The cost of labor, material and equipment expended on the items that were measured in the quantity takeoffs is usually referred to as the direct costs of the work. The general expenses of a project comprise all of the additional, indirect costs that are also necessary to facilitate the construction of the project. These indirect costs are sometimes titled general requirements of the project or project overheads. This chapter is devoted for the estimating of different items represents the overheads of a project and also discusses the pricing of the project items after defining both the direct costs and markup values.

5.1 Estimating Work Items Cost

Estimating the cost of any work items include estimating the cost of labor, equipment and material. The analysis of a given job requires a thorough review of the plans and specifications of the bid documents, an evaluation of the soil investigation report and a visit to the jobsite where the project is to be constructed. For earthwork estimates, the bid documents usually contain a soil report that provides geotechnical information about the soil and subsurface conditions. The estimator can use other sources that help in developing an accurate estimate.

5.1.1 Swell and compaction factors

To estimate the cost of excavating and hauling earth, it is necessary to know the physical properties of earth because the volume changes during construction operations. For an earth work operation, the soil is excavated from its natural state, placed in a hauling unit
and transported to the disposal area, where it is distributed and compacted. For example, one cubic meter of soil that is excavated from the ground may occupy 1.25 cubic meters after it is loosened and placed in the hauling unit. After the soil is compacted in place it may occupy 0.9 cubic meter. The soil to be excavated is called bank measure, in its undisturbed condition, prior to excavating or after being compacted in place. Also, any additional requirements to support the excavation operation should be also added to the cost estimating of an excavation operation. For example, excavation support, dewatering, etc.

5.1.2 Calculating truck requirements

The estimator has to determine the optimum number of trucks required to transport excavated materials. A simple formula can be used for this calculation based on the premise that it is desirable to have sufficient trucking capacity to ensure that the excavation equipment is able to operate continuously and not have to waste time waiting for trucks. Obviously, three trucks will be required if it takes 10 minutes to load a truck and 20 minutes for that truck to unload and return for another load, because while the first truck is away, two other trucks can be loaded. Thus, the number of trucks can be calculated as:

\[
\text{Number of required trucks} = \frac{\text{truck cycle time}}{\text{loading time}} \quad (5.1)
\]

\[
\text{Truck cycle time} = \text{loading time} + \text{going time} + \text{return time} + \text{dumping time} \quad (5.2)
\]

\[
\text{Loading time} = \frac{\text{truck capacity}}{\text{production rate of loader}} \quad (5.3)
\]

\[
\text{Truck capacity (bank measure)} = \frac{\text{truck capacity (loose)}}{1 + \text{swelling factor}} \quad (5.4)
\]

Note that the number of trucks obtained from Eq. 5.1 should always be rounded up no matter how small the decimal. Most estimators consider it better to have more rather than less capacity so that the excavator is kept occupied.
5.1.3 Waste factors

When estimating the material required for any job, it is necessary to add a portion for the wastage of material used. The quantities of material taken off are the unadjusted net amounts calculated from the drawings. Allowance for waste and spillage of this material can be made by increasing the takeoff quantities or by raising the price by the percentage factor considered necessary. The values of waste factors usually lie between one and 10 percent for different materials.

Example 5.1

Calculate the equipment and labor prices per m$^3$ to excavate 3000 m$^3$ of trench using 0.75 m$^3$ backhoe costing LE670/day (day = 8 hrs), plus LE4000 for transportation and set up charges. Expected output is 60 m$^3$/day with an operator and 0.5 labor at wages of LE40 and LE30 respectively.

Solution

Operator unit price = LE40/hr; Labor unit price = 0.5 x 30 = LE15/hr
Backhoe unit price = 670 / 8 = LE83.75/hr

This crew produces 60 m$^3$/day,
Labor price/m$^3$ = 55 / 60 = LE0.92/m$^3$
Equipment price/m$^3$ = 83.75 / 60 = LE1.4/m$^3$
Transportation price = 4000 / 3000 = LE1.33/m$^3$

Then price/m$^3$ = LE3.65/m$^3$

Example 5.2

Calculate the price of obtaining a gravel form a pit located 16 km from the work site, where unit price is LE2.5/m$^3$, using a loader with a rate of 50 m$^3$/hr (bank measure) and 12 m$^3$ trucks to transport the gravel. The loader and trucks are priced at rates of LE450/day and LE300/day respectively. The labor crew consists of one equipment operator at LE40/hr, two labors at LE30/hr and truck driver at LE30/hr. the dump truck travel at an average speed of 20 km/hr. the gravel has swell factor of 12% and 5 minute required to off-load the truck.
Solution

