CHAPTER 6

COST ESTIMATING

Cost is a major factor in most decisions regarding construction, and cost estimates are prepared throughout the planning, design, and construction phases of a construction project, different types of cost estimating from preliminary to detailed are conducted for different purposes. All of these estimates are important because they invariably influence the expenditure of major sums. However, estimates made in the early phases of a project are particularly important because they affect the most basic decisions about a project. In most cases, the final cost (or cost projections during construction) has been significantly higher than the cost estimates prepared and released during initial planning, preliminary engineering, final design, or even at the start of construction.

6.1   Purpose of Estimating

The purpose of estimating is to determine the forecast costs required to complete a project in accordance with the contract plans and specifications. For any given project, the estimator can determine with reasonable accuracy the direct costs for materials, labor, and equipment. The bid price can then be determined by adding to the direct cost the costs for overhead (indirect costs required to build the project), contingencies (costs for any potential unforeseen work), and profit (cost for compensation for performing the work). The bid price of a project should be high enough to enable the contractor to complete the project with a reasonable profit, yet low enough to be within the owner's budget.

There are two distinct tasks in estimating: determining the probable cost and determining the probable time to build a project. With an increased emphasis on project planning and

scheduling, the estimator is often requested to provide production rates, crew sizes, equipment spreads, and the estimated time required to perform individual work items. This information, combined with costs, allows an integration of the estimating and scheduling functions of construction project management. Because construction estimates are prepared before a project is constructed, the estimate is, at best, a dose approximation of the actual costs. The true cost of the project will not be known until the project has been completed and all costs have been recorded.

6.2   Types of Cost Estimating

There are many types of cost estimates that can be performed on a project, each type having different levels of accuracy. The estimating process becomes increasingly more expensive as more detailed and accurate techniques are applied. Estimating can be categorized into several classes according to purposes, budget, limitation, time, and accuracy. Generally, the nature and characteristics of estimating can be summarized as follow: accuracy improves with the development of the project such that the distribution of errors narrows from feasibility to settlement; underestimates are more likely than overestimates and the final cost of a project cannot be established until the settlement of project accounts.

For example, cost estimates is divided into seven types: 1- Preliminary or rough cost or approximate estimate is prepared to decide the financial aspect and accompanied by detailed report, brief specifications, layout plan showing the proposal in hand; and brief idea of rates for different items; 2- Detailed estimate, is prepared in detail prior to inviting of tenders; 3- Quantity estimate, is a complete estimate of quantities for all items of work required to complete a project; 4- Revised estimate is also a detailed estimate and is prepared afresh, when the original sanctioned detailed estimate exceeds by 5% or more; 5- Annual repair or maintenance prepared in order to keep the structures in proper condition; 6- Supplementary estimate, when some additions are done in the original work; and 7- Extension estimate, when some changes and extensions are required to be made in old work.

Typically, cost estimates are divided into three major types: 1- Conceptual cost estimates are developed using incomplete project documentation; 2- Semi-detailed cost estimates are prepared when parts of the project have been completely designed; and 3- Detailed cost estimates are prepared based on fully developed construction drawings and specifications. The accuracy of the estimate depends on the completeness of the contract documents and the experience of an estimator. The typical accuracy of the various types of cost estimates is shown in Table 6.1.

Table 6.1: Accuracy of different types of cost estimates

Type of Estimate	Construction Document Development	Expected Percent Error*
Conceptual	Schematic Design 0-30% Construction Documents	± 10-20 %
Semi-Detailed	Design Development 30-90% Construction Documents	± 5-10 %
Detailed	90-100% Plans and Specifications	± 2-4 %

* Percent error means the expected variation between cost estimate and actual cost

There are many types of cost estimates and re-estimates for a project based on the stage of project development. Estimates are performed throughout the life of a project, beginning with the first estimate and extending through the various phases of design and into construction. Initial cost estimates form the basis to which all future estimates are compared. Future estimates are often expected to agree with (i.e., be equal to or less than) the initial estimates. However, too often the final project costs exceed the initial estimates. Estimates are performed throughout the life of a project, beginning with the first estimate and extending through the various phases of design and into construction.

Traditionally, the different classifications of estimates conclude that there are three main types of estimates:

1. Conceptual cost estimates.
2. Semi-detailed cost estimates.

3. Detailed cost estimates.

Conceptual estimate

A conceptual estimate is also known as a top-down, order of magnitude, feasibility, analogous, or preliminary estimate. It is the first serious effort made at attempting to predict the cost of the project. A conceptual estimate is usually performed as part of the project feasibility analysis at the beginning of the project. In this way, the estimate is made with limited information on project scope, and is usually made without detailed design and engineering data.

The conceptual estimate is also defined as approximate estimate and used to know the budget for a project. Considerable experience and judgment are required to obtain a dependable approximate estimate for the cost.

Semi-detailed estimate

Semi-detailed cost estimates are developed while basic design decisions are being made to verify that the project can be constructed at its intended scope within the owner's budget. Some aspects of the project may be completely designed. Detailed estimating methods can be used to estimate the cost of project components that have been designed, and conceptual estimating methods are used to estimate the cost of those components that remain to be designed. This means that databases are used to estimate the cost of components for which the design is not complete, and project data are used to estimate the cost of components for which the design is complete. Therefore, these estimates are known as semi-detailed cost estimates.

Detailed estimate

A detailed estimate is also known as a bottom-up, fair-cost, or bid estimate. Detailed estimates are prepared once the design has been completed and all construction documents prepared. The estimator divides the project into individual elements of work and estimates the quantities of work for each element. Next, the individual elements of

work are priced to determine an estimated cost for each one. The estimated costs are summed, and overhead costs are added to cover the contractor's cost of managing the work.

