of production rates and subsequent bid item prices. PMs should be aware of adjoining projects and nearby work, even from other regions or local agencies.

Experimental or research items

Projects that include experimental or research items usually receive higher bids. Costs may need to be adjusted to account for the Contractor's lack of experience with it and the potential increased risk in construction. If the work is likely to be subcontracted to a specialist, then the prime Contractor may also add a mark-up to the Subcontractor's price.

Specifications

Price considerations will be dictated by the specifications of the material and works.

Specialty work

Specialty items are not necessarily new construction methods or new items, but those items that are somehow different then the majority of the work on a given project and require a specialist Subcontractor for its execution. For example, on infrastructure projects with bridges, traffic signal or mechanical, electrical, and plumbing (MEP) work may be classified as specialty work, although it will not be classified as such on a project that was predominately MEP or signal and lighting work. Estimating the cost of specialty work requires a thorough understanding of the work involved and the resources required to accomplish the work; therefore, projects that include specialty work need to be considered appropriately during the estimating.

Whilst estimating for specialty work, the Estimator should seek the advice of experts in the area of concern. Care should be observed when utilising historical bid data to account for the differences between the historical projects and the current Project. Another factor to be considered is the number of qualified Contractors capable of doing such specialty work. Other examples of specialty work may be landscaping, marine works, or the rehabilitation of an existing bridge. Personnel familiar with that particular type of work should conduct a peer review.

Nonstandard items

Standard items, as listed on the standard BoQ (*i.e.,* BoQ based on Client's or standard method of measurement), are familiar to both the Client and the Contractors. These items of work typically represent a known quantity and quality to both the Client and Contractor, and the bid history tends to reflect that. When such items are changed in some way to become a nonstandard item, then uncertainty is introduced. Contractors will offset this uncertainty by increasing the price for the item, especially when the item is introduced for the first time in a contract.

Whenever possible, the practise of using standard items should be followed. Where it is required to change a standard item into a nonstandard item, the Estimator should recognise that and may adjust the price from the historical prices.

First time used

Sometimes, items of work are required for a project that has little or no historical data to rely on to establish unit prices. In these instances, the Estimator shall look for similar items that may provide some guidance on cost. Additionally, the Estimator shall gather information from others who may be familiar with the item, such as other government agencies or suppliers. Appropriate overhead and profit shall be added to the estimated cost.

If the item is thought to be of minor significance, then it may not be worthwhile to spend much time determining a reasonable bid price; however, if the item is likely to be significant to the overall project bid, research should be conducted to establish a reasonable cost.

Soil conditions

Assumptions (based on the prevailing in the vicinity) about soil conditions may be made early in the estimating process, but should be updated as and when the data is available. Additionally, assumptions regarding soil conditions (during early stages) and the potential effects of unknown soil conditions should be clearly documented. Soil conditions can be a significant cost risk to a project. Risk-based estimating techniques should be utilised to quantify geotechnical risks if they pose a significant threat or opportunity.

Drawing clarity

Drawings that are neat, clear, and accurate will usually avoid any unnecessary assumptions by the Contractor during pricing and contribute to lower overall unit bid prices.

Allowances

Allowance and contingency are interchangeably used in estimation. Please refer to the definition of contingency provided in the Glossary. Construction contingencies are typically meant to cover a variety of possible risks or events that are not specifically identified or quantified, such as uncertainties in quantities and minor risk events related to quantities, work elements, or other project requirements during construction. They are also used to account for a lack of project definition during the preparation of planning estimates. It will be a mistake to use allowance or contingency funds to cover additional scope, as the allowance or contingency will then not be available to cover the risk item(s) for which it was originally intended.

Allowances should be shown as separate from the base cost. Allowance amount breakdown details should be properly documented so that they can be managed appropriately as the design progresses. This will assist in the review of the estimate and will help designers and PMs manage the risk.

Other funding sources

Whether or not a project is expected to receive contributions from outside funding sources should also be documented. This may include major developers (for access) or funding from public-private partnerships.

2.13.13 Selecting the appropriate method

Selecting a method for the preparation of a Project cost estimate depends on the purpose for which the estimate is to be used, and therefore the required level of confidence of the estimate, and the level of the available data.

Important Note

In practise, it is common to use combinations of different estimating methods. Make sure to direct most of the efforts in ensuring the accuracy of the 20 percent of items that often make up 80 percent of the costs – the Pareto approach.

2.13.14 Recommended method

Table 2-5 shows the recommended methods for various types of estimates. The Estimator, in coordination with the PM (Client's), must decide on the Project type as defined in Table **2-4** and agree to the estimating methodology employed. Table 2-5 is a guide to the types of estimating methodologies that may be used.

Table 2-4: Project types

Type A	Significant road and infrastructure projects that are complex, high risk, or high cost, and thus require higher amounts of rigour and control
Type B	Relatively straightforward, low-risk road and infrastructure projects for which a lesser amount of rigour and control is appropriate
Type C	Bulk minor work category projects

Table 2-5: Recommended estimating methods

Estimate stage	Type A	Type B	Type C
Initiation	Unit rate method	Global estimate	Global estimate
Proposal	Unit rate method	Unit rate method	Global estimate
Option analysis	70 percent value at unit rate estimate, 30 percent value at first	Unit rate method	Global estimate

	principle estimate		
Concept	20 percent value at unit rates estimate, 80 percent value at first principle estimate	70 percent value at unit rates estimate, 30 percent value at first principle estimate	Unit rate method
Preliminary design	First principle estimate	20 percent value at unit rates estimate, 80 percent value at first principle estimate	20 percent value at unit rates estimate, 80 percent value at first principle estimate
Detailed design	First principle estimate	First principle estimate	First principle estimate

2.13.15 Monte Carlo analysis

Monte Carlo simulation is a technique used to understand the impact of risk and uncertainty in project management, cost, risk, and other forecasting models. This method can be used in cost estimating and is based on the generation of multiple trials to determine the expected values of random variable.

In a construction project, usually there will be a maximum cost a project might take, in the worst possible case; and the minimum cost, in the best possible scenario. By using a range of possible values, instead of a single average cost, it is possible to create a more realistic scenario of what might be the most probable result.

In a Monte Carlo analysis, a random value is selected for each task in estimate, based on the range of estimates. Calculation of the model is based on this random value. Generated results are recorded, and the process is repeated again. Typical Monte Carlo simulations calculate the model hundreds or thousands of times, each time using different randomly selected values. Upon completion of the simulation, a large number of results from the model, each based on random input values is obtained. These results are used to describe the likelihood, or probability, of reaching various results in the model.

Table 2-6 provides an example that explains the principles of the Monte Carlo analysis principles.

Assume a project for road works have the following activities:

Table 2-6: Estimate for road works – example

Activity	Best-case estimate (AED)	Most likely estimate (AED)	Worst-case estimate (AED)
Earth works	100,000	110,000	120,000
Road works	300,000	335,000	370,000
Street lighting	160,000	170,000	180,000

Total Cost	560,000	615,000	670,000

Monte Carlo simulations randomly select the input values for the different tasks to generate the possible outcomes. Assuming that the simulation is run 500 times, the above table shows that the Project can be completed anywhere between AED 560,000 to AED 670,000. When the Monte Carlo simulation runs are performed, the Estimator can analyse the percentage of times each cost outcome between AED 560,000 to AED 670,000 is obtained. Table **2-7** depicts the outcome of a possible Monte Carlo simulation.

Table 2-7: Monte Carlo simulation

Total Project Cost (AED)	Number of times the simulation result was less than or equal to the Total Project Cost	Percentage of simulation runs where the result was less than or equal to the Total Project Cost
560,000	0	0%
570,000	1	1%
580,000	28	4%
590,000	69	15%
600,000	145	27%
610,000	223	38%
620,000	296	51%
630,000	365	66%
640,000	427	84%
650,000	471	95%
660,000	497	99%
670,000	500	100%

This can be shown graphically in the following manner:

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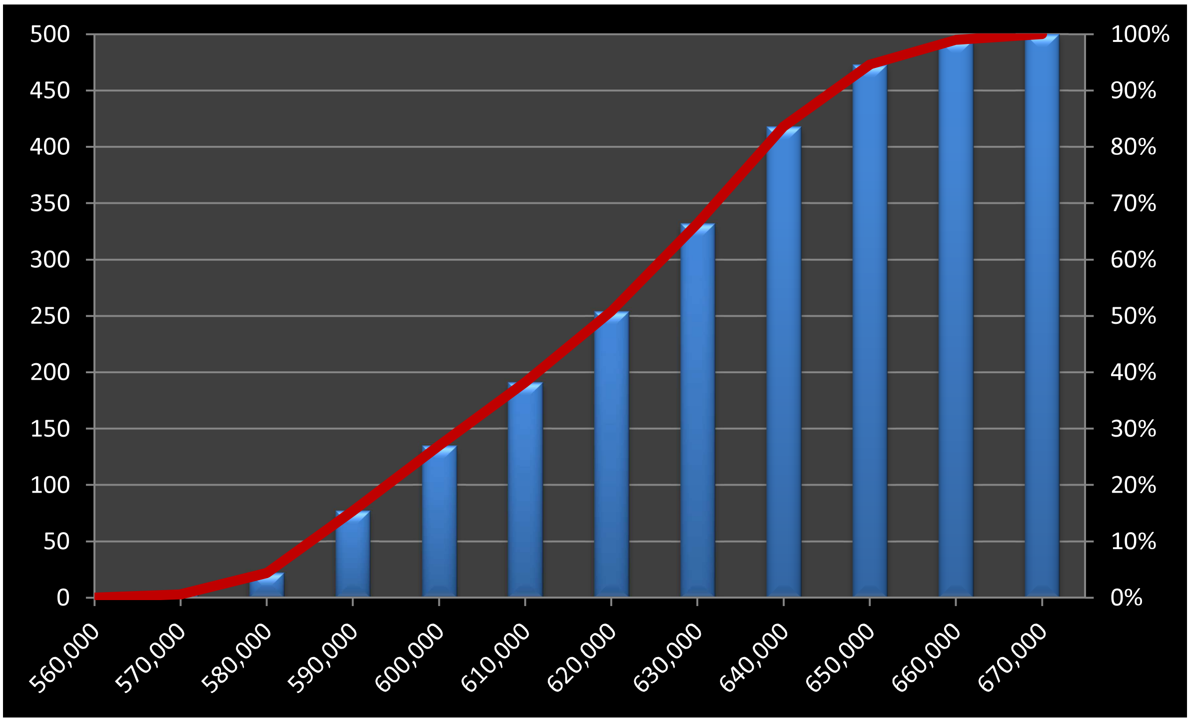

Figure 2-8: Monte Carlo simulation

Table 2-7and Figure 2-8 suggest that the likelihood of completing the Project in AED 615,000 is 45 percent. Similarly, the likelihood of completing the Project at an estimated value of AED 640,000 is 82 percent. Note the importance of verifying the possibility of completing the Project in AED 615,000, as this, according to the Most Likely estimates, was the cost an Estimator will expect the Project to take. Given the above analysis, it looks much more likely that the Project will end up taking anywhere between AED 640,000 to AED 650,000.

2.13.15.1 Benefits of using the Monte Carlo analysis

Key benefits of using the Monte Carlo analysis include the following:

- Monte Carlo simulation provides an easy method for arriving at the likely outcome for uncertain cost and an associated confidence limit for the outcome.
- It is a useful technique for easing decision-making based on numerical data to back the decision.

2.13.16 Three-point estimating

Based on statistical methods, the three-point estimation produces the following three estimates for every case:

b = the most optimistic estimate
m = the most likely estimate
w = the worst-case estimate

These values are used to calculate a C value for the estimate and a Standard Deviation (SD) where:

$$C = (b + (4*m) + w)/6$$
$$SD = (w - b)/6$$

C is a weighted average which takes into account the most likely, the most optimistic and most pessimistic estimates, whilst SD measures the uncertainty or variability in the estimate.

To produce project estimate using three point;

":" or ";" --- check also elsewhere

1. Divide the Project into a list of estimable tasks, *i.e.,* based on a WBS;
2. Estimate the C value and SD for each task;
3. Calculate the C value for the total project work as C (Project Work) = Σ C (activity);
4. Calculate the SD value for the total project work as SD (Project Work) = Square root (Σ SD (activity)^2); and,
5. Use the C and SD values to convert the Project estimates to confidence levels using Monte Carlo or other simulation techniques.

Rough methods of expressing confidence levels without using Monte Carlo, or other simulation techniques, can be as follows:

- Confidence level in C value is approximately 50 percent;
- Confidence level in C value + SD is approximately 70 percent;
- Confidence level in C value + 2 * SD is approximately 95 percent; and,
- Confidence level in C value + 3 * SD is approximately 99.5 percent.

3 ESTIMATING PROCESS

3.1 Overview

Cost estimation should be based on the maximum amount of available information, which requires Estimators to be aware of what information they should be provided and what information they should pursue. When developing an estimate, the Estimator produces a cost-estimating package, which includes the estimate, the technical scope, and the schedule, all of which should be cross referenced to ensure they are consistent. This establishes a baseline document for the programme at its outset. This section is a guide for Estimators through the general sequence of activities involved in the development of a cost estimate, and their responsibilities throughout that process.

Regardless of what stage the estimate is in, and where the estimating documents are in their development, there is a common process for developing an estimate. Figure 3-1 shows this process.

Each estimating process usually consists of the following six key events:

i. Project scope definition
ii. Estimate and resource planning
iii. Cost estimate development
iv. Risk identification/quantification
v. Escalation
vi. Review and approval

3.2 Project scope definition

When determining the reliability of any cost estimate the main issue is the ability to define the Project scope — a well-defined project scope is the starting point for any estimate. Scope statement provides what is and is not included in the Project, and forms a documented basis for a common understanding amongst project stakeholders. Clear functional and physical descriptions of the Project in the first instance will help to monitor and control any changes affecting the cost as the Project progresses through subsequent preconstruction phases.

Well-defined scopes allow the Estimator to confirm the basis for developing an estimate; therefore, it is critical to achieving accurate estimates. There is a distinct order in which the Project scope definition should be structured, as shown in Figure 3-2. In principle, the objectives must be set first to establish the performance criteria and functionality requirements.

Project scope definition is determined by the following:

- Project objectives;
- Project performance requirements;
- Project definition; and,
- Physical scope.

PM (Client's) is responsible for clearly articulating the Project scope elements; however, the Estimator is particularly interested in the Project definition and physical scope components as these are the basis for initiating any estimate. Where details are not provided, the Estimator is responsible for notifying the PM and requesting outstanding details, as required.

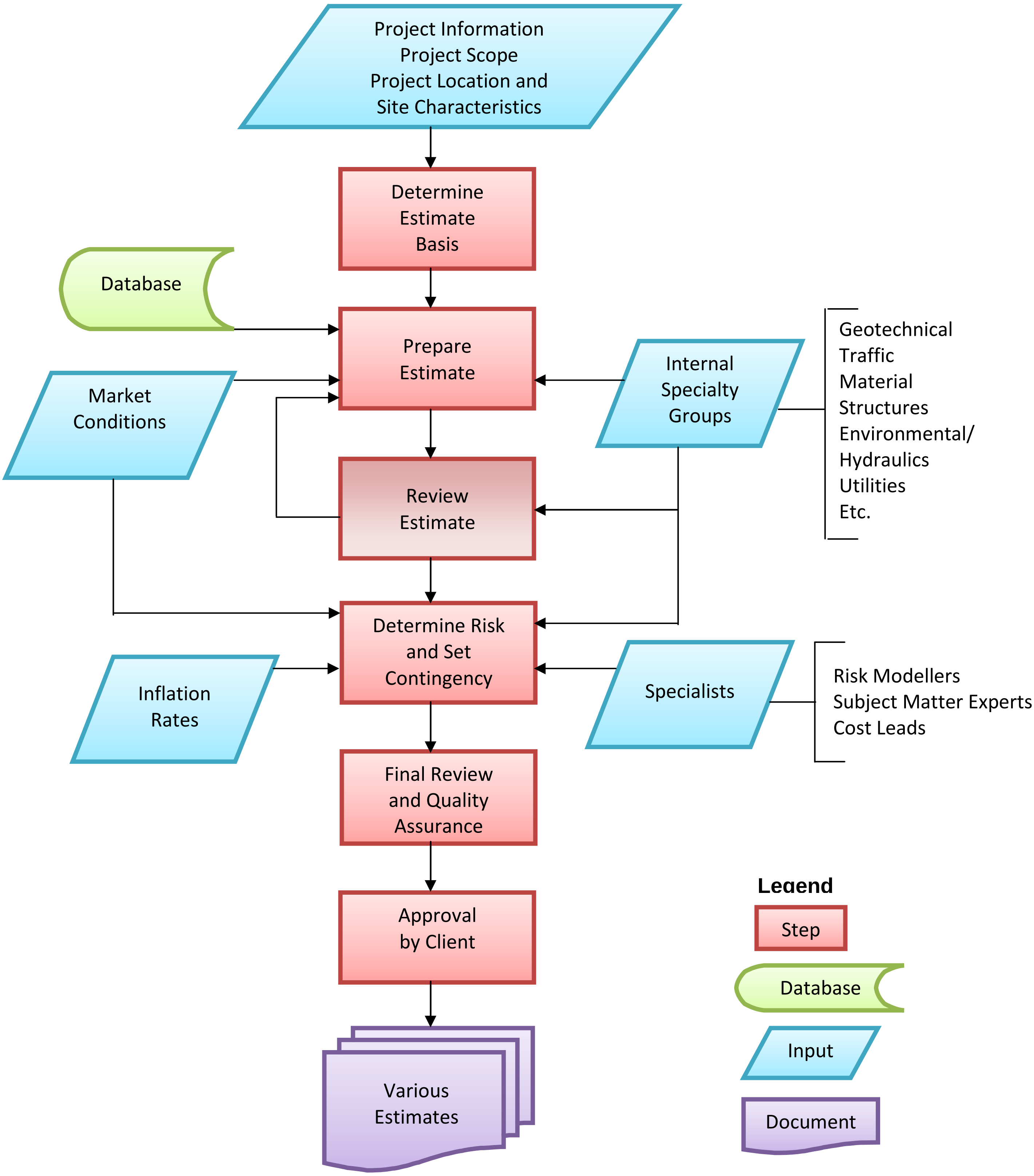

Figure 3-1: Typical cost estimating process

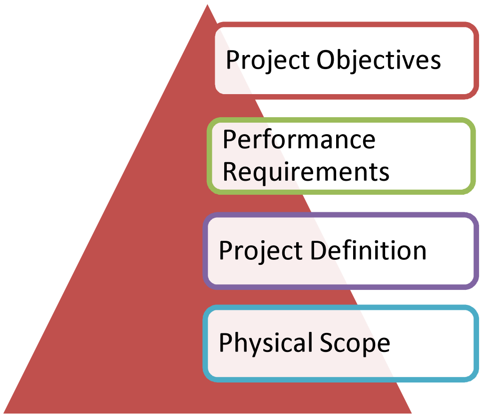

Figure 3-2: Project scope definition

3.2.1 Project objectives

Each project should have well-defined objectives. Several examples of what might be included, or excluded, in the Project objectives include the following:

- Operational target date;
- Purpose of the Project;
- Community linking facility;
- Safety target; and,
- Noted exclusions.

3.2.2 Performance requirements

Based on the Project objectives, performance or functional requirements should be identified. These requirements should be capable of measurement so that any subsequent design and/or construction can be assessed against them. Poorly defined measurable performance and criteria prior to concept and preliminary engineering may affect the reliability of cost estimates. Result is that, additional features might be included that were not originally anticipated or budgeted. Examples of performance requirements for an infrastructure project for public use are:

- Vehicle carrying capacity;
- Purpose of an intersection/junction;
- Design and speed limits;
- Pavement or track life/axle load capacity;
- Sustainability criteria;
- Maintenance and operational requirements for structures; and,
- Noted exclusions.

3.2.3 Project definition

Project definition is not immediately apparent in the list of items that comprises the costs because the definition and context of a project is what affects productivity. It determines the financial exposure and level of risk expected, which in turn governs the rates, the indirect costs, the Contractor's margin, and the contingency allowances to be included in the cost estimate.

Some examples of definition, context, constraints, and programme include the following:

- Likely project programme, including the preconstruction and construction phases;

- Requirements for temporary works and staging;
- Type of project to establish level of risk and complexity;
- What constraints exist (on access/possessions, staging, and continuity of traffic flow, etc.);
- Key interfaces so that the extent of the Project is known and which conditions apply at those interfaces;
- Method of delivery (re-measured, design and build, etc.);
- Defined out-of-scope work; and,
- Exclusions to the Project as defined.

3.2.4 Physical scope

Estimates must be based on a properly defined scope. Estimates developed based on a poorly defined scope become merely a guess, and not necessarily an informed one. Where some information is not available, and assumptions are required to prepare the estimate, these assumptions must be properly recorded and attached to the estimate.

Based on the performance requirements, and taking into account the definition, a preliminary engineering design should be created for identification of the physical permanent and temporary scope of work. Extent of the design and its accuracy will depend on the stage of the Project, the level of planning and investigation, and the experience of the designer.

Important Note

An important aspect for a reliable cost estimate is to focus design resources on the part of a project that accounts for the greater risk or cost. Cheaper or straightforward items can be evaluated from the performance criteria with limited design, or allowances may be made based on past experience and benchmarking standards.

Thoroughly examining drawings and specifications, as well as other contract documents, usually eliminates errors or omissions in the estimates. Checklists can be used to ensure that all cost items have been accounted for in the estimate. Checklists should not be a substitute for sound engineering judgement by the Estimators or the reviewers. Estimators must independently evaluate the significant data upon which the estimates are based, but the checklists help to ensure completeness.

Checklist templates assist in ensuring that Estimators and reviewers develop a complete estimate. They guide the Estimator through suggested items and consideration of factors that impact project cost. Checklists serve to delineate the many factors that must be considered during estimate preparation. Therefore, checklists are an excellent means of ensuring that the estimate completely addresses the stated scope of the Project, avoiding omissions, and calling attention to the interaction between factors that can impact costs.

Checklists can support estimating at all stages of project development. Their purpose is to assist the Estimator in planning, formatting, and developing a complete estimate.

Important Note

There can be many individual checklists to support different phases of estimate preparation and specific cost areas. These can include a plan review checklist; a site checklist; a checklist for developing quantities; and a checklist to consider construction noise, dust, and other construction nuisance issues.

Some examples of checklists include the following:

- Clearing (hectare);
- Earthwork (m3), including unclassified, borrow, and undercut;
- Drainage (per kilometre);
- Paving (m2);
- Stabilization (m2);
- Guardrail (m);
- Anchor units (each type);
- Fencing (kilometre);
- Interchange signing (type and location);
- Traffic diversion plan (per kilometre);
- Thermo and markers (per mile or kilometre);
- Utilities (m);
- Traffic signals (each and location);
- Retaining walls or noise walls (m2, with average height);
- Bridges (individual location); and,
- Reinforced concrete box culverts (individual location).

is this an acceptable way to do it or should you rather use superscript, e.g. m^2

Design reports should be prepared with comments and lists of constraints, such as property acquisitions and regulatory approvals. Future Project development should be assessed against this report. Some examples of physical scope criteria that the Estimator should be provided include the following:

- Nature of work, such as intersections, new road construction, widening existing highways, bridge work, change to traffic signals, etc.;
- Extent and limits of work so there is less uncertainty as to extent of work costs;
- Assumptions made in the design of key features, such as pavement design, earthworks, extent of rock, etc.;
- Sequence of events and their interdependencies;
- Interfaces, such as property, grade separations, and existing infrastructure;
- Services, such as utilities, relocations — as these are usually vastly underestimated;
- Specific exclusions to physical scope, so that scope creep can be measured;
- Defined out of scope work; and,
- WBS.

3.2.5 Information required to prepare an estimate

As a project progresses through different stages (*i.e.*, from initiation to development), the level of information available also increases. Guidance for the level of information that would be expected at each stage is provided by the Association for the Advancement of Cost Engineering, (AACE International) in its Recommended Practice Note No 18R-97, February 2005.

Whilst the AACE paper is based on the mechanical process industries, the principles are applicable to any sector. AACE refers to its Estimate Input Checklist and Maturity Matrix to describe the classification of estimates and what the appropriate inputs would be.

Appendix E contains an Estimate Input Checklist applicable to the road sector and the classifications recommended in this report.

3.2.6 Common scope issues

Common problems encountered in the Project scope definition include the following:

- Complete item omissions;
- Incorrect item quantity determinations;
- Inappropriate items included;
- Unapproved variations; and,
- Authorities' approval requirements.

3.2.6.1 Complete omission (or erroneous inclusion) of items

Examples of items that might be omitted from, or wrongly included in, a project's scope include the following:

- Culverts or drainage facilities;
- Service diversions, due to non-availability of existing conditions or poor data collection;
- Drainage in cuttings;
- Noise barriers;
- Stabilisation work;
- Subgrade improvement or strengthening; and,
- Temporary works.

Such omissions or erroneous inclusions must be avoided by using a schedule containing all possible items. When estimates are based on other than global methods, and if insufficient documented details are available, the Estimator must use its experience from similar projects to determine the likelihood of the inclusion of such features. Such inclusions must be listed as assumptions and adjusted or removed when more details become known or available.

3.2.6.2 Incorrect quantity of an item

Details of the information available govern the accuracy of quantities determined. During the initial stages, often in a time-constrained environment of estimate preparation, gross errors can occur. Examples include exclusion of landscaping or inclusion of only half of the pavement quantity in dual carriageway roads, or half of the concrete quantity in twin deck bridges. The Estimator must minimise the risk of quantity error by methodically and logically undertaking quantity take-off.

3.2.6.3 Inclusion of inappropriate items

Examples of inclusion of inappropriate items are the inappropriate pavement- or bridge-type for a particular application or the protection of existing services that do not meet the requirements of the service authorities.

3.2.6.4 Unapproved variations

Unapproved additions to a project after the scope has been defined and approved often stress a project budget due to their additional costs, and can undermine the integrity of the estimate. Such practises should be avoided. Formal approval of variations must be obtained to include items previously omitted from the approved Project scope because of oversight or poor project definition.

3.2.6.5 Authorities' approval requirements

Requirements imposed by service authorities or their general standard policies and conditions of approval must be taken into consideration in the scope of work. This sometimes requires a change in the scope of the work.

3.3 Estimate planning

Once the scope information is available, the Estimator can start estimate planning. As a part of estimating planning, all plans and documents produced to-date are reviewed, an estimating team is formed, and a site visit conducted. Appendix F includes a site visit risk checklist template, which shall be included in the estimate. Information relevant to the estimate planning will include the following:

- Project history;
- Project objectives;
- Investigation reports (*e.g.*, technical and environmental);
- Project scope statement;
- Construction staging plans and methodology and temporary works;
- Plans and specifications;
- Project delivery strategy;
- Preliminary programme of work;
- Costs expended to-date;
- Record of site visit, including risk identification; and,
- Historical cost information.

To guide development of the estimate within the Project constraints, the Estimator shall prepare a simple estimating plan.

3.4 Resource planning

3.4.1 General

Resource planning includes determination of quantity and kind of resources (equipment, labour, materials, and subcontract) required to execute Project activities. Usually, resource planning is carried out in concurrence with the next step in the estimating process – cost estimating.

Important Note

To carry out resource planning, a clear definition and well-defined Project scope, a WBS, a clear understanding of the work methods to achieve the requirements, an understanding of the availability of resources to execute the work, and the expected productivity of labour and the Project site are required.

The estimate breakdown should be based on a WBS so that prices can be related to the established market benchmarks. The Estimator will be required to inquire and obtain market rates for components normally carried out by specialised Subcontractors/Subconsultants. This may be performed by either a formal procurement process or alternatively by maintaining contact with industry suppliers. This process can be summarised in terms of its inputs, key activities, and outputs as indicated in Table 3-1.

Table 3-1: Resource planning overview

Inputs	Activities	Outputs
• Drawings and specifications • WBS • Resource groups • Schedule and work activities • Resource pool analysis • Project cost records and reports	• Work method statement study • Procurement/market testing • Activity durations	• Resource requirements • Resource prices

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3.4.2 Constructability

Studies are often required for significant items to determine the feasibility and efficiency of alternative production methods. For example, when considering the construction component of a project, the Estimator may need to examine the earthwork mass haul diagram to evaluate haul quantities and distances, borrow and spoil requirements, and the most effective construction fleet for the particular site conditions.

Similarly, for major projects in high traffic areas, it may be necessary to develop traffic management and construction staging plans to evaluate the cost of traffic management activities. Estimators need to match the level of estimating effort with the expectations of estimating accuracy for the estimate stage under consideration.

3.5 Cost estimate development

Cost estimating is the process of developing the cost estimate. The estimates are developed in accordance with the estimate structure outlined in Figure 3-3. To produce a Project cost estimate, all components of the Project need to be estimated.

Estimates are vital for establishing the basis for key project decisions, for creating the metrics against which project success can be measured, and for communicating the status of a project at any given point of time. Therefore, reasonable and logical cost estimates are essential in maintaining confidence and trust throughout the life of a project.

This section provides guidance for the preparation of a project cost estimate for a project. The project cost estimate includes construction, engineering, ROW acquisition, and related costs. Guidance should be appropriately used, depending on the type of project.

This guidance is intended to assist the Clients and other agencies with ensuring that all Project cost estimates are prepared using sound practises that result in logical and realistic initial estimated costs of the projects, and providing more stable cost estimates as the Project progresses.

3.5.1 Key principles

Key principles required when preparing a Project cost estimate at any stage of a project include the following.

3.5.1.1 Integrity

Highest standards of ethical integrity are required. Cost estimates at any stage must be calculated through a transparent or open process. Any uncertainties should be well documented and explained in a manner easily understood. False precision and early optimism should be avoided to maintain the trust, support, and confidence in the Project personnel.

3.5.1.2 Cost estimate contents

Subject to the Client's requirements, the Project cost estimate should include all costs and the value of any resources needed to complete the design, ROW activities, environmental mitigation, public outreach, construction, overall project management, specific management plans (*e.g.*, transportation management plans), and appropriate reserves for unknowns, as well as costs and resources paid to others for work related to the Project such as utility adjustments or relocations and environmental mitigations.

Although this guidance will focus on developing a cost-to-complete estimate, the Estimator should include both expended and future costs when presenting the total cost of a project, ensuring that all components of the Project are estimated. Following are the usual cost components for acquiring a project. The estimate can include one or more of the components below depending upon the requirement of Client.

- Concept planning;
- Design development;
- Detailed design;
- Land acquisition;
- Risk contingencies;
- Alterations to public utility plant;
- Construction;
- Temporary works, including sacrificial works, and traffic management;
- Handover; and,
- Project management.

Estimating methods should be chosen commensurate with the expected accuracy and information available. More than one estimating method can be applied within an estimate, as different work items often have different levels of available details.

3.5.1.3 Year-of-expenditure

Project estimates should be expressed in out-turn value to reflect the actual project cost at completion. Out-turn costs are calculated by adding an allowance for escalation to the base cost estimate and contingencies, which have been developed in current year value.

This can be performed by assigning an inflation rate per year (refer to Appendix C for additional guidance). The Estimator shall make certain that the selected year-of-expenditure reflects a realistic scenario, taking into account project planning and development durations, as well as construction. Potential schedule delays can also be accounted for in a project contingency. Clearly specify how inflation is considered in the estimate and clearly state that the estimate relates to year-of-expenditure. Consider multiple sources for determining the inflation rate, including nationwide and local references. Include consideration of any locality-specific cost factors that may reflect a growth rate significantly in excess of the inflation rate, such as land acquisition costs in highly active markets.

3.5.1.4 Cost estimate basis

Estimates should be developed using the best information available. When preparing any estimate, engineering judgement must be applied. For example, bid-based estimating is only good if the historical prices are for similar work and similar sized projects. Engineering judgement must also be applied to any assumptions made. The Estimator should maintain well-organised worksheets and documentation, whilst developing an estimate. These include the following:

- Definition of what is included in the total project cost.
- Methodology used to develop the estimate. This would include information such as any cost databases used, actual quotes, and any cost estimating relationships used.
- Description of direct and indirect costs.
- Explanation of site overhead rates.
- Operating costs if the estimate includes operations as well as construction activities.
- Details of escalation costs (source, application calculations, etc.)
- Analysis of how the contingency was developed.
- Any estimate history, if this is a change order estimate or revision to an existing estimate.
- Name, signature, and/or initials of the person preparing the estimate and the person reviewing it.

3.5.1.5 Risk and uncertainty

Risk is defined as the chance of something happening that will have an impact on project objectives. It is measured in terms of consequences and likelihood (AS/NZS 4360:2004 Risk Management). Costs for risks and uncertainties should be determined within an estimate. All of the Project elements must be expressed as a cost that can be budgeted and accounted. Risk identification can be initiated using a risk management workshop. It would be helpful at the outset in distinguishing between the concepts of risk, uncertainty, and contingency.

- Risk is experienced as being exposed to profit or the probability of suffering a loss. Risk is then a measure of the probability of a profit or loss occurring by a known means.
- Uncertainty represents unknown or ill-defined variables causing a loss or profit.
- Contingency represents the resources gathered to mitigate or address risk and uncertainty. These resources can be in terms of time, costs, materials, or processes.

A comprehensive and disciplined method of assessing/reassessing project risk and uncertainty should be followed. Special consideration for major projects should be given for project risk and complexity in order to produce accurate contingencies. Contingency estimates should be well-defined and quantified throughout the Project development. As the Project estimate phase progresses and the available details are refined, the contingency should reflect the shift of contingencies into actual cost categories. Contingencies should be expressed in terms that can be easily presented and understood. Over optimism or appearance of false precision must be avoided as they will only cause problems as the Project progresses.

Many elements of the cost estimate have some element of uncertainty in relation to their scope. An allowance for uncertain elements of the scope is provided for within the Contingency and discussed in Sections 3.6 and 3.7.

Important Note

Early cost estimates usually contain a larger degree of uncertainty. To account for this uncertainty, a Project cost estimate can be expressed as a range or can be expressed with an indication of the confidence level; however, this should not substitute the level of effort required to produce the estimate.