First: calculate the number of trucks required to have a balanced crew

Number of required trucks = truck cycle time / loading time

Truck cycle time = loading time + going time + return time + dumping time

Loading time = truck capacity / production rate of loader

Truck capacity = 12 (loose material) / 1.12 = 10.71 m³ (bank measure)

Loading time = 10.71 × 60 / 50 = 12.85 min

Travel time = 16 × 2 × 60 / 20 = 96 min

Cycle time = 12.85 + 96 + 5 = 113.85 min

No. of trucks = 113.85 / 12.85 = 8.86 = 9 trucks

Second: calculate the gravel supply price

Loader = 450 / 8 = LE56.25/hr

Trucks = 9 × 300 / 8 = LE337.5/hr

Operator = LE40/hr

Labors = 2 × 30 = LE60/hr

Drivers = 9 × 30 = LE270/hr

Crew hourly cost = 56.25 + 337.5 + 40 + 60 + 270 = LE763.76/hr

Crew unit price = 763.76 / 50 = LE15.28/m³

Then, gravel unit price = crew price + gravel cost = 15.28 + 2.5 = LE15.78/m³

Example 5.3

It is required to determine the unit price for plain concrete given the following information:

Plain concrete (PC) quantity = 1080 m³.

One cubic meter of PC comprises of 250 kg cement; 0.8 m³ gravel and 0.4 m³ sand.

The prices of these materials are LE500/ton; LE80/m³ and LE40/m³ for cement, gravel and sand respectively. Assume 10% wastage for all these materials.

The details of the crew used are shown in the table below.

Assume overheads and markup 20%.
<table>
<thead>
<tr>
<th>Crew item</th>
<th>No</th>
<th>Production</th>
<th>Price rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump</td>
<td>1</td>
<td>30 m³/hr</td>
<td>LE450/day</td>
</tr>
<tr>
<td>Truck mixer</td>
<td>3</td>
<td>9 m³/hr/one</td>
<td>LE350/day/one</td>
</tr>
<tr>
<td>Vibrator</td>
<td>2</td>
<td>-</td>
<td>LE100/day/one</td>
</tr>
<tr>
<td>Labor</td>
<td>5</td>
<td>-</td>
<td>LE15/day/one</td>
</tr>
<tr>
<td>Foreman</td>
<td>1</td>
<td>-</td>
<td>LE30/day/one</td>
</tr>
</tbody>
</table>

**Solution**

Assume 8-working hours/day

Pump production rate = 30 m³/hr = 30 × 8 = 240 m³/day

Truck mixers production rate = 3 × 9 × 8 = 216 m³/day

The crew production rate equals the production rate of the critical resources (the lowest) = 216 m³/day

Then, duration = 1080 / 216 = 5 days

**Material cost:**

Cost per/m³ = 1.1 × (0.25 × 500 + 0.8 × 80 + 0.4 × 40) = LE225.5/m³

Total material cost = 225.5 × 1080 = LE243,540

**Equipment cost:**

Equipment cost/day = 450 + 3 × 350 + 2 × 100 = LE1700/day

Equipment cost = 1700 × 5 = LE8,500

**Labor cost:**

Labor crew cost/day = 15 × 5 + 1 × 30 = LE105/day

Labor cost = 105 × 5 = LE525

**Item price:**

Item cost = 243540 + 8500 + 525 = LE252,565

Item price = 252565 × 1.2 = LE303,078

Then, the item unit price = 303078 / 1080 = LE280.63/m³

5.1.4 **Subcontractors**

In essence, subcontractor quotations should be solicited and analyzed in the same way as material quotes. A primary concern is that the bid covers the work as per plans and specifications, and that all appropriate work alternates and allowances are included. Any
exclusion should be clearly stated and explained. Oral bids quotes should be followed up by fax/e-mail and hard copy confirmation. Any unique scheduling or payment requirements must be noted and evaluated prior to submission of the prime bid. Such requirements could affect or restrict the normal progress of the project, and should therefore be known in advance.

The estimator should note how long the subcontract bid will be honored. This time period usually varies from 30 to 90 days and is often included as a condition in complete bids. The general contractor may have to define the time limits of the prime bid based on certain subcontractors. The estimator must also note any escalation clauses that may be included in subcontractor bids.

Reliability is another factor to be considered when soliciting and evaluating subcontractor bids. Reliability cannot be measured or priced until the project is actually under construction. Most general contractors stay with the same subcontractors for just this reason. A certain unspoken communication exists in these established relationships and usually has a positive effect on the performance of the work. Such familiarity, however, can often erode the competitive nature of bidding. To be competitive with the prime bid, always obtain comparison subcontract prices. The estimator should question and verify the bonding capability and capacity of unfamiliar subcontractors. Taking such action may be necessary when bidding in a new location. Other than word of mouth, these inquiries may be the only way to confirm subcontractor reliability.

