# CHAPTER 3

# CONCEPTUAL COST ESTIMATING

At the beginning of a project by the owner, prior to any design, only limited information is known about a project. However, the owner must know the approximate to evaluate the economic feasibility of proceeding with the project. Thus, there is a need to determine the approximate cost of a project during its conceptual phase.

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 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.

## 3.1    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.

### 3.1.1   Conceptual cost estimating definition

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.

### 3.1.2  *Conceptual cost estimating characteristics*

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.

### 3.1.3 Importance of conceptual cost estimates

Preliminary estimate assists the overall cost-control program by serving as the first check against the budget. It will indicate the cost overruns early enough for the project team to review the design for possible alternates. Since preliminary estimate is made prior to the completion of detailed design, the margin of error will be relatively large. Then, the larger contingency should be applied. The contingency varies with the amount of design information available and the extent of cost information obtainable from similar projects.

### 3.1.4 Preparation of conceptual cost estimates

A generic conceptual cost estimating preparations is shown in Figure 3.1, the preparations begins with a request made by management to estimate the cost of a new project. The most important part of the request is the project scope. The first task for the estimator is to study and interpret the project scope and produce an estimating plan. The next task is to collect historical data related to similar past projects. The selection and usage of these data is crucial for the estimating preparations because inappropriate information will negatively affect the estimate. The outputs from this stage are the project conceptual cost estimate and a documented estimating basis used to develop this cost. It is very important to describe in detail all the information, assumptions, adjustments, and procedures considered in the estimate. The resulting conceptual cost estimate is then submitted to management for decision-making.

To prepare an elemental cost plan the following information should be assembled:
- A cost analysis of a previous similar building
- Sketch plans and elevations of the proposed project
- Outline specification/levels of services installation, etc. for the proposed project.

### 3.1.5 Conceptual Cost Estimating Output

The primary output of the cost estimating effort is the cost estimate. The estimate is typically expressed in unit cost. Alternative units can be work quantities, material quantities, or staff work hours. However, for majority of the highway construction

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projects, the unit cost are mostly applicable; therefore, they are frequently used.
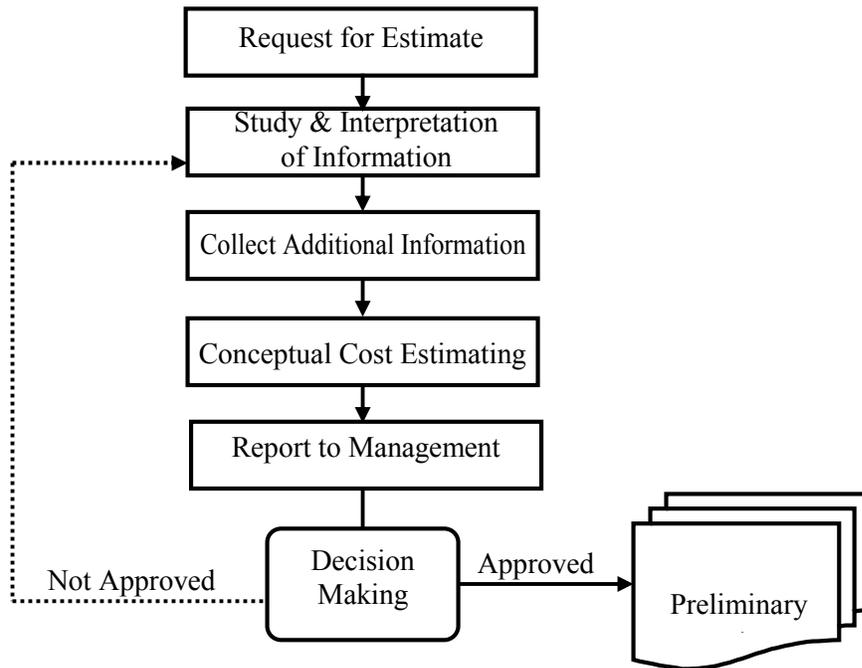


Fig. 3.1: Conceptual cost estimating preparations

## 3.2    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. (3.1) can be used for weighting cost data from previous projects.

$$UC = (A + 4B + C) / 6 \qquad\qquad (3.1)$$

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 3.1*

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 3.1.

Table 3.1: 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 3.2.


Table 3.2: 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. 3.1, 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

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## 3.3    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.

### 3.3.1   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 3.2*

Suppose the indices for building construction projects show these economic trends (Table 3.3). 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 3.3: 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:

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

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

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

### 3.3.2 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 3.3.1, 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 3.3*

Suppose the indices for different location of construction costs are shown in Table 3.4. 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.

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Table 3.4: 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 × (1.105 / 1.025) = LE417,420

### 3.3.3  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.

### 3.3.4  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 3.4*

Use the time and location indices presented in Tables 3.3 and 3.4 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

= Previous cost × Time adjustment × Location adjustment × Size adjustment

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

= LE3,700,360

### 3.3.5 *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 3.5*

Cost records from previous projects show this information (Table 3.5). Find the unit cost as a function of the number of units.

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Table 3.5: 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 3.6.