3.5.1.6 Project delivery phase transitions

Estimates should include the phase of the Project that they corresponds to, such as feasibility study, preliminary engineering, final design, and construction; and should be tracked throughout the life of the Project. Assumptions and estimate information must be well documented and include any changes in the estimate.

3.5.1.7 Team of experts

When developing an estimate, an interdisciplinary team of skilled personnel should be involved and a clearly identified scope of work should be used. Estimates should always be prepared based on consultation and input from the Client's experts, including all service authority requirements. For example, required diversion of any existing services should be determined in accordance with the standards of the service authorities affected, and ROW acquisition costs should be determined in consultation with the DoT.

Field studies, in accordance with the phase requirement, and reviews must be conducted prior to preparing any estimate. For work that is unusual, such as metro and buildings, consultation with outside agencies may be appropriate. Cost estimation teams shall be led by an experienced individual who is well versed in project cost estimating. This team should be comprised of experienced personnel with the requisite technical knowledge of cost estimating, managerial, and communication skills. This team should also have a thorough understanding of the Project scope and must be able to determine and evaluate critical issues and risks.

3.5.1.8 Schedule

Schedule can play an important role in the cost estimate because it can help identify the basis for budget cycle timing, any premiums on long-lead items to ensure their timely delivery, and the basis for escalation. Schedules used or developed with the cost estimate should be documented.

3.5.1.9 Documentation

Well-documented cost estimates withstand scrutiny; the more rigorous the documentation and estimation procedures, the higher the credibility of the estimate prepared. It is important to document all steps of the estimate process. Following items should be well documented and incorporated into the cost estimate:

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- Type and/or purpose of the estimate.

- Detailed description of the scope of work, which should include the performance specification and the work activities required. It shall also identify work not included, any constraints or special conditions, ground rules, and assumptions.
- All backups of the estimate, including, but not limited to, quantity take-offs, calculations, databases used, historical data, cost estimating relationships, and actual quotes.
- Detailed description of indirect costs, a description of what is included, and how they were estimated.
- Explanation of site overhead rates.
- Basis of any operating costs with associated backup.
- Basis of escalation.
- Basis of the contingency and how it was calculated.
- Schedule in the form of a list, bar chart, or network diagram.
- Resource loading report, if appropriate.
- Cash flow.
- Details of how the WBS was developed and a correlating activity dictionary.
- Reviewed estimate.

3.5.2 Project cost estimate elements

Depending on the Client's requirements, the following cost elements should be included when preparing a Project cost estimate, as appropriate.

3.5.2.1 Preliminary engineering

Preliminary engineering cost includes the preparation of the construction documents and any field investigation, testing, and administration of the design work. Cost of a Consultant for this work would be included within this section.

3.5.2.2 Right-of-way

This is the cost required to investigate and acquire the Project ROW. It also includes ROW costs for services management and other work outside of the roadway prism. This includes the contractual obligations with property owners to relocate fencing and boundary walls and reconstruct gates and road approaches.

If the extent of the ROW acquisition is not known, then a contingency should be added. Additionally, the Estimator shall consider the ROW acquisition schedule whilst evaluating the cost, as the ROW acquisition costs will increase quickly in rapidly developing areas. Special acquisitions, such as those from government sites, can be time consuming and costly.

Important Note

Estimates are dependent on the accuracy and reliability of information concerning the location of the ROW limits of a project. A small change in the location of the ROW line, particularly in commercial areas, can affect the ROW cost estimate significantly.

3.5.2.3 Utilities adjustments

Due to vast growth of infrastructure, many projects are often located in urban areas with a high concentration of existing utilities. Ground condition drawings and existing features drawings received may not be updated, and as such, some existing utilities may not have been shown on the drawing. Third-party requirements have a high potential for risk and change. Whilst it will be best to locate and avoid as many utilities as possible during the design phase, appropriate contingencies for utility adjustments should be included. If not all external third-party work can be identified, appropriate contingencies should be included.

3.5.2.4 Traffic diversion and traffic management system

Cost estimates should include the costs required for the development and implementation of the transportation diversion and traffic management system along the construction corridor and in the communities near the Project during the construction period.

3.5.2.5 Construction estimate

This is the cost of physically constructing the Project in the time required based on current costs for labour, materials, equipment, mobilization, overhead, and profit. Guidance, as provided in Section 2.13.12, should be considered when preparing the construction cost estimate.

3.5.2.6 Additional factors

Risks of encountering differing site conditions, contaminated soil, and multi-agency involvement are a few of the potential impacts to the construction contingency.

3.5.2.7 Construction administration

Construction administration includes construction engineering, inspection, and administrative costs during construction. Cost of a General Engineering Consultant for this work would be included here. Costs incurred by or to be incurred by Client staff should be included only if requested.

3.5.2.8 Management reserve

A management reserve may be appropriate for high risk projects. A management reserve is beneficial if significant consequences could result from the Project being underestimated.

3.5.3 Estimate structure

This section examines the major elements of the estimate structure. All estimates are comprised of the following:

- Construction costs (the Contractor’s);
- Employer’s costs ;
- Risk and contingency allowance; and,
- Escalation allowance.

Figure 3-3 shows the cost structure for a typical project.

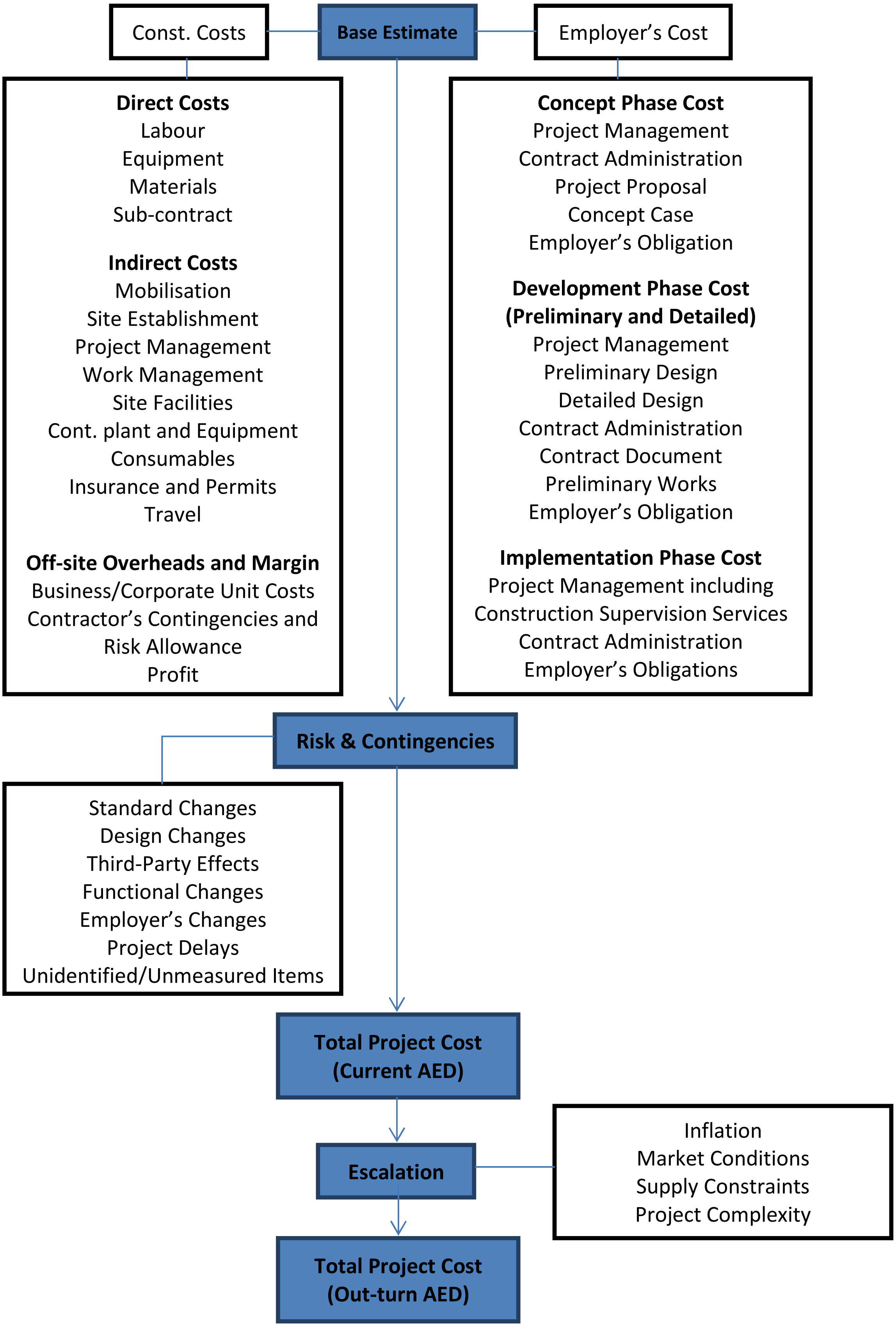

Figure 3-3: Project estimate structure

3.5.4 Construction costs (the Contractor's)

3.5.4.1 Direct costs

To estimate the direct cost, each activity within the standard WBS is sub-divided into sub-activities according to the processes needed to complete the work. For example, concrete in a bridge deck is typically subdivided into formwork, reinforcement steel, concrete supply and placement, finishing and curing. It is to be noted that these sub-activities do not necessarily need to be dependent on the method of measurement.

Resources, such as labour, the Contractor's equipment, and materials, are then allocated to the scheduled quantity of work based on their capacity, resource availability, production rates, and unit costs. The sum of all of the activity direct costs provides the direct costs for the Project. Table **3-2** summarises an example of direct costs expressed in current value terms.

Table 3-2: Example of direct costs (in current value)

Cost Category	Components	Subcomponents
Direct costs	Labour	Gross wages and salaries
		Award allowances (*e.g.*, construction worker allowance; camp allowance; overtime loading; annual leave loading, including air fares, if any; site-specific allowances; and severance allowance)
		Training
		Superannuation
		Work cover
		Personal protective equipment
		Labour administration support cost, etc.
	Contractor's equipment	Equipment hire charges, including fuels, oils, expendables, ground engaging tools, and operator
		Mobilisation of equipment items (within construction site)
	Materials	Permanent material incorporated in the final work (*e.g.*, supply and delivery of pavement materials, pipes, etc.)
		Temporary materials not incorporated in the final work (*e.g.*, formwork, setting-out pegs, etc.)
	Subcontract	Components of permanent or temporary work subcontracted by the Contractor (*e.g.*, sheet piling) including Subcontractors' indirect job and off-site costs

3.5.4.2 How to estimate direct costs

In the initial stages of the Project estimate development, estimates may be derived by using various relationships; however, as the Project develops and more details are available, the estimate should also be more detailed. Following are some general steps that may be used to develop direct costs for a detailed estimate.

Take-off

A material, labour, and equipment take-off is developed from drawing and specification review. The amount and accuracy of the detailed take-off will vary with the amount of design detail. Whilst a planning estimate has minimal detail, a detailed design estimate has a large amount of detail. Take-offs is divided into categories or accounts, and each account has sub-accounts. Each project should have an established code of accounts. By listing the accounts, a checklist of potential items and activities that should be included in an estimate is formed. Each account should be considered, even when developing planning estimates, to help eliminate any omissions or oversights.

Labour

There is no official publication of productivity data for the United Arab Emirates (UAE). Estimators can refer to some standard books providing guidelines for calculating cost data, such as the *RS Means Heavy Construction Cost Data, Means Heavy Construction Handbook,* and the *Spon's Middle East Construction Price Book, etc.* One important thing that must be remembered when using this production data is that it is based on a national average construction project for the private industries within other countries. For reasons such as these, local productivity studies should be conducted to monitor the productivity at the specific site. If an estimate is derived using this data, the site productivity factor must be incorporated. This should be performed prior to the multiplication of the labour hours by the labour rate.

When estimating labour costs, the worker's base rate plus all payroll indirect costs are multiplied by the estimated labour hours to generate the labour cost. Typically, this sum is handled as a direct labour cost. For ease of estimating, an average crew rate can be used and rounded to the nearest even dirhams hourly rate.

Pricing the material and plant

Freight charges on the material are included in the material cost. Material and plant costs that are specified as free issue material should be identified and kept separate from the Contractor's furnished material. Upon completion of the quantity take-off, the next step is to price the individual items. Several acceptable ways of pricing material are verbal or written vendor quotations, up-to-date catalogue price sheets, estimating manuals, and historical data.

Current material prices should be used as much as possible. If old prices are used, escalation must be added to make the prices current as of the estimate date. Escalation beyond the date of the estimate is included as a separate item.

Construction equipment

Construction equipment and tools are required to carry out the physical work and install material. Productivity rates, as defined above, can be used to determine the quantity of resources required to carry out the work. Databases can be used to obtain an equipment usage relationship with the materials. Depending on its size, equipment may be estimated on an activity basis or may be estimated for the duration of the Project. Pricing can be obtained from verbal or written vendor quotes, estimating manuals, and historical data. Current prices should be used whenever possible, or they should be adjusted to reflect prices at the time of the estimate date.

Some projects require special tools or equipment for the completion of the work, such as a precast bridge, which requires specialised placing equipment for setting precast units. Here, the cost of the crane would be considered a direct cost. Examples of indirect construction equipment are small tools and pickup trucks. These costs would be included as an indirect cost. However, on cost-plus-fixed-percentage contracts, all costs for construction equipment and small tools are considered as direct costs.

Special conditions

All factors that affect construction must be given consideration. Some of these factors include the following:

- Anticipated weather conditions during the construction period;
- Availability of skilled and experienced manpower and productivity;
- Need for overtime work;
- Work in congested or radiation areas;
- Security requirements imposed on the work area; and,
- Use of respirators and special clothing.

Factors in general to be considered are discussed in Chapter 2. Special conditions may be estimated by applying a factor. For example, a factor of 10 percent can be applied to the labour hours for loss of productivity due to work in a congested area. Other items may be calculated by performing a detailed take-off. An example of this would be an activity that could only be performed over a two-day period. Overtime would be required to complete the activity. The cost would be higher for this activity than normal due to lesser productivity in overtime hours, higher wages during overtime, and required lighting arrangements.

Free-issue material

Labour and equipment costs for installation of free-issue materials must be included for each item. They may be estimated as discussed above. Free-issue materials issued by various authorities for which a client is required to pay, a cost of such free-issue material should be included in the provisional sums.

Sampling and analysis costs

Sampling and analysis costs are part of the operations in some maintenance or repair projects. They can be determined by using the technical scope requirements of the type of sampling and analysis that will be performed and the Project requirement to calculate the quantity of samples that will be collected. Costs can be obtained from historical data or from current vendor quotes.

Transportation and waste disposal

If waste disposal is part of a project, the waste classification must be identified. Based on the waste classification, disposal options can be identified. If waste is required to be land-filled, the nearest appropriate landfill can be identified so that the transportation and disposal costs can be calculated.

3.5.4.3 *Indirect costs*

Indirect costs are the costs that are not directly related to the work carried out on-site. They includes the allowances that Contractors require to manage the Project and cover their risk, corporate overhead, and margins. Options include the following:

- Separate schedule item for indirect costs; and,
- Indirect costs are distributed through the scheduled activities, either as a uniform percentage mark-up on direct job costs or allocated to specific activities.

Contractors preparing detailed estimates for tenders normally adopt the basic cost method. It is the most accurate estimating method, but relies on a high level of scope definition for best results. On-site indirect costs, often referred to as on-site overhead, are summarised in Table **3-3**

Table 3-3: Example of indirect costs (on-site)

Cost Category	Components	Subcomponents
On-site indirect costs overhead (recurring)	Project Management	PM
		Contracts Manager, Project Engineer, other site personnel
	Work Management	Foremen
		Systems Officers
		Surveyor
		Laboratory Technicians/Workshop Technicians
	Site Facilities	Office rentals (*e.g.*, accommodation, photocopier, computer hardware, and software)
		Service utility charges (*e.g.*, telephone, power)
		Maintenance staff
	Equipment	Site staff vehicle, pumps and generators, site vehicle
	Consumables	Stationary and miscellaneous materials
	Insurance and Permits	Charges related to insurance required by the Contractor, bank guarantees, and financial charges
	Travel	Travel costs not included in wages and salaries
On-site overhead indirect costs (fixed)	Site Establishment	Transport and erection of site facilities
	Mobilisation	Mobilisation, site offices, and amenities for the Contractor, Client/Engineer's team, and in some cases, the Subcontractor

3.5.4.4 How to estimate indirect costs

Each indirect cost

One method of estimating indirect costs is to assign costs from each cost account. Indirect costs may be included as part of the code of accounts for a project. This must be based on the size and type of contract and can include many items. This method requires a large amount of experience and a working knowledge of the construction firm's general methodology to execute similar projects.

Percentage

A multiplier from a local database can be developed to determine percentages. Figure 3-4 is a chart that was developed over a set time frame for the average indirect costs of various fixed-price Contractors working at the Idaho National Energy Laboratory.

To use the chart, the ratio of direct cost material to labour must be determined. This ratio is plotted at the bottom of the graph. A vertical line is drawn from this point to intersect with the curve. The multiplier is read on the left-hand side of the graph and is applied to the direct cost to determine the estimated indirect cost. All agencies are encouraged to develop these local charts.

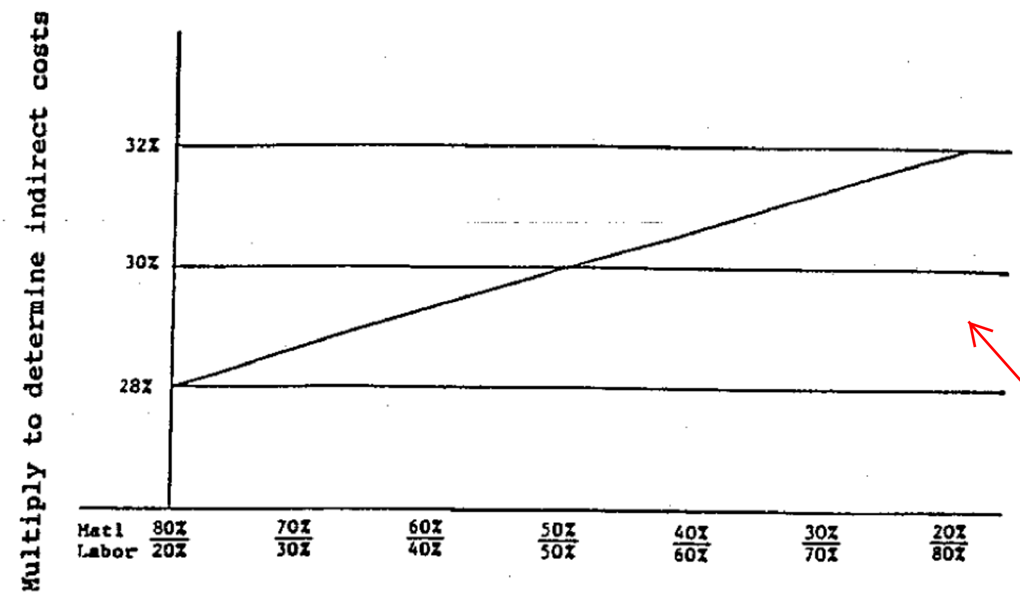

Figure 3-4: Idaho National Energy Laboratory indirect cost (1988)

Straighten this figure. Can't you reproduce this to have a similar good appearance as all of your other figures?

Free-issue material

If a project has free-issue material that the Contractor must install, an additional amount of five percent to 10 percent of the value of the free-issue material must be added to cover the Contractor's risk, insurance, and documentation.

3.5.4.5 Off-site overhead costs and margin

Table 3-4 summarises the off-site overhead costs.

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Table 3-4: Example of indirect costs (off-site)

Cost Category	Components	Subcomponents
Off-site indirect costs overhead (recurring)	Business unit costs	Local area costs associated with the management, operation, human resources, business system, and finances
	Corporate cost	Costs associated with strategy and policy development, business development, finance, human resources, business systems, technical advice, and contract advice
Off-site allowance	Contingencies and risk allowance	Costs to cover unforeseen factors related to the delivery of the Project objectives, which are not covered elsewhere
Margin	Profit margin	Profit as a percentage of the total job costs

3.5.4.6 Employer's costs

Employer's costs are the costs incurred by the employer to conceptualise, develop, deliver, and finalise a project. Employer's costs spread across various phases in project development. Some cost items occur in every phase, whilst others occur in more than one. Costs include items such as Client staff costs, engaged consultancy costs, community consultation, public utility plant costs, and acquiring the ROW (resumptions). Employer's costs do not include contract costs for construction work.

Risks and contingencies associated with employer's costs should be included (if advised by Client) as part of the Project's risk matrix/ register with appropriate cost allowances included in the estimate

3.5.4.7 Feasibility phase costs

This phase costs relate to the costs to investigate project options and the preferred option to a sufficient confidence level. Depending on the complexity and potential risks of the Project, these costs may include appropriate engineering surveys and geotechnical and design investigations to achieve the level of required confidence. In some instances, this may include acquisition of ROW. Concept phase costs include project management costs (refer to Section 3.5.4.11) and may include employer's obligations costs (refer to Section 3.5.4.12).

Project proposal costs

Project proposal costs relate to the costs incurred in the preparation of project proposal documentation. Depending on the complexity of the Project, the costs may range from relatively small up to substantial costs for large, complex projects. These costs are considered as project management costs and can be determined first by employer's costing or from benchmarked values (refer to Section 3.5.4.11).

Option analysis/preferred option cost

Option analysis costs relate to the cost to develop comparative options, and analyse and establish the preferred option. Activities will be required in both work management and project management domains. These costs can be determined first by employer's costing or from benchmarked values.

Concept case cost

Concept case costs relate to those costs that are incurred in the preparation of concept case documentation. Activities will be required in both work and project management domains. These costs can be determined first by employer's costing or from benchmarked values (refer to Section 3.5.4.11).

3.5.4.8 Development phase costs

Development phase costs relate to those costs that are required to further develop and finalise the Project's design. This phase will include any engineering surveys, community engagement, geotechnical, and design work to further develop the concept design from the concept phase. Development phase costs include project management costs (refer to Section 3.5.4.11) and include employer's obligations costs (refer to Section 3.5.4.12).

Preliminary design cost

Not all projects will have a preliminary design stage. Preliminary design stage is usually used to confirm that the design produced matches with the approved scope and its project estimate is used for comparison with the approved budget prior to finalising detailed drawings and contract documents for procurement. Costs to progress the preferred option to the preliminary design stage will involve work management activities.

Detailed design cost

Detailed design includes costs for activities to finalise the design and detailed drawings suitable for a construction contract. Detailed design costs will also involve work management activities. These costs can be determined first by employer's costing or from benchmarked values (refer to Section 3.5.4.11).

Prepare tender/contract documents costs

Costs associated with preparing the tender/contract documentation will involve work management activities. These costs can be determined first by employer's costing or from benchmarked values (refer to Section 3.5.4.11).

Procurement costs

The procurement stage costs include the tendering activities (*e.g.*, any notice to tenderers), tender analysis, financial approval, and engaging the successful Contractors. These costs can be determined first by first employer's costing or from benchmarked values (refer to Section 3.5.4.11).

3.5.4.9 Construction phase costs

Construction phase costs include for costs to actually deliver, manage the Project, and administer the construction contracts. This phase may also include any "last minute" work for the Project such as noise barriers if any major road runs through a community and the work required for community engagement. This phase may run in parallel with the finalisation phase. Costs to construct the work are treated separately under construction costs. Implementation phase costs include project management costs (refer to Section 3.5.4.11) and may include employer's obligations costs (refer to Section 3.5.4.12).

3.5.4.10 Finalisation phase costs

Finalisation phase costs relate to the Project management activities to close out the Project. These costs include handing over the Project, undertaking completion report activities, and final accounting for the Project.

3.5.4.11 Project management costs (all phases)

Project management costs are the costs to prepare project plans and manage (monitor and control) the entire project. Project management costs are spent in each of the Project management phases and are required to be estimated separately for each phase. These are to be included in the estimate if required by the Client.

Project management costs can be estimated by first principles (*i.e.*, by first determining the tasks to be completed), the number of people required to complete each task, each person's work effort (hours, days), and the resource charge (dhs/hr, dhs/day). Standard hourly rates for the Client's resources can be obtained from the Client.

An alternative method of bench-marked values determined from previous projects can be used for determining the Project management costs. For example, the percentage value of project management activities compared to the Project's total cost could be used.

3.5.4.12 Employer's obligations (three phases)

Employer's obligations can include acquiring the ROW (resumptions), planning etc. Depending on the urgency of some employer's obligations, these costs may occur in the concept, development, and implementation phases.

Table 3-5: Example of an employer's cost

Cost Category	Components	Subcomponents
Establishment	Planning, design, land acquisition, administration	Planning, community consultation, ROW acquisition, Client's staff costs, geotechnical surveys, engineering surveys, employer's risks not included in the contract risks, and contract administration
Project Allowance	Contingencies and risk allowance	Amount to cover unforeseen factors related to the delivery of the Project objectives that are not provided for elsewhere in the total Project cost
	Design and standards	Increase in cost due to change in design, specifications, and community expectation
Contract Management	Hidden costs	Accounting, legal fees, and managing project documents
Project Management	Management costs and construction supervision services	Costs related to managing the Project

3.6 Risk

Risks are, by definition, uncertainties that have the potential to affect a project's expected outcomes. The Project's cost estimate is one such expected outcome. In relation to cost, risks are uncertainties that have the potential to lead to overruns to the cost estimate. The financial impact of a risk is the increase in the cost of the Project that will occur should the risk occur.

Potential financial impacts of identified project risks are reflected within the contingency of the cost estimate, whilst the base cost reflects the expected cost of the known and certain elements of the work. As the Project progresses, the contingency becomes a much smaller component of the Project cost estimate — as risks either eventuates, and become cost items in the base cost, or are fully mitigated.

A structured and systematic risk management process is implemented on all DoT's projects in accordance with the DoT's *Project Risk Management Manual* (PRMM). PRMM establishes a structured and formalised procedure under which risks are identified, managed and monitored. Objectives of risk management under the PRMM are to ensure the following:

- Uncertainties that have a potential impact on the Project outcomes, the DoT or the Emirate of Abu Dhabi are identified as early as possible within the Project's development;
- Potential impacts of such risks are accounted for as contingencies or allowances in the Project outcomes; and,
- Strategies to reduce the likelihood of risks occurring and/or minimise the impact of the risk, should it occur, are developed, implemented, and reviewed in a comprehensive and systematic manner.

Risks must be comprehensively identified and their potential financial impact defined in accordance with the DoT's Project Risk Management Manual. The Manual provides detailed guidance on the types of risks that should be considered in each project development stage as well as the procedures to be followed in the identification and quantification of the Project risks.

3.7 Contingency

Contingency applications for various types of cost estimates cover the entire cycle of a project, from feasibility through execution to closeout. Guidelines presented in this section provide a standard approach to determine Project contingency and improve the understanding of contingency in the Project management process.

Contingency is used for managing risks on a project and can be in many forms. It may be a cost allowance in the Project cost estimate to account for the risk retained; a time allowance in the programme of work for delays, such as extreme weather; or a contingency process in case an event occurs. Contingency amounts should be reassessed at review points during the Project life cycle to reflect current knowledge and level of uncertainty with a view to forecast the most likely outcome.

3.7.1 Contingency definitions

3.7.1.1 General Contingency

Contingency is an integral part of the total estimated costs of a project. Definition as adopted by the American Association of Cost Engineers is:

"Specific provision for unforeseeable elements of cost within the defined project scope. [Contingency is] particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events, which will increase costs, are likely to occur"

3.7.1.2 Buried Contingencies

Some Estimators seek to hide contingency provisions to doubly ensure that the final value of the Project does not go over the budget. This is known as buried contingency. All external and internal Estimators should refrain from burying extra contingency allowances within the estimate. A culture of honesty should be promoted so that it is not necessary to bury contingency. Further, estimators should be aware that the buried contingency would be identified during estimate reviews. The estimate reviewer is obligated to remove the buried contingency.

3.7.2 Exclusions

Contingency amounts should not be used to cover all consequences. It is important, therefore, to understand the limitations imposed. These limitations include the following:

- Contingency does not cover changes in the scope of a project. Contingencies reflect the allowance for varying circumstances only within the approved scope of the Project. If the scope of a project has been changed, then the project will need to be justified again. This is required each time the scope is revised.
- Contingency is limited to the events that are foreseeable and pose a risk to the Project in terms of their perceived likelihood and consequence. These are also sometimes referred to as known risks.
- Project contingency excludes those events that are unknown in terms of their existence and likelihood of occurrence.

3.7.3 Applying contingencies

Estimators shall carry out a detailed analysis of all the identified risks in accordance to the process as defined in DoT's PRMM. Estimators for others clients should use their respective risk management process. Descriptions of each contingency allowance and justification must be documented in writing. If extraordinary conditions exist that call for higher contingencies, the rationale and basis should be documented in the estimate.

3.7.4 Quantification of contingencies

Because of the uncertain nature of the assessment process, it is difficult to be prescriptive as to how contingency costs should be estimated. Estimators preparing estimates for DoT are required to follow the procedures as described in the DoT's PRMM. Estimators for other clients should use their applicable guidelines. Standard ranges for contingencies have been provided below to guide the Estimator. Estimators and PMs must use their experience and professional judgement to weigh competing factors to arrive at the most likely value. Historical events may be used as a guide.

Table 3-6 presents the contingency allowances by type of construction estimate for the standard estimate types. Estimate types shown in Table 3-6 are primarily an indication of the degree of completeness of the design. For current working estimates, contingency depends upon the completeness of design, procurement, and construction. An independent estimate may occur at any time, and the corresponding contingency can be used.

Table 3-6: Contingency allowance guide by type of estimate

Type of Estimate	Overall Contingency Allowance	Includes
INITIATION Standard Experimental/Special Conditions	 Up to 35% Up to 50%	An assessment of risk is required to be carried out and included under contingency item of BoQ
FEASIBILITY Standard Experimental/Special Conditions	 Up to 25% Up to 30%	An assessment of risk is required to be carried out and included under contingency item of BoQ.
CONCEPT	Up to 20%	An assessment of risk is required to be carried out and included under contingency item of BoQ.
PRELIMINARY DESIGN	Up to 15%	An assessment of risk is required to be carried out and included under contingency item of BoQ.
DETAILED DESIGN	Up to 10% (Generally 5% to 7% for projects where scope is reasonably defined)	An assessment of risk is required to be carried out and included under contingency item of BoQ. However, for known work items, but unknown scope, the estimated amount should be included under provisional sum.
TENDER STAGE	3% to 5% adjusted to suit market conditions	3 percent to 5 percent represents the residual risk for the Project. At this stage most of the risk would have been either taken care in design or rates. For known work items (say landscaping) but unknown scope, the estimated amount should be included under provisional sum.

Range stated in Table 3-6 reflects the maximum standard allowable contingency in an estimate (including design-build contract, cost-plus contract, etc.). Contingency should cover all appropriate risks and uncertainties.

The contingencies are calculated and included in the contingency section of the estimate, as shown in the standard templates in Appendix L. It should be noted that, upon inclusion of the assessed amount of contingency in an estimate, if the percentage of contingency with respect to the overall estimate is more that the range as provided in the above table, the Estimator is required to reassess the risk and uncertainties by gathering more data on the Project. Generally, larger the Project, lesser is the overall percentage of the contingency.

3.7.5 Reviewing contingencies

Risks should be reviewed at intervals throughout the Project life cycle and updated to reflect the most recent level of uncertainty surrounding the Project. Contingencies should reflect the current level of risk. Sometimes risks for which contingencies were provided early in the Project may, at some later time, be overcome by further investigation or modification of the design.

For example, a contingency allowance for stabilisation/rock excavation early in the Project may be replaced by specific quantities and costs following a geotechnical investigation with no residual uncertainty. This highlights the importance of updating and identifying contingencies separately from the base cost of work activities, and for the recording of reasons for their inclusion. Risk registers provide a convenient place to record such decisions.

3.8 Escalation

Escalation is the increase or decrease in project costs over time due to the rise or fall of labour, Contractor's equipment, and materials, as well as other resources to complete the Project, and applies to the whole of the estimated costs. Table 3-7 provides advice on the nature of those items likely to be present in most projects. It may well be that their impact is negligible or non-existent for some projects, but this assumption should be tested. Refer to Appendix C for details.

Table 3-7: Example of escalation

Components	Description
Inflation	Rise and fall of rates. This figure pertains to inflation or deflation for labour, the Contractor's equipment, and material.
Market Conditions	Competition among Contractors in the marketplace may affect tender prices and Contractor's margins.
Supply Constraints	Costs may be inflated for some of the materials due to time constraints on supply of scarce materials or services.

3.9 Peer review/independent review

A competent team, other than the cost estimating team, should review the cost estimates as described in the quality assurance section of this manual. Periodic reviews of estimates are important for various reasons, including the following:

- Conditions and assumptions made during development of original and subsequent estimates often change. Subsequently, estimates need to be updated to account for these changes.
- Key decisions in public interest are required to be made throughout the Project development phases, which must be made based on the most current and accurate estimates possible.
- Peer and independent reviews act as a means of minimizing the potential for surprises concerning the financial condition of the Project.
- Review of the estimate will also allow the managers and decision-makers an opportunity to capture a different perspective or at least a second opinion.

Peer review officials are responsible for the following:

- Checking that all necessary documentation has been completed;
- Reviewing quantities and rates of various items;
- Reviewing optimism bias;
- Identifying potential errors in the estimate;
- Reporting cost trends for the Project;
- Reviewing benchmarks for similar work;
- Reviewing project constructability;
- Reviewing risk registers and contingency allowances;
- Assessing construction methodologies and checking the preferred options;
- Verifying that key assumptions have been listed and appropriate allowances have been made;
- Ensuring that the scope is fully understood and addressed in the estimate;
- Verifying that previous quantities, rates, lump sums, and contingencies have been reviewed in view of additional information having become available; and,
- Preparing an estimate peer review report (refer to Appendix G for additional information).