For major subcontract items such as mechanical, electrical, and conveying systems, it may be necessary to make up spreadsheets in order to tabulate inclusions and omissions. This procedure ensures that all cost considerations are included in the “adjusted” quotation. Time permitting, it’s a good idea to do a takeoff and price these major subcontract items to compare with the subcontractor bids. If time does not permit a detailed takeoff, the estimator should at least budget the work. An assembly’s estimate is ideal for this purpose.
5.1.5 Preparation of method statement

It is an essential part before the cost estimating of a given work item is to prepare its method statement. Method statement represents the way in which the work will be carried out. This includes:

1. Site staff detail who are going to supervise the work. A given supervisor may be experienced with a certain job but not with other job.
2. A schedule of the required materials and the proposed sources of supply.
3. A schedule of the basic costs at the time of tender of the equipment, labor and materials.
4. Details of the proposal for staff housing, offices, workshops and stores.
5. A list of subcontractors the estimator proposes to use.
7. Construction method of each work item.
8. List of risks and uncertainties the contractor is going to carry and responses to deal with them.
9. Work breakdown structure of the work.
10. A schedule of the activities showing the labor and materials required.
11. A detailed program of the work (schedule) showing the proposed duration of each work item.

5.2 Estimating Direct Cost

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.

5.2.1 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.

5.2.2 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 5.4

This question relates to the construction of a reinforced concrete basement (50 m × 30 m × 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:
**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 $2.5 \times \text{net volume}$.
- 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, LE5000 each 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 = $22500$ m$^3$.
- Total net cost = $37500 \times 3 + 22500 \times 1 + 22500 \times 1 = \text{LE}157,500$

**Method B (steel cofferdam):**
Excavation quantity within cofferdam = 15000 m$^3$ = 15000 × 8 = LE120,000.
Sheet piling mobilization/demobilization (two times) = 2 × 5000 = LE10,000.
Sheet piling (30 + 30 + 50 + 50) × 15 = 2400 × 20 = LE48,000.
Extract cofferdam = LE5,000.
Total net cost = LE183,000.

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

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

So, the rate to be included in the bill of quantity should be = 194040/15000 = LE12.936/m$^3$.

**Example 5.5**

A grout curtain is to be constructed underneath a dam. This involves drilling through the underlying rock. The total length of the grout holes to be drilled is 21390 m distributed over 388 holes. The following table shows the work involved into five activities along with the sued resources.

<table>
<thead>
<tr>
<th>Act</th>
<th>Description</th>
<th>No of holes</th>
<th>Length (m)</th>
<th>No of drilling and grouting pits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grout 1</td>
<td>154</td>
<td>7400</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Grout 2</td>
<td>53</td>
<td>2870</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Grout 3</td>
<td>55</td>
<td>3130</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Grout 4</td>
<td>79</td>
<td>4510</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Grout 5</td>
<td>47</td>
<td>3480</td>
<td>3</td>
</tr>
</tbody>
</table>
Assume that the drilling and grouting rate equals 20m/day. The drilling rig requires \(\frac{1}{2}\) day moving from a hole to another. The cost of the used equipment is LE2300/wk/unit and the cost for grout material is LE5.8/m. The week comprises of 6 days. It is required to determine the duration of each activity. The direct unit cost using the unit rate estimating and the operational estimating.

**Solution**

Calculating activities’ durations:

<table>
<thead>
<tr>
<th>Act</th>
<th>drilling and grouting duration (days)</th>
<th>Moving rig (days)</th>
<th>Total duration (week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7400 / (20×4) = 92.5</td>
<td>154 / (2×4) = 19.3</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>2870 / (20×2) = 71.8</td>
<td>53 / (2×2) = 13.3</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>3130 / (20×3) = 52.2</td>
<td>55 / (2×3) = 9.2</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>4510 / (20×4) = 56.4</td>
<td>79 / (2×4) = 9.9</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>3480 / (20×3) = 58.0</td>
<td>47 / (2×3) = 7.8</td>
<td>11</td>
</tr>
</tbody>
</table>

Assume the following activity schedule:

![Activity Schedule Diagram](image)

Calculating cost using unit-rate estimating:

The drilling and grouting rate = 20m/day = 0.05 day/m

Time of moving equipment = 388 × 0.5 = 194 days = 194/21390 = 0.009 day/m

Total time = 0.05 + 0.009 = 0.059 day/m

Daily cost of equipment = 2300 / 6 = LE383.33

Grouting unit rate = 5.8 + 0.059 × 383.33 = LE28.42/m

Calculating cost using operational estimating:
Total equipment-weeks used = 19×4 + 15×2 + 11×(3+4+3) + 7 = 223 unit.week
Cost of equipment = 223 ×2300 = LE512900
Unit cost rate = 5.8 + 512900/21390 = LE29.58/m

5.3 Estimating Indirect Cost

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

5.3.1 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. Certainly not all items are relevant for each report. If the project is in a remote area or in a harsh environment, more items will be checked and questions answered during the site visit. Later, they will be converted to line items with an estimated cost toward job site overhead. 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
- Bonds, insurance, permits, and taxes required in the contract general conditions;
- Utilities needed for material storage;
- Cost of temporary site utilities.

5.3.2 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:

- Non reimbursable salaries
- President
- Vice president
- Estimating group
- Human resource personnel
- Secretaries
- Payroll clerk
- Accounts payable clerks
- Total office non reimbursable salaries
- Benefits
- Office/shops rent
- Depreciation of capital expenditures
- Office utilities and communication
- Office supplies
- Office equipment (rented, if owned depreciated)
- Office maintenance
- Advertising/jobs procurement/public relations
- Associations and clubs dues
- Licenses and fees
- Donations/sponsored research
- Trade journals subscriptions and books
- Travel
- Entertainment
- Company sponsored training programs
- Accounting services
- Legal services
- Estimating and project management (not salaries)
- Consulting fees (legal, etc.)
- 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.

5.3.3 Construction 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. For underground work the contingencies should be increased by 2 to 5% for
each design phase. For buildings, it is recommended to decrease the contingencies by 1 to 3% for each phase. 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.

To management, contingency is money it hopes will not be expended, but instead returned as profit at project completion. If the amount of contingency added to the bid is too large the contractor risks not getting the project and recording an additional expense for doing the estimate and bidding. This is the reason that a cost line item is usually not included in the bid.

5.3.4 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. Bidding a job with a high profit added does not mean the contactor will get the job. Bidding a job below cost with no planned profit or a minimum profit only to get the work is also no guarantee of being a successful contractor. A contractor can go broke by not obtaining enough profitable work.

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. Different kinds of profits are related to several considerations, including the following:

- The firm must recoup sufficient profit for return on equity.
- The profit must be commensurate with industry averages.
- The profit must consider competitive bidding strategies.
- The profit must be as high as possible or what the competitive market will bear, while commensurate with the contractor’s risk.

5.4 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 5.1).

![Figure 5.1: Components of a tender price](image)

If you are much involved in the construction business, you must have experienced how difficult it is to decide on a suitable margin to make your bid competitive against other contractors. We need to decide on the markup percentage that makes the bid low enough
to win and, at the same time, high enough to make reasonable profit. Generally, contractors often have to main methods of assessing a specific contract markup.

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 5.1; 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. Estimating profit and risk allowance margins will be presented in the next subsection.

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 are 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, so that the bid price is ready to be submitted to the client.

5.4.1 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 balanced bid.

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

Example 5.5

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 = LE 100,000

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

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

5.4.2 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 remain 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 5.7

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 5.1. 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 5.1: Data for Example 5.5

<table>
<thead>
<tr>
<th>Activity</th>
<th>Quantity</th>
<th>Direct cost rate</th>
<th>Balanced bid</th>
<th>Unbalanced bid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rate</td>
<td>Price</td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>4</td>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>8</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>16</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
<td>16</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td>E</td>
<td>100</td>
<td>8</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>Tender price</td>
<td></td>
<td></td>
<td>6500</td>
<td>6500</td>
</tr>
</tbody>
</table>

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 5.2 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 5.2: Effect of change in quantity of activity B

<table>
<thead>
<tr>
<th>Activity</th>
<th>Quantity</th>
<th>Direct cost rate</th>
<th>Balanced bid</th>
<th>Unbalanced bid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rate</td>
<td>Price</td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>4</td>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>B</td>
<td>150</td>
<td>8</td>
<td>10</td>
<td>1500</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
<td>16</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
<td>16</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td>E</td>
<td>100</td>
<td>8</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>Tender price</td>
<td></td>
<td></td>
<td>7000</td>
<td>7200</td>
</tr>
</tbody>
</table>

- Table 5.3 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 5.3: Effect of change in quantity of activity C