The breakdown of tender price is illustrated in Figure 6.1. The tender price consists of two components, the construction cost estimate and mark-up (margin). The direct cost is the combined costs of labor, equipment, material, and subcontractor's costs. The addition of site overheads and office overheads to the direct cost produces the construction cost estimates. The second component of the tender price is the mark-up (margin) which consists of the profit margin, risk allowance, and financial charge.
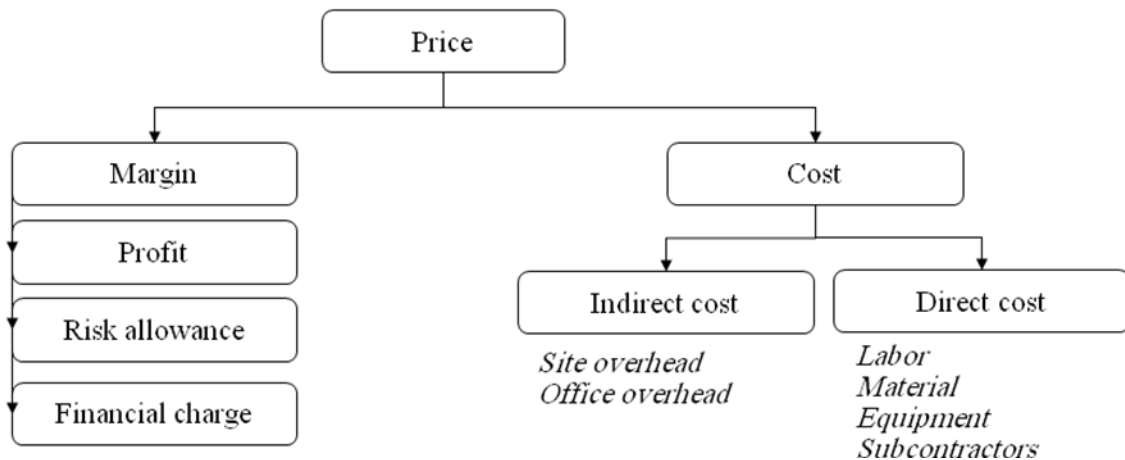
Figure 6.1: Schematic diagram of the structure of tender price

The various estimates discussed above are carried out in sequence, the previous cost estimate being the input to the next one. The estimates are successively refined, incorporating new information and thus keeping a continuously updated estimate that becomes the budget, available for control process. As the project progresses, the number of unknowns and uncertainties decreases, while the level of details and the project information increases. In this way, the accuracy of the estimate improves as it moves from conceptual to detailed estimate.

A detailed estimate is prepared by determining the costs of materials, labor, equipment and subcontractor work. Detailed estimate is prepared from a complete set of contract documents before the submission of a bid. It follows a systematic procedure begins with a thorough review of the complete set of contract documents, drawing and technical specification. A site visit should be done to observe factors that can influence the cost of construction such as: available space for material storing, security, control of traffic and existing underground utilities.

The estimator prepares a material quantity take-off of all materials from the drawings. The quantity of material multiplied by the unit cost of the materials yields the material cost. The quantity of work required of equipment is divided by the equipment production rate and then multiplied by the unit cost of equipment to obtain the total cost of equipment and similarly, the cost of labor are calculated.

The direct cost of a project includes material, labor, equipment, and subcontractor costs. Upon the completion of the estimate of direct costs, the estimator must determine the indirect costs of taxes, bonds, insurance and overhead required to complete the project. A risk analysis of uncertainties is required to determine an appropriate contingency to be added to the base estimate to account for the unforeseen work that develops during construction. Upon calculation of the direct and indirect costs, analysis of risk and assignment of contingency, a profit is added to the estimate to establish the bid price. The amount of profit can vary considerably, depending on numerous factors such as the size and complexity of the project, amount of work in progress by the contractor, accuracy and completeness of the bid documents, competition for work.

6.3   Conceptual Cost Estimating Basics

Conceptual cost estimating is an important pre-design planning process. The following subsections present the conceptual cost estimating definitions, characteristics, importance, preparation, process, and outputs.

A "conceptual estimate" is an estimate prepared by using engineering concepts and

avoiding the counting of individual pieces. As the name implies, conceptual estimates are generally made in the early phases of a project, before construction drawings are completed, often before they are hardly begin. The first function of a conceptual estimate is to tell the owner about the anticipated cost, thus presenting useful information for the owner in contemplating the project feasibility and further development. A conceptual estimate is also used to set a preliminary construction budget, and to control construction costs at the most critical stage, during the design. Conceptual cost estimating is defined as the forecast of project costs that is performed before any significant amount of information is available from detailed design and with incomplete work scope definition, with the purpose of using it as the basis for important project decisions like go/no-go and the appropriation of funds decisions.

The first recognized characteristic of conceptual estimating, like all other estimating, is the inexactness in the process. With the absence of data and with shortage of time, there may be no other way to evaluate designs but to use opinion. Conceptual estimating is a mixture of art and science; the science of estimating tells the cost of past work. The art is in visualizing a project and the construction of each detail, selecting comparative costs from past projects and adjusting them to new conditions.

The second characteristic of conceptual estimating is that its accuracy and validity are highly related to the level of information provided by the project scope. The availability of a good, complete scope definition is considered the most crucial factor for conceptual estimating.

The third characteristic of conceptual estimating is that it is a resource restricted activity. The main resources for conceptual estimating are information, time, and cost. Due to the fact that conceptual estimating is performed in the early stages of the project, the scope information available is usually restricted in detail as well as in precision. In addition, the time and cost available for making the estimate is restricted. Conceptual estimating is used to determine the feasibility of a project quickly or screen several alternative designs. Therefore, the estimate, although important, cannot be given much time and resources.