3.10 Life-cycle cost

Life-cycle cost is an anticipated costs associated with a project throughout its life. Analysing life-cycle costs helps in comparing the relative merit of the alternative designs. Life-cycle costs include costs from inception through disposal. This includes costs related to acquisition, construction, operation, maintenance, refurbishment, and disposal. Consideration of all of the costs estimated to be incurred during the life of the Project will help Client select the most appropriate option. This chapter contains a discussion of life-cycle costs analysis.

3.10.1 Life-cycle cost analysis

Life-cycle cost analysis (LCCA) is a systematic assessment method useful for the consideration of investment decisions. It assists in determining the best (the lowest-cost) way to achieve the Project. This approach enables the comparison, on a common basis, of the total cost of various design (or refurbishment) alternatives, each of which is appropriate for implementation and meeting the overall objectives of a project. This also enables decision-makers to make decisions in the light of full costs implications of the Project. All the relevant costs that occur throughout the life of an alternative are included.

In short, the LCCA process begins with the development of alternatives. The Estimator then identifies the initial and future activities involved in implementing each Project design alternative. The costs of each activity are then estimated. Estimated costs are converted into present-day values by using an economic tool known as discounting. The Estimator can then determine which alternative is the most cost-effective and suitable for implementation.

Discount rates used in the discounting technique are defined by the *Life-Cycle Costing for Design Professionals* (2nd Edition) as “the rate of interest reflecting the investor’s time value of money.”

Important Note

It is important to note that, it may not be necessary to implement the lowest Life-cycle cost option. Other considerations, such as available budgets, risk, political, and environmental concerns, can also be an factor in selecting the most appropriate option. Life-cycle cost analysis provides information to assist in the overall decision-making process, but not the final answer.

It should be remembered that the LCCA is applied only to compare Project alternatives that are similar and will result in the same level of benefits and service to the user. For instance, the LCCA is an appropriate technique to use when comparing two alternatives to replace an interchange that has reached the end of its service life, where each of the design alternatives will yield the same level of service to the user.

It is important to consider all the future costs in the LCCA. Infrastructure projects are required to provide service for many years. Each project's success depend upon the ability to provide satisfactory service over its intended life, which requires proper maintenance. Thus, the Project investment decision should consider not only the initial cost but also all future costs that will be required to keep that asset available to the public.

3.10.2 LCCA process

LCCA process includes the following steps:

1. Define the Project scope;
2. Establish the design alternatives;
3. Determine the service life and timings of various activities that involve costs;
4. Estimate costs;
5. Compute life-cycle costs; and,
6. Analyse the results.

3.10.3 Define the Project scope

Project analysis must be based on a properly defined scope. Analysis developed based on a poorly defined scope becomes merely a guess, and not necessarily an informed one. Where some information is not available and assumptions are required, these assumptions must be properly recorded and attached to the estimate.

Based on the performance requirements, and taking into account the definition, a preliminary engineering design should be created for identification of the physical scope of work, both permanent and temporary. Extent of the design and its accuracy will depend on the stage of the Project, the level of planning and investigation and the experience of the designer (refer to Section 3.2, for additional information).

3.10.4 Establish the design alternatives

After an overall scope is defined and the Project is initiated for development, a range of possible alternatives can be identified for accomplishing that development or improvement. At least two options must be considered, and the economic difference between these alternatives can be assumed to be attributable to the total cost of each.

In this step, the activities involved in each alternative are identified and listed. Analysis periods for comparison of each alternative are then defined. Initial construction cost of the Project, or a major rehabilitation cost, is only the first of these activities. To provide a definite level of performance throughout an asset's life, a periodic maintenance of the asset and its subsequent rehabilitation are required. Different alternatives are likely to require different maintenance and rehabilitation activities.

Important Note

Transportation projects provide service for generations. Each nominated design alternative may have a different service life; however, for life-cycle cost analysis, a common period of time should be used to assess cost differences between these alternatives, so that the results can be fairly compared.

Usually, the maintenance and rehabilitation activities are identified based on current and historical practise, Client's general policies, research etc. Defining the analysis period and common timeframes for all alternatives on which initial and future costs will be evaluated is important in this step. Broadly, the analysis period should at least be long enough to include one major rehabilitation activity for each alternative under consideration.

3.10.5 Determine the service life and the timing of various activities that involve costs

Once the activities for each nominated Project alternative have been identified, the alternative's rehabilitation and maintenance plan is developed. This plan will also provide a schedule to Client for future maintenance and rehabilitation activities; funds that will be expended; and when, and for how long, Client will establish work zones for carrying out maintenance and rehabilitation.

Figure 3-5 demonstrates a typical pavement service cycle of construction, deterioration, and rehabilitation. As the pavement service condition nears the Client's minimum acceptable condition, rehabilitation activities are required to be conducted. Deterioration rates, depending upon the pavement preservation practises, dictate the timing of activities such as maintenance and rehabilitation.

It is important that the maintenance and rehabilitation activities forecasted for each strategy are accurate because all the expenses related with these activities can cover a significant portion of a project's life-cycle cost. Rehabilitation activity schedules should be established on prevailing performance records, such as those available from a Client's pavement or bridge management system. This information may be enhanced with findings from outside research. When the actual data required for above is not available or not applicable, the judgement based on the experience should be made.

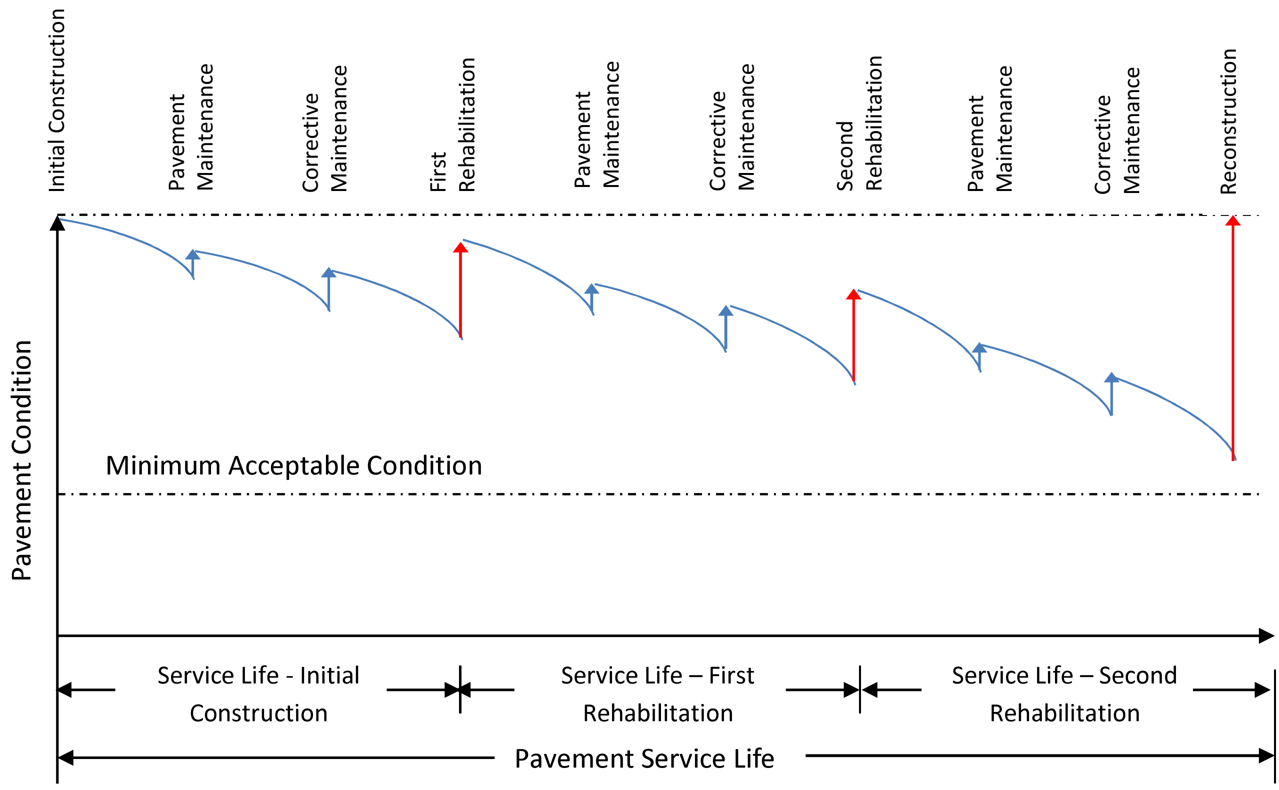


Figure 3-5: Example of maintenance and rehabilitation strategies for pavement design alternatives

3.10.6 Estimate costs of each activity

For comparison of the alternatives, all the costs associated with each alternative may not necessarily be considered. Only the costs that demonstrate the differences between the alternatives can be explored. For example, the rehabilitation or maintenance activities can be included, but expenses that are common to all the alternatives (*e.g.*, land costs) may be removed from the analysis; however, a total life-cycle cost for an alternative selected to be implemented should be estimated.

Data on construction costs should be obtained from current bids, historical data, and engineering judgement. Costs should be calculated in accordance to the procedures described in this manual. Similarly, the costs must be estimated for maintenance and rehabilitation activities to maintain the transportation asset above Client's predetermined performance, condition, and safety levels. These costs generally include day-to-day routine maintenance, preventive activities to extend the life of the asset, and rehabilitation or restoration activities. Another consideration affecting total life-cycle costs is the value of the alternative at the end of the analysis period. It is usually the net value from the recycling of materials at the end of a project's life.

3.10.7 Compute life-cycle costs

In previous steps, the cost of each activity, and its timing, were defined in the alternatives. Now, the objective at this point is to calculate the total life-cycle cost for each alternative for comparison. Because the money spent at different times in the future will have different present values, the projected activity costs in the life cycle for an alternative cannot simply be added together.

Available economic tools and techniques can be used to convert anticipated future costs to present values (PVs) so that the life-cycle costs of different alternatives can be directly compared. One of the most commonly used techniques is the present value (PV) approach (also known as present worth).

3.10.7.1 Present value method

This method brings the initial and future dirhams costs to a chosen single point in time. Usually, the chosen time is the present or the time of the first cost expense.

PV is calculated as follows:

$$PV = At \times 1/(1 + r)^t$$

where,
PV = present value
At = amount of one-time cost at a time
r = real discount rate
t = time (expressed as number of years)
PV of future recurring costs is calculated as follows:

$$PV = A0 \times \frac{(1 + r)^t - 1}{r \times (1 + r)^t}$$

where,
PV = present value
A0 = amount of recurring cost
r = real discount rate
t = time (expressed as number of years)

3.10.8 Analyse the results and re-evaluate alternatives

Next step involves analysing and interpreting the LCCA results. LCCAs conclude with a review of the findings made to determine if any adjustments or modifications to the nominated alternatives might be directed prior to finalizing the alternative selection. Revisions might include design changes and change in performance criteria, etc. Section 3.10.9 provides a simple example of the LCCA.

3.10.9 LCCA example

This example considers a road project with an analysis period of 45 years. It is assumed that the road will have pavement maintenance at 5th year (form construction and rehabilitation), corrective maintenance at 10th year, and rehabilitation at 15th year.

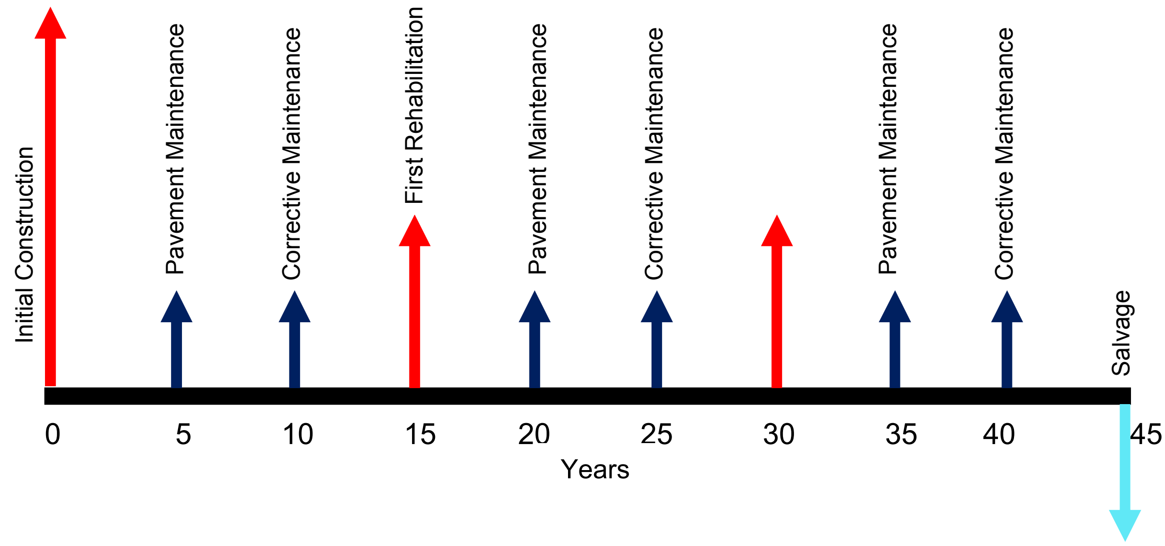


Figure 3-6: Estimated timings of various maintenance and rehabilitation activities

Next, estimate the most likely cost of each activity using principles as explained in Chapter 2 to Chapter 4. For example, consider 50 million dirhams in capital construction costs, 1 million dirhams for maintenance costs, 3 million dirhams for corrective maintenance, and 15 million dirhams for rehabilitation.

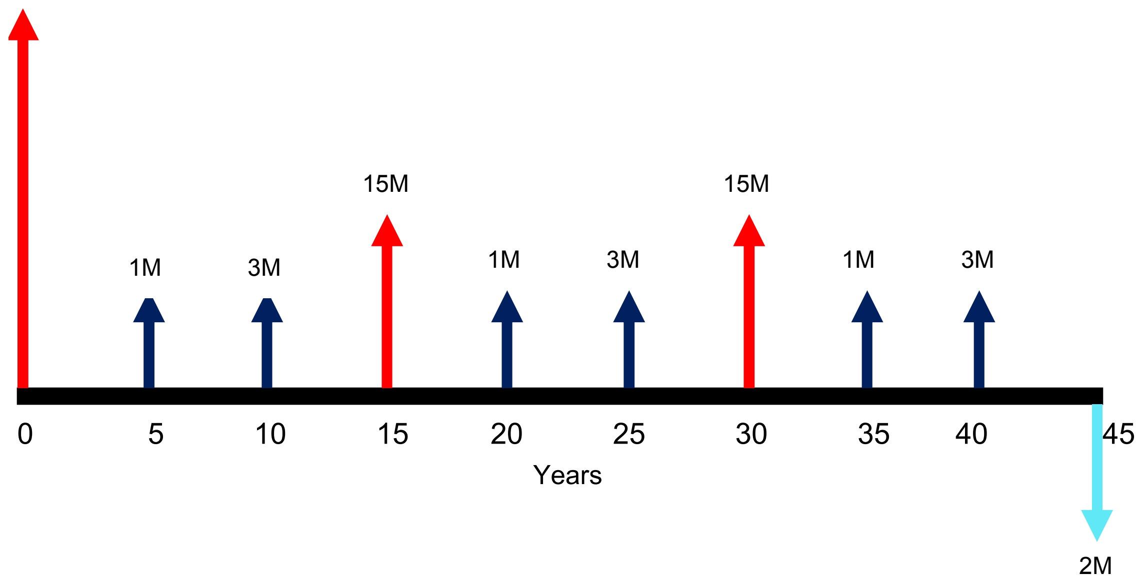


Figure 3-7: Estimated cost of various maintenance and rehabilitation activities

As this expenditure occurs over a different point of time in the life cycle, these are adjusted to the present worth before adding together. In this example, discount rate is assumed to be at 4 percent. PV is calculated at the initial construction; therefore, the initial construction cost remains unchanged.

PV shall be calculated using the following formula:

$$PV = At \times 1/(1+r)^t$$

remove?

where,
PV = present value
At = amount of one-time cost at a time
r = real discount rate (assumed to be 4 percent)
t = time (expressed as number of years)

PV for maintenance at the 5th year shall be calculated as follows:

$$PV = 1.0 \times \frac{1}{(1 + 0.04)^5}$$

PV= 0.82

Similarly, the PV for all the cost is to be calculated as shown in Table 3-8.

Table 3-8: Calculations of PV

Year	Estimated cost (in millions Dhs)	PV (in millions Dhs)
0	50	50
5	1	0.82
10	3	2.03
15	15	8.33
20	1	0.46
25	3	1.13
30	15	4.62
35	1	0.25
40	3	0.63
Total life-cycle cost	92.00	67.93

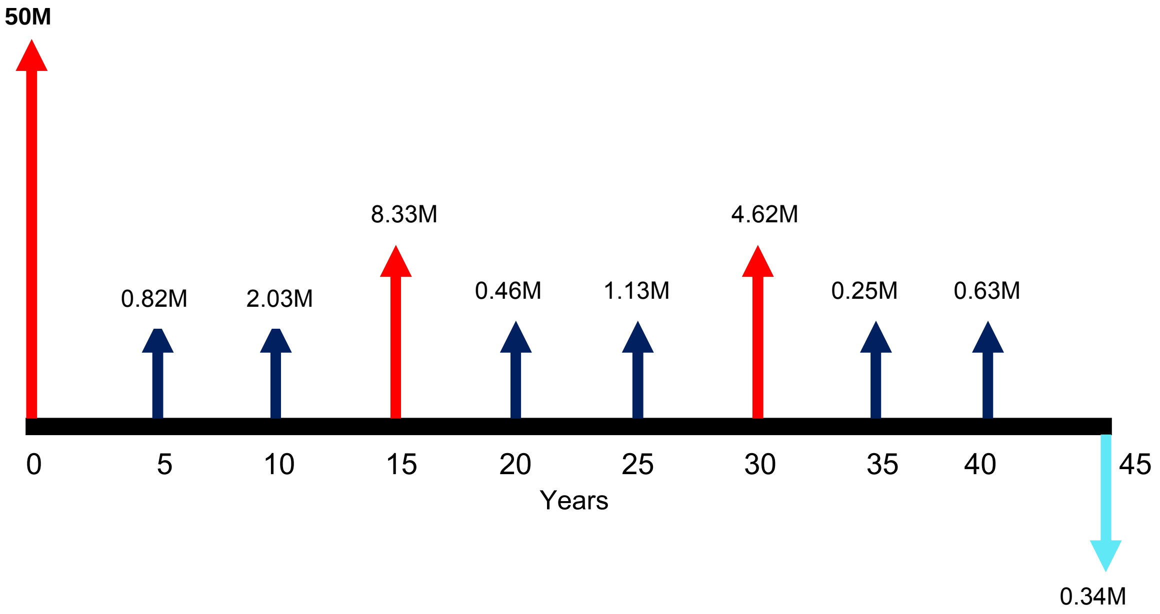


Figure 3-8: Estimated timings of various maintenance and rehabilitation activities

4 ESTIMATE DEVELOPMENT BY STAGE

4.1 Overview

This chapter describes the estimate development process in different project development phases. Each phase has unique requirements for the cost estimation practise and cost estimation management. Structures and formats for all estimates are generally the same; however, the contents vary depending on the Project phase, the Project information, the data available, and the purpose of the cost estimates relative to the phase. Figure 4-1 provides an indication of accuracy of the estimate against project development.

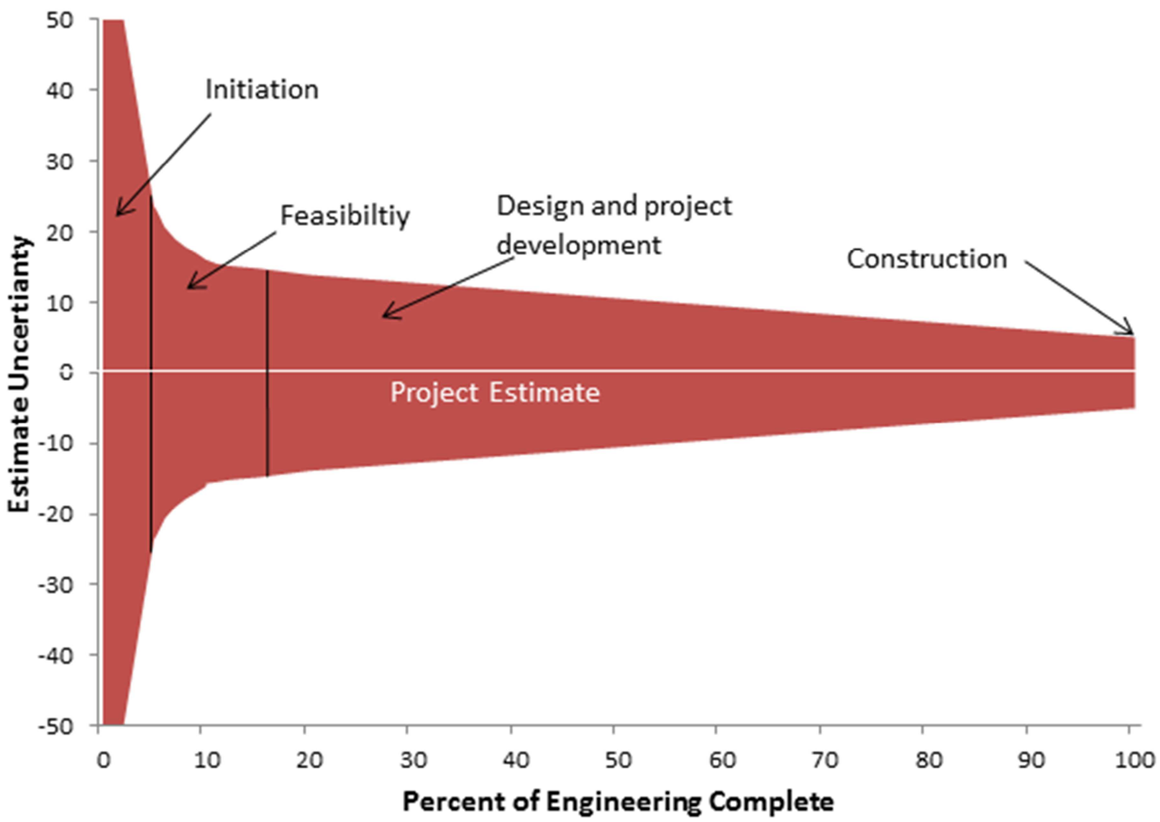
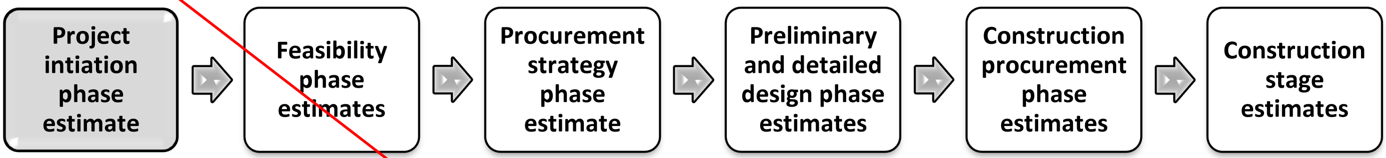


Figure 4-1: Estimate accuracy versus project development

4.2 Project initiation phase

Project initiation phase estimates (PI), or strategic estimates (SE), will often be developed on poor or negligible information. Great care needs to be exercised whilst estimating in this phase. Percentage ranges for some of the work elements, including those during strategic and conceptual stages, are provided in Appendix J; however, these percentages are indicative only, and must be viewed against the background information upon which these estimates are developed.

4.2.1 Project initiation estimate (strategic estimate)



Strategic (SE) is used for planning purposes so that the nominated projects can be prioritised. These estimates provide an order-of-magnitude estimate of the anticipated funds needed and provide a meaningful comparison of nominated projects. Because these estimates are prepared based on limited information, and for feasibility purposes, SE shall not be used for financial planning, cost control, or budget setting.

Some of the key inputs into the cost estimation practise [illegible] s applicable, project scope and type, major project parameter [illegible], and anticipated size. Historical data form the basis for th [illegible] d during planning. This process is frequently iterative in the i [illegible] o form investment decisions. These cost estimates are th [illegible] s through preliminary design and final design. Because the [illegible] g process include considerable uncertainty, it is incumbe [illegible] o understand the range of uncertainty associated with these [illegible] s level of doubt to decision-makers (*i.e.*, managers).

> Why do you have a third level heading in here - there is no 4.2.2 - so no need to have a single third level heading. The fourth level headings below could be third level?
> This also occurs elsewhere -check if needed. see: 4.4.1, 6.3.1, 6.4.1, 7.4.1, 7.5.1

Major challenges faced whilst producing estimates at this stage is the lack of information available and lack of definitive options to price. Processes outlined in this section will provide guidance for preparing reliable SE. Figure 4-2 shows a generic process of cost estimation for a SE.

4.2.1.1 Procedure for preparing an SE

When a SE is prepared, there is usually little information available and most often the estimate is required in a short time span, thereby leaving minimal time for research. Whilst providing an estimate under these conditions, careful consideration must be given to the element of risk involved in respect of any information that is available at the time. Typical global rates and the unit costs of tendered or completed projects can be used as a guide to develop the cost estimate.

Limited information available at this stage may include some or all of the following:

- Project size;
- Major structures information;
- Lane configuration;
- Constraints;
- Property impacts, including ROW expropriation;
- Major utility adjustments, including diversion, slewing, etc.; and,
- Major risks identified.

When the period given for the preparation of a SE is short, such time constraints can influence the accuracy of the estimate and therefore shall be appropriately reflected in the amount allowed for contingency.

4.2.1.2 Overview of the process

Figure 4-2 shows an overview of the process for preparing a SE, which includes the following three major steps:

- Gathering information;
- Preparing the estimate; and,
- Reviewing.

These steps are explained in greater detail in the following sections.

Gathering information (also refer to Section 3.2)

Proper investigation and efforts must be made to ensure adequate data is collected before the estimate can be developed. This includes the following:

- Defining the Project scope;
- Collecting available Project information or data;
- Site visit; and,
- Collating data for the estimate.

Defining the scope of the Project

Defining the Project scope and functionality is the starting point of any estimate. When defining scope and function, a clear understanding of the Project objectives and the means by which those objectives will be delivered is essential. It is vital that, even during the Project feasibility stage, the Project scope and functionality is understood in sufficient detail to allow the production of a reliable estimate. Any change in scope or functionality will be recorded and agreed upon to provide an audit trail through the Project estimate life cycle.

Information, such as the Project size, lane configuration, major structures, property issues, constraints, utilities, and risks are required to prepare a reasonable SE. At this stage of the Project proposal, the nature of SE is such that some of the information will not be available or reliable. Appropriate assumptions shall be made and recorded in such instances to complete the estimating process.

Project estimates must take into consideration all the factors affecting the cost estimate. If this is impractical, consultants must qualify or specifically exclude items from the Project estimate. This will ensure that the Client can fully understand the limitations of the current scope of work and therefore, the Project estimate.

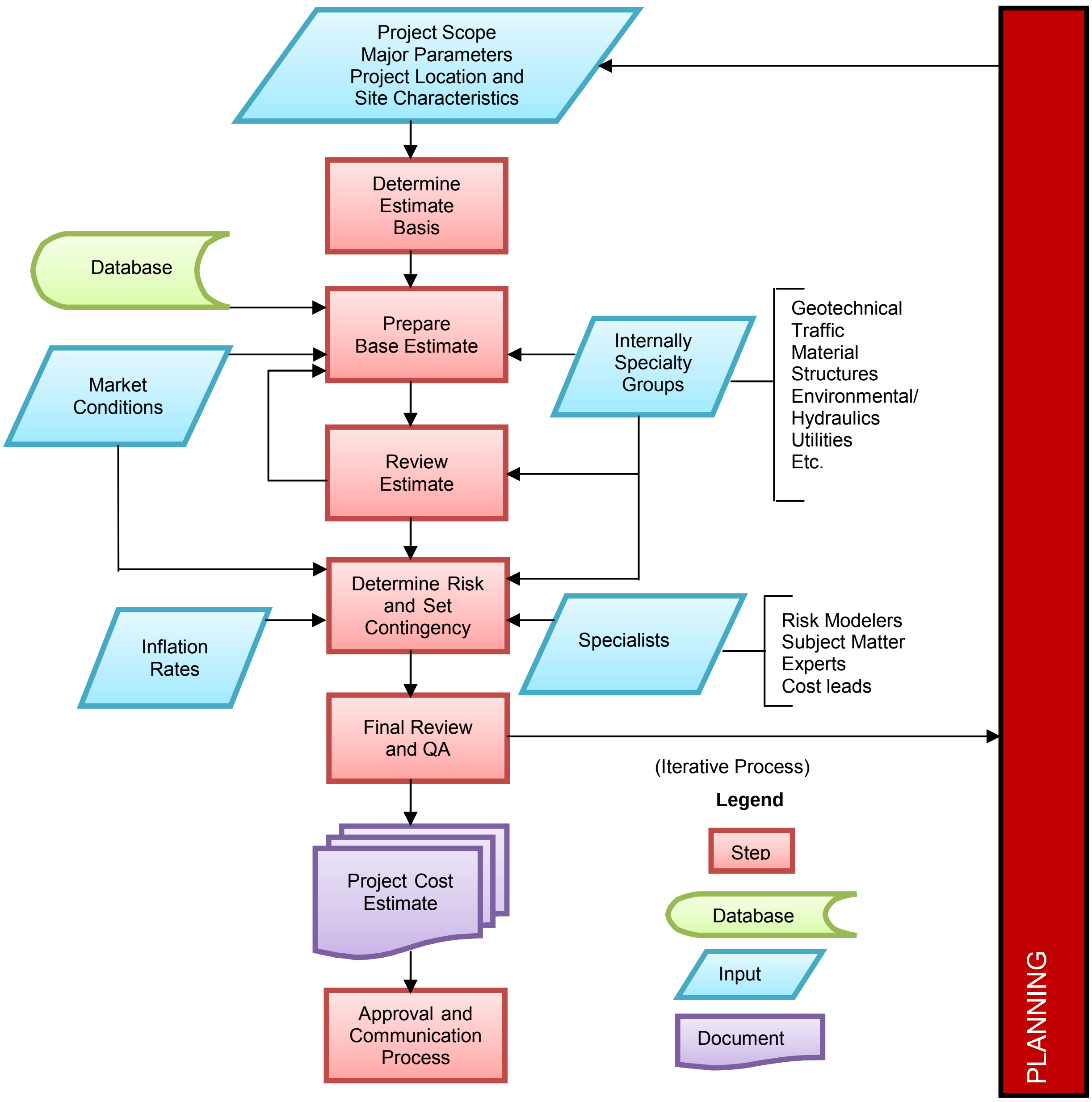


Figure 4-2: Cost estimating process during strategic phase

Important Note

Standard management practice and a standard set of forms to document project scope can be developed. As project scope is often revisited during the planning phase, the standard practices deveoped will provide an audit trail of how the project scope was developed and changed.

Collect available project information

The Estimator must collect all of the following available information and take it into consideration whilst developing an estimate:

- Employer's requirements. ← next page?

- Understanding the expected contracting strategy for the Project, including traditions, lump sum, design and construct, early Contractor involvement, open tender, sole invitee, etc.
- Clear description of the scope of the Project with its limits. This is an essential component in ensuring the reliability of the estimate.
- Plan or sketch.
- Exclusions, if any, of the proposal.
- Risk assessment.
- Constructability.
- Details of the costs spent on the Project to date.
- Any available existing reports that might influence the development cost estimate (*e.g.*, geotechnical report, traffic study report, etc.).
- Key dates (*e.g.*, commencement of design, construction, etc.).
- Any conditions of approvals, including environmental approvals, likely to be required.
- Any other available information, such as sketch plans, aerial photographs, Google maps, general property valuations, utilities, etc.

Due to the limitation of the availability of the information, any assumptions made must be clearly stated.

Site visit

Wherever possible, the Estimator, preferably along with the PM, shall make a site visit to improve the understanding of site conditions, uncertainties, unknowns, and risks.

Collate data for the estimate

Quantities during this stage are likely to be approximate in nature and will be broad in character, based on an understanding of the Project proposal scope. Depending on the type of the Project, global and unit rates can be used for developing the SEs, and comparisons can be made to costs of completed projects, in the absence of other relevant information. Historical unit rates, or rates determined from first principles, can also be used if there is sufficient information to calculate quantities. Quantities and rates adopted must be compatible with the Project scope, whilst the rates used must be applicable to the quantities adopted.

Preparing the base estimate (also refer to Sections 3.3, 3.4, and 3.5)

Usually at this point, the base estimate for the Project is produced using global or unit rates. Global rates are not intended to replace engineering design and estimating calculations but rather to provide a resource for generating a realistic cost for a project proposal when minimal information is available.

Understanding historical data

Historical data collected shall be analysed to determine the following:

- Market conditions prevailing at the time of the tender from which the data was collected;
- Any uniqueness of the Project from which the data was collected;
- Any affect due to duration or start time of the Project, including a short-term project executed in summer when the working hours are restricted;
- Current and prevailing legal environment affecting the Project data collected;
- Client's requirements at the time the reference data was collected;

- Approximate allowances for the Contractors' on- and off-site overhead and profit, if available; and,
- Method that was used for the delivery of the Project.

Adjusted historical data (refer to Section 2.12.12)

Historical data must be adjusted to bring it into line with the requirements of the Project being estimated, including an adjustment for the following, if necessary:

- Site conditions;
- Inflation;
- Project location;
- Variation in the magnitude of the quantities between the historical source of the data and the present proposal;
- Effects of government legislation;
- Client's changes in policies and specifications
- Contractor's on- and off-site overhead and profit; and,
- Method of delivery, including traditional, design and construct, and early Contractor involvement.

Important Note

Each project is unique and reflects a specific situation; therefore, each project should be looked at individually. Lessons learned regarding risk and contingency from similar projects should be considered; however, they should not be applied without careful analysis of the project-specific context.

Strategic infrastructure cost estimate

SE is calculated by multiplying the global quantities by the rates deduced from historical data, or by multiplying the coarse quantities by the unit rates deduced from historical data.