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Table 3.2: 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 3.2. 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 $= -0.056 \times 170 + 27.81 = LE18.29$
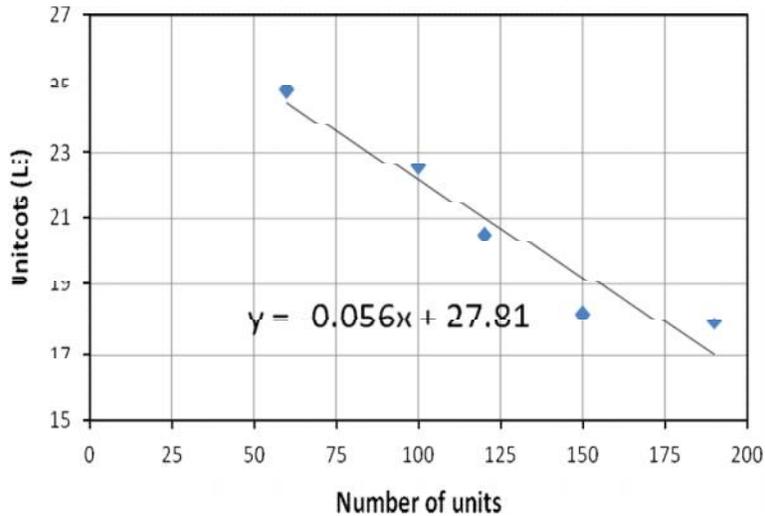


Fig. 3.2: Comparison of size and cost per unit

As illustrated in the Example 3.5, 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.

## 3.4    Conceptual Estimating Techniques

### 3.4.1    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.

### 3.4.2 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 3.6*

    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 3.7*

    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 3.8*

    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


### 3.4.3 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 3.9*

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

- 2 x 3.0 x 7.50 = 205.0 m$^2$

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

Basement 7.00 x 25.0 = 175.0 m$^2$ x LE1300 /m$^2$             =   LE227,500.0
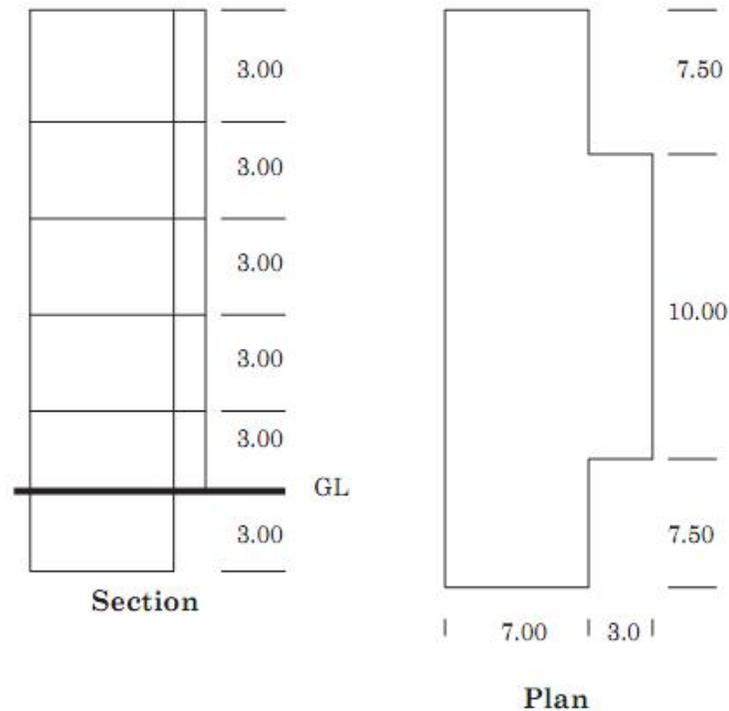
Estimate for block LE1,355,000.0

Fig. 3.3: Plan and cross section of Example 3.9

### 3.4.4 *Approximate quantities*

Approximated quantities are regarded as the most reliable and accurate method of estimating, provided that there is sufficient information to work on. Depending on the experience of the surveyor, measurement can be carried out fairly quickly using composite rates to save time. The rules of measurement are simple although it must be said they are not standardized and tend to vary slightly from one surveyor to another.

- One approach involves grouping together items corresponding to a sequence of operations and relating them to a common unit of measurement; unlike the measurement for a bill of quantities, where items are measured separately.
- Composite rates are then built up from the data available in the office for that sequence of operations.
- All measurements are taken as gross over all but the very large openings.
- Initially, the composite rates require time to build up, but once calculated they may be used on a variety of estimating needs.

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## 3.5    Parametric Cost Estimate Models

The parametric model uses historical data as the basis of the model's predictive features. However, the characteristics that are input into the process are primarily based on performance indicators such as speed, accuracy, tolerance, reliability, friendliness, error rate, and complexity of the environment of the deliverables. Parametric estimating is used primarily in software development and system development projects. The output of parametric models includes the cost of major phases, duration of project major phases, total project cost, and resource requirements.

Parametric models calculate the dependent variables of cost and duration based on one or more independent variables. These independent variables are quantitative indices of performance and/or physical attributes. More sophisticated models provide a multitude of levels of estimates. If, during the early stages, a small array of data regarding the project is available, a rough estimate is provided. However, if a large array of project data is available later in the project's life; more accurate estimates are calculated using the same model.

A parametric model, for a construction project, would use the data provided by the user on any or all of the following characteristics: project type, frame material, exterior material, ground conditions, desired floor space, and roof type. Then, using the general relationships developed between these input and output variables, the model provides an estimate of some or all of the output variables. The output variables include cost of the design process, cost of the structure, size of major equipment, optimum size of construction crew, size of the parking lot, and duration of structure construction, duration of equipment installation, and overall project duration.

Parametric estimate models are refined and fine-tuned for specific projects within specific industries. Many organizations have developed parametric models for projects of their own specialty. Depending on the organizational environment and on the nature of targeted projects, these models use different statistically derived algorithms, which in turn would use different sets of input and output data in calculating the output variables

based on the input variables. These models are, or should be, regularly evaluated, validated, calibrated, and customized for accuracy and appropriateness. The estimates of cost and duration developed by the parametric model usually establish a preliminary budget for the project that will compare its financial desirability with other projects of the enterprise.

## 3.6   Exercises

1.   Use the time and location indices shown below to estimate the cost of a building that contains 32500 $m^2$ 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 $m^2$ 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-$m^2$ 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.

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