6.4 Broad Scope of Conceptual Estimates

Prior the design of a project, cost estimate could be prepared based on the cost information based on previously completed projects similar to the proposed project. The number of units or size of the project is the only available information. Although the range of costs varies among projects, the estimator can develop unit costs to forecast the cost of future projects.

The unit cost should be developed from weighting the data that emphasizes the average value, yet it should account for the extreme maximum and minimum values. In that regard Eq. (6.1) can be used for weighting cost data from previous projects.

$$UC = (A + 4B + C) / 6 \tag{6.1}$$

Where: UC = forecast unit cost

A = minimum unit cost of previous projects

B = average unit cost of previous project

C = maximum unit cost of previous projects

Example 6.1

Use the weighted unit cost to determine the conceptual cost estimate for a proposed parking that is to contain 135 parked cars. Previous projects data are given in Table 6.2.

Table 6.2: Previous projects cost data

Project No.	Cost (LE)	No. of cars
1	466,580	150
2	290,304	80
3	525,096	120
4	349,920	90
5	259,290	60
6	657,206	220
7	291,718	70
8	711,414	180

Solution

The unit cost per car can be calculated as given in Table 6.3.

Table 6.3: Unit cost per car

Project No.	Unit cost (LE/car)
1	3,110.4
2	3,628.8
3	4,375.8
4	3,888.0
5	4,321.5
6	2,978.3
7	4,167.4
8	3,952.3

Then, the average unit cost = 30,431.5 / 8 = LE3,803.94 / car

Using Eq. 6.1, the forecast unit cost = (2,987.3 + 4 × 3,803.94 + 4,375.8) / 6 = 3,763.14.

Accordingly, the cost estimate for 135-cars parking = 135 × 3,763.14 = LE508,023

6.5   Conceptual Estimate Adjustment

It is necessary for the estimator to adjust the cost information from previously completed projects for use in the preparation of a conceptual cost estimate for a proposed project. There should be adjustment for time, location, and size.

6.5.1   Adjustment for time

The use of cost information from a previous project to forecast the cost of a proposed project will not be reliable unless an adjustment is made proportional to the difference in tine between the two projects. The adjustment should represent the relative inflation or deflation of costs with respect to time due to factors such as labor rates, material costs, interest rates, etc.

Measures of changes in items such as location, building costs or tender prices are performed using index numbers. Index numbers are a means of expressing data relative to a base year. For example, in the case of a building cost index, a selection of building

materials is identified, recorded and given the index number 100. Let us say for the sake of argument that the cost of the materials included in the base index is LE70.00 in January 2005. Every 3 months the costs are recorded for exactly the same materials and any increase or decrease in cost is reflected in the index as follows: Building cost index January 2005 = 100; Building cost index January 2009 = 135. This, therefore, represents an increase of 35% in the cost of the selected materials and this information can be used if, for example, data from a 2005 cost analysis was being used as the basis for calculating costs for an estimate in January 2009.

Various organizations publish indices that show the economic trends of the construction industry with respect to time. The estimator can use the change of value of an index between any two years to adjust past cost records and to forecast future project costs.

Example 6.2

Suppose the indices for building construction projects show these economic trends (Table 6.4). It is required to use the cost of a LE843,500 project completed last year to prepare a conceptual estimate for a project proposed for construction 3 years from now.

Table 6.4: Construction economic trends

Year	Index
3 years ago	358
2 years ago	359
1 year ago	367
Current year	378

Solution

The equivalent interest rate can be calculated based on the change in the cost index during the 3-year period as follow:

$(378/358) = (1 + i)^3$, then $i = 1.83\%$

Accordingly, the cost of the project should be adjusted for time as follows:

Cost = LE843,500 $\times (1 + 0.0183)^4$ = LE906,960

6.5.2 Adjustment for location

Tender price levels vary according to the region of the country where the work is carried out. Similarly, as stated previously in section 6.5.1, the use of cost information from a previous project to forecast the cost of a proposed project will not be reliable unless an adjustment is made proportional that represents the difference in cost between the locations of the two projects. The adjustment should represent the relative difference in costs material, equipment and labor of the two locations. Indices that show the relative difference in construction costs with respect to geographical location is usually published by many organizations.

Example 6.3

Suppose the indices for different location of construction costs are shown in Table 6.5. Suppose that the construction cost of a project completed at city A is LE387,200, it is required to prepare a conceptual estimate for a similar project proposed in city D.

Table 6.5: Locations cost indices

Location	Index
City A	1.025
City B	1.170
City C	1.260
City D	1.105
City E	1.240

Solution

The cost of the proposed project could be adjusted for location as follows:

$$Cost = LE387,200 \times (1.105 / 1.025) = LE417,420$$

6.5.3 Adjustment for size

The use of cost information from a previous project to forecast the cost of a future project will not be reliable unless an adjustment is made that represents the difference in size of the two projects. In general, the cost of a project is directly proportional to its size. The

adjustment is generally a simple ratio of the size of the proposed project to the size of the previous project from which the cost data are obtained.

6.5.4 Combined adjustment

The conceptual cost estimate for a proposed project is prepared from cost records of a project completed at a different time and at a different location with a different size. The estimator must adjust the previous cost information for the combination of time, location and size.

Example 6.4

Use the time and location indices presented in Tables 6.4 and 6.5 to prepare the conceptual cost estimate for a building with 62,700 m^2 of floor area. The building is to be constructed 3 years from now in city B. A similar type of building that cost LE2,197,540 and contained 38,500 m^2 completed 2 years ago in city E. Estimate the probable cost of the proposed building.