Concept development costs

These costs include all of the activities involved in the option investigation, concept design, concept case development, and approval stages of the Project. Including these costs in the estimate depends upon the requirements of the Project in consultation with Client. Concept development costs shall either be estimated based on data from previous relevant projects, or as a percentage of construction costs.

Detailed design and documentation costs

Detailed design and documentation costs include costs for all activities involved in the detailed design documentation. Including these costs in the estimate depends upon the requirements of the Project in consultation with the Client. Detailed design costs shall usually be estimated as a percentage of construction costs.

Property acquisition costs

Inclusion of these costs in the estimate depends on the requirements of the Project in consultation with the Client. Generally, the level of contingency is higher in urban, and particularly in metropolitan areas, than in rural areas. Value of all land required for the Project, either as the acquisition cost for newly acquired land, or the potential sale value for previously acquired land, must be included as a project cost. In the case of land that is required only for the period of construction, and that is acquired for temporary use, a residual land value must be credited against the Project cost.

Property acquisitions might include the following:

- Actual area acquired or utilised permanently for the Project, including subsurface easements and acquisitions (*e.g.*, for tunnels), if applicable.
- Compensation paid to land owners in respect of effects of the Project on their land.
- Any land that might be permanently or temporarily required for compensatory habitats.
- Contractor's work and site areas, including provisions for site offices, temporary environmental work, traffic diversions, etc.
- Client’s site office and facilities areas, if separate from the Contractor's area.
- Land required for any Client’s work to be undertaken as part of the Project.
- Residual value of land temporarily acquired or made available by the demolition of existing infrastructure replaced by the Project work. Contingency allowances must be made for known property adjustments.

Finalisation phase costs

Inclusion of these costs in the estimate depends on the Project requirements in consultation with the Client. Finalisation phase costs include all costs of all those activities involved with project management finalisation processes. Finalisation phase costs shall either be estimated based on data from previous relevant projects or as a percentage of construction costs.

Utilities adjustment costs

Utilities adjustment costs include all diversions, slewing, adjustments, replacements, etc., that are required as a consequence of the Project proximity; whether it is undertaken by the responsible authority, a Contractor engaged by that authority, or by the Client — either as part of the main Contractor's work or through a separate contract. In some instances, utilities adjustments might be undertaken partly by the Project main Contractor and partly by others, outside of the main contract scope of work, but still within the overall project scope. In such circumstances, care must be taken to ensure that the correct scope of utilities adjustments is contained in the main contract scope and in the scope of other work, and that the scope description makes the division of utilities adjustments clear.

It is often difficult at the initial stage to ascertain the potential costs to the Client due to the effect of existing utilities on a project. Appropriate workouts or contingencies must be applied.

Utilities costs might include, but are not limited to, the following:

- Design costs associated with diversions;
- Etisalat, Du, and other communications carriers' adjustments;
- Electrical services adjustments;
- Water, irrigation, landscaping, and sewerage adjustments, including possible protection of existing services;
- Gas main adjustments; and,
- Fuel pipelines.

Completing the SE (also refer to Sections 3.6, 3.7, and 3.8)

Following section describes the activities that must be undertaken in this final step of preparing a SE.

Conduct reality check

Key costs that form the major component of the Project must be subjected to a reality check by comparing them with similar projects, or with other available details. At a minimum, the following key costs must be subjected to the following reality check steps:

- Total project costs: Reality check calculations for cost per lane kilometre must include the total project costs and length of the Project on the main carriageways. Reality check calculations for cost per lane kilometre must include the total Project cost and length of acceleration and deceleration lanes, left- and right-turn bays along the main carriageways, and ramps at intersections. Total cost used in the reality check calculation must include the cost of structures.
- Project management costs: Reality check calculations for Project management costs, as a percentage of total project costs, must include all of the Project management costs associated with the Project, such as all phases, stages, and activities.

Assess risks

Important risks at this stage of the Project include the following:

- Information used upon which the estimate is based;
- Possibility that the Project scope will change; and,
- Risks associated with providing an estimate at this early stage of the planning life cycle.

Risk assessment for DoT estimates should be in accordance to DoT's PRMM guidelines.

Determine level of contingency

Appropriate levels of contingency must be added to each component of the Project estimate. Contingency must be determined in such a way as to reflect the confidence and reliability of the information used in preparing the estimate and to take into consideration the risks associated with the Project. Each risk element must be properly reviewed and due consideration must be given to the reliability and confidence of the information used in its calculations; the higher the confidence in and the reliability of the information used, the lower the percentage points allocated to the risk element and vice versa. For more in-depth guidance for calculating contingency for SE, refer to Section 3.7.

Provide reference number and include in cited references

Factoring in escalation

SE shall be prepared in current day dirhams. It is not until the nomin [illegible] pproved proposal of the Project time frames that an estimate can be prepared in out-turn dirhams.

Document the information

Estimate shall document the Project proposal covering the scope, estimate, assumptions, and all of the information used to determine the estimate. It is suggested that SE are described as a cost range in addition to stating a most likely estimate within that range. It is advised that maximum documentation detailing how the estimate is prepared shall be provided as attachments.

Cost estimating model

DoT has instigated a development of cost estimating model for estimating the Projects at PI and Fe. Presently, this model is based on few projects; however, the model will be populated with more projects in due course of time. Appendix M provides guidance on how to use this model and the model software can be downloaded from DoT portal.

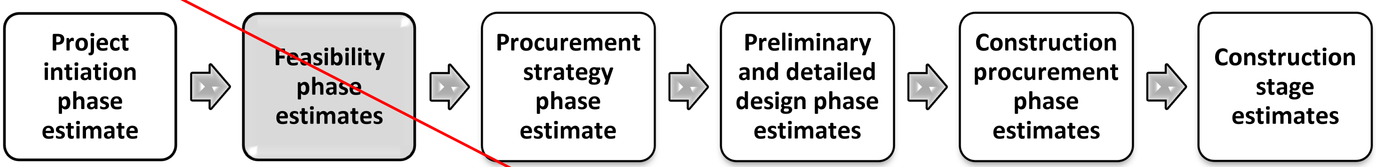
It is noted that this model is developed based on completed, tendered, ongoing projects and the Estimators are required to take in to account the general considerations as provided in Section 2.13.12.

SE review (also refer to Section 3.9)

Review of SE will not be as intensive as subsequent estimates; however, some form of rigour must exist to ensure the estimate is realistic. Depending upon the type and scale of the Project, the PM must arrange for a peer review of the estimate and the appropriate documentation. This must be in a structured format and must be documented. Any comments made by the reviewer must be discussed, agreed upon, and incorporated in the estimate report.

Appendix H provides a template for submitting a Project cost estimate.

4.3 Feasibility phase estimate



Feasibility estimate (Fe) represents the stage during which a nominated project receives sufficient priority to win funding. This phase requires a greater definition of the work to deliver the Project estimate. There are two estimates in this phase, the project proposal estimate and the option analysis estimate.

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Objectives of the feasibility estimate include the following:

- Provide for cost analysis of competing solutions; and,
- Full Project cost to deliver its products.

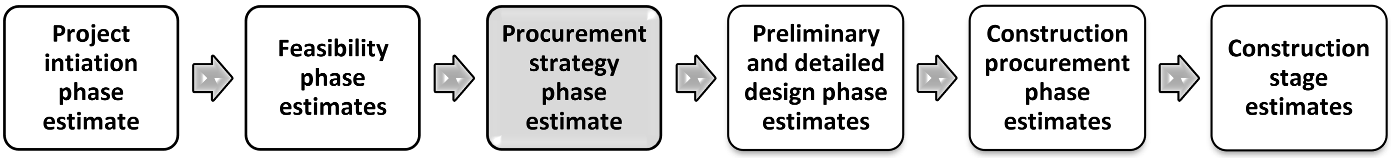
4.3.1.1 Project proposal estimate

Project proposal estimate (PPE) is generally developed to determine if a project is acceptable to address a particular circumstance and supports a PM's proposal to undertake the work necessary to deliver the Project scope and concept case. It is developed on just enough information to serve for that stage of the Project development. Proper risk analysis needs to be carried out to ensure appropriate and sufficient contingency is identified. The process for compiling a PPE is similar to the process for compiling a strategic estimate (SE). Table 2-5 includes an estimating methodology for a PPE.

4.3.1.2 Options analysis estimate

These estimates are prepared for comparison of various options that can meet the desired project objectives. Depending on the requirements, these estimates may require total project cost for each option or may be restricted to a component of the options for which costs will be significantly different because the rest of the Project costs will be the same. Processes for compiling an estimate is similar to the process for compiling a SE. Peer review is needed to ensure accuracy.

4.4 Estimating in the procurement strategy phase



This stage includes the development of a concept estimate (CE) based on a selected estimate from the nomination and will function as benchmark against which all future estimates are compared. This estimate is the pre-design estimate that the Client will use to secure funding for the design phase.

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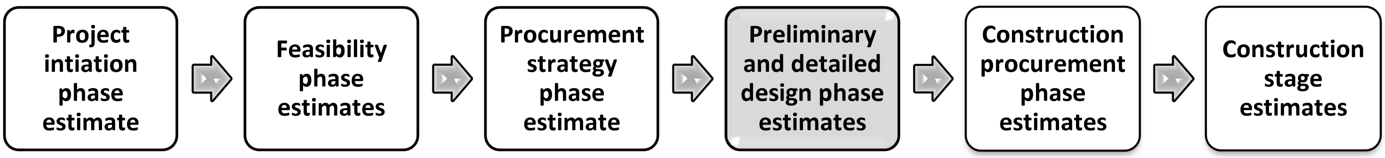
4.4.1 Concept estimates

CE shall be prepared based on a selected estimate from the nominations and will act as a benchmark against which all future estimates are referred. This estimate is as fully developed as current information and available time allows at the end of the concept phase, and that appropriate contingency is provided for any outstanding risks.

This estimate is important, as it will be used as the baseline for future estimate performance. Approved concept cases provide justification for a project and allocation of funding. These allocations and the time and quality requirements represent the criteria by which the Project will be judged to have succeeded or not. Additionally, this estimate provides an important baseline for controlling subsequent design development resulting from approved functional or standards changes.

Guidelines discussed in previous chapters appropriate to this stage and the information available shall be rigorously followed. Table 2-5 recommends the estimating methodology for the concept case estimate. Peer review is needed to ensure accuracy.

4.5 Estimating in the preliminary and detailed design phase



Following three estimates can be created in the development phase:

- Concept estimate;
- Preliminary design estimate; and,
- Detailed design estimate.

Detailed design, tender documents, and an agreed upon contract ready for the construction phase, are the key outputs of the development phase. Detailed design estimates guide the estimate for comparison of tenders, which upon acceptance, appraises the budget cost estimate. Note that the financial approval process is also aligned by the budget cost estimate.

4.5.1 Preliminary design estimates

Preliminary design phase involves developing the engineering design and preliminary design estimate with cooperation from the various functional disciplines, including, but not limited to, survey, environment, safety, highway design, geotechnical, structural design, construction, etc., to support the decision-making process. Aim of the preliminary design estimate is to ensure that, the advanced design and its associated estimate align with the concept case and budget. This is carried out so that if the Project is deemed unfeasible to continue, the costs associated with a full detailed design is not incurred.

Preliminary design is typically developed to approximately the 15 percent to 25 percent level of design detail using substantial additional engineering data, information, and input to supplement the information gathered during the conceptual phase.

This phase may usually include, but is not limited to, developing pavement design, alignment configurations, roadside features, bridge and tunnels type, or other alternatives for evaluation. Apart from developing the preliminary design and preliminary design estimate, this phase also includes identifying a detailed scope of engineering activities and a project delivery plan for achieving the Project objectives on schedule and within budget. For small-scale improvement projects related to resurfacing, restoration, refurbishment of bridges, and other small-scale projects with limited and/or well-defined scope, the preliminary design and most of the information required for developing an estimate is often readily identifiable and available.

Guidance for identifying the Project scope is described in Section 3.2. Level of scope definition depends upon and is commensurate to the level of details available at this stage. Sections 3.3 and 3.4 describe the basis of estimate and resource planning. For the cost estimate development principle and element, refer to Section 3.5. Table 2-5 provides recommendations on the estimating methodology for preliminary design estimate. Figure 4-3 explains the procedure for preparing a preliminary design estimate. Guidance on risk evaluation and contingency are provided in Sections 3.6 and 3.7. The base estimate prepared at current prices requires escalations to reflect the cost during which the Project is executed. Section 3.8 describes the procedure of escalation. Guidance on conducting a peer review is described in Section 3.9.

4.5.2 Detailed design estimates

Detailed design estimate is prepared based on the full set of information of the construction aspects of a project, and thus, is what a project's construction estimate needs to be based on prior to construction. Table 2-5 provides recommendations on the estimating methodology for detailed design estimate. Figure 4-4 explains the procedure for preparation of the detailed design estimate. Guidelines discussed in Chapters 2 and 3, as appropriate to this stage, shall be rigorously followed.

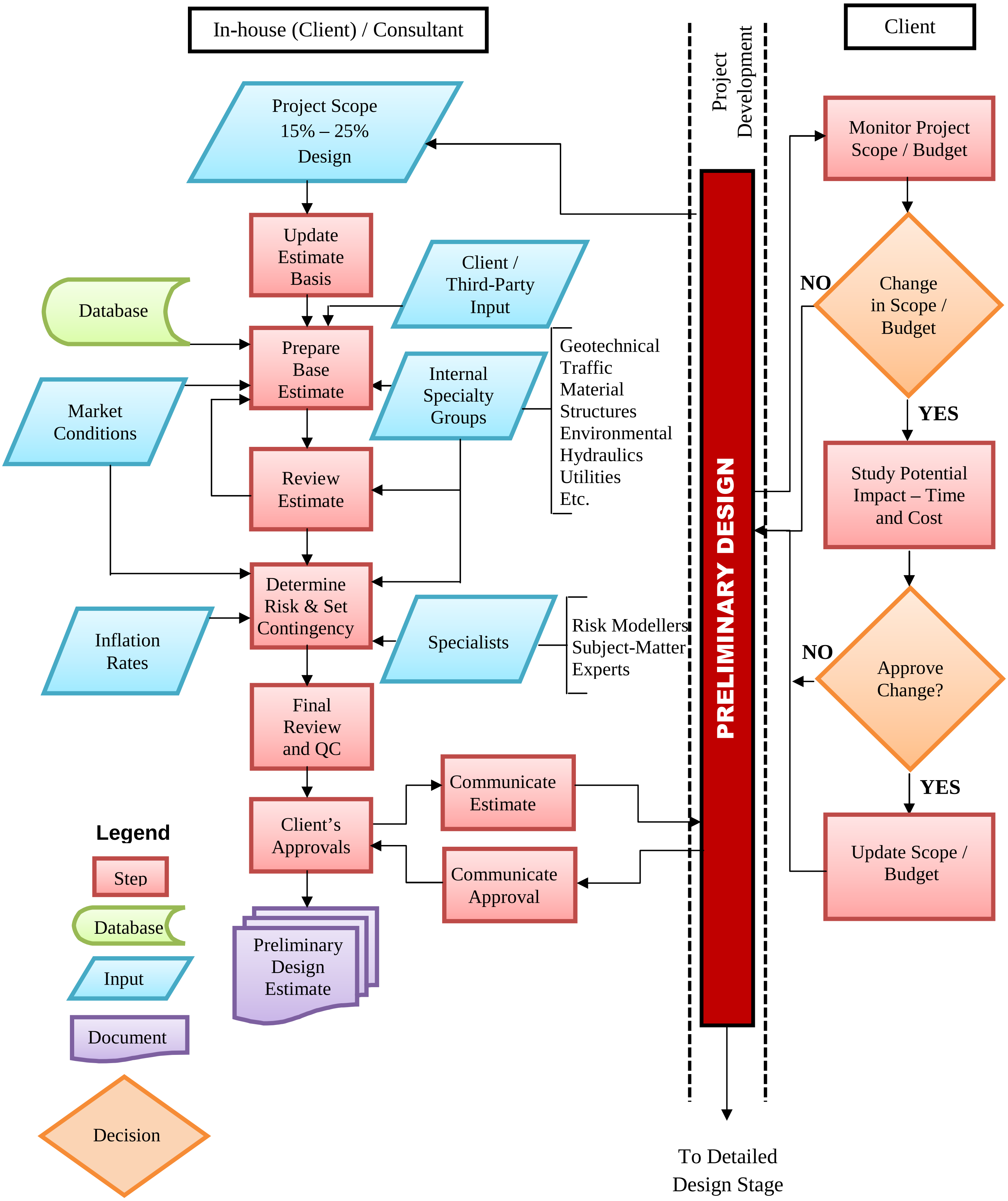


Figure 4-3: Cost estimating process during preliminary design phase

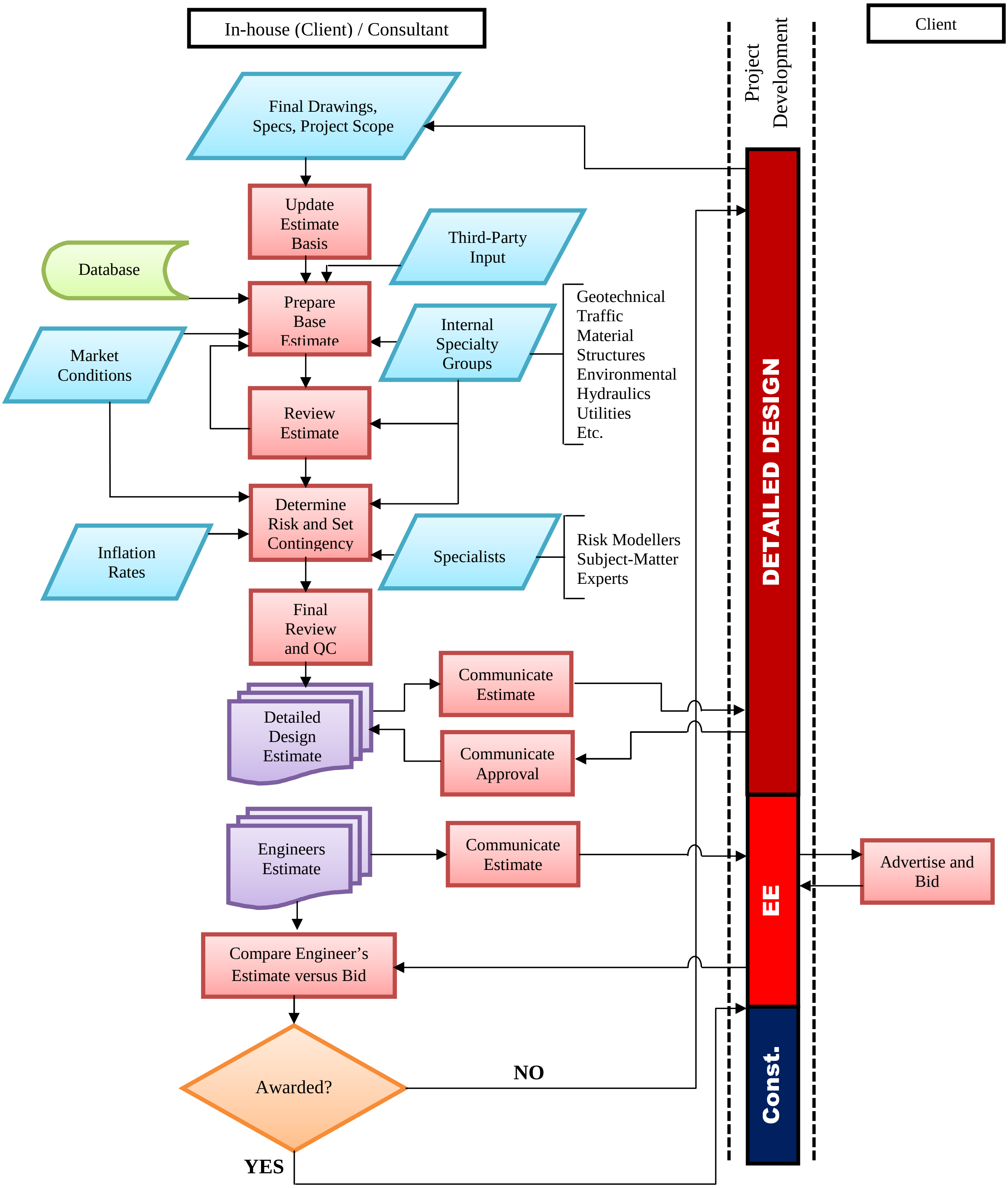
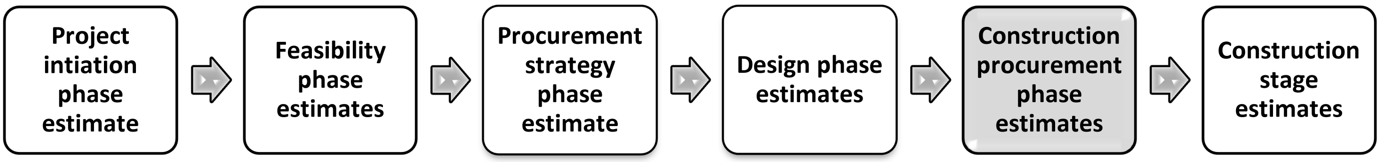


Figure 4-4: Cost estimating process through detail design phase

4.6 Estimating in construction procurement phase



Detailed design estimate is used to prepare the most accurate estimate for comparison of tender (ECT) possible prior to the start of competitive bidding and construction. ECT is used to secure construction-phase funding. The proposed project is tendered out to the market. After the receipt of tenders and before the contract is awarded, the estimate will be revised to a budget cost estimate, which the Client's PM and the Consultant will then manage until project completion.

4.6.1 Estimate for comparison with tender

This estimate allows for submitted tenders to be compared with the Client's estimation of construction costs. Reasonable market rates are assumed for the Contractor's construction costs to develop this estimate. This provides the means for validating and comparing tender costs. Note that the costs factored into the estimate depend on the type of contract used, which shall have been determined as early as the concept case. This estimate will provide support to the tender analysis phase of the Client's delivery system. When developing the estimate for comparison with the tender, the following shall be considered.

4.6.2 Data verification

Whilst developing this estimate, the Estimator shall be provided with all relevant information, including the following:

- Detailed design estimate report;
- Proposed contracting strategy;
- Complete set of current tender documentation, as issued to the tenderers, including any notices to tenders issued; and,
- Any further relevant information available at this stage.

Estimators must verify that no new information made available, or not considered in prior estimates, changes the values or the assumptions used in the preparation of the detailed design estimate. Estimators shall also verify that no event has occurred since the preparation of the detailed design estimate. If new information or an event causes a change to the values and the assumptions made, appropriate adjustments must be made to the estimate.

4.6.3 Site visit

Site visits shall be conducted if an estimating team is unfamiliar with the Project site or to confirm that no developments have occurred on-site that affect the estimate and the assumptions made.

4.6.4 Risk assessment

Estimators must update the Project risk analysis for any new updates to the risks. Relevant cost risks for each tender based on that Contractor's performance shall be allowed.

Only those risks that have been transferred to the Contractor and will vary depending on the delivery method chosen shall be included. For example, on a traditional infrastructure contract, risk on quantities is retained by the employer and risk on rates is transferred to the Contractor. Under design and construct, risk, in respect of both quantities and rates, is transferred to the Contractor.

4.6.5 Construction programme

Estimators must verify that the construction programme prepared at the detailed design estimate stage is current and appropriate.

4.6.6 Construction method

Estimators must verify that the construction methods assumed for the detailed design estimate are relevant and the appropriate constructability aspects of the Project have been allowed for in the contract.

4.6.7 Quantities and rates

Quantities used for developing this estimate are usually an extract from the detailed design estimate. Estimators must verify that the rates adopted match the quantities measured. If any changes are made during the tender queries, the quantities must be updated to reflect the latest designs. Drawing quantities and sources of quantities for each item must be documented and summarised. If some time has passed since the detailed design estimate was prepared or if an event has occurred that can influence costs, the Estimator must adjust the rates appropriately.

4.6.8 Employer’s cost

Estimates prepared shall reflect the contract tendered. In most cases, this is an extract from the detailed estimate that will exclude the employer's costs, Client-retained risks, and contingencies.

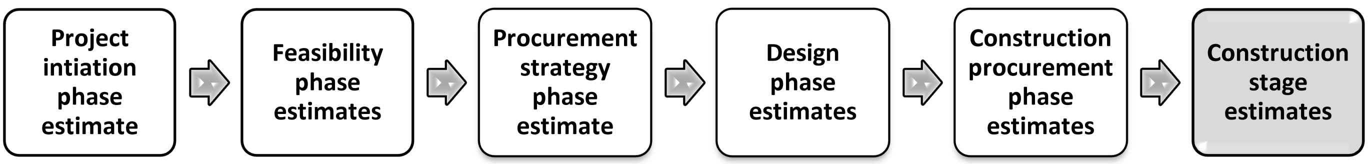
4.6.9 Review

Peer reviews may be arranged by the PM, if deemed necessary.

4.6.10 Budget cost estimate

Budget cost estimate is prepared using the preferred, negotiated, and approved Contractor's offer. This estimate shall be used to update the total project cost, taking into account that risk and contingency will need to be reviewed and the escalation updated prior to comparing it to the Project budget.

4.7 Estimating in the construction phase



Cost estimating during the implementation phase mainly refers to regular updates of the BCE, variations, and cost forecasting.

4.7.1 Budget cost updates

Updating the budget cost keeps the estimate current and provides managers and decision-makers with a clearer picture for major decisions of what-if scenarios. Three activities associated with updating the cost estimate regularly include the following:

- Quantities reconciliation;
- Project approved variations; and,
- Incorporating lessons learned from feedback.

Project budget costs must be updated whenever the Project scope changes.

4.7.2 Periodic forecasting

It is necessary to exercise cost control by forecasting the expected final cost based on current events. As the Project progresses, construction activities costs will vary and risks may or may not eventuate. Therefore, allowances for contingency and escalation will normally change as the Project's risks do or do not eventuate. If a contingency allowance allocated for a particular item is not consumed, it can be shown as savings to the Project and may be released by the Client for other projects. On the contrary, where the estimated final cost is likely to exceed the Project budget, then reasons resulting in an increase in price shall be documented and reported to the Client.

4.7.3 Contract variations

Principles used in the preparation of pre-contract estimates can also be adopted when preparing major variations before they are proposed, and when assessing variation requests from a Contractor.

4.7.3.1 Pricing the variation

Pricing variations include the following:

- To increase or decrease the quantity of any work included in the contract;
- To omit any such work included in the contract;
- To change the character, quality, or kind of any material or work;
- To change the levels, lines, position, and dimensions of any part of the work included in the contract;
- To execute additional work, demolition of work no longer required, etc.; and,
- To change any specified sequence or timing of construction of any part of the work.

Pricing variations must be done in a way that is consistent and takes into account the method of construction and the circumstances and timing during which the variation occurs. Most standard forms of contracts include a clause under which the employer or their representative can issue an instruction to the Contractor to vary the work that is described in the contract. It will also include a mechanism for evaluating the financial effect of the variation.

Additionally, pricing variations is usually based on the rates and prices set out in the contract, if the same is applicable. If the contract does not contain any rates or prices applicable to the varied work, the rates and prices in the contract then form the basis for valuation so far as may be reasonable. Sometimes major variations may require additional resources; therefore, such costs might need to be considered. Seeking and obtaining approval for a variation must include both financial and time costs.

Calculation of indirect costs, overhead, and profits shall only be addressed when the direct cost pricing has been completed.

4.7.3.2 Scope variations

Principles used in the preparation of estimates can also be adopted when preparing scope variations before they are proposed. All variations shall be accurately recorded and documented at all phases of the Project. Requirements for assessing or determining the value of the construction portion of the variation must comply with the requirements as stated above. In addition to the construction portion of the variation, the following allowances must be made for additional costs:

- Investigation and design;
- Development;
- Contract administration;
- Project management;
- Acquisition;
- Sponsor;
- Insurance;
- Utility adjustment costs that have not been included; and,
- Finalisation.

Whilst preparing a scope variation, the time impact to the Project's programme must be taken into account, where appropriate. Time impacts usually will have cost implications and shall be properly assessed. Seeking and obtaining approval for the scope variation must include both financial and time costs. Other implications, such as risk, shall also be considered.

4.8 Finalisation estimate

Information on project cost data is an important source of data for future reference, and therefore shall be analysed at the end of the Project. It also acts as a device to measure estimating performance. Activities that shall be undertaken include analysing and reporting project cost data, analysing and reporting an estimate’s performance against standards benchmarking, and utilising actual data. Appendix K provides a sample, which can be used for analysing and reporting Project cost data.

4.8.1 Requirements

To close out completed project activities progressively, the following reports are required to be submitted to the Client.

- FCA (refer to Appendix K for an example); and,
- Completion report.

4.8.2 Lessons learned

Lessons learned and outcomes regarding project estimating shall be documented, which will provide support whilst estimating future projects. Reports shall mention the reasons, sources of discrepancy for differences in the Project final cost when compared with the original sanctioned budget, and the concept case estimate. Reasons for the differences can include, but are not limited to, the following:

- Poor Project cost estimating;
- Poor Project cost management;
- Poor contract management; or,
- Poor adoption of Project management processes, in particular scoping and risk analysis or management.

Information that provides grounds for learning is captured in the following documentation:

- Departmental project management documentation, including the following:
    - Project completion report;
    - Project close out report; and,
    - Project reviews.
- Contract documentation.
- Archived data.
- Performance reviews.

Project lessons can help improve the decision-making and planning processes for new projects.

5 ESTIMATE QUALITY ASSURANCE

5.1 Overview

This chapter describes the processes and guidelines that will assist in achieving reliable Project cost estimate performance, using quality assurance (QA) and quality control (QC) techniques.

5.2 General

Major objectives of cost estimate reviews are to verify the accuracy of and confirm the reasonableness of cost estimates upon which key management decisions are based. Therefore, the estimating process should always include QA/QC. Cost estimates must be re-evaluated/revalidated at significant milestones or stages throughout the process of cost estimating. Each estimate should be scrutinised to some level through a review process.

Reviews of estimates are important for various reasons, including the following:

- Conditions and assumptions made during the development of original and subsequent estimates often change, so estimates need to account for these changes.
- Key decisions in the interest of the public are required to be made throughout project development phases. These decisions must be made based upon the most current and accurate estimates possible.
- Peer/independent review acts as a means of minimising the potential for surprises concerning the financial condition of the Project.
- Reviewing the estimate serves an opportunity for managers and decision-makers to capture a different perspective, or at least obtain a second opinion.
- Estimate reviews ensure that base cost estimates accurately reflect a project's scope of work and verify that items are not missing, that historical data reasonably reflects project conditions, and that assumptions and the basis for assumptions are appropriate for the Project. These reviews also provide input to completed base cost estimates (including backup calculations) and the completed estimate basis and assumptions technique.

5.3 Checks

Checking an estimate prior to peer review is one way to ensure QA/QC. Checks include comparing an estimate and/or its components with benchmark values. This process helps in identifying gross inconsistencies in the estimates.

5.4 Internal peer review

An internal peer review should be conducted on all types of estimates, regardless of the complexity or scale of the Project. Peer review is required in order to provide an assurance that good practises have been followed to develop the manual. This type of review is similar to the internal project team review, but is performed by any other person, team, or office. A peer reviewer can be a person within the organisation, or it could be an independent person, nominated by the Consultant and agreed to by the Client's PM. A reviewer must be competent and must possess reasonable skill and experience in project cost estimating. Furthermore, the reviewer should not have been involved or have participated in developing the cost estimate and should be able to demonstrate independence from the original estimate development team. This ensures that the estimate is reviewed with a fresh perspective.

A reviewer should be able to understand the estimate and documentation smoothly. For example, if the reviewer is not able to understand the existing estimate or documentation, then the documentation is most likely insufficient to support the estimate in the approval process.

A peer reviewer is responsible for the following:

- Checking that all necessary documentation has been completed;
- Gaining a satisfactory understanding of the Project to proceed with the peer review;
- Undertaking a site visit;
- Ensuring that the scope is fully understood and addressed in the estimate (*i.e.*, checking for its adequacy and completeness);
- Reviewing quantities and rates of various items;
- Ensuring that the lump sum and provisional sums are appropriate;
- Reviewing optimism bias;
- Identifying potential errors in the estimate;
- Reporting cost trends for the Project;
- Reviewing benchmarks for similar work;
- Reviewing project constructability;
- Reviewing risk registers and contingency allowances;
- Assessing construction methodologies and checking the preferred options;
- Verifying that key assumptions have been listed and appropriate allowances have been made in the estimate;
- Conducting arithmetical checks;
- Reviewing estimate inclusions and exclusions; and,
- Verifying that previous quantities, rates, lump sums, and contingencies have been reviewed with respect to any additional information having become available.

A sample peer review report is attached in Appendix G.

Findings and recommendations of the peer review should be documented and incorporated.

6 PRESENTATION OF ESTIMATE AND REPORTING

6.1 Overview

Cost estimates are required to be prepared and presented using a standardised format. This is essential to provide a high level of consistency, to improve the understanding of estimates, and to reduce the risk of items being left out.

This chapter describes the presentation of estimates and provides templates to assist in achieving reliable Project cost estimate performance.

6.2 General

Cost estimates prepared and presented using a standardised format are easily understood by the reader and reduce the risk of items being left out. This provides a high level of consistency and assists in achieving desired Project cost estimate performance. A method had been established for the presentation and reporting of estimates. These are supported by templates that are required to be used for presentations at all stages of the estimate.

If a project consists of a number of packages, the Estimator should present each package separately and then summarise all of the packages on a main form. All cost estimates shall be accompanied by a report, as shown in Appendix H.

6.3 Work breakdown structure

Presentation of cost estimates is dependent on the work breakdown structure (WBS). The WBS is a tree structure that shows a subdivision of the work required to achieve an objective. It provides a menu of activities, commencing with the broadest work packages at Level 1 to the more detailed Level 3.

WBS also provides the framework necessary for detailed cost estimating, along with providing guidance for schedule development and control. Comparing actual costs using the same WBS organisation will help project controls to track any cost changes against the baseline WBS element. Cost breakdown structure (CBS) based on WBS should be adopted for the Project cost estimates.