<table>
<thead>
<tr>
<th>Activity</th>
<th>Quantity</th>
<th>Direct cost rate</th>
<th>Balanced bid</th>
<th>Unbalanced bid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rate</td>
<td>Price</td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>4</td>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>8</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>C</td>
<td>150</td>
<td>16</td>
<td>20</td>
<td>3000</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
<td>16</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td>E</td>
<td>100</td>
<td>8</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>Tender price</td>
<td></td>
<td></td>
<td>7500</td>
<td></td>
</tr>
</tbody>
</table>

5.4.3 Method related charge

As it has been seen before, the prices entered in the conventional bill of quantities may not represent the real cost of the work defined in the individuals items. This is because not all costs are directly related to the quantity of work in that item. Therefore, adjustment for the price due to a change in a quantity of a particular item may not represent the real variation in cost. For example, a site overhead is mainly a time-related cost. Assume that it will be incurred monthly. In conventional bill of quantitates, the cost of site overheads recovered by spreading it over the quantities proportional rates. If variation occurs and the site facilities are required for a longer period, there is no systematic way for adjusting the contract price. Accordingly, if the time-related cost of the site overheads could be entered in the bill of quantities as a time-related charge, then the cash flow pattern would be more realistic and this item could be adjusted in the case of relevant variation.

The method related charge is used to allow for entering items in the bill of quantities for any operation whose cost is not directly linked to the quantities of permanent work. The main advantages of using this method for pricing the bill of quantities are:

- It allows a systematic evaluation of variations and changes.
- It provides a reasonable payment for work varied in quantities.
- It realistically reflects the cost of construction which reduces the effect of inflation and investment required from the contractor.
- Improves the cash flow and consequently reduces the need for the loading of rates.

The following table shows a BOQ example containing some method-related charge items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit price</th>
<th>Total price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heath Safety Equipment and Monitoring.</td>
<td></td>
<td>Lump Sum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Project Site Mobilization.</td>
<td></td>
<td>Lump Sum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Steel Structure Decontamination.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Decontaminate steel structure</td>
<td>1100</td>
<td>Square Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Load and haul debris to Landfill in Alexandria</td>
<td>5</td>
<td>Ton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Walls Decontamination and Coating.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Support walls</td>
<td>1200</td>
<td>Square Meters</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Rolling Scaffold</td>
<td>1200</td>
<td>Square Meters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.5 Exercises

1. A crew comprising 3 labors and 0.5 foreman is deserved to take (16 hr) 2-days to excavate 36 $m^3$ of soil. If the average rate of labor is LE21/hr and foreman is LE24/hr. Find the unit cost of excavation.

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

<table>
<thead>
<tr>
<th>Crew member</th>
<th>No</th>
<th>All-in rate/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick layer</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Assistant</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Labor</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Material</th>
<th>Primary quotation form vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>One cubic meter</td>
<td>Sand</td>
<td>LE15/$m^3$</td>
</tr>
<tr>
<td>6 sacks (50 kg each)</td>
<td>Cement</td>
<td>LE240/ton</td>
</tr>
</tbody>
</table>

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.

3. Calculate the price of pit-run gravel delivered to the site per cubic meter (bank measure) based on the following data:
   - The pit is located 10 km from the site.
   - Truck costs LE40/hr, including fuel and maintenance; they have 12 cubic meter (loose material) capacity and travel at an average speed of 30 km/hr empty and 20 km/hr loaded.
   - The swell factor for this material is 20% and the compaction factor is 90%.
- Trucks take 5 minutes to unload at the site.
- The loader costs LE80/hr and loads material at the rate of 40 m$^3$/hr.
- Truck driver’s wage is LE32/hr and the equipment operator’s wage is LE40/hr.
- Gravel price (loose) = LE40/m$^3$.
- Quantity of gravel required to fill an excavated site with dimensions 30 × 30 × 1 m$^3$.
- Assume overheads and markup of 10%.

4. Consider the following items of a given project.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Direct cost (LE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Material</td>
</tr>
<tr>
<td>1</td>
<td>m3</td>
<td>150</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>m3</td>
<td>180</td>
<td>1800</td>
</tr>
<tr>
<td>3</td>
<td>m3</td>
<td>40</td>
<td>960</td>
</tr>
<tr>
<td>4</td>
<td>m3</td>
<td>60</td>
<td>1200</td>
</tr>
<tr>
<td>5</td>
<td>lump-sum</td>
<td>Lump-sum</td>
<td>-</td>
</tr>
</tbody>
</table>

- Site overheads = 5% of Direct cost (i.e., LE10500).
- General overheads = 5% of Construction cost.
- Profit and risk = 10% of Total cost.

It is required to:

a. Develop a balanced tender price (balanced –bid).

b. Develop an un-balanced tender price (unbalanced-bid).