Solution

Proposed cost

$\quad$ = Previous cost × Time adjustment × Location adjustment × Size adjustment

$\quad$ = LE2,179,540 × (1 + 0.0183)^5 × (1.17 / 1.24) × (62,700 / 38,500)

$\quad$ = LE3,700,360

6.5.5 Unit-cost adjustment

Although the total cost of a project will increase with size, the cost per unit may decrease. For example, the cost of an 1800 m^2 house may be LE535/m^2 where as the cost of a 2200 m^2 house of comparable construction maybe only LE487/m^2. This is because certain items such as furniture, garage, etc., are independent of the size of the project. Size adjustment for a project is unique to the type of project. The estimator must obtain cost records from previous projects and develop appropriate adjustments for his/her particular project.

Example 6.5

Cost records from previous projects show this information (Table 6.6). Find the unit cost as a function of the number of units.

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Table 6.6: Previous projects cost data

Project No.	Cost (LE)	Size, no. of units
1	2,250	100
2	1,485	60
3	2,467	120
4	2,730	150
5	3,401	190

Solution

The unit costs are calculated as given in Table 6.7.

Table 6.7: Unit cost

Project No.	Unit cost (LE)
1	22.5
2	24.75
3	20.56
4	18.20
5	17.90

A plot of these points is shown in Figure 6.2. For the first order relationship, the general equation for a straight line is: $y = ax + b$. The equation of the straight line can be determined as:

$$y = [(17.9 - 24.75) / (190 - 60)] \, x + 24.75 \quad = - \, 0.0526 \, x + 24.75$$

where $60 < x < 190$, then $y = 24.75 - 0.0526 \, (S - 60)$

where S the number if units in the proposed project.

Or by adding a trend line of linear type, thus yields the equation shown in Figure 3.1:

$$y = - \, 0.056 \, x + 27.81$$

Obtaining the unit cost for 170 units project size $= - \, 0.056 \times 170 + 27.81 = LE18.29$
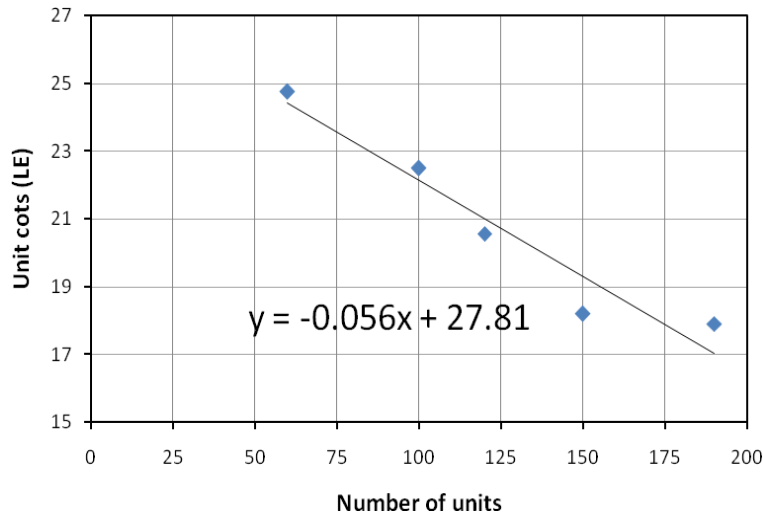
Fig. 6.2: Comparison of size and cost per unit

As illustrated in the Example 6.5, the adjustment of unit costs based on the size of a project is unique and can be obtained only from previous cost records. The cost data for some types of projects could be nonlinear. Accordingly, a second order equation may better fit the data for some types of projects. The estimator must evaluate his/her own particular cost records and develop a unit cost-size relationship.

6.6   Conceptual Estimating Techniques

6.6.1   Interpolation

Interpolation is a technique used in the early stages of the design sequence when information on the proposed project is in short supply. It requires a good deal of skill and experience and is the process of adding in or deducting from the cost analysis to arrive at a budget for a new project. Therefore in preparing a budget for a new project assume a cost analysis has been chosen as the basis for the estimate. However, the cost analysis will contain items that are not required for the new project and these must be deducted. For example, in the new project the client wishes to exclude the installation of air conditioning from the estimate and this will have to be deducted from the budget; but on the other hand the client wishes to include CCTV throughout and the cost of providing this must be calculated and added in. It is important, as described later, to adjust costs to

take account of differences in price levels. The process continues until all identified differences have been accounted for. Other credible approaches to approximate estimating that are available to the quantity surveyor are:

• The unit and square meter methods, generally used for preliminary estimates when firm information is scarce.
• Approximate quantities and elemental cost planning for later stage estimates.
• Other approaches are often cited, most notably cubic meter and storey enclosure methods, but the accuracy of these approaches are somewhat dubious and they are seldom used in practice and are not considered here.

6.6.2 Unit method

The unit method is a single price rate method based upon the cost per functional unit of the building, a functional unit being, for example, a hotel bedroom. This method is often regarded as a way of making a comparison between buildings in order to satisfy the design team that the costs are reasonable in relation to other buildings of a similar nature. It is not possible to adjust the single rate price and therefore is very much a ball park approach. It is suitable for clients who specialize in one type of project; for example, hotel or supermarket chains, where it can be surprisingly accurate. Other examples where unit costs may apply are:
• Schools – cost per pupil
• Hospitals – cost per bed space.

Example 6.6

Assume that the current cost for a 120-pupil school constructed of wood frame for a city is LE1,200,000. We are asked to develop an estimate for a 90-pupil school.