CBS should match the level of work [illegible] level of information available. Work breakdown level will depend on the ty[illegible]e likely delivery method. For example, for a strategic, the Estimator might divide activities at the broadest work packages based on details available; whereas, for a detailed design estimate, most activities will be required to be at more detailed Level. Project managers and Estimators shall use their experience to create the CBS.

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6.3.1 Construction activities

It is expected that the Estimator will develop an estimate based on a WBS, which, in turn, will have to be based on the level of information available for the estimate stage. For a detailed estimate, the Estimator can refer to the CBS, the standard BoQ, and the specifications, which describe the work activities and quality standards required to complete each item of work.

6.4 Project cost estimates

Standard formats for cost estimates includes the item number, a description of work, the unit of measurement, an estimated quantity, a unit rate, and the amount. Costs are required to be divided, where possible, into project management or work management activities. This will allow the Estimators to monitor the costs of individual work items, in percentage terms, against the total cost. Using these, the Estimator can focus on the 20 percent of items that, when combined, often make up 70 percent to 80 percent of the costs (Pareto's approach).

The estimated cost is expressed in out-turn costs to reflect the actual completion cost of the Project against the planned timings of the execution of the Project.

6.4.1 Reporting estimates

It is important that the full cost range for a project is reported accurately from the feasibility stage through the conception of the Project. From the period of initiation to the selection of a preferred option, the Project's estimate is not limited to one option, but should cover the range of the entire scope of potential options. Whilst undertaking this, the Estimator is required to report the preferred option and the probability of success of each option.

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Appendix L includes the templates and examples for estimates.

6.5 Supporting information

Several supporting documents are required to be included with the basis of estimate. Supporting information should include, but not be limited to, the following:

6.5.1 Estimate deliverables checklist

A checklist in support of the preparation of an estimate should be provided to relate to classification of the estimate.

6.5.2 Reference documents

Documents used in the development of estimates, such as drawings, specifications, and other references, should be provided. Clearly identify the date of issue and revisions for key documents. All documents used as references, upon which the estimate is based, should be listed in a way similar to a bibliography, including revision numbers and document dates.

6.5.3 Schedule documents

Project design and the construction schedule shall be documented and include working days, shift assumptions, key milestones, and critical path activities.

6.5.4 Additional attachments

Any other attachments that may be necessary or required, such as the following, shall be included:

- Reconciliation report;
- Detailed scope statement;
- Benchmarking report;
- Risk analysis schedule;
- Assumptions;

- Escalation calculations;
- Options analysis;
- Constraints;
- Significant issues; and,
- Current approval status.

6.6 Communication of Project cost estimate

Estimators or Consultants have an obligation to ensure that the Client is provided with appropriate information regarding projects. Communication plays an important part in the success of a project. Proper planning should be devised to ensure that correct information reaches its intended audience on specified target dates in a form that is easily understood by all concerned.

7 CONSTRUCTION COST MANAGEMENT

7.1 Overview

Cost management is an integral part of programme management. This section provides a link between Project cost estimating and programme management activities at the post-tender stage. Cost management during the construction phase mainly involves periodic cost estimate updates, managing variations, cost forecasting, and final cost analysis (FCA).

7.2 General

Construction cost management in the post-tender stage involves updating cost estimates and controlling project costs. It also involves continually updating the estimate with revisions as they become apparent, revising the estimate to reflect changes, and analysing differences between estimated and forecasted actual costs. Cost management activities include regularly updating Project cost data, managing variations, forecasting the final cost of the Project, and completing a FCA to support the development of a cost database.

7.3 Budget cost updates

Budget costs should be updated regularly with approved variations, so they are always relevant and current. Additionally, projects must be monitored continuously to evaluate their effectiveness by comparing actual and planned performance. As the Project proceeds, frequent updates to the budget cost increase the quality and enable Estimators to incorporate lessons learned. Knowledge gained by analysing lessons learned from current cost estimation activities can improve future estimates. For example, cost variances resulting from incorrect assumptions, if documented rigorously, help Estimators avoid repeating similar mistakes in the future (refer to Section 4.7.2). Finally, Estimators should archive actual cost, technical, and schedule data in a database, for use in supporting future estimates.

Cost Managers should update the forecasted final cost every month, or as required by the Client. Each project's duration and the magnitude of changes may mandate more frequent updates to the forecasted final cost. For example, instructions for major changes from the Client will immediately require submission of a revised Project cost estimate. Before approving changes, however, managers should assess their advantages and effects on the programme's cost. Effective programme and cost control requires periodic revision to cost estimate, budget, and projected estimates at completion.

Regardless of whether changes instructed by the Client result in a major contract modification, managers should update the forecasted final budget cost regularly to reflect all changes. By regularly updating the forecasted final cost estimate, managers can check the accuracy of the budget cost, shorten turnaround times, defend the budget cost over time, and record cost and technical data for use in future estimates. Current, accurate, and relevant forecasted final budget cost are critical sources of information for decision-makers. Related activities include the following:

- Updating the budget cost whenever the Client mandates changes, when the Project requirements or scope changes, and at major milestones. Such updates also require reconciling the results with the Project budget.

- Properly recording all changes that affect the overall project budget cost to enable tracking the difference from budget cost.
- Updating the forecasted final budget cost with actual costs as they become available (due to re-measurements and other changes) during the Project's life cycle.
- Recording FCA and other pertinent technical information, such as schedule and risk items, so they can be used to estimate future projects.
- At project completion, obtaining Client feedback, assessing the lessons learned, and recording the lessons learned so they can be used when developing future estimates.

7.4 Over-budget baselines

At times, the remaining budget and scheduled project completion targets may not be sufficient and the current baseline may no longer be valid as a realistic measurement of performance. Using an unrealistic baseline can make an unfavourable cost condition worse. As necessary, to re-establish control over remaining project activities, the Client may request an over-budget baseline. An over-budget baseline can provide a meaningful basis for performance management.

For example, if the variance between the remaining budget and projected costs is too big, management may struggle to discover new problems that can still be mitigated. An over-budget baseline can eliminate historic variances, add budget for future work, and enable management to quickly identify new variances.

7.4.1 Over-budget baseline rationale

Whilst developing an over-budget baseline, management should ensure that the cost estimated to complete the remaining work is valid, identify and track balance risks, identify a management reserve, and ensure that the new baseline is meaningful and adequate for future performance measurements. An over-budget baseline does not always affect all remaining work; sometimes only a portion of the WBS requires an increas

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Programs should rarely need an over-budget baseline. A programme that frequently requires over-budget baselines may have a scope that is not well-defined or be based on unrealistic estimates. Before developing and implementing an over-budget baseline, consider the following:

- Percentage of work completed: Typically, a project should be between 25 to 85 percent complete to develop an over-budget baseline. A project that is less than 25 percent complete may not yet be mature enough. A project that is more than 85 percent complete has insufficient time remaining.
- Projected growth: When budget and project growth are projected to be more than 15 percent, an over-budget baseline may be warranted. An over-budget baseline is most critical when it is necessary to restore the ability to collect meaningful performance measurements.
- Remaining schedule: When the remaining duration of the Project is less than six months, implementing an over-budget baseline will most likely have a negligible impact, because the time to implement the new baseline is limited.

7.5 Cost database

Because project cost data is important for future reference, managers must analyse project costs at the end of the Project. Such analysis is also critical when estimating and measuring performance. In addition to analysing and reporting project cost data, management must analyse and report an estimate's performance against standard benchmarking. Management can use a sample, similar to one provided in Appendix K, for analysing and reporting project cost data.

7.5.1 Tasks involved in preparing a cost database

Figure 7-1 shows general steps to collect and compile cost data.

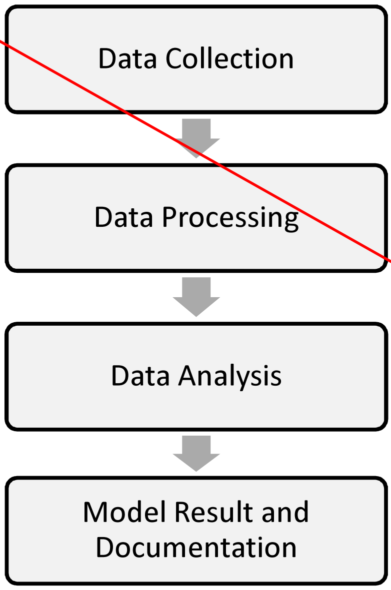

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Figure 7-1: Cost database development process

7.5.1.1 Data collection

Collected data should include technical, schedule, programme, and cost data. Collected data must be documented, protected, and stored for future use in retrievable databases.

7.5.1.2 Data processing

To process collected data in a way that best achieves cost estimating relationships, ensure that the process includes the following:

- Describe Data: Divide collected data into major work items that comprise approximately 80 percent of total project costs. Such categorizations help in estimating the cost during the preliminary stage of the Project, when key information related to these major work items is collected.
- Prepare Data: Analyse data quality, extract key features, perform data transformation, and identify missing data.

7.5.1.3 Data analysis

Data analysis should be performed to normalise the cost of the major work items. Take into account actions such as front-end loading or typing errors into the BoQ, to resolve any unusually high or low rates in the Project.

7.5.1.4 Results and documentation

Arrange analysed data to support future cost planning. Refer to Appendix K for guidance on a list of items, required formats for items in the cost database, and an example. Whilst the cost estimating relationship that must be analysed, as shown in Appendix K, will not change, the bill of quantity items that are required to obtain a cost estimating relationship will require modifications, depending upon the method of measurement.

7.5.1.5 Considerations when using a database

Data to be used for estimating a new project should relate to a project of similar nature, which should have been executed more or less under similar circumstances. Suitable adjustment shall be required for estimating any project in the future using this data, to allow for the following factors:

- Cost escalation;
- Different types of work;
- Different risks;
- Competitiveness of the tenderers in the market; and,
- Different locations.

Because project data is only useful for a limited time, the Estimator shall consider periodically refreshing the baseline data to reflect newly completed projects. Before using the data, carefully compare the Project for the cost that is being estimated to the projects that have provided data for the baseline cost data.

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Document No:
XX-00-00

Please refer to original guidelines for preparing manuals regarding referencing:
Cited references are those references that are refered to in text and which should be used with this document.
These should be numbered and the reference number should be included in text every time you refer to that that reference.
Also include the DOT Document Number in this list...as indicated

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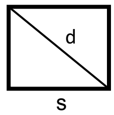
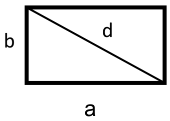
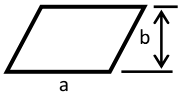
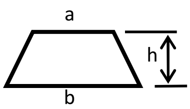
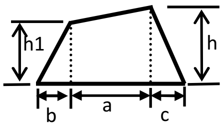
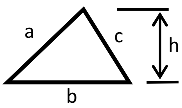
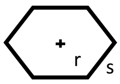
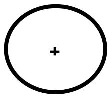
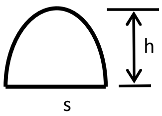
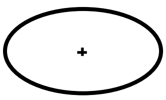
INDEX

APPENDIX A: FORMULAS AND RELATIVE DENSITY

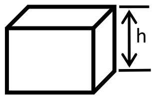
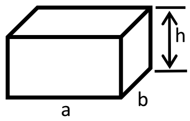
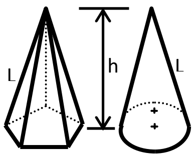
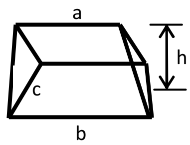
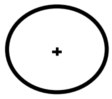
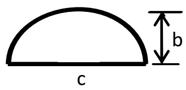
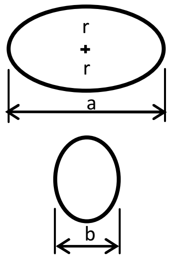
A.1. Formulas

Some standard formulas are provided in the following section for calculation of area and volume.

AREAS OF PLANES

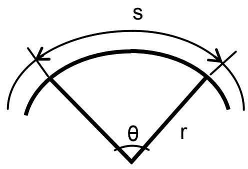
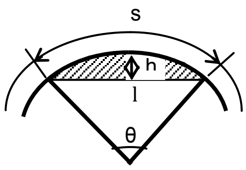
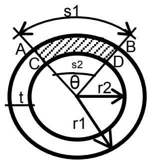
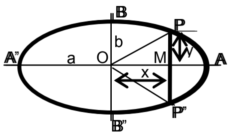
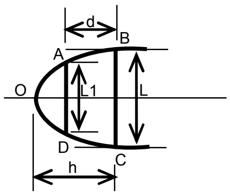
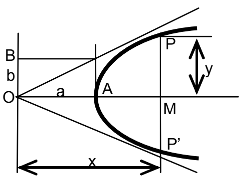
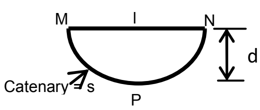
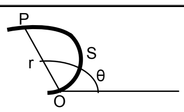
Square		$A = s^2 = 0.5\ d^2$
Rectangle		$A = ab$ $A = b\sqrt{d^2 - b^2}$
Parallelogram		$A = ab$
Trapezoid		$A = \frac{1}{2}\ h\ (a + b)$
Trapezium		$A = \frac{1}{2}\ [a\ (h + h1) + bh1 + ch]$
Triangles		$A = \frac{1}{2}\ bh$ $A = \sqrt{s(s-a)(s-b)(s-c)}$ Where: $s = \frac{a+b+c}{2}$
Regular Polygons		$A = nr^2 tan\frac{180°}{n}$ or $A = \frac{n}{4}s^2 cot\frac{180°}{n}$ Where: n = number of sides r = radius s = length of side
Circle		$A = \pi r^2 = \frac{\pi d^2}{4}$ Where: r = radius d = diameter
Parabola		$A = \frac{2}{3}sh$
Ellipse		$A = \pi\ ab$ Where: a = short radius b = long radius

VOLUME AND SURFACE AREA OF SOLIDS

Cube		$V = h^3$ $S = 6h^2$
Rectangular Prism		$V = abh$ $S = 2(ab + ah + bh)$
Pyramid or Cone (Right & Regular)		$V = \frac{Bh}{3}$ $S = \frac{PbL}{2} + B$ Where: Pb = perimeter of base B = area of base
Wedge (Regular)		$V = \frac{ch}{6}(2a + b)$ Where: h = perpendicular height c = width of base
Sphere		$V = \frac{4\pi r^3}{3}$ $S = 4\pi r^2$ Where: r = radius of sphere
Spherical Segment		$V = \frac{1}{3}\pi b^2(3r - b)$ $V = \frac{1}{24}\pi b(3c^{2}+4b^2)$ Where: r = radius of sphere
Ellipsoid		$V = \frac{1}{3}\ \pi rab$

Notations: A = area V = volume S = surface area

PLANE CURVILINEAR FIGURES

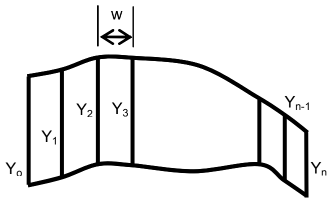
Circular Sector (and Semicircle)		For circular sector: $A = \frac{\theta r^2}{2} = \frac{s}{2}$ For semicircle: $A = \frac{\pi r^2}{2}$
Circular Segment		$A = \frac{r^2}{2}(\theta - sin\theta)$ $A = \frac{1}{2}(sr \mp l\{r-h\}), (-if\ h \le r;\ +if\ h \ge r)$ $A = \frac{2lh}{3} = \frac{h}{15}(8l^6 + 6l)$ ** ** Approximate Formulas: For h small compared with r, error is small For h = r/4, first formula error is about 3.5% and second less than 1%
Annulus		Surface between two concentric circles $A = \pi(r1^2 - r2^2) = \pi(r1+r2)(r1-r2)$ $A\ of\ sector\ ABCD = \frac{\theta}{2}(r1^2 - r2^2) = \frac{\theta}{2}(r1+r2)(r1-r2)$ $= \frac{1}{2}(s1 + s2)$
Ellipse		$P = \pi(a+b)\left\{1 + \frac{R^2}{4} + \frac{R^4}{64} + \frac{R^6}{256} + \ldots\right\}\ where\ R = \frac{a-b}{a+b}$ $P = \pi(a+b)\frac{64 - 3R^4}{64 - 16R^2}\ Approximate\ Formula$ $A = \pi ab;\ A\ of\ quadrant\ AOB = \frac{\pi ab}{4}$ $A\ of\ sector\ AOP = \frac{ab}{2}cos^{-1}\frac{x}{a};\ A\ of\ sector\ POB = \frac{ab}{2}sin^{-1}\frac{x}{a};$ $A\ of\ sector\ BPP'B; = xy + absin^{-1}\frac{x}{a};$ $A\ of\ segment\ PAP'P = -xy + ab\cos^{-1}\frac{x}{a}$
Parabola		$Arc\ BOC = s = \frac{1}{2}\sqrt{l^2 + 16h^2} + \frac{l^2}{8h}\log_e\frac{4h + \sqrt{l^2 + 16h^2}}{l}$ $Let\ R = \frac{h}{l}, then$ $s = l\left\{1 + \frac{8R^2}{3} - \frac{32R^4}{5} + \cdots\right\}\ approximate\ formula$ $d = \frac{h}{l^2}(l^2 - l1^2); l1 = \frac{l\sqrt{h\ \ - d}}{h}; h = \frac{dl^2}{l^2 - l1^2};$ $A\ segment\ of\ BOC = \frac{2hl}{3};$ $A\ section\ of\ ABCD = \frac{2}{3}d\left(\frac{l^3 - l1^3}{l^2 - l1^2}\right)$
Hyperbola		$A\ of\ figure\ OPAP'O = ab\ \log_e\left(\frac{x}{a} + \frac{y}{b}\right) = ab\ \cosh^{-1}\frac{x}{a};$ $A\ of\ segment\ PAP' = xy - ab\log_e\left(\frac{x}{a} + \frac{y}{b}\right) = xy - ab\cosh^{-1}\frac{x}{a}$
Catenary		$If\ d\ is\ small\ compared\ with\ l:$ $Arc\ MPN = s = l\left[1 + \frac{2}{3}\left(\frac{2d}{l}\right)^2\right]$ approximately
Spiral of Archimedes		$Let\ a = \frac{r}{\theta}, then$ $Arc\ OP = s = [\frac{a}{2}\left(\theta\sqrt{1+\theta^2}\right) + \log_e\left\{\theta + \sqrt{1+\theta^2}\right\}]$

Notations:

A = area C = circumference s = chord of arc P = perimeter θ = angle in radians

PLANE CURVILINEAR FIGURES (cont.)

Irregular Figure



Divide the figure into an even number, n, of strips by means of (n+1) ordinates, $y_{o\sim n}$, spaced equal distances, w. Area can then be determined approximately by any of the following formulas, which are presented in the order of usual increasing approach to accuracy. In any of the first three cases, the greater the number of strips used, the more nearly accurate will be the result.

Approximate formulas:

Trapezoidal Rule: $A = w\{\left(\frac{yo+yn}{2}\right) + y1 + y2 + \cdots + yn - 1\};$

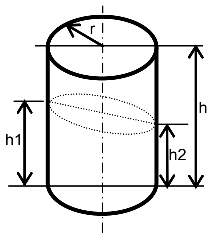
Durand's Rule: $A = w\{0.4(yo+yn) + 1.1(y1 + yn - 1) + y2 + y3 \ldots + yn - 2\};$

Simpson's Rule: $A = \frac{w}{3}[(yo+yn) + 4(y1 + y3 + \cdots + yn - 1) + 2(y2 + y4 + \cdots + yn - 2)]$

Weddle's Rule (for six strips only): $A = \frac{3w}{10}[5(y1 + y3) + 6y3 + yo + y2 + y4 + y6]$

SOLID HAVING CURVED SURFACES

Right Circular Cylinder (and Truncated Right Circular Cylinder)



For right circular cylinder:

$At = 2\pi rh;\ At = 2\pi r(r+h);$

$V = \pi r^2 h$

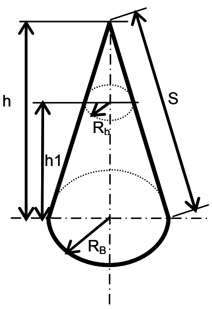
For truncated right circular cylinder:

$At = \pi r(h1 + h2);$

$At = \pi r\left[(h1 + h2) + r + \sqrt{r^2 + \left(\frac{h1 - h2}{2}\right)^2}\right]$

$V = \frac{\pi r^2}{2}(h1 + h2)$

Right Circular Cone (and frustum of Right Circular Cone)



For right circular cone :

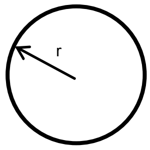
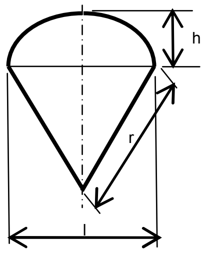
$At = \pi RBs = \pi RB\sqrt{RB^2 + h^2}\ ;\ Ar = \pi RB(RB + s)$ $V = \frac{\pi RB^2}{3}h$

For frustum of right circular cone: $S = \sqrt{h1^2 + (RB - Rb)^2}\ ;$

$At = \pi s(RB + Rb)$ $V = \frac{\pi h1}{3}(RB^2 + Rb^2 + RBRb)$

Notations:

A = area	C = circumference	s = chord of segment	V = volume
P = perimeter	θ = angle in radians	At = total area	

SOLID HAVING CURVED SURFACES (cont.)		
Sphere		Let diameter = d $At = 4\pi r^2 = \pi d^2$ $V = \frac{4\pi r^3}{3} = \frac{\pi d^3}{6}$
Spherical Sector (and Hemisphere)		For spherical sector: $At = \frac{\pi r}{2}(4h + l); V = \frac{2\pi h r^2}{3}$ For hemisphere (Letting h = l/2 = r): $At = 3\pi r^2; V = \frac{2\pi r^3}{3}$

Notations:

A = area　C = circumference　s = chord of segment　V = volume

P = perimeter　θ = angle in radians　At = total area

A.2. Relative density

For guidance purposes, the following are the relative density of commonly used aggregates and bitumen in United Arab Emirates (UAE). Estimators should note that the relative density may vary from the ranges provided below, depending upon the source of the material.

Specific Gravity of Aggregates		
A) Concrete Aggregate		
Aggregate Size	**Relative Density (Specific Gravity)**	**Remarks**
20 mm	2.81 – 2.85	Coarse Crushed Rock
10 mm	2.81 – 2.85	
5 mm	2.81 – 2.85	Sand Crushed Rock
1 mm	2.66 – 2.69	Sand Uncrushed
Note: Permissible Limit, Specific Gravity for Concrete Aggregate = Minimum 2.60		
B) Asphalt Aggregate		
Aggregate Size	**Relative Density (Specific Gravity)**	**Remarks**
32 mm	2.91 – 2.95	Coarse Crushed Rock (Asbestos Base Course)
20 mm	2.91 – 2.99	
10 mm	2.92 – 2.99	
5 mm	2.91 – 2.98	

Density Of Bituminous Material		
Asphalt Cement Penetration 60/70	**1.034**	Bahrain Petroleum Co.

Steel Weight	
Structural Steel	$\mathbf{7.856\ x\ 10^3\ Kg/m^3}$

APPENDIX B: WEIGHTS AND MEASURES

Metric System

Table B-9: Linear Measure

10 mm	= 1 cm	= 0.3937 in.
10 cm	= 1 decimetre	= 3.937 in.
10 dm	= 1 m	= 39.37 in. or 3.28 ft.
10 m	= 1 dm	= 393.7 in.
10 dm	= 1 hm	= 328 ft. 1 in.
10 hm	= 1 km	= 0.621 mi.

Table B-10: Square Measure

100 mm^2	= 1 cm^2	= 0.15499 sq. in.
100 cm^2	= 1 dm^2	= 15.499 sq. in.
100 dm^2	= 1 m^2	= 1,549.9 sq. in. = 1.196 sq. yd.
100 m^2	= 1 dm^2	= 119.6 sq. yd.
100 dm^2	= 1 hm^2	= 2.471 acres
100 hm^2	= 1 km^2	= 0.386 sq. mi.

Table B-11: Land Measure

1 m^2		= 1,549.9 sq. in.
100 m^2	= 1 acre	= 119.6 sq. yd.
100 acres	= 1 ha	= 2.471 acres
100 ha	= 1 km^2	= 0.386 sq. mi.

Table B-12: Volume Measure

1,000 mm^3	= 1 cm^3	= 0.06102 cu. in.
1,000 cm^3	= 1 dm^3	= 61.02 cu. in.
1,000 dm^3	= 1 m^3	= 35.314 cu. ft.

Table B-13: Weights

10 grams	= 1/100 kg	= 1 dag
1000 grams	= 1 kg	= 2.2046 lb.
1000 kg	= 1 t	= 2,204.6 lb.

American and British Imperial Units

Table B-14: Linear Measure

1 in.		= 2.54 cm
12 in.	= 1 ft.	= 0.3048 m
3 ft.	= 1 yd.	= 0.9144 m
5 1/2 yd. 16 1/2 ft.	= 1 rod (or pole or perch)	= 5.029 m
40 rods	= 1 furlong	= 201.17 m
8 furlongs 1,760 yd. 5,280 ft.	= 1 (statute) mi.	= 1,609.3 m
3 mi.	= 1 (land) league	= 4.83 km

Table B-15: Square Measure

1 sq. in.	= 6.452 cm^2	
144 sq. in.	= 1 sq. ft.	= 929 cm^2
9 sq. ft.	= 1 sq. yd.	= 0.8361 m^2
30 1/4 sq. yd.	= 1 sq. rod = sq. pole = sq. perch	= 25.29 m^2
160 sq. rods 4,840 sq. yd. 43,560 sq. ft.	= 1 acre	= 0.4047 ha
640 acres	= 1 sq. mi.	= 259 ha = 2.59 km^2

Table B-16: Cubic Measure

1 cu. in.		= 16,387 cm^3
1,728 cu. in.	= 1 cu. ft.	= 0.0283 m^3
27 cu. ft.	= 1 cu. yd.	= 0.7646 m^3

16 cu. ft.		= 1 cord ft.
8 cord ft.	= 1 cord	= 3.625 m^3

Table B-17: Dry Measure

1 pt.	= 33.60 cu. in.		= 0.5505 l
2 pt.	= 1 qt.	= 67.20 cu. in.	= 1.1012 l
8 qt.	= 1 peck	= 537.61 cu. in.	= 8.8096 l
4 pecks	= 1 bushel	= 2,150.42 cu. in.	= 35.2383 l

Table B-18: Liquid Measure

1 gill	= 4 fluid ounces	= 7.219 cu. in.	= 0.1183 l
4 gills	= 1 pt.	= 28.875 cu. in.	= 0.4732 l
2 pt.	= 1 qt.	= 57.75 cu. in.	= 0.9463 l
4 qt.	= 1 gal.	= 231 cu. in.	= 3.7853 l

One British imperial gal. (4 imperial qt.) = 277.42 cu. in. = 4.546 l.
The barrel in Great Britain equals 36 imperial gal., in the United States, usually 31.5 gal.

Table B-19: Avoirdupois Weight

1 dram or 27.34 grains	= 1.772 grams	
16 drams or 437.5 grains	= 1 ounce	= 28.3495 grams
16 ounces or 7,000 grains	= 1 lb.	= 453.59 grams
100 lb.	= 1 hundredweight	= 45.36 kg
2,000 lb.	= 1 ton	= 907.18 kg

One grain is equal to 0.0648 gram
In Great Britain, 14 lb. (6.35 kg) = 1 stone, 112 lb. (50.80 kg) = 1 hundred weight, and 2,240 lb. (1,016.05 kg) = 1 long ton.

APPENDIX C: EXAMPLE OF ESCALATION

C.1. Introduction

Escalation is the provision in a cost estimate to account for future increases or decreases in the costs of equipment, material, and labour. If properly used, the escalation adjustment is a reliable tool to estimate the future costs of a project or to bring historical costs to the present. Cost estimating is usually performed in current dirhams, and then escalated to the time when the project will be accomplished.

C.2. Example of escalation

Project durations usually extend over a year, or several years in the case of major projects. It is therefore necessary to have a method of forecasting the funds that must be made available in the future for completion of the work. This is where forecast escalation indices are used. Current year's cost estimate is divided into components grouped to match the available predictive escalation indices. Then each group of components is multiplied by the appropriate escalation index. Costs of these components are then summed to give the total cost of the project. Escalation accuracy for the total project increases with the number of schedule activities used in summation.

To properly apply escalation indices for a particular project, the following data is required:

- Escalation index, including issue date and index, used to prepare the estimate;
- Current schedule, with start and completion dates of scheduled activities; and,
- Reference date the estimate was prepared.

Escalation should be used in all estimates in which total project cost may be impacted due to inflation or increases in unit costs. Generic steps for calculating escalation include the following:

Step 1

Complete the cost estimate and schedule for the completion of the project (for cost estimate purposes, the method does not matter; however, it should be organised by WBS).

Step 2

Determine the midpoint of scheduled activities (typically, an upper-level WBS is necessary to segregate types of activities such as design or construction). It is not necessary to calculate escalation at the lowest levels of activities, because most activities are grouped into logistical WBS elements.

Step 3

Select appropriate escalation factors. These rates are typically based on locally documented information.

Step 4

Calculate escalation for each scheduled activity by using the estimate preparation date as a starting point and applying the escalation rates selected in Step 3 to midpoint dates determined in Step 2.

Following is an example of a five-year project that requires escalation calculations to determine the total project costs in the base year's Dirhams (estimate reference date is January 1, 2005).

Step 1 – Determine midpoint of schedule activity.

Table C-1: Escalation example – midpoint of schedule activity

WBS	Scheduled Activity	Total Base Cost (000Dhs)	Start	Complete	Duration (months)	Midpoint
A100	Preliminary design	200	1-May-05	31-Oct-05	6	1-Aug-05
A200	Detailed design	400	1-Nov-05	30-Apr-06	6	1-Feb-06
A300	Contract document and tender award	50	1-May-06	31-Aug-06	4	1-Jul-06
A400	Construction	30,000	1-Sep-06	29-Feb-08	18	1-Jun-07
A500	Project management	750	1-May-05	29-Feb-08	34	1-Oct-06
A600	Construction management	900	1-May-05	29-Feb-08	34	1-Oct-06
A700	Project support	500	1-May-05	29-Feb-08	34	1-Oct-06

Step 2 – Select appropriate predictive escalation rates (assumed, for example).

Table C-1: Escalation example – escalation rates

Year	Escalation
2005	7%
2006	8%
2007	10.80%
2008	9.26%
2009	(4.09%)

Step 3 – Calculate appropriate escalation rates for each scheduled activity, using the estimate preparation date as a starting point, and apply the escalation rates in Step 2 to the midpoint dates determined in Step 1. (For example, A400 – Construction [midpoint: June 1, 2007]).

Table C-2: Escalation example – appropriate escalation rates

FY (Fiscal year) Period	Years	Escalation Index	Escalation Factor
01-Jan-05 to 31-Dec-05	1.0	0.07	0.07
01-Jan-06 to 31-Dec-06	1.0	0.08	0.08
01-Jan-07 to 01-Jun-07	0.417	0.108	0.045

Compound Escalation = 1.07 x 1.08 x 1.045 = 1.2076 or 20.76%

Assume that costs for A400 – Construction are AED 30 million for the base year and the escalated value would be:

AED 30,000,000 x 1.2076 = 36,228,000

Thus, the cost used for A400 – Construction in the total project cost is AED 36,228,000.

Repetition of calculation is obvious. Table C-5 shows a sample, detailed spreadsheet of escalation rates applied in preparing the following sample project cost estimate summary.

Table C-3: Sample project cost estimate summary – includes escalation

WBS	Scheduled Activity	Total Base Cost (000Dhs)	Start	Complete	Duration (months)	Midpoint	Compounded Escalation Rate	Total Escalated Cost (000Dhs)
A100	Preliminary design	200	1-May-05	31-Oct-05	6	1-Aug-05	4.08%	208.16
A200	Detailed design	400	1-Nov-05	30-Apr-06	6	1-Feb-06	7.71%	430.84
A300	Contract document and tender award	50	1-May-06	31-Aug-06	4	1-Jul-06	11.28%	55.64
A400	Construction	30,000	1-Sep-06	29-Feb-08	18	1-Jun-07	20.76%	36,228.00
A500	Project management	750	1-May-05	29-Feb-08	34	1-Oct-06	24.92%	936.90
A600	Construction management	900	1-May-05	29-Feb-08	34	1-Oct-06	24.92%	1124.28
A700	Project support	500	1-May-05	29-Feb-08	34	1-Oct-06	24.92%	624.60
	Total	**32,800**						**39,608.42**

Table C-4: Escalation rates distribution (based on assumed escalation in Step 2)

Months of Escalation		0	1	2	3	4	5	6	7	8	9	10	11	12
FY	**Escalation Rate**													
2005	7.00%	0.00%	0.58%	1.17%	1.75%	2.33%	2.92%	3.50%	4.08%	4.67%	5.25%	5.83%	6.42%	7.00%
2006	8.00%	7.00%	7.71%	8.43%	9.14%	9.85%	10.57%	11.28%	11.99%	12.71%	13.42%	14.13%	14.85%	15.56%
2007	10.80%	15.56%	16.6%	17.64%	18.68%	19.72%	20.76%	21.8%	22.84%	23.88%	24.92%	25.96%	27%	28.04%
2008	9.26%	28.04%	29.03%	30.02%	31%	31.99%	32.98%	33.97%	34.96%	35.94%	36.93%	37.92%	38.91%	39.9%
2009	-4.09%	39.9%	39.42%	38.95%	38.47%	37.99%	37.52%	37.04%	36.56%	36.09%	35.61%	35.13%	34.65%	34.18%

C.3. Escalation relationships

Escalation and inflation in cost estimating are used for two main purposes: (a) to convert historical costs to current costs using the historical escalation index; and, (b) to escalate current costs into the future using the predictive escalation index. Historical cost data are frequently used to estimate the cost of future projects, and therefore, it is necessary to bring the historical cost to the present using the historical escalation index and use the predictive escalation index to predict the cost to the future.

a. Historical escalation

Historical escalation is easily evaluated. For example, the cost of reinforcement in 1991 differed from 2005. Ratios of the two costs expressed as a percentage is the escalation, which, when expressed as a decimal number, is the index. Generally, escalation indices should be grouped. For example, all types of concrete works may be grouped together, and a historical escalation index determined for the group.

b. Predictive escalation

Predictive escalation indices are obtained from forecasting services, which supply their most current predictions using an econometric model. They are the ratio of the future value to the current value, expressed as a decimal. Predictive escalation indices are typically prepared for various groups and may be different for different groups. For example, the escalation index for earthwork may be different than the one for concreting.