Solution

The first step is to separate the per-pupil cost = LE1,200,000/120 = LE10,000/pupil
Apply the unit cost to the new school = LE10,000/pupil X 90 pupils = LE900,000

Example 6.7

The current cost for a 100-bed hospital constructed is LE1,250,000. We are asked to estimate a 125-bed hospital.

Solution

Cost per-bed   = LE1,250,000/100   = LE12,500/bed

New hospital cost = LE12,500/bed X 125 bed   =   LE1,562,500

Example 6.8

For a multistory garage spaced for 500 cars the construction cost was LE3,000,000. What is the estimate of 450-car garage?

Solution

Cost per-car   = LE3,000,000/500 = LE6,000/car

New Garage cost = LE6,000/car X 450 car = LE2,270,000

6.6.3 Superficial method

The superficial method is a single price rate method based on the cost per square meter of the building. The use of this method should be restricted to the early stages of the design sequence and is probably the most frequently used method of approximate estimating. Its major advantage is that most published cost data is expressed in this form. The method is quick and simple to use though, as in the case of the unit method, it is imperative to use data from similarly designed projects. Another advantage of the superficial method is that the unit of measurement is meaningful to both the client and the design team. Although the area for this method is relatively easy to calculate, it does require skill in assessing the price rate. The rules for calculating the area are:

- All measurements are taken from the face of external walls. No deduction is made for internal walls, lift shafts, stairwells, etc. – gross internal floor area.
- Where different parts of the building vary in function, then the areas are calculated separately.

- External works and non-standard items such as piling are calculated separately and then added into the estimate. Figures for specialist works may be available from sub-contractors and specialist contractors.

Example 6.9

Gross floor area for office block shown in Figure 3.3 $= 10.0 \times 25.0 = 250.0$ m^2

- $2 \times 3.0 \times 7.50 = 205.0$ m^2

Area of 5 floors $205.0 \times 5 = 1025.0$ m^2 x LE1100 /m^2 = LE1,127,500.0

Basement $7.00 \times 25.0 = 175.0$ m^2 x LE1300 /m^2 = LE227,500.0

Estimate for block LE1,355,000.0
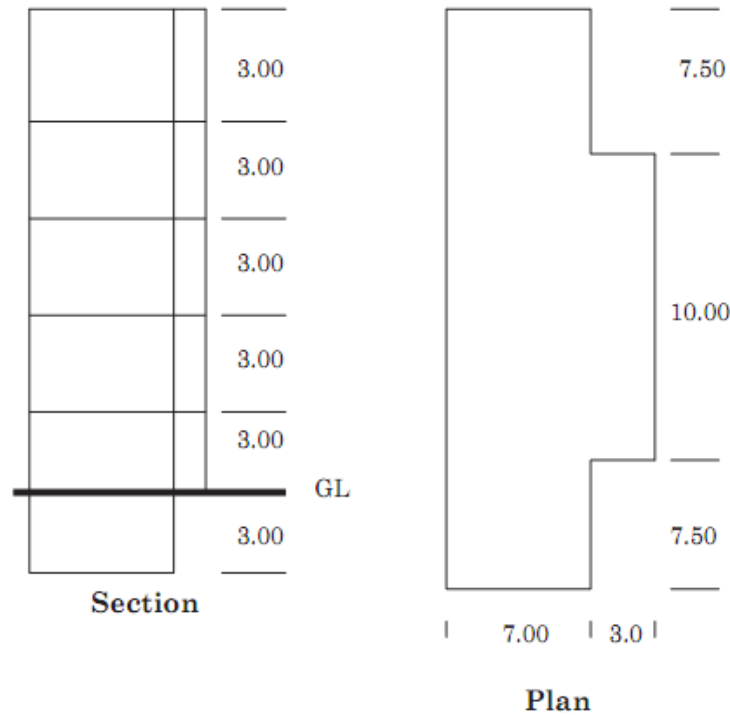

Fig. 6.3: Plan and cross section of Example 6.9

6.7   Detailed Estimate of Direct Costs

The direct cost if each bid item represents the sum of its material, labor, equipment and subcontractor costs. The sum of bid items direct costs gives the estimated direct cost of the contract. The direct cost of a given item can be estimated using the unit rate estimating, operational estimating.

6.7.1 Unit rate estimating

This type of estimating is used in building work and for civil work items where the nature of work is repetitive. It is based on the resources required and their output rates for each category of work. Working drawings and specifications are needed to determine the quantities of materials, equipment, and labor. Current and accurate costs for these items (unit prices) are also necessary. Because of the detail involved and the need for accuracy, unit price estimates require a great deal of time and expense to complete properly. For this reason, unit price estimating is best suited for construction bidding. It can also be effective for determining certain detailed costs in conceptual budgets or during design development.

There are some disadvantages of using the unit-rate method for estimating major works. It does not demand the examination of the program (schedule) or the method statement or the risks costs in undertaking the work. Also, the precision and level of detail in pricing an item can give a false sense of confidence in the resulting estimate. This method does not need having a construction schedule.

6.7.2 Operational estimating

Operational estimating, which is the recommended method for estimating civil engineering work, requires the estimator to build up the cost of the operation based on its principles including the total cost of construction equipment, labor and permanent/temporary materials. This method links well with the planning and scheduling process as it embraces the total anticipated time that the construction equipment and labor crew are involved in the operation including all idle time.

The operational estimating involves the following:
  - Prepare the method statement showing the sequence, resources, timing, etc.
  - Prepare an early completion program with unlimited resources.
  - Revise the program by smoothing or leveling the resources.