C.4. Escalation application

The Owner requires that economic escalation be applied to all estimates to accommodate the impact of economic forces on the prices of labour, material, and equipment — in accordance with the following requirements:

- Escalation shall be applied for the period from the date the estimate was prepared to the midpoint of the performance schedule;
- Economic escalation rates are usually revised annually; therefore, all estimates shall include the issue date of the escalation rates used to prepare the estimate; and,
- Costs used for the design concept shall be fully escalated and referenced, as required.

C.5. Escalation indices

Costs are never stable and are continuously changing due to inflation, the changing value of monetary units, changing technology, and changing availability of materials and labour. Escalation indices are therefore developed to keep up with these changing costs. Estimators should choose the escalation indices based on the indices provided by the Abu Dhabi Statistical Centre. Additionally, the Consumer Price Index (CPI) can also be used; however, the Estimator should verify its relevance. To ensure the proper usage of an index, an understanding of how it is developed and its basis is required.

a. Limitations

Cost indices have limitations because they are developed based on average data. Thus, judgment is required to decide whether an index applies to a specific cost being updated. When using an index for a long-term project, proper precautions must be adopted for its long-term accuracy.

C.6. Price adjustment due to escalation during construction stage

Common price adjustment practises, due to escalation during the construction stage, is to adjust the base price of the preselected elements by changes in their respective rates. Usually major elements of the project are allocated percentage weight and the price index at the beginning of the project is agreed. Certain portions of the base price may be kept fixed, depending upon the nature of project, and this is commonly referred to as the fixed portion and is the element of the contract price that is not subject to price adjustment. This principle is also adopted by FIDIC 1999 Conditions of Contract. Allotted escalation factors, or percentage weightage, are important in allocating risk between Client and the Contractor.

Example of a basic escalation formula using index values

A = P x ((a x L1/ L0) + (S x C1/C0) + (c x S1/S0) + d))

Where:

A = monthly payment value in accordance with contract after adjustment for price escalation
P = value of monthly payment
a = agreed proportion for labour = 30 percent
L0 = base labour price
L1 = current labour price
b = agreed proportion for concrete = 25 percent
F0 = base concrete price
F1 = current concrete price
c = agreed proportion for steel = 10 percent
S0 = base steel index
S1 = current steel index
d = Agreed constant = 35 percent

APPENDIX D: EXAMPLE OF COST-BASED UNIT PRICE

Project Name and Number: DoT – Improvement of XYZ Road
Pay Item Number: 20010-24
Description: Excavation for cuttings; material other than top soil, rock, or artificial hard material
Quantity: 100000
Unit: Cubic Meter

ASSUMPTIONS		
Description	**Assumed Value**	**Remarks**
Haul Assumptions		
Type of haul vehicle	10 wheeler	
Haul vehicle capacity (CM)	10	
Number of haul vehicles	5	
Load time (1) (minutes)	5	
Dump time (2) (minutes)	10	Includes turnaround time
Haul speed (KMPH)	30	Slower speed when fully loaded
Return speed (KMPH)	40	Speed limit along haul route
Haul distance (KM)	3.0	Average haul distance
Shift length (hours)	10	
Efficiency factor (3)	85%	Inefficiencies include traffic restrictions, night work, excessive OT, breakdowns, weather, coffee breaks, etc.
Excavation Assumptions		
Blasting required?	No	
Is the material rippable?	Yes	Assumed common material rippable with excavator

Production rate	100 cum/hr	
Haul road grade and maintain		
Production rate	0.25 km/day	

(1) Default load time = 5 minutes

(2) Default dump time = 10 minutes

(3) Default efficiency factor = 85%

EXCAVATION EQUIPMENT									
Description (1)	**Quantity**	**Unit**	**Cost/Unit** AED	**Subtotal** AED	**Overhead** (4)	**Subtotal** AED	**Profit** (5)	**Total AED**	**Remarks**
Dozer D8	1,000	hour	240.00	240,000.00	10%	264,000.00	8%	285,120.00	
TOTAL =							**AED**	**285,120.00**	

EXCAVATION LABOUR											
Description (1)	**Quantity**	**Unit**	**Cost/Unit** (2) AED	**Subtotal AED**	**Payroll Burden** (3)	**Subtotal AED**	**Overhead** (4)	**Subtotal AED**	**Profit** (5)	**Total AED**	**Remarks**
Equipment operator	1,000	hour	20.00	20,000.00	30%	26,000.00	10%	28,600.00	8%	30,888.00	
Chargehand	1,000	hour	25.00	25,000.00	30%	32,500.00	10%	35,750.00	8%	38,610.00	
Grade checker	1,000	hour	10.00	10,000.00	30%	13,000.00	10%	14,300.00	8%	15,444.00	
TOTAL =									**AED**	**84,942.00**	

1) These are typical types of labour used in this operation. Adjust for any project-specific requirements.

2) Use historical rates; use judgement where rates are not available.

3) Default payroll burden = 30%

4) Default overhead = 10%

5) Default profit = 8%

Excavation Equipment Price =	AED 285,120.00
Excavation Labour Price =	AED 84,942.00
Total Excavation =	CM 100,000.00
Total Cost/Unit for Excavation =	**AED 3.70**

EXCAVATION UNIT PRICE =	**AED 3.70 per CM**

LOAD AND TRANSPORT TO A SITE STOCK PILE USING 966 (EQUIPMENT COST PER HOUR)								
Description (1)	**Quantity**	**Cost/Hour (2) AED**	**Total Price/ Hour (3) AED**	**Overhead (4)**	**Subtotal AED**	**Profit (5)**	**Total AED**	**Remarks**
Haul vehicle	5	100.00	500.00	10%	550.00	8%	594.00	
Cat 966 Loader	1	130.00	130.00	10%	143.00	8%	154.44	
TOTAL HAUL EQUIPMENT =						**AED**	**748.44**	

1) These are typical types of equipment used in this operation. Adjust for any project-specific requirements.

2) These costs/unit can be obtained from historical bid prices.

3) Default payroll burden = 30%

4) Default overhead = 10%

5) Default profit = 8%

HAUL LABOUR										
Description [(1)]	**Quantity**	**Cost/Unit [(2)] AED**	**Subtotal**	**Payroll Burden [(3)] AED**	**Subtotal**	**Overhead [(4)] AED**	**Subtotal**	**Profit [(5)] AED**	**Total**	**Remarks**
Truck drivers	5	18.00	90.00	30%	117.00	10%	128.70	8%	139.00	
Operators	1	20.00	20.00	30%	26.00	10%	28.60	8%	30.89	
Trip checker	1	12.00	12.00	30%	15.60	10%	17.16	8%	18.53	
Dumpman	1	10.00	10.00	30%	13.00	10%	14.30	8%	15.44	
TOTAL HAUL LABOUR =								**AED**	**203.86**	

1) These are typical types of equipment used in this operation. Adjust for any project-specific requirements.

2) These costs/unit can be obtained from historical bid prices.

3) Default payroll burden = 30%

4) Default overhead = 10%

5) Default profit = 8%

CYCLE TIME		
	Hours	**Remarks**
Load Time =	0.08	
Haul Time =	0.10	
Dump Time =	0.17	
Return Time =	0.08	
HOURS PER CYCLE =	**0.51**	Adjusted by efficiency factor

Number of Cycles =	2,000	Qty of EW / (No. of haul vehicle x vehicle capacity)
Total Number of Hours =	1,020.0	Number of cycles x cycle time
Total Cost to Haul and Place Roadway Excavation Material =	AED 971,346.82	= Total number of hrs x (haul labour + haul equipment)
Total Cost/Unit for Haul =	**AED 9.71**	= Total cost / total qty. of earthwork (EW)

HAUL UNIT PRICE =	**AED 9.71**	**per CM**

HAUL ROAD GRADE AND MAINTAIN (LABOUR COST PER HOUR)									
Description [1]	**Quantity**	**Unit**	**Cost/Unit (Includes Overhead and Profit) [2] (AED)**	**Total Price**	**Overhead [4]**	**Subtotal (AED)**	**Profit [5]**	**Total (AED)**	**Remarks**
Motor Grader 14G	140	hour	115.00	16,100.00	10%	17,710.00	8%	19,126.80	3 km at 0.25 km/day = 12 days +
6,000 gal. water truck	140	hour	75.00	10,500.00	10%	11,550.00	8%	12,474.00	Maintenance every month (2 days)
Roller vibrating single drum	140	hour	60.00	8,400.00	10%	9,240.00	8%	9,979.20	
TOTAL EQUIPMENT =								**41,580.00**	

1) These are typical types of labour used in this operation. Adjust for any project-specific requirements.

2) Use historical rates; use judgement where rates aren't available.

3) Default payroll burden = 30%

4) Default overhead = 10%

5) Default profit =8%

HAUL ROAD GRADE AND MAINTAIN (EQUIPMENT COST PER HOUR)											
Description [(1)]	Quantity	Unit	Cost/Unit [(2)] (AED)	Subtotal (AED)	Payroll Burden [(3)]	Subtotal (AED)	Overhead [(4)]	Subtotal (AED)	Profit [(5)]	Total (AED)	Remarks
Chargehand	140	hour	20.00	2,800.00	30%	3,640.00	10%	4,004.00	8%	4,324.32	
Labour	140	hour	10.00	1,400.00	30%	1,820.00	10%	2,002.00	8%	2,162.16	
Truck driver	140	hour	18.00	2,520.00	30%	3,276.00	10%	3,603.60	8%	3,891.89	
Operator – Grader	140	hour	20.00	2,800.00	30%	3,640.00	10%	4,004.00	8%	4,324.32	
Operator – Vibrator	140	hour	20.00	2,800.00	30%	3,640.00	10%	4,004.00	8%	4,324.32	
TOTAL LABOUR =										**19,027.01**	

1) These are typical types of labour used in this operation. Adjust for any project-specific requirements.

2) Use historical rates; use judgement where rates aren't available.

3) Default payroll burden = 30%

4) Default overhead = 10%

5) Default profit = 8%

Equipment price =	AED 41,580.00
Labour price =	AED 19,027.01
Total Cost/Unit form Finishing =	**AED 0.61**

FINISHING UNIT PRICE =	**AED 0.61**	**per CM**

TOTAL UNIT PRICE (EXCAVATION + HAUL + HAUL ROAD MAINTAIN) =	**AED 14.02**	**per CM**

APPENDIX E: ESTIMATE INPUT CHECKLIST

This schedule describes the level of information that should be provided at each respective stage.

Information provided at the development phase is influenced by the procurement strategy. For example, designed and built procurement path would not require a detailed reference design.

Project Data	Project Initiation / Feasibility Phase	Procurement Strategy / Preliminary Design Phase	Detailed Design / Construction Procurement Phase
General			
Performance and Functionality Requirements	General description	Developing definition	Defined
Project Scope Description	General description	Developing definition	Defined
Alignment – Horizontal	Assumed (*e.g.*, on map, photo)		
Alignment – Vertical	Assumptions described		
Survey	Maps/boundaries overlaid on photomaps	Preliminary survey details, identify problem areas	Detailed survey
Property Requirements	Major requirements and assumptions noted	Preliminary schedule of properties prepared	Complete schedule of properties
Geotechnical	Regional data, data from surrounding projects, knowledge	Limited investigation	Detailed investigation

Project Data	Project Initiation / Feasibility Phase	Procurement Strategy / Preliminary Design Phase	Detailed Design / Construction Procurement Phase
Community	Assumptions, key issues	Preliminary studies and consultation with the community, to the extent possible	Full consultation and requirements identified
Noise Studies	Assumptions, key issues	Preliminary studies, consultation	Full consultation
Escalation	Apply escalation factors at overall level	Based on preliminary cash flow	Based on developed cash flow
WBS	Level 1/2	Level 2/3	Level 3
Contracting Strategy	Assumption	Preliminary	Defined
Engineering Documentation			
Utility Adjustments	Assumptions and research for major issues	Limited research	Detailed research and documentation
Bulk Earthworks	Assumptions, based on experienced judgement	Preliminary cut and fill quantities, key sections	Confirmed cut and fill quantities, all sections
Drainage	Key areas identified, otherwise, assumptions	Preliminary layout, sizing of major items	Detailed layout, sizing of all items
Retaining Walls	Major locations identified, otherwise, assumptions	Locations and extent defined, assumed types	Locations and extent defined, defined types

Project Data	Project Initiation / Feasibility Phase	Procurement Strategy / Preliminary Design Phase	Detailed Design / Construction Procurement Phase
Bridges	Locations identified (typical solutions assumed)	Preliminary designs, sizes available for all structures	Detailed designs, sizes available for all structures
Pavement	Preliminary types identified	Developed types and locations shown	Detailed types and locations shown
Noise Barriers	Assumed possible locations	Extent and type shown, typical solutions	Extent and type shown, detailed solutions
Road Lighting	Assumption only	Assumptions, shown by locations	Detailed extent shown
Road Furniture and Safety Barriers	Assumption only	Assumptions, shown by locations	Detailed extent shown
Road Markings and Signage	Assumption only	Assumptions, shown by locations	Detailed extent shown
Traffic Signals	Assumed locations	Preliminary extent	Detailed extent shown
Landscaping	Assumptions only, key issues identified	Preliminary scope	Detailed scope

APPENDIX F: SITE VISIT/DATA COLLECTION CHECKLIST – IMPACT ON PROJECT

Project No.	
Project description:	
Location:	
Date of visit:	

Attendance at the site visit:

Attendee	Organisation

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
1.0	**POLITICAL**					
1.1	Sensitive issues					
1.2	Works on local government roads					
1.3	Community expectations					
2.0	**CLIMATE**					
2.1	Average summer temperature					
2.2	Summer work-hour restrictions					
2.3	Average annual rainfall					
2.4	Average annual wet days					

Lines formatting

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
2.5	Likelihood of flooding					
3.0	**TOPOGRAPHY**					
3.1	Geotechnical data					
3.2	Foundation bore logs					
3.3	Water table					
4.0	**ROW ACQUISITION**					
4.1	Resumption from properties					
4.2	Accommodation works					
4.3	Fencing					
4.4	Names of affected property owners					
5.0	**ENVIRONMENT**					
5.1	Air quality					
5.2	Water quality					
5.3	Contaminated land					
5.4	Hazardous materials					
5.5	Disturbance of canal or waterway					
5.6	Marine habitat					
5.7	Cultural heritage					
5.8	Erosion and sediment control					
5.9	Temporary structures					
6.0	**SAFETY**					
6.1	Safety of workers					
6.2	Safety of pedestrians					

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
6.3	Safety of traffic					
7.0	**TRAFFIC**					
7.1	Traffic management					
7.2	Traffic diversions					
7.3	Temporary works (*e.g.*, pavement widening, sidetracks, etc.)					
7.4	Construction haul roads					
8.0	**UTILITIES**					
8.1	Diversion requirement to electricity works					
8.2	Diversion requirement to telecommunication works					
8.3	Diversion requirement to gas works					
8.4	Diversion requirement to water, irrigations, and local services					
8.5	Diversion requirement to drainage, sewerage services					
8.6	Diversion requirement to military services					
9.0	**SITE FACILITIES**					
9.1	Location of site accommodation					
9.2	Accommodation required					
9.3	Security					
9.4	Construction water supply					

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
9.5	Permits and fees					
10.0	**ACCESS**					
10.1	Nearest centre					
10.2	Property access					
10.3	Public transport					
10.4	Construction access, including restrictions					
11.0	**CLEARING**					
11.1	Clearing limits					
11.2	Vegetation density					
11.3	Construction methods (*e.g.*, chipping, dozer, excavator, etc.)					
11.4	Removal of structures					
11.5	Preservation of heritage sites					
12.0	**EARTHWORKS**					
12.1	Mass haul diagram					
12.2	Borrow and spoil areas					
12.3	Rock					
12.4	Construction methods					
12.5	Stripped material stockpile areas					
12.6	Unsuitable material to be removed and disposed					
13.0	**LONGITUDINAL AND CROSS DRAINAGE**					
13.1	Access to site					

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
13.2	Excavation of rock					
13.3	Unsuitable material to be removed and replaced below structures					
13.4	Depth of trenching					
13.5	Shoring					
13.6	Construction method					
13.7	Exposure to flooding					
13.8	Dewatering					
14.0	**BRIDGES**					
14.1	Site establishment					
14.2	Access roads and hard stand areas					
14.3	Construction methods					
14.4	Dewatering					
14.5	Exposure to flooding					
14.6	Canal/stream crossing					
15.0	**RETAINING WALLS**					
15.1	Type of wall (soil or retaining)					
15.2	Foundation investigations					
15.3	Construction method					
16.0	**PAVEMENT**					
16.1	Design method (*e.g.*, whole-of-life, capital cost analysis)					
16.2	Material supply/availability					
16.3	Construction method					

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
16.4	Stockpile sites					
17.0	**TRAFFIC CONTROL**					
17.1	Existing signs and road markings to be removed					
17.2	New signing					
17.3	Temporary signing and road markings					
17.4	Traffic controllers					
17.5	Traffic barriers					
17.6	Temporary signals					
18.0	**STREET LIGHTING**					
18.1	Existing lighting to be removed					
18.2	New lighting					
18.3	Temporary lighting					
18.4	Construction lighting					
19.0	**PROJECT MANAGEMENT**					
19.1	Programme of works					
19.2	Staging for construction					
19.3	Possession of site					
19.4	Separable portions					
19.5	Community consultation					
19.6	Workplace relations					
20.0	**DIRECT LABOUR**					
20.1	Site allowance					

Ref.	Item	Impact On Project				Remarks
		Low	Moderate	High	Extreme	
20.2	Accommodation					
20.3	Travel arrangement					
21.0	**SITE MANAGEMENT**					
21.1	On-site staff					
21.2	Project office					

APPENDIX G: ESTIMATE PEER REVIEW CHECKLIST

G.1. Peer Review Checklist for Conceptual Estimates

PROJECT NO.	
PROJECT DESCRIPTION:	
LOCATION	
DATE OF VISIT	Lines formatting
ESTIMATE OF COST	**DATE:**

Activity/Task	Verification ✓ - Yes, ✗ - No N/A	Evidence	File Ref/Remarks
Review of project management process.			
Geographical limits of the project set?			
Number of traffic lanes determined?			
Intersections or interchanges properly determined?			
Design cross section provided?			
Pavement life determined?			
Number, type, and lengths of major structures determined?			
Known risks listed?			
Information collected on development, design, property acquisitions, public utilities, and construction?			
Cost data collected and properly documented?			

Activity/Task	Verification ✓ - Yes, ✗ - No N/A	Evidence	File Ref/Remarks
Differences between this project and comparable project considered?			
Individual project item estimates prepared?			
Are all major assumptions used in developing the scope for the project clearly identified and justified in the documentation?			
Contingency escalation allowances added?			
Overall estimate compiled in standard format?			
Check project objectives and scope are acceptable to the Client?			
Reality checks provided?			
Sign off checklist?			

Above activities have/have not been satisfactorily completed

Comments/Actions (attach details if required)

Signed: ……………………………………………….. **Date:** ……………………………….

Name (Print): ………………………………………

Estimate Peer Reviewer

Response:

Signed: ……………………………………………….. **Date:** ……………………………….

Name (Print): ………………………………………

Project Manager

G.2. Peer Review Checklist for Detailed Estimates

PROJECT NO.	
PROJECT DESCRIPTION:	
LOCATION	
DATE OF VISIT	
ESTIMATE OF COST	**DATE:**

ACTIVITY/TASK	Verification ✓ - Yes, ✗ - No N/A	Evidence	File Ref/Remarks
Review of project management process.			
Checks for technical scope documentation include the following: ➢ Description of the works to be carried out under the project; ➢ End product of scope of works; ➢ Performance criteria and requirements; ➢ Tasks and deliverables; ➢ Sequence of events and discrete milestones; ➢ Work not included in the scope; and, ➢ Geographical limits of the project.			
Does the technical scope include for support activities (*e.g.*, health and safety, traffic management, QA etc.) related with the works to be carried out?			
If the project contains milestones, does the documentation include a milestone log and description sheets of each milestone related with the project?			
Is the scope for the estimate consistent with the work objectives, regulatory drivers, and constraints (*e.g.*, service			

ACTIVITY/TASK	Verification ✓ - Yes, ✗ - No N/A	Evidence	File Ref/Remarks
authorities' requirements, other local authorities)?			
Is historical cost data collected and included in the cost estimate for the activities for which costs have been estimated?			
Does the cost estimate show clearly each activity broken down into the quantity associated with each activity and costs incurred per unit quantity?			
Are indirect, overhead, or other costs included in the cost estimate?			
Are all remaining major assumptions used in developing the scope for the project clearly identified and justified in the documentation?			
Has the cost estimate been updated in a timely manner in response to relevant changes in its basis, background data, or assumptions?			
Does the estimate development history include an itemised and chronological list of the changes made to the cost estimate since initiation of its preparation, and the rationale for each change?			
Has an estimate-specific WBS been developed for the program?			
Is the WBS logical and consistent?			
Is the cost estimate activity based?			
Are activities, quantities, and unit costs associated with the work clearly identified and defined in the cost estimate?			
Are escalation factors used to escalate the cost estimate documented properly and appropriately applied?			

ACTIVITY/TASK	Verification ✓ - Yes, ✗ - No N/A	Evidence	File Ref/Remarks
Is an estimate criteria document included in the cost estimate?			
Does the estimate criteria document clearly describe the methodology by which the cost estimate was developed?			
Is backup for contingencies attached?			
Is the overall estimate complied in standard format?			
Are reality checks provided?			

Above activities have/have not been satisfactorily completed

Comments/Actions (attach details if required)

Signed: ……………………………………………….. **Date:** ………………………………

Name (Print): ………………………………………

Estimate Peer Reviewer

Response:

Signed: ……………………………………………….. **Date:** ………………………………

Name (Print): ………………………………………

Project Manager

APPENDIX H: PROJECT REPORT FORMAT

Project name

TYPE THE DOCUMENT TITLE

[Under document title, enter the type of document, such as Project Proposal/Option Analysis/ Concept/Preliminary Design/Detailed Design, etc.]

[Pick the date]

Guidelines for completing the templates

- This document should be managed in accordance with the Client's requirements.
- Templates should be completed in such a way that is clear and easy to understand, well punctuated, and grammatically correct.
- Every section in this template should be addressed. If the section is not relevant to the Project, use "not applicable to this project."
- If required, information can be presented in table form, where it is more efficient and effective to read and understand.
- All of the relevant documents should be attached. Appendices at the back of the document have been generally developed for major projects and may need to be modified based on the size and complexity of the Project.
- It could be useful to refer to a prior completed submission as an example of how to complete this document.

Check list (depending on type of estimate)

- Objectives and real underlying problems to be addressed have been identified.
- Products or services to be delivered have been clearly determined.
- Scope is clearly defined (*e.g.*, inclusions and exclusions).
- Risk register is attached, including assessment and control measures.
- Performance of the Project has been assessed against predetermined success criteria.
- Recommended plan for the next stage is included.

Revision Control

Revision #	Revision Date	Revision by	Nature of revision

Details

Prepared by: Name of the person/organisation
Title: Job title (if individual name mentioned above)
Address: Address of the preparer
Version: 1
Version date: dd/mm/yyyy
Status: Consultant Draft/Approved Document/Minor Revision/Major Revision

Table of Contents

Executive summary

Summarise the important points, for example:

- Describe briefly the Project location or problems resolved due to the proposed project;
- Describe the problem or opportunity and identify the scope;
- List the outcomes and benefits from the Project; and,
- Outline the key risks and issues.

1 Introduction

1.1 Purpose

Identify the purpose of preparing this document under this section (please do not explain the Project here). Document purposes will depend upon the type of estimate. For example, the purpose of the Project proposal is to:

- Establish the link to the Client's goals and objectives;
- Explain and confirm the need for the Project;
- Establish project outcome requirements;
- Obtain support from the Client for management of the Project; and,
- Obtain funding for further phases.

1.2 References

Provide a list of documents that are referred to in this document. Also include all previous documentation prepared as part of this project.

1.3 Definitions

In this section, define the terms that may not be understood by the readers, including specific terms, abbreviations, and acronyms.

2 Management

2.1. Project manager

Appointed by the Client to manage the Project.

- ❖ Enter the name of the Project manager.

2.2. Management structure

Provide a brief outline of the Client's management structure involved in the Project.

3 Project purpose

3.1 Background and current situation

Provide a brief history of the Project including details about the following:

- How the Project was initiated.
- What are the reasons for initiating the Project?
- Describe the current site situation, including problem, needs, etc.
- Problems this project will address.
- Past engagement with the communities and developers, issues, and outcomes.
- List important decisions from previous project phases, if any.
- Benchmarking.
- What are the steps taken in developing this document? For example, this could include investigations carried out to date, information sources, etc.

3.2 Outcomes and benefits

Define the resultant outcomes and benefits from this project.

4 Project scope

4.1 Inclusions

- ❖ Define the scope of work included in the Project or update, as necessary, and the scope outlined in any previous documentation. Guidance on establishing the scope is provided below.

Guidance for scope development (also refer to Section 3.1 of these standard specifications):

Item	Description
Has a workshop on the scope of work been conducted with relevant personnel?	This will clarify any uncertain situations and ensure a shared understanding between the Project stakeholders.
Is the purpose of determining the scope clear?	This will ensure a common understanding of what is included or excluded from a project.
Is the level of detail appropriate for the document being prepared?	Each level of details will govern the accuracy of the estimate being prepared. The Estimator should ensure that the level of details is commensurate with the type of estimate being prepared.
Are deliverables defined properly?	External deliverables – output the Project delivers to the users. Internal deliverables – weekly status reports, business requirements specifications, prototypes, etc.
Is functionality defined?	Functionality should be defined for the Project outcomes.

4.2 Exclusions

- ❖ List the exclusions (*i.e.* identify the items not included in the scope of work).

4.3 Adjacent projects

- ❖ List the Projects adjacent to the Project and their relationship with this project.
- ❖ Identify the impacts or constraints imposed by the adjacent projects.

4.4 Project constraints

- ❖ Identify the constraints to the Project and define the factors that restrict how a project can be executed or managed.
- ❖ Common constraints include time, cost, quality, material availability, implementation issues, etc.

4.5 Assumptions

- ❖ List all of the assumptions made while producing this document.
- ❖ Review all of the assumptions made in the previous document.

Note: Assumptions are statements taken to be true in the absence of precise information for preparing an estimate and could change in the future, depending on the information available. It can therefore be reviewed as part of the regular review process.

5 Project procurement

5.1 Procurement path

As necessary, and wherever possible, consideration should be given to the following:

- Procurement paths available for the whole of the Project, such as traditional/design and built/lump sum, etc.
- Options available for selected procurement (sole invitee, multiple invitees, etc.)

6 Risks and uncertainties

6.1 Risks

List all of the risks associated with the Project during the whole Project life cycle and its assessment. Risks could include, but are not limited to, the following:

Financial risks:

- Project financing (the Client's cash flow);
- Cost overrun;
- Operation and maintenance cost;
- Changes in interest rates;
- Currency fluctuation;
- Escalation in labour, material, and equipment cost;
- Changes in regulatory laws; and,
- Improper cost estimation.

Operational risks:

- Prequalification – soundness, ability, and quality of work of the Contractor and Subcontractors;
- Labour – availability, skill, culture, and productivity;
- Material – availability and quality;
- Workplace health and safety;
- Weather; and,
- Supplier risk.

Contractual risks:

- Contractor's and Subcontractor's default;
- Design faults;
- Liquidation;
- Design variations by the Client;
- Change in management, politics, and government;
- Force majeure;
- Indemnification risk; and,
- Workers compensation, warranties, and employers' liability.

Related to project time period:

- Unrealistic programme of work;
- Procedures and time required for approvals from local authorities;
- Lead items and lead time; and,

- Weather and natural disaster.

General issues:

- Construction site (locality);
- Security;
- Information;
- Traffic;
- Political;
- Related projects;
- Scope definition;
- Communications;
- Traffic;
- Cultural;
- Subsoil conditions;
- Stakeholders;
- Drainage structures;
- Service relocation; and,
- Resumptions/land acquisitions – options available for selected procurement (sole invitee, multiple invitees, etc.).

6.2 Uncertainties

- Identify any known uncertainties related to the Project and its assessment.

7 Cost estimate and budget

- Attach a detailed cost estimate and budget for the delivery of the Project in accordance with the Client's requirements.

Refer to Appendix R for the cost estimate template.

APPENDIX J: COST ESTIMATING REFERENCE FOR STRATEGIC AND CONCEPTUAL ESTIMATES, USING BASIS OF QUANTITY AND UNIT COST MEASURE

This appendix describes many standard items that affect project cost estimates, but it is not exhaustive. Cost Estimators should follow the general considerations and guidelines stated throughout this manual. Units of measurement provided in this appendix are most appropriate for conceptual estimates made before all details are specified. Estimators are encouraged to use more appropriate units of measure, when available.

J.1. General items

Contractors incur an array of general costs to engage labour, facilities, and machinery in efforts to fulfil contractual requirements. Such costs include insurance, security, and the provision of accommodations and services for contracting and engineering staff. General costs also include temporary works, such as detours; testing of works, contractor supervision, and the installation and removal of all items necessary to maintain reasonable traffic flow and safety throughout the construction project. Items such as temporary pavement, signs, signals, barriers, striping, traffic control, and traffic management planning are part of general costs. If projects for freeways, interchanges, or major arteries require significant detours or construction staging, an estimate may need to include additional costs for these general items. If any of the items and activities listed above are included in global and unit rates or used in calculations of other construction elements, estimators should make suitable adjustments to the guidelines in this appendix.

Unit of Measure	Sum
Estimate Guideline	8 percent to 20 percent of total construction costs (not including costs related to project management and principal costs).

J.2. Site clearance and demolition

Site clearing estimates should include all expenses for labour, plant operations, materials, and incidental costs related to clearing vegetation, shrubs, and trees from the entire construction ROW. Such costs include the removal of stumps and the disposal of cleared items.

Unit of Measure	Sum
Estimate Guideline	1 percent to 2 percent of total construction cost.

J.3. Demolition (typical)

Demolition estimates should include all expenses for labour, plant operations, materials, and incidental costs related to the removal of all items that interfere with the construction of the proposed work within the ROW. Typical demolition expenses include the cost to haul and dispose all demolished items. Refer to Section J.4 for details about demolition for bridges, major structures, and buildings - which should be estimated separately.

Unit of Measure	Sum

Estimate Guideline	1 percent to 2 percent of total construction cost.

J.4. Demolition of bridges, major structures, and buildings

Because the removal of buildings, bridges, and other major structures can involve significant costs, Estimators should handle such costs separately.

Unit of Measure	Sum
Estimate Guideline	No definite guideline can be provided. Cost shall have to be assessed based on the specific project requirements.

J.5. Ground investigation

Ground investigation costs include, but are not limited to, trial trenches to verify existing services, boreholes to check soil conditions and water level, and soil tests.

Unit of Measure	Sum
Estimate Guideline	0.5 percent to 1 percent of total construction costs.

J.6. Earthwork

Earthwork estimates should include all expenses for labour, plant operations, materials, and incidental costs related to earthwork operations, including hauling and disposing of excess excavation, backfill compaction, and grading.

Cost for earthwork, which primarily involve roadway excavation, vary significantly between larger and smaller projects. For smaller projects, a significant portion of roadway excavation is often associated with grading for the roadway pavement section. Because such work is more labour intensive than other earthwork activities, earthwork for small projects is a greater percentage of total costs than for larger projects, even when the scope of earthworks for such large projects is substantial. Estimators should use a unit price that is consistent with the size of the project.

Unit of Measure	Generally included within the roadwork estimate.

J.7. Roads and paving

Roadwork estimates should include all expenses for labour; plant operations; materials; and incidental costs for compaction; fine grading; and the placement of sub-base, base, and wearing course. Estimators shall handle costs for signs, gantries, striping, and pavement markings, including all delineators and reflectors, separately.

Roads that are not freeways or expressways typically include kerbs and sidewalks, and sometimes include raised medians. Estimates should include these as line items.

Costs associated with roadway pavement sections vary significantly between large highways, such as freeways and expressways; and smaller works, such as local streets and arterials. Costs also vary between small and large projects. Estimators should apply unit costs that accurately reflect project scope.

J.7.1. Asphalt pavement

Estimates for asphalt concrete (AC) pavement should include the area of main road, shoulders, and ramps. Unit price should include necessary surface coatings, such as prime coat and tack coat. For conceptual estimates, road pavements can include pavement stripping, signs, gantries etc.

Estimates for pavement striping include costs for reflective paint, delineator buttons, and reflectors.

Asphalt Pavement, including earthwork, pavement marking, signs and gantries	
Unit of Measure	LM (linear metre) of road length (based on number of lanes)
Estimate Guideline	Varies based on type of pavement. Use data from recently completed/ongoing projects.

J.7.2. Kerbs, sidewalks

Estimates for kerbs assume the use of concrete.

Unit of Measure	LM (linear metre) of kerb
Estimate Guideline	Use data from recently completed/ongoing projects.

Estimates for sidewalks assume the use of pavement blocks.

Unit of Measure	Sq.m (square metre) of sidewalk
Estimate Guideline	Use data from recently completed/ongoing projects.

J.8. Structures

Structures include bridges, bridge approaches, and sound barriers. Estimates for structures should include all expenses for labour, plant operations, materials, and incidental costs related to the construction of structural earthwork, foundations, and superstructures.

J.8.1. Bridges

Estimates for bridges include structural excavation and backfill, piles, abutments, foundations, piers, diaphragm beams, and completion of the bridge deck.