Example 6.10

This question relates to the construction of a reinforced concrete basement (50 m $\times$ 30 m $\times$ 10 m deep) built below the ground. The contractor's estimate is required to calculate an appropriate BOQ rate. This item is listed in the BOQ as follow:

| No	Description	Units	Quantity	Unit price	Total
E1	Excavation for foundation, material other than top soil, rock or artificial hard material maximum depth 5-10 m	m^3	15000		

Consider two alternative construction methods:

- Method A: open cut with battered sides (the open cut method requires additional work space to allow for erect and strip shutter of the outer face). Accordingly, assume total volume of excavation equals 2.5 $\times$ net volume.
- Method B: Steel cofferdam built around net perimeter of basement.

Assume the following net costs (based on quotations from subcontractors):

- Excavation open cut, LE3/m^3.
- Disposal on site LE1/m^3.
- Bring back and fill, LE1/m^3.
- Excavation within cofferdam, LE8/m^3.
- Sheet piling (assume 15 m deep), LE20/m^2.
- Mobilization/demobilization of piling rig, LE5000each way.
- Extract cofferdam piling, LE5000.
- Site overheads, 10%, head office overheads and profit, 12%.
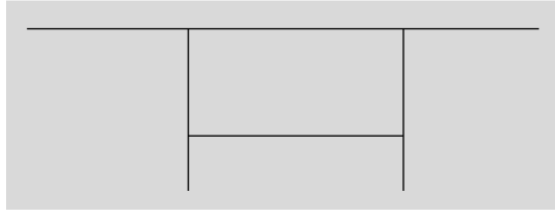
Solution

Method A (open-cut):
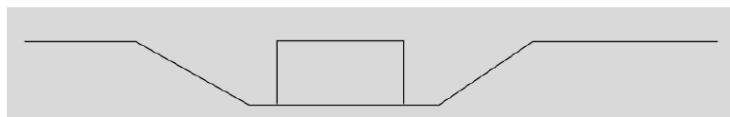
Excavation quantity of open-cut = 15000 $\times$ 2.5   = 37500 m^3.

Disposal on site = 37500 – 15000   = 22500 m^3.

Bring back and fill $= 22500 \text{ m}^3$.

Total net cost $= 37500 \times 3 + 22500 \times 1 + 22500 \times 1 = \text{LE157,500}$

Method B (steel cofferdam):

Excavation quantity within cofferdam $= 15000 \text{ m}^3 = 15000 \times 8$ $= \text{LE120,000}$.

Sheet piling mobilization/demobilization (two times) $= 2 \times 5000$ $= \text{LE10,000}$.

Sheet piling $(30 + 30 + 50 + 50) \times 15 = 2400 \times 20$ $= \text{LE48,000}$.

Extract cofferdam $= \text{LE5,000}$.

Total net cost $= \text{LE183,000}$.

Thus, based on the above, the estimator would choose the open-cut method.

Net cost of open-cut method	$= \text{LE157,500}$
10% site overheads	$= \text{LE15,750}$
Subtotal	$= \text{LE173,250}$
12% head office overheads and profit	$= \text{LE20,790}$
Total	$= \text{LE194,040}$

So, the rate to be included in the bill of quantity should be $= 194040/15000 = \text{LE12.936/m3}$.

6.8   Estimating Indirect Cost

The indirect costs comprise both site and head office (general) overheads.

6.8.1   Site overheads

To accommodate various site situations, it is a good idea for a construction company to develop comprehensive checklists for general jobsite requirements regarding its specialized line of business. Such a list would aid the estimator, ensuring that no important cost items are forgotten under the time pressure of finalizing the bid. Visits to

the jobsite by an experienced estimator and a principal of the firm are a must after a preliminary review of drawings and specifications. A site investigation report can be used to collect needed information useful for organizing the future jobsite and, above all, to determine prior bidding costs. Any missing items will reduce overall profit. A prudent contractor and subcontractor will not be satisfied applying a fee to the direct estimated costs, a fee that is supposed to cover jobsite overhead and markup.

The estimated total jobsite overhead costs will become the baseline budget for jobsite overhead expenditure control. These items might include:
- Jobsite personnel wages and fringe benefits;
- Jobsite personnel project-related travel expenses;
- Outside contracted engineering support (surveying, materials testing, etc.);
- General use equipment for the benefit of the general contractors and subcontractors (cranes, hoists);
- Field buildings;
- Site utilities for the job duration;
- Horizontal structures (roads, parking, fences, and gates);
- Temporary environmental controls requirements;
- Winter and summer protection of completed works or works in progress;
- Related camp facilities for remote jobs;
- Jobsite production facilities (concrete batching plants, quarry, various shops);
- Protective aids for workers (gloves, hard hats, etc.) during construction and final cleanup of the project; and
- Utilities needed for material storage;
- Cost of temporary site utilities.

6.8.2   General overheads

The company home office expenses cannot be chargeable most of the time to a single project. General overhead represents contractor fixed expenses. A general contractor's or subcontractor's main office expense consists of many items.

A summary of the major categories is presented below:

- Salaries

- President and vice president

- Estimating group

- Human resource personnel

- Secretaries

- Payroll clerk and accounts payable clerks

- Benefits

- Office/shops rent

- Office utilities and communication

- Office supplies and equipment

- Office maintenance

- Advertising/jobs procurement/public relations

- Associations and clubs' dues

- Licenses and fees

- Trade journals subscriptions and books

- Travel and entertainment

- Company sponsored training programs

- Accounting services

- Legal services

- Home office vehicles, depreciation, operation expenses

- Insurance expenses

- Total anticipated home office expense

The expense list presented above is not appropriate for all contractors. For smaller contractors who operate from a truck, the list would contain considerably fewer items and for a large contractor, the list could fill pages, but the concept is the same. The expenses should be estimated, and all efforts must be made to stay in the budget and to generate the planned business volume. In general, main office expense ranges from 2.5 to 10% of annual construction billings.

6.8.3 *Contingencies*

Contingency is that amount of money added to an estimate to cover the unforeseen needs of the project, construction difficulties, or estimating accuracy. Many chief estimators or contractor executives add a contingency to the estimate to cover one or possibly more of the following:

- Unpredictable price escalation for materials, labor, and installed equipment for projects with an estimated duration greater than 12 months;
- Project complexity;
- Incomplete working drawings at the time detail estimate is performed;
- Incomplete design in the fast-track or design-build contracting approach;
- Soft spots in the detail estimate due to possible estimating errors, to balance an estimate that is biased low;
- Abnormal construction methods and startup requirements;
- Estimator personal concerns regarding project, unusual construction risk, and difficulties to build;
- Unforeseen safety and environmental requirements;
- To provide a form of insurance that the contractor will stay within bid price.

Most often, if for any reason an accurate estimate is not made (95 to 100% accuracy), an estimator never knows how much money to allow for these "forgotten" items. Many times, added contingencies are an excuse for using poor estimating practices such as not enough time, subcontractors not reporting, no time to visit the job site, and so on. Contingency for these reasons is difficult to sell to management and can hurt the credibility of the estimating team. On the other hand, compounding building projects' bidding complexity justifies the need to add contingency as part of the markup. This construction risk compensation is added to the final direct and jobsite overhead cost. The magnitude depends on the type of contract agreement, type of construction, and certainly project location.

Contingency is not potential profit. It includes risk and uncertainty but explicitly excludes changes in the project scope (change orders). The contingency should absolutely not be

treated as an allowance. Allowances are costs that are foreseen to be spent, and need to be included in the detail estimate in the proper construction category of work and not as a total for the project. There are many factors that affect the amount of contingency to be included in the estimate. General contingency guidelines also apply to different types of construction. In general, contingency reflects the contracting organization's judgment decision to avoid bid cost overrun. On the other hand, too much contingency will create a "fat" estimate if management is not willing to accept some construction risks.

6.8.4 Contractor/Subcontractor profit

The last item to be included in the bid and representing contractor's return on investment is the profit. The magnitude of desired profit must be decided by the owner for each individual bid, depending on local market conditions, competition, and the contractors' need for new work. In the construction industry, markup is defined as "the amount added to the estimated direct cost and estimated job into overhead cost" to recover the firm's main office allocated overhead (general overhead) and desired profit. The less profit added to a bid, the greater the chance is of being the successful bidder.

To be competitive, a construction company's general overhead and profit should be close to industry norms. The concept of percentage of return on indirect cost investment must also be considered. The return on indirect cost is calculated by dividing the corporation's annual net profit before taxes by the general overhead cost. General overhead and profit recovery factors are developed from the annual general overhead budget. After bid opening, contractors occasionally ask close competitors what percent they added for profit. Surprisingly, competitors are refreshingly candid in revealing the amount added for profit. This natural curiosity is related to the many kinds of profit. Contractors are intuitively trying to ascertain why competitor A, who lost the job, marked up 2%, and competitor B, who marked up 4%, was awarded the bid.

6.9   Finalizing a Tender Price

The total price of a tender comprises the cost and the markup. The cost includes direct and indirect costs. The markup, on the other hand, includes profit margin, financial charges (cost of borrowing), and a risk allowance margin (Figure 6.1).

Estimating a single percentage markup to be added to the total cost. It is assumed that this percentage will cover all the components of markup as shown in Figure 6.1; and Detailed analysis of the risky components in the project and their impact on the project in terms of increased time and cost. Also, cash flow analysis to estimate the financial charge and estimating a reasonable profit margin. Calculations of the financial charges (cost of borrowing) were, also, presented previously in this chapter based on the cash flow analysis of the contract.

Having all contract costs (direct and indirect), and markup components (profit margin, risk allowance and financial charge), it is time to finalize the bid price. While, the direct cost is associated directly to the contract activities, indirect cost and markup are not associated with specific activities but with the whole contract. Accordingly, pricing policy is the method by which the indirect costs and markup will be distributed among the items of the bill of quantities.

6.9.1   Balanced bid (straight forward method)

In this method, the indirect cost and the markup will be distributed among different items based on their direct cost; i.e., the more the direct cost of an item, the more its share from indirect cost and markup. The resulting bid price is called a balance d bid.

$$\text{The share of specific item} = \frac{\text{Direct cost of this item}}{\text{Total contract direct cost}} \times (\text{total indirect cost} + \text{markup})$$

Example 6.11

Assume that the direct cost for an item (a) is LE 400,000 and that item is included in a contract whose price is LE 3,500,000 and its total direct cost is LE 2,800,000. Calculate the price for item (a) considering a balanced bid.

Solution

Bid price = direct cost + indirect cost + markup

Indirect cost + markup (for the whole contract)

= Bid price - direct cost = 3,500,000 - 2,800,000 = LE 700,000

Then, Indirect cost + markup for activity (a)

$$= \frac{400,000}{2,800,000} \times 700,000 = \text{LE } 100,000$$

Then, price of activity a   = its direct cost + indirect cost

= 400,000 + 100,000 = LE 500,000

6.9.2   *Unbalanced bid (Loading of Rates)*

The contract price is said to be unbalanced if the contractor raises the prices on certain bid items (usually the early items on the bill of quantities) and decreases the prices on other items so that the tender price remains the same. This process is also called the loading of rates. The contractor usually loads the prices of the first items to ensure more cash at the beginning of the contract and to reduce the negative cash flow and accordingly reduces borrowing of money.