Unit of Measure	Sq.m (square metre) of bridge deck
Estimate Guideline	Most bridges can be classified as "standard and uncomplicated" or "complex", with the unit price reflecting this assessment. Estimators should closely examine complex bridges and adjust unit prices based on the types of materials and specific engineering requirements. Use data from recently completed/ongoing projects.

J.8.2. Bridge approaches

Estimates for bridge approaches generally include structural earthwork, footing, and retaining walls.

Unit of Measure	Number of approaches, in accordance with the number of bridges
Estimate Guideline	Retaining wall costs vary based on height. If a project involves exceptionally long or tall walls, estimators should adjust unit prices accordingly. They should also adjust estimates depending on whether retaining walls are cantilever walls or fressenet panel walls. Use data from recently completed/ongoing projects.

J.8.3. Sound barriers

Estimates for sound barriers include expenses for structural earthworks, concrete bases, reinforced masonry walls, and pre-cast or cast-in-place concrete walls.

Unit of Measure	LM (linear metre) of sound barrier
Estimate Guideline	Estimators should apply a unit price based on a sound wall's height. For conceptual estimates, assume that a typical sound wall is concrete masonry 4 m high and 20 cm thick on a concrete base that is 50 cm high.

J.9. Tunnels

Estimates for tunnels should include all expenses for labour, plant operations, materials, and incidental costs related to the construction of structural earthworks, foundations, and superstructures. Tunnel estimates should not include effort to construct pump stations (for drainage and fire fighting).

Unit of Measure	Sq.m (square metre) of Tunnel for open sections and closed sections
Estimate Guideline	Use data from recently completed/ongoing projects.

J.10. Drainage

Estimates for drainage should include all expenses for labour, plant operations, materials, and incidental costs related to providing adequate drainage for the roadway, establishing all connections to existing storm water lines, modifying existing catch basins, and providing manholes.

Unit of Measure	LM (linear metre) of road length
Estimate Guideline	Use data from recently completed/ongoing projects.

J.11. Water

Estimates for water should include all expenses for labour, plant operations, materials, and incidental costs related to diverting existing lines that will be affected by the proposed project.

Unit of Measure	LM (linear metre) of road length
Estimate Guideline	Use data from recently completed/ongoing project.

J.11.1 New Water lines

Unit of Measure	As appropriate
Estimate Guideline	Based on the requirements of the Authorities, the Estimator should work out the estimate using the rates from ongoing / recently completed projects, as appropriate.

J.12. Sewerage

Estimates for sewerage should include all expenses for labour, plant operations, materials, and incidental costs related to diverting existing lines that will be affected by the proposed project.

Unit of Measure	LM (linear metre) of road length
Estimate Guideline	Use data from recently completed/ongoing projects.

J.12.1 New Sewerage lines

Unit of Measure	As appropriate
Estimate Guideline	Based on the requirements of the authorities, the Estimator should work out the estimate using the rates from ongoing/recently completed projects, as appropriate.

J.13. Irrigation

Estimates for irrigation should include all expenses for labour, plant operations, materials, and incidental costs related to irrigating areas that surround roads that are impacted by the proposed project.

Unit of Measure	LM (linear metre) of road length
Estimate Guideline	Use data from recently completed/ongoing projects.

J.13.1 New Irrigation lines

Unit of Measure	As appropriate
Estimate Guideline	Based on the requirements of the authorities, the Estimator should work out the estimate using the rates from ongoing/recently completed projects, as appropriate.

Miscellaneous items

Estimates should include any miscellaneous expenses, which may include fencing, traffic signals, roadway lighting, and landscaping.

J.13.1. Fencing

Estimates for fencing should include all posts, rails, chain link fabric, and hardware.

Unit of Measure	LM (linear metre) of fence
Estimate Guideline	Unit prices vary based on fence height, inclusion of barbed wire, and project size.

J.13.2. Traffic signals

Estimates for traffic signals should include costs for signals, supports, controllers, and power supplies.

Unit of Measure	EA (each) intersection
Estimate Guideline	Costs for traffic signals differ depending on intersection size and whether the intersection requires partial modifications to an existing system, total reconstruction of an existing system, or a new system. Use data from recently completed/ongoing projects.

J.13.3. Roadway lighting

Estimates for roadway lighting include costs for fixtures, posts, cabling, power supplies, panels, and controls.

Unit of Measure	LM (linear metre) of road length each individual streetlight (for further detailed estimates). Estimators should apply the specific street light spacing requirements for the individual jurisdiction that will operate the roadway to estimate the approximate total number of lights required. Estimates should provide separate measurements for any required substation pillars or feeder pillars.
Estimate Guideline	Use data from recently completed/ongoing projects.

J.13.4. Landscaping

Landscaping estimates include all seeding, planting of shrubs and trees, fertilizing, and mulching, but exclude any hydro-seeding included under erosion control and irrigation.

Unit of Measure	LM (Linear metre) of road length
Estimate Guideline	Variable; unit prices for landscaping make no provision for hardscaping. Use data from recently completed/ongoing projects.

J.14. Work by others

Estimates shall include all expenses for labour, plant operations, materials, and incidental items that are furnished by companies or agencies other than the construction contractor. Typical costs for work by others include permanent power connection charges and change over charges for diversion.

Unit of Measure	Sum
Estimate Guideline	A Provisional sum can be included in the contract based on the project specific requirements and using estimates from previous projects.

J.15. Engineering and management

Estimates should include costs for engineering and management, which include principal costs, engineering studies, environmental studies, design engineering, construction management, and ROW.

J.15.1. Principal costs

Refer to Chapter 3 of this manual for information on estimating principal costs.

J.15.2. Engineering studies

Estimates for engineering studies should include all expenses for labour, plant operations, materials, and incidental costs associated with conceptual engineering activities. Such activities may include site investigation, alternative configuration studies, information gathering, and other engineering studies and report creation, as needed, except for activities included in estimates for environmental studies.

Estimate Guideline	2 percent to 3 percent of total construction costs. Estimators should carefully consider the project's complexity and size to determine an appropriate estimate for engineering studies, which may not fall within the 2 percent to 3 percent guideline.

J.15.3. Environmental studies

Estimates for environmental studies shall include all costs to conduct studies and reporting as required to obtain an environmental permit, all consulting fees, and any costs for compliance with regulatory requirements.

Estimate Guideline	1 percent to 2 percent of total construction costs. Estimators should carefully consider the size and nature of a project to determine an appropriate estimate for environmental studies, which may not fall within the 1 percent to 2 percent guidelines. Because certain types of environmental studies have a minimum cost, regardless of the construction value of the project, their potential cost impact can easily be underestimated for smaller projects.

J.15.4. Design engineering

Estimates for design engineering shall include all costs from preliminary engineering to completion of final construction drawings, all consulting fees, any fieldwork necessary for design, and any costs for coordination with regulatory agencies and authorities.

Estimate Guideline	2 percent to 3 percent of total construction costs

J.15.5. Construction management

Estimates for construction management include all supervision, inspection, administrative support, and materials testing necessary to ensure that the work is being constructed in accordance with appropriate standards.

Estimate Guideline	3 percent of total construction costs

J.15.6. Right-of-way expropriation

Estimates for ROW expropriation shall include all costs associated with land purchases, and temporary acquisitions. Estimators must provide backup documentation for all ROW costs.

Unit of Measure	Sum
Estimate Guideline	Varies based on the project vicinity and scope of works. Land cost data should be collected from the respective owner of the land.

APPENDIX K: FINAL COST ANALYSIS

A soft copy of a model and a worked example for analysing and reporting project cost data has been provided in the CD, attached to this Manual.

Provide file names on CD.
I propose that the file name should not be Appendix K. Name the file what it is, for example: Cost Estimating Model or Cost Estimating Model - Example....etc

APPENDIX L: ESTIMATE TEMPLATES

A soft copy of templates and examples for estimates has been included in the CD, attached to this Manual.

Provide file names on CD

APPENDIX M: COST ESTIMATING MODEL USER GUIDE

M.1. Introduction

DoT has initiated a development of cost estimating model for estimating the projects at strategic and conceptual phase. Guidance on how to use this model is provided below. The model soft copy can be downloaded from DoT portal.

M.1.1. Basis of Cost Estimating Model

The model uses Global estimating tool for generating the estimate. Global estimating is an approximate method of estimating that involves using global composite rates. With this method, the project consists of few estimating elements on which the estimate is prepared. Examples are bridge costs per square metre of deck area, underpass costs per square metre (closed or open section), or road costs per kilometre.

Numbering?

The rates to be used for estimate are developed from completed/tendered/on-going projects data. Presently, this model is based on few projects; however, the model can be populated with additional projects by each Client once the data become available. Certain assumptions are used in generating the cost estimates which are provided in the model help-files. For further information, please refer to Appendix K – Final Cost Analysis.

M.2.1. Project data

Prior to using the cost estimating model, Estimator should study the information provided in the project data (used in developing the cost estimating model) for selecting the appropriate project/projects as reference to the cost estimate. The model is developed based on completed/tendered/on-going projects and the Estimator is required to take into account the general considerations as provided in Section 2.13.12 of the Project Cost Estimating Manual and the assumptions used in developing the cost estimating relationships. Suitable adjustment should be made for differing conditions.

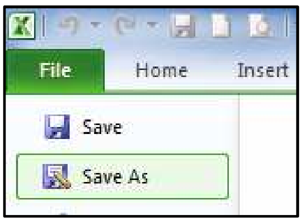
M.2. Procedure

M.2.2. Renaming and saving the model

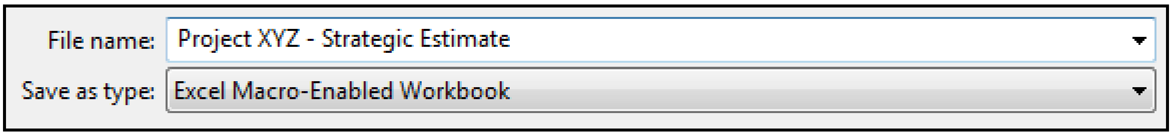
The model should be renamed and saved ***before*** the data is entered. This is to avoid any damage to the original model. Care should be observed so as not to delete any information / row / column from the model file.

<u>Steps</u>

Open the file. Go to the file menu and select **Save as**.



Select the file name appropriate to the project to be estimated.



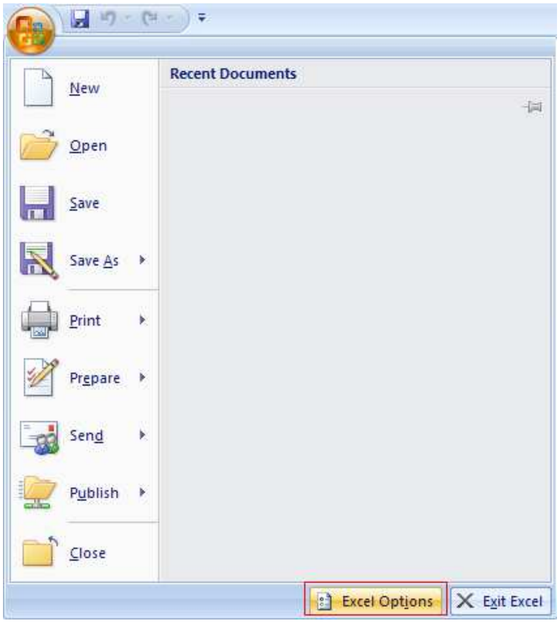
Make sure that, the file is saved as **Excel Macro-Enabled Workbook**

M.2.3. Enable Macros

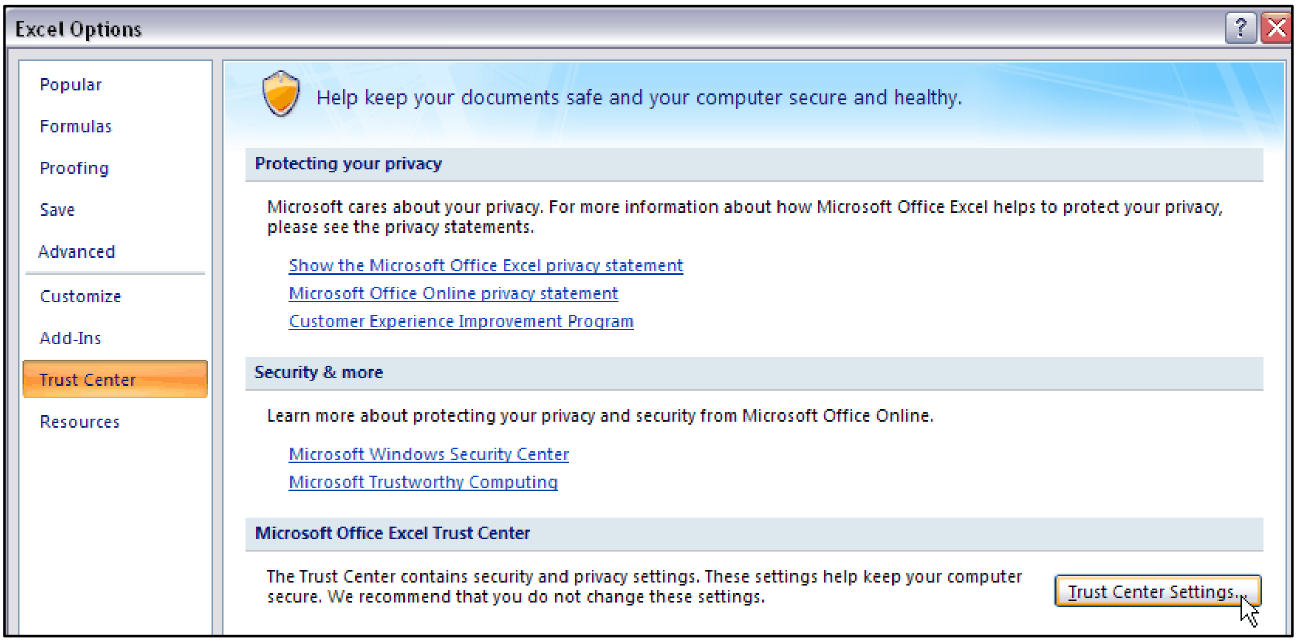
Macros should be enabled prior to using the cost estimating model. The procedure to enable the macros in Microsoft Excel 2007 and Microsoft Excel 2010 is demonstrated below.

Excel 2007

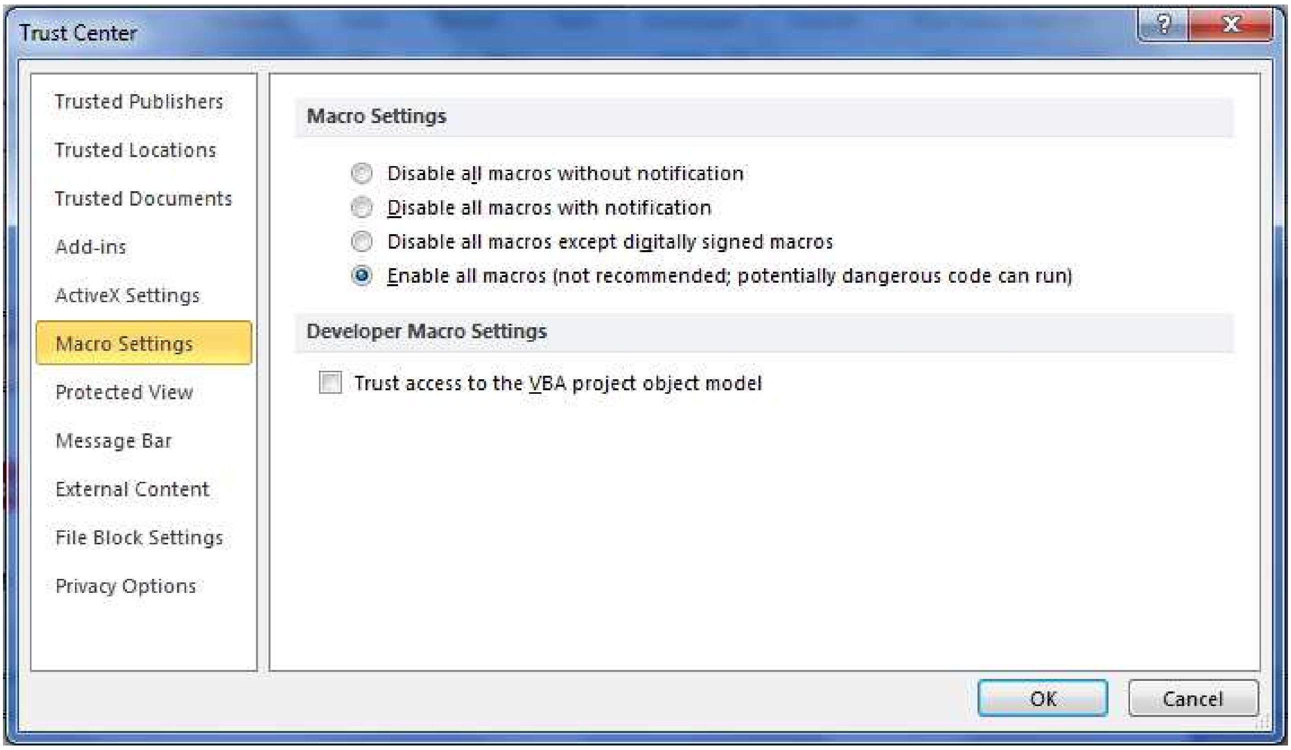
Open Microsoft Excel and click on to **Office Button**, which is displayed on extreme left of the screen



Now, click on to the button at the bottom showing **Excel Options**. Following window will appear;

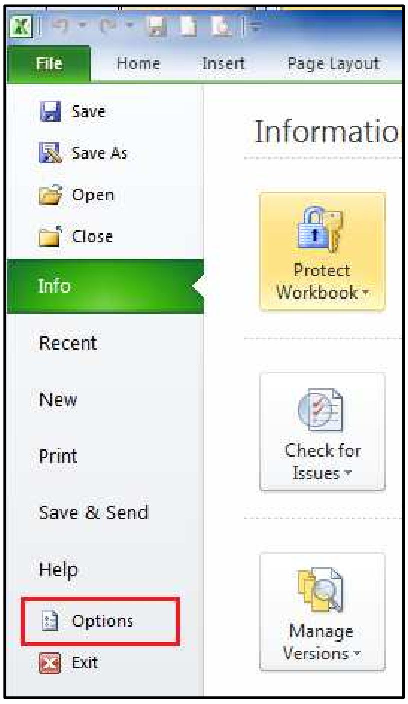


Select **Trust Center**. In the new window that appears, choose **Macro Settings** from the sidebar and select **Enable all macros (not recommended; potentially dangerous code can run)** from the list of options that appears. Click OK to exit this window.

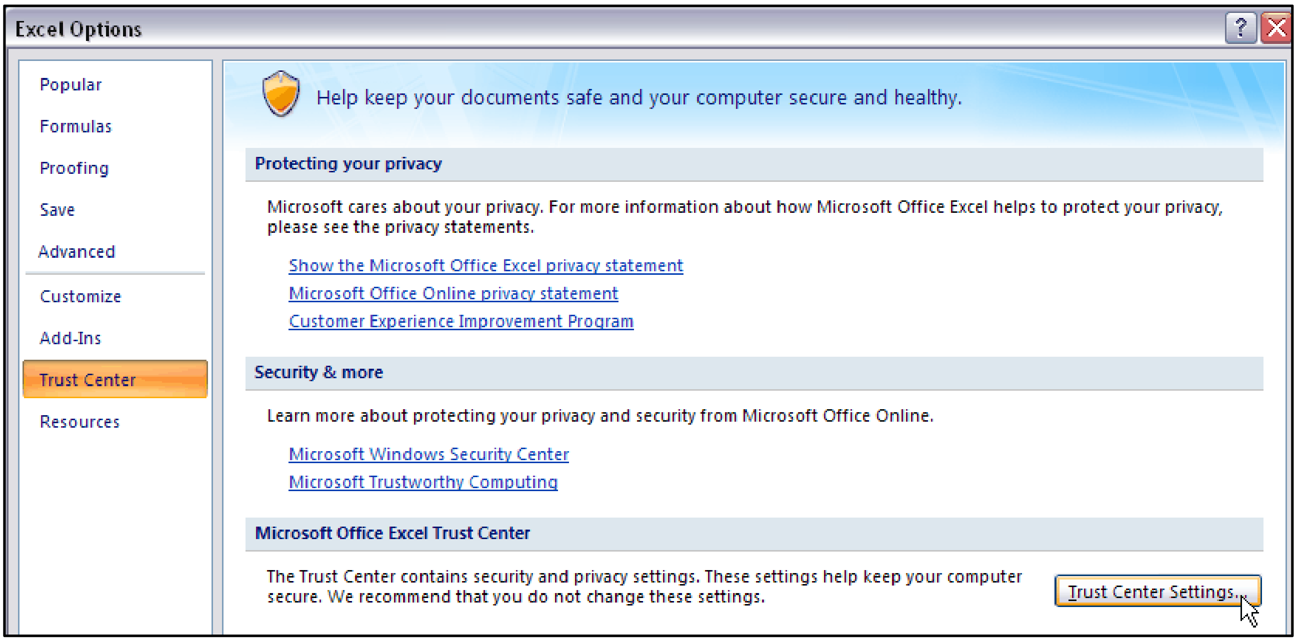


Excel 2010

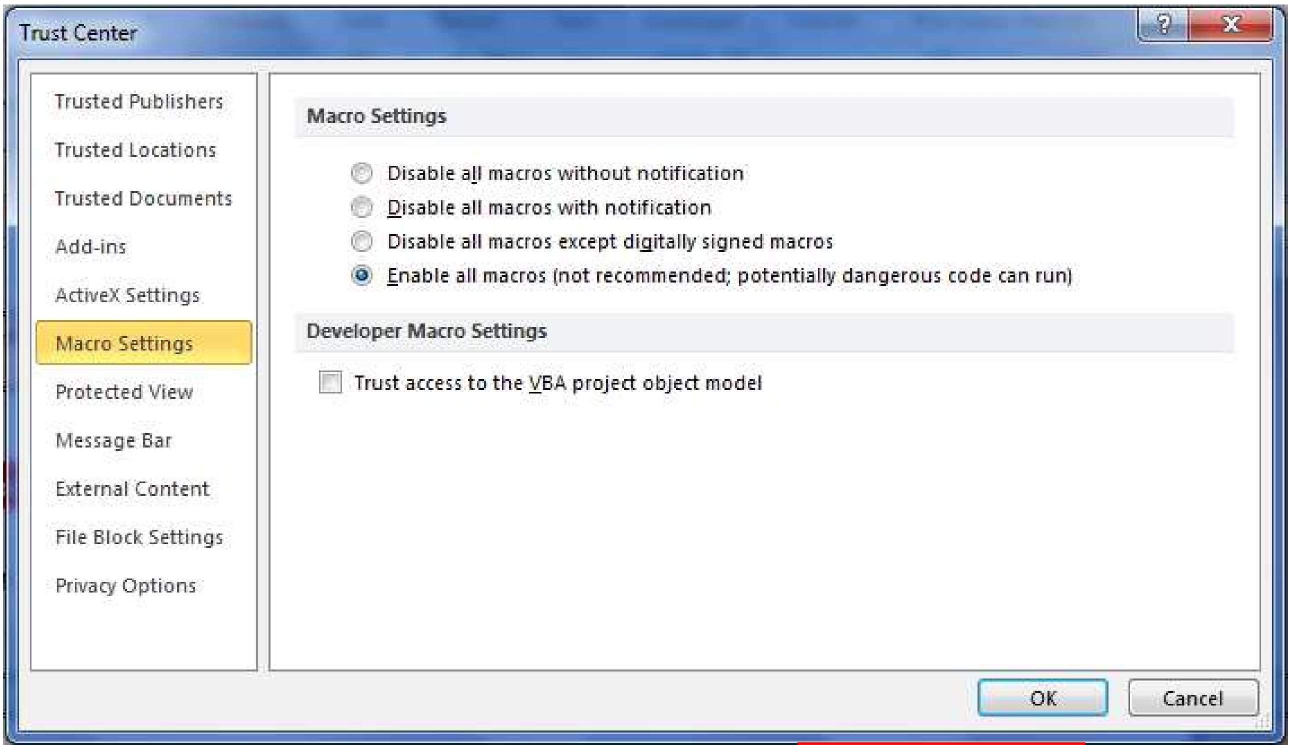
Open Microsoft Excel and click on to **File**, which is displayed on extreme left of the screen. Select **Options** from the list.



A new window will appear. Select **Trust Center** from the sidebar on the left and then click on the **Trust Center Settings** at the bottom right.



In the new window that appears, choose **Macro Settings** from the sidebar and select **Enable all macros (not recommended; potentially dangerous code can run)** from the list of options that appear. Click OK to exit this window.



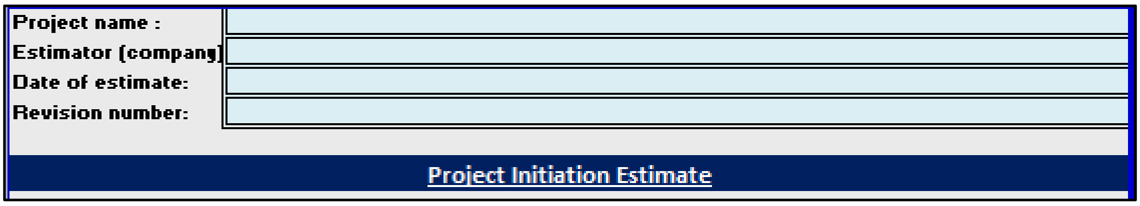
Numbering?

M.2.4. Step-by-step directions for entering data

M.2.3.1 Project initiation estimate

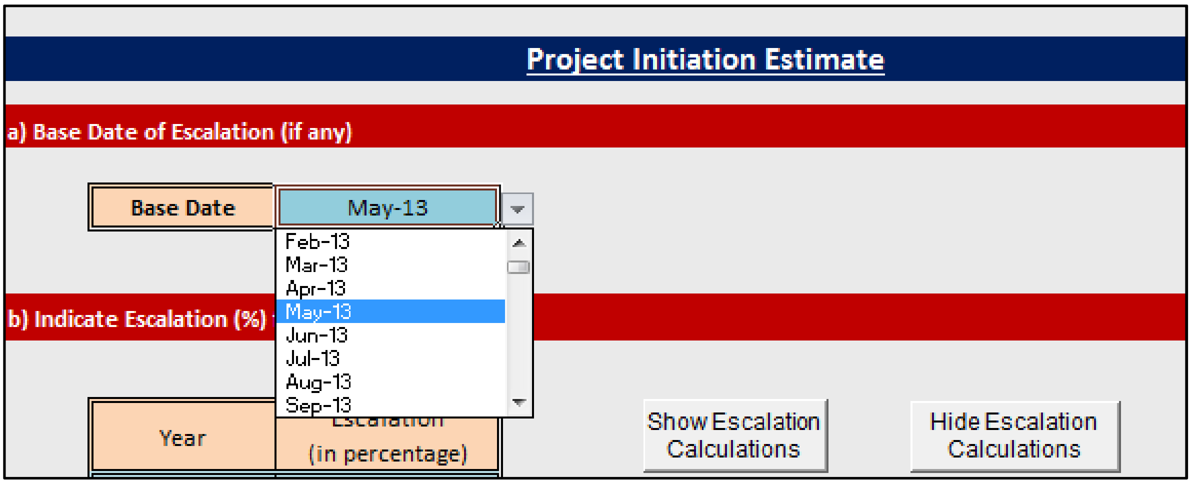
a) Project details

Enter the details such as the name of the project, Estimator, date of the estimate and revision number.



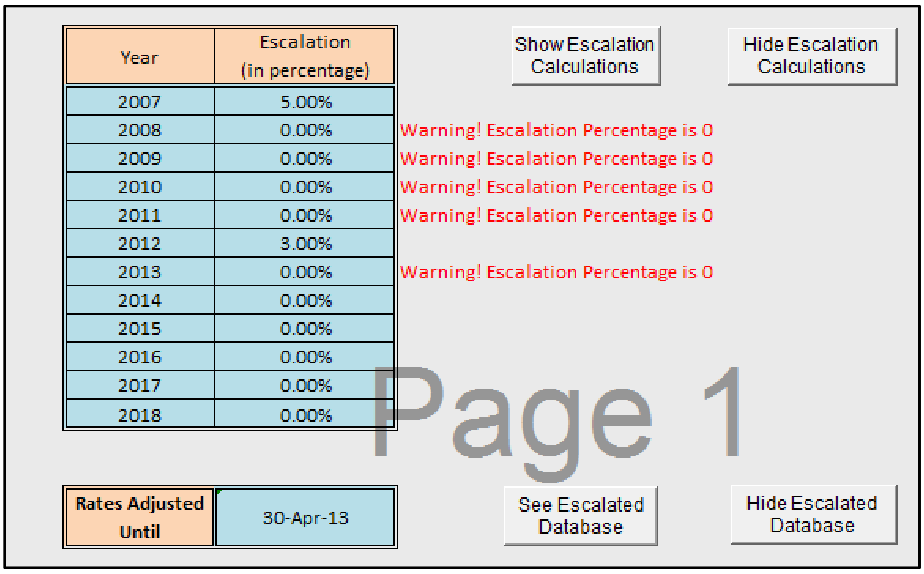
b) *Base date*

Select the Base Date of the estimate. The Base Date of the estimate is the anticipated start date of the project.



c) *Escalation*

Enter the escalation rate for the years up to the selected base date. In case of escalation rate is not entered, a warning message will appear. The selected project rates will be escalated to relate to a period a month before the base date.



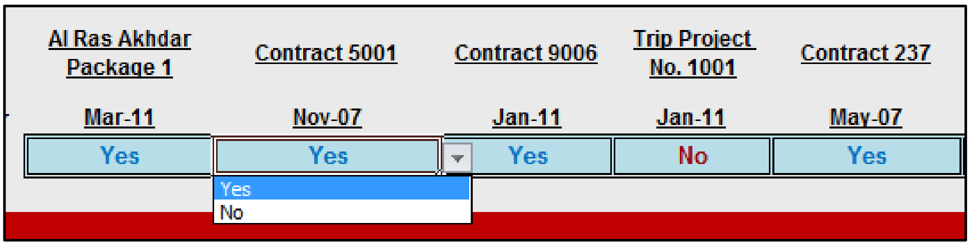
Escalation calculation for each selected project can be seen by clicking **Show Escalation Calculations.** Upon clicking an escalation calculation sheet will appear on the bottom bar. Similarly, Escalated database can be seen by clicking **Show Escalated Database.**

Before

After

d) Select project for reference

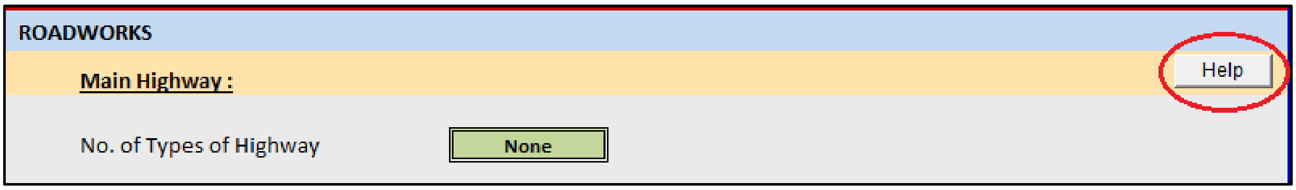
Select the projects most suited for the project to be estimated. The project information of all reference projects is available in **Project Information** file



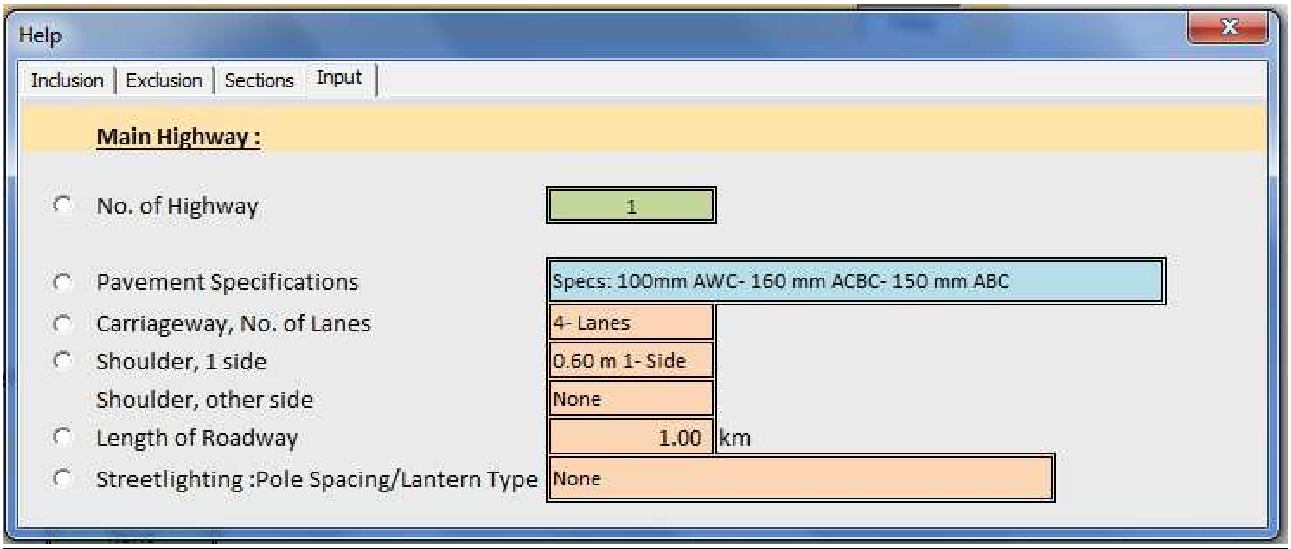
The model provides estimate for major items of works in an infrastructure projects such as different types of road works, bridge works, tunnels, traffic signals, loop ramps, roundabout, drainage and diversion of services.

e) Input for road works

A **Help** file is provided in the model against the each item for guidance.