Loading of rates may be risky to both the contractor and the owner. If the contractor raised the price for an item and the quantity of this item increased than that was estimated in the bill of quantities then, this situation is more risky to the owner as it will cost the owner more money. On the other hand, if the contractor reduced the price of a specific item and the quantity of that item increased, thus situation will be more risky to the contractor. So, it is better to follow a balanced way of distributing the indirect costs and markup among contract items.

Example 6.12

Consider a small contract comprises of five sequential activities of equal duration. The quantity of work in each activity, the direct cost rate, and total cost rate for balanced and unbalanced bid are given in Table 6.8. Determine the effect of

unbalanced bid on the contractors' profit if: Quantity of activity (B) is increased by 50%. Quantity of activity (C) is increased by 50%.

Table 6.8: Data for Example 6.12

Activity	Quantity	Direct cost rate	Balanced bid		Unbalanced bid	
			Rate	Price	Rate	Price
A	100	4	5	500	6	600
B	100	8	10	1000	14	1400
C	100	16	20	2000	18	1800
D	100	16	20	2000	18	1800
E	100	8	10	1000	9	900
Tender price				6500		6500

Solution

- Contract total direct cost $= 100 (4 + 8 + 16 + 16 + 8) = 5200$

- Contract price $= 6500$

- Contract markup and profit $= 6500 - 5200 = 1300 = 25\%$ of direct cost

- Table 6.9 shows the effect of tender price if the quantity of activity "B" increased by 50%.

- The price of the unbalanced bid (7200) is greater than that of the balanced bid (7000) which means more profit to the contractor and more risk to the owner.

Table 6.9: Effect of change in quantity of activity B

Activity	Quantity	Direct cost rate	Balanced bid		Unbalanced bid	
			Rate	Price	Rate	Price
A	100	4	5	500	6	600
B	150	8	10	1500	14	2100
C	100	16	20	2000	18	1800
D	100	16	20	2000	18	1800
E	100	8	10	1000	9	900
Tender price				7000		7200

- Table 6.10 shows the effect of tender price if the quantity of activity "C" increased by 50%.

- The price of the unbalanced bid (7400) is less than that of the balanced bid (7500) which means less profit and more risk to the contractor.

This decrease means that the profit of the contractor has been decreased and thus represents risk to the contractor.

Table 6.10: Effect of change in quantity of activity C

Activity	Quantity	Direct cost rate	Balanced bid		Unbalanced bid	
			Rate	Price	Rate	Price
A	100	4	5	500	6	600
B	100	8	10	1000	14	1400
C	150	16	20	3000	18	2700
D	100	16	20	2000	18	1800
E	100	8	10	1000	9	900
Tender price				7500		7400

6.10 Exercises

1. Use the time and location indices shown below to estimate the cost of a building that contains 32500 m² of floor area. The building is to be constructed 2 years from now in City A. The cost of a similar type of building that contained 48300 m² was completed last year in City C for a cost of LE3,308,500.

Construction economic trends

Year	Index
3 years ago	358
2 years ago	359
1 year ago	367
Current year	378

Locations cost indices

Location	Index
City A	1.025
City B	1.170
City C	1.260
City D	1.105
City E	1.240

2. Find the weighted unit cost per square meter for the project data shown and determine the cost of a 2700-m² project.

Project No.	Total cost (LE)	Size, m^2
1	147,300	2580
2	153,700	2900
3	128,100	2100
4	118,400	1850
5	135,700	2300

3. Determine the relationship between unit cost and size for the project data shown in Problem 2 to estimate the cost of a 2200-m^2 project.

4. Complete the following sentences:
   a. Conceptual cost estimate is also known as: ………, ……….., ………
   b. The conceptual estimate is defined as …………………………………
   c. The important project decision based on the conceptual estimate is ...
   d. The most important piece of information in conceptual estimate is ….
   e. When using historical data to predict the cost of a new project, these data should be adjusted for ……., ……. and ……………
   f. The time adjustment should account for the ………. and …………..
   g. The parametric models calculate ……….. based on ……………….
   h. In parametric model, some of the input independent variables are ……., ……., ……. and …….

5. Assume that the current cost for a 120-pupil school constructed of wood frame for a city is LE1,200,000. We are asked to develop an estimate for a 90-pupil school to be constructed this year in City A. The 120-pupil school was constructed in 2008 in City E. the inflation rate was assumed to be 2.3% annually.

6. A bill of quantity of a project includes 500m^2 of masonry work. The work will be done by one crew with a production rate of 50 m^2/day and consists of:

Crew member	No	All-in rate/day
Brick layer	2	50
Assistant	1	25

Labor	2	12

Vendor price of 1000 bricks = LE160. Each 55 bricks are estimated to make one square meter of masonry. Each one cubic meter of mortar is used to join brick area of 50 m^2 and consists of:

Quantity	Material	Primary quotation form vendor
One cubic meter	Sand	LE15/m^3
6 sacks (50 kg each)	Cement	LE240/ton

As a contractor, it is required to estimate the item price and the unit price. Assume all material waste as 20% and assume overheads and markup as 20% of total cost.

7. Consider the following items of a given project:

Item	Unit	Quantity	Direct cost (LE)			
			Material	Equipment	Labor	Subcontractor
1	m^3	150	1000	11200	4000	-
2	m^3	180	1800	1000	4000	-
3	m^3	40	960	400	3200	-
4	m^3	60	1200	600	4800	-
5	lump-sum	Lump-sum	-	-	-	2000

-   Site overheads = 5% of Direct cost.

-   General overheads = 5% of Construction cost.

-   Profit and risk = 10% of Total cost.

It is required to develop a balanced tender price (balanced –bid).

Calculate the unit price of each item through developing a balanced bid.