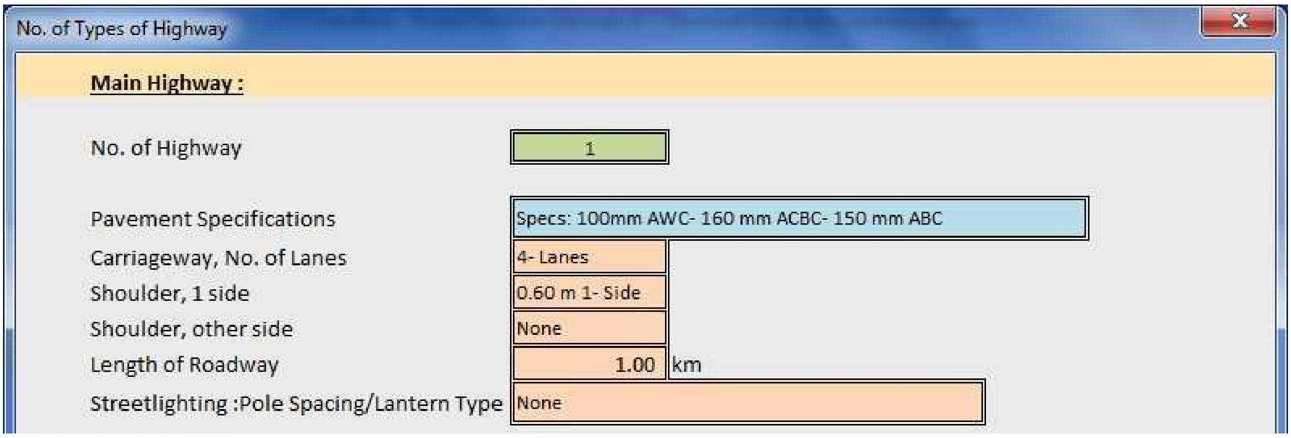


Help file includes tabs for inclusion, exclusion, sections, and help of Input data



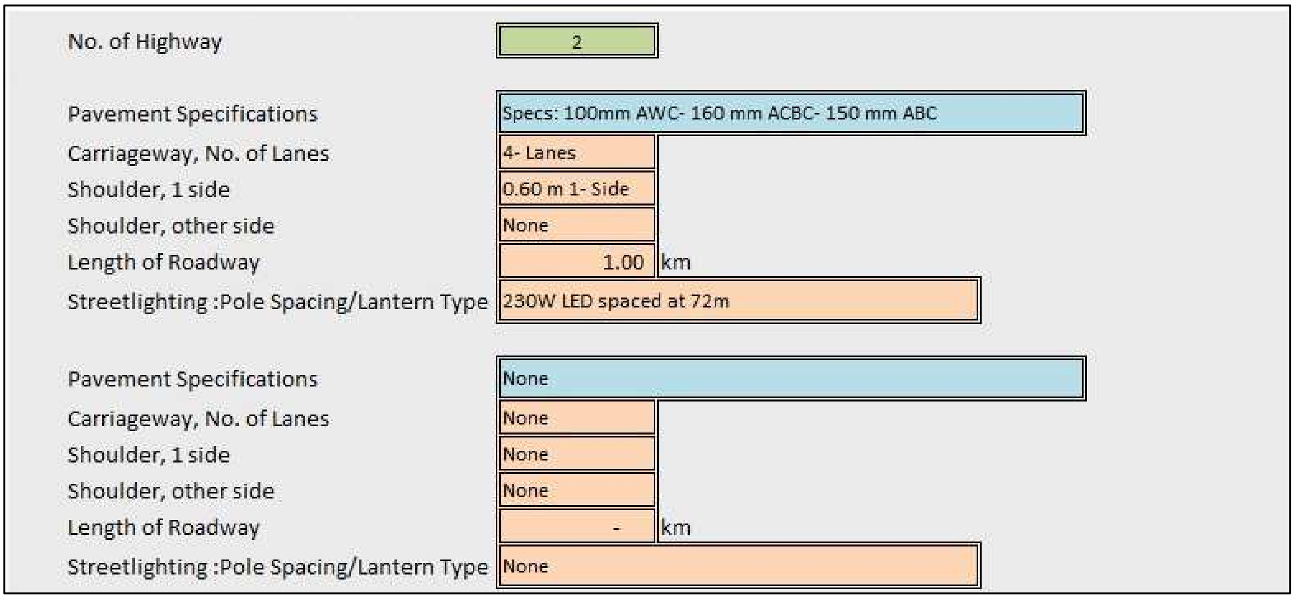
Inclusion	This field shows what items of works are included in the cost estimation.
Exclusion	This field shows what items of works are excluded in the cost estimation.
Sections	Displays road sections.
Input	Provides guidance on the input.

Entering data (these guidance are also included under **Input** tab of **help** file



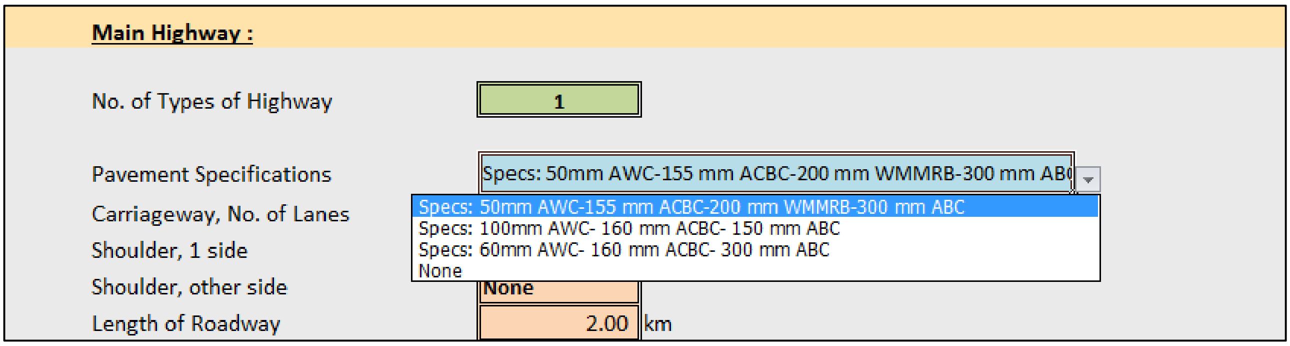
No. of Types of Highway

Enter the number of highways depending upon the number of lanes and the specifications. Provision is made to select up to 8 numbers of highways. If the project does not contain any highways, select ‘None’. Depending upon the numbers selected, input section for each type of highway will appear as shown below;



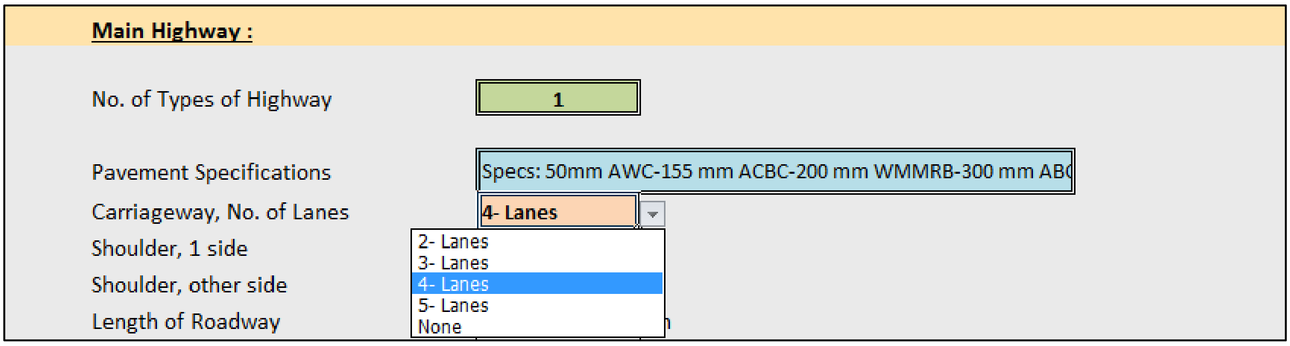
Payment Specification

Select the specification type appropriate to the project from the drop down menu. Different sections can be viewed under the **Sections** tab of the **Help** file.



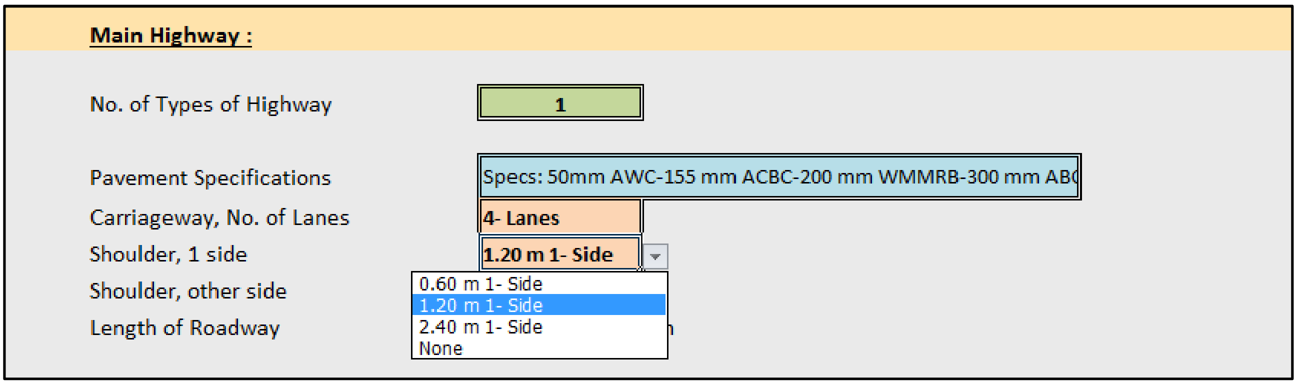
Carriageway, No. of Lanes

Select the number of lanes from the drop down menu.



Shoulder

Select the width of the shoulders on the either side of the road from the drop down menu.



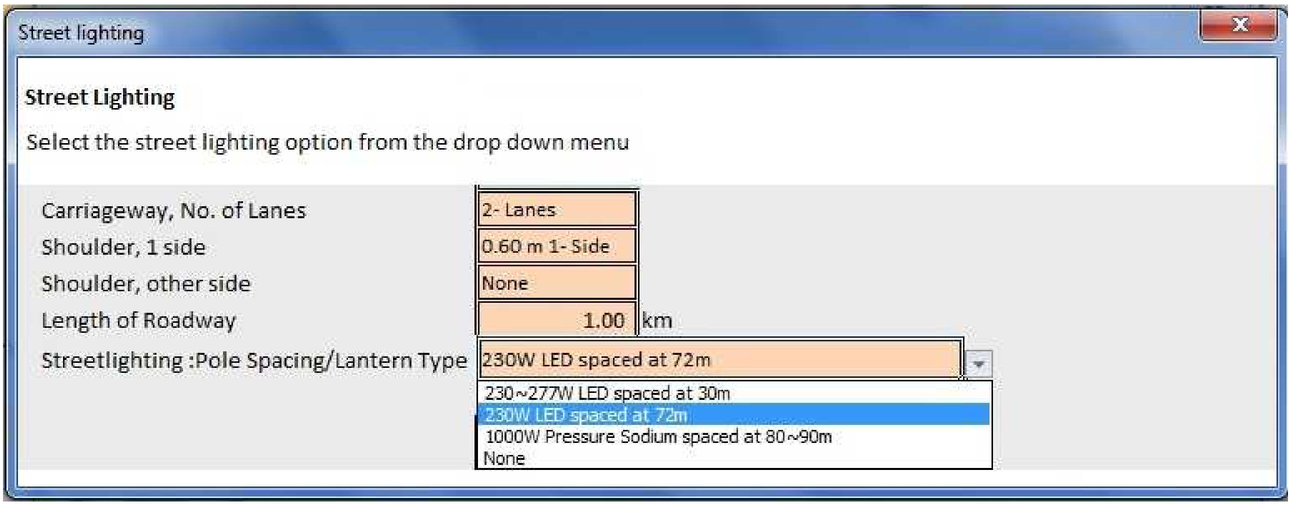
Length of Roadway

Enter the length of the roadway in kilometres.

The above guidance is also applicable to different types of roads such as service road, truck road, military access road etc.

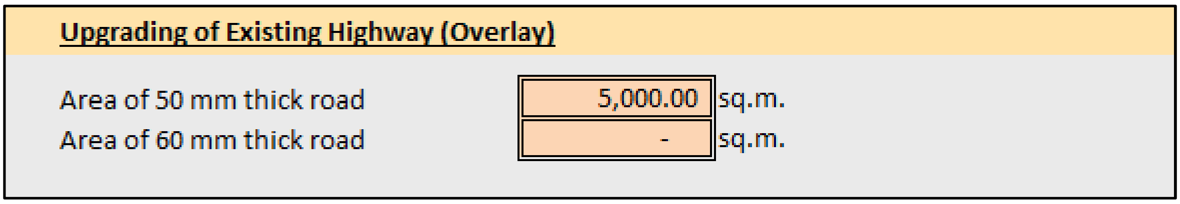
Street lighting: Pole Spacing/Lantern Type

Select the number of lanes from the drop down menu.



f) *Input for upgrading of existing highway*

Enter the area the road to be overlaid within the required thickness of overlay.

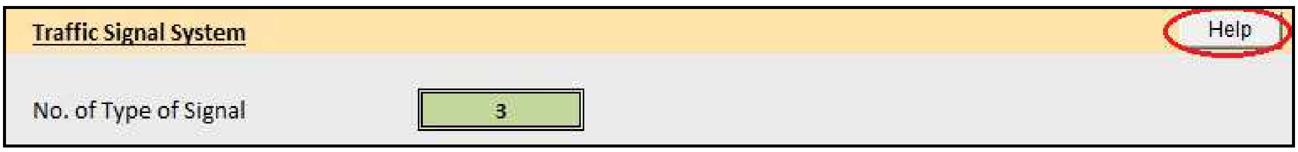


g) *Drainage System*

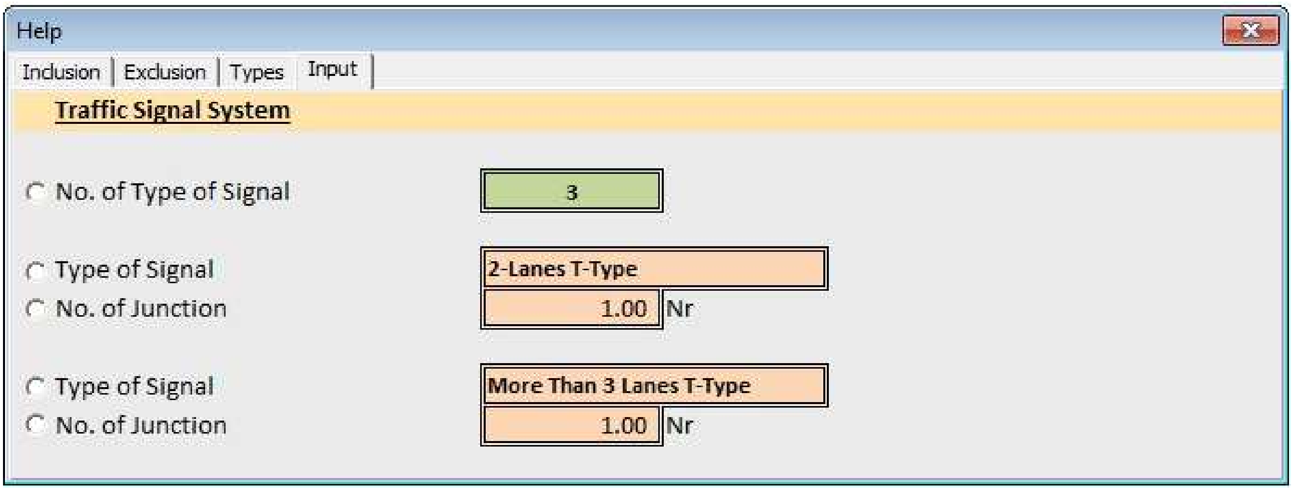
Enter the length of the drainage along the type of roads.

h) *Input for traffic signal system*

A **Help** file is provided against each item of works for guidance.



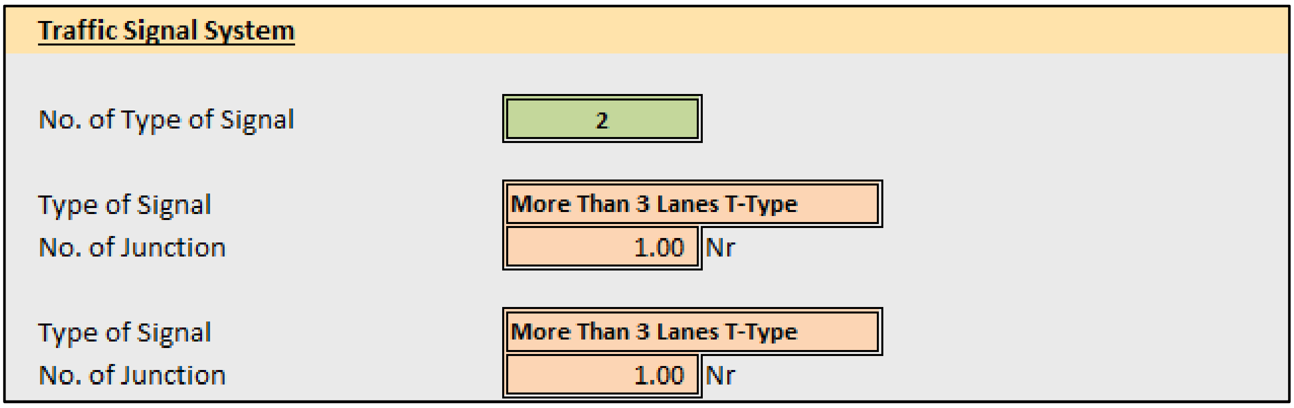
Help file provides details on inclusion, exclusion, signal types, and help of the input data.



Inclusion	This field shows what items of works are included in the cost estimation.
Exclusion	This field shows what items of works are excluded in the cost estimation.
Types	Displays plan for types of signals.
Input	Provides guidance on the input.

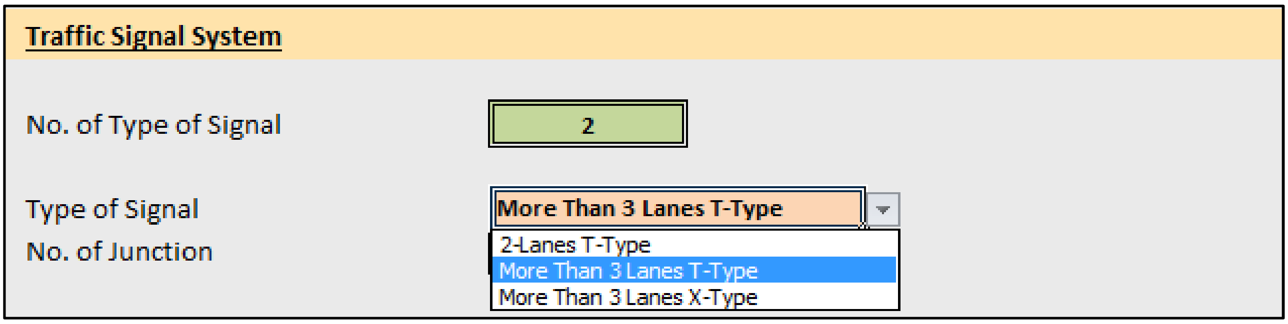
No. of Types of Signal

Enter the number of signals depending upon the number of lanes and the specifications. Provision is made to select up to 3 numbers of signal. If the project does not contain any signal, select 'None'. Depending upon the numbers selected, input section for each type of signal will appear as shown below;



Type of Signal

Select the type appropriate to the project from the drop down menu. Different types of signals can be viewed under the **Types** tab of the **Help** file.



No. of Junction

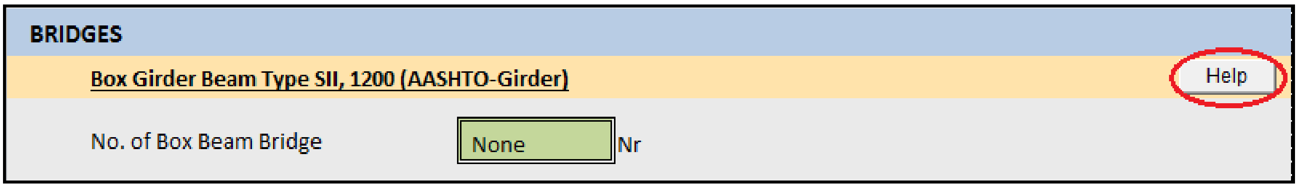
Enter the junctions of selected type.

Enter the data for other types of signal as explained above.

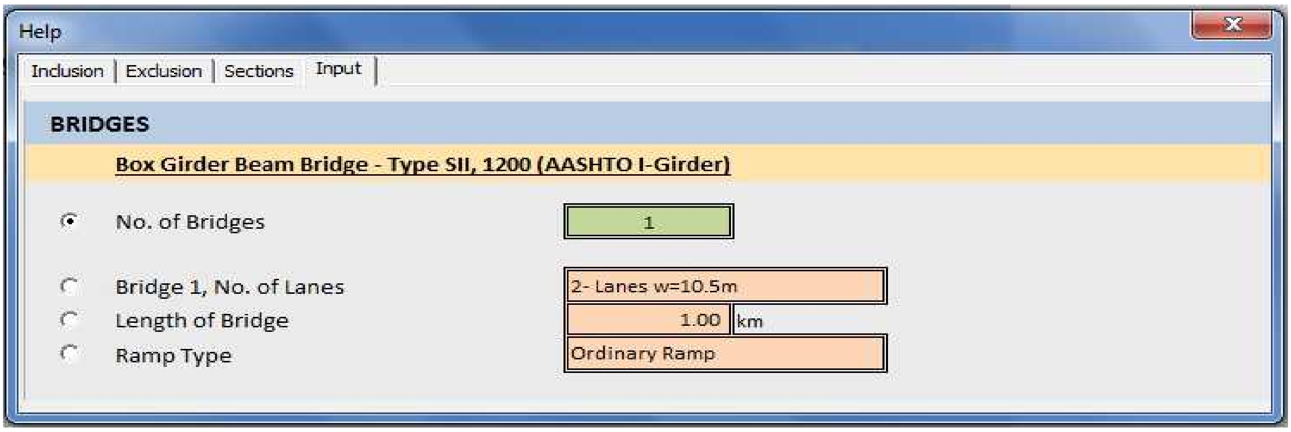
i) Input for bridge works

Box girder beam type

A **Help** file is provided against each item of works for guidance.



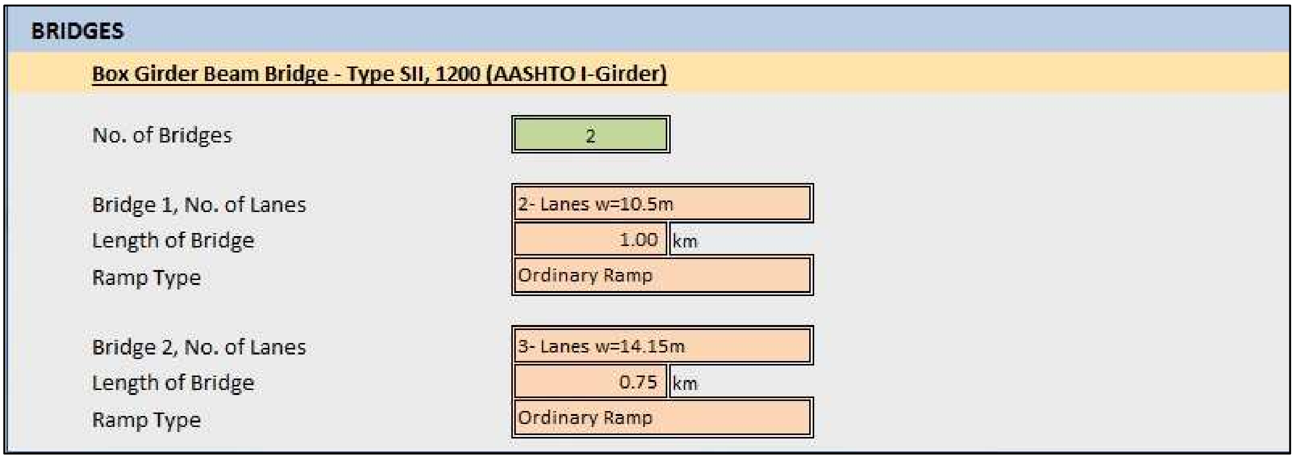
Help file provides details on inclusion, exclusion, bridge section, and help of the input data.



Inclusion	This field shows what items of works are included in the cost estimation.
Exclusion	This field shows what items of works are excluded in the cost estimation.
Sections	Displays bridge section.
Input	Provides guidance on the input.

No. of Box Beam Bridge

Enter the number of bridges. Provision is made to select up to 2 numbers (2 lanes and 3 lanes) of bridge. If the project does not contain any bridge, select ‘None’. Depending upon the numbers selected, input section for each type of bridge will appear as shown below;



Length of bridge

Enter the length of the bridges in kilometres. If there is more than 1 (2 lanes or 3 lanes) bridge of same type, than enter the sum of length of each type of bridge.

No. of Lanes

Select the no. of lanes from the drop down menu.

Ramps

Select from the drop down menu the type of ramp.

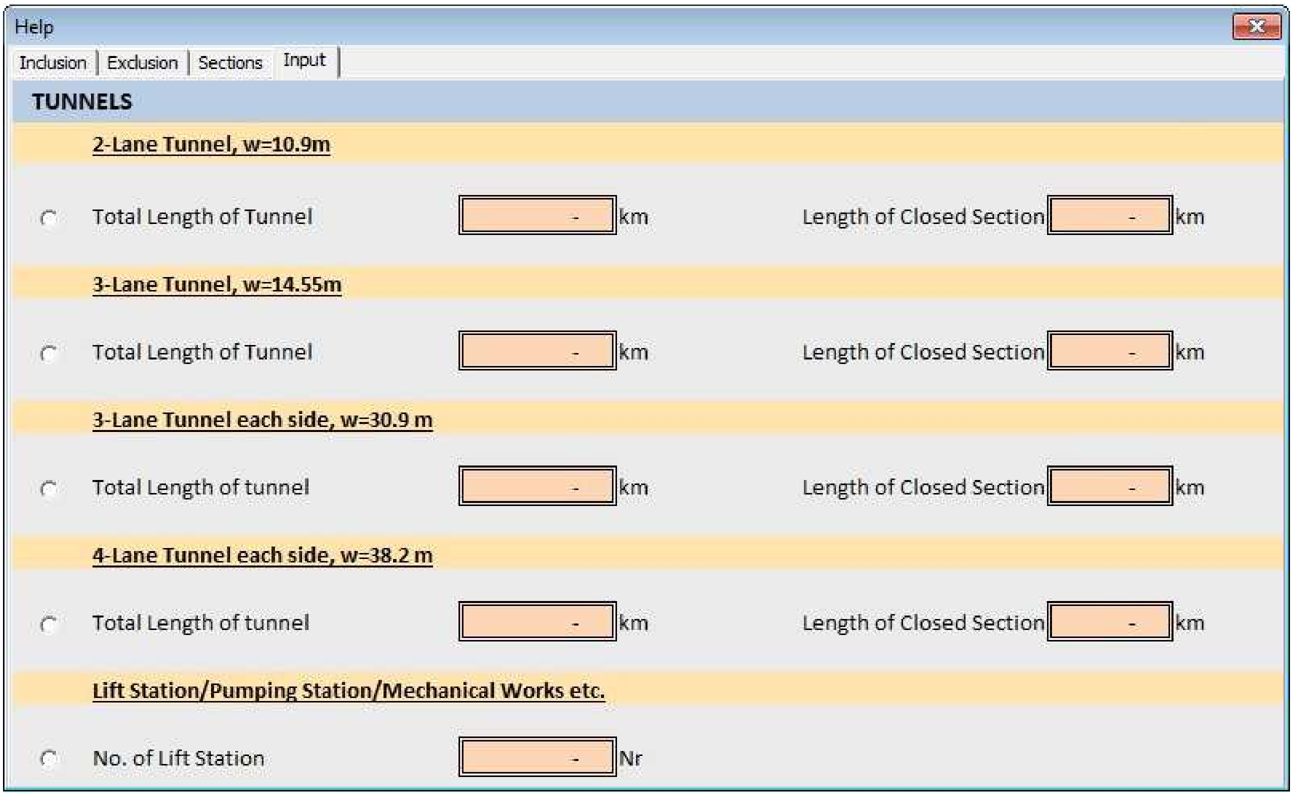
Pre-stressed post-tensioned type

The guidance provided for the Box girder beam type bridge is applicable to pre-stressed post-tensioned type bridge.

j) Input for tunnel / underpass works

A **Help** file is provided against each item of works for guidance.

Help file provides details on inclusion, exclusion, tunnel sections, and help of the input data.



Inclusion	This field shows what items of works are included in the cost estimation.
Exclusion	This field shows what items of works are excluded in the cost estimation.
Sections	Displays tunnel sections.
Input	Provides guidance on the input.

Total length of Tunnel

Enter the total length of the tunnel. Total length includes the length of open and closed section.

Length of Closed Section

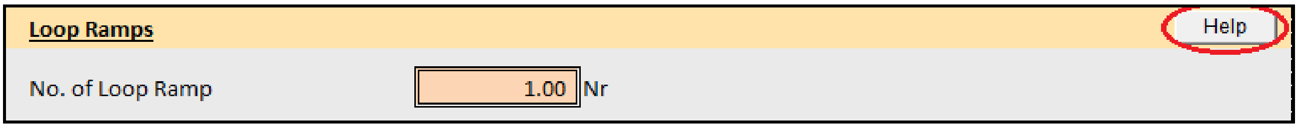
Enter the length of the closed section

Lift station / pumping station / mechanical works

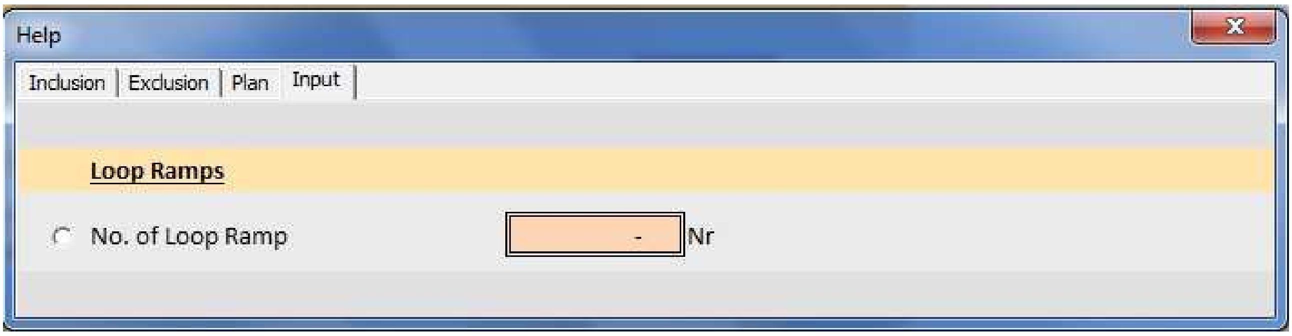
Enter the no. of lift station for the tunnels.

k) Input for loop ramps

A **Help** file is provided against each item of works for guidance.



Help file provides details on inclusion, exclusion, plan, and help on the input data.



Inclusion This field shows what items of works are included in the cost estimation.

Exclusion This field shows what items of works are excluded in the cost estimation.

Sections Displays plan of loop ramp.

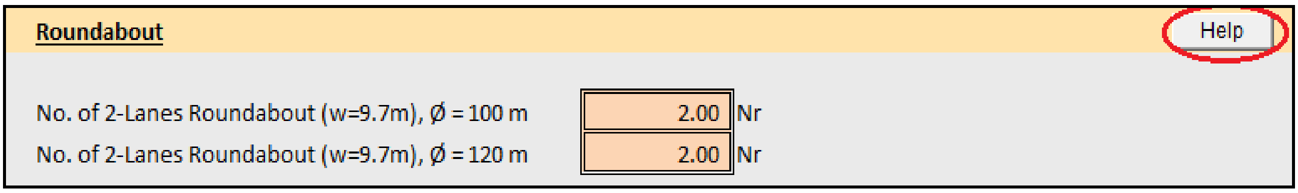
Input Provides guidance on the input.

No. of Loop Ramp

Enter the number of loop ramps in the project.

Roundabout

A **Help** file is provided for guidance.



Help file provides details on inclusion, exclusion, and help of the input data.

No. of 2/3/4-lanes Roundabout

Enter the no. of roundabouts in the project from the provided range of lanes and diameter.

l) *Contingencies*

Contingencies are required to be entered in the project estimate sheet. Enter the amount of contingencies in Dirhams. For further information of the contingencies please refer to Section 3.7 of the Project Cost Estimating Manual.

	Sub-total Construction Cost				**438,551,465.24**	
B	**Contingency/Allowance**					
B.1	**General Items**	%	1.00	9.28%	40,683,792.30	
B.2	**Other Authorities/Services**	%	1.00	15.17%	66,527,836.49	
B.3	**Contingency/Allowance**	%	1.00	29.32%	160,000,000.00	
	TOTAL PROJECT ESTIMATE				**705,760,000.00**	

m) *Cost estimation data*

If the cost estimation data is not available from the projects selected as reference, the project estimate sheet will show “No Data”

A.5.2	**Box Girder Type**					
A.5.2.1	Bridge 1,3- Lanes each side w=31.10m	Per KM	0.30	No Data	No Data	
A.5.2.2	Bridge 2,4- Lanes each side w=38.40m	Per KM	0.50	No Data	No Data	
A.5.2.3	Ramps with MSE Wall	Per Nr	1.00	No Data	No Data	
A.5.2.4	Ordinary Ramps	Per Nr	1.00	14,139,518.48	14,139,518.48	

M.2.3.2 *Concept estimate*

The guidance provided in (a) to (k) above is equally applicable for concept estimate except that the Estimator is required to provide area now in lieu of the length that was required in case of initiation estimate. Help file is provided in the soft copy against each item of the input file to guide the Estimator in entering the data. A link to **Calculation Sheet** is provided for calculating the area. The quantities from the **Calculation Sheet** are automatically carried forward in the input sheet.

Numbering?

Attach pocket with CD here

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