

## **Chapter 8: Project Finance and Contract Pricing**

### **8.1 Introduction**

In the previous chapters, techniques for project planning, scheduling, resources management, and time-cost trade off have been introduced. This chapter will deal with project cash flow to predict the actual flow of money during the contract duration. Also, this chapter will introduce the means for finalizing a contract price. A project's cash flow is basically the difference between the project's income and its expense. The difference between a company's total income and its total expense over a period of time is the company cash flow.

### **8.2 Contract Cash Flow**

At the project level, a project's cash flow is the difference between the project's expense and income. At the construction company level, the difference between company's total expense and its total income over a period of time is the company's cash flow.

$$\begin{aligned}\text{Cash flow} &= \text{Cash in} - \text{Cash out} \\ &= \text{Income} - \text{Expense}\end{aligned}$$

Forecasting cash flow is necessary for a construction company for the following reasons:

- To ensure that sufficient cash is available to meet the demands.
- It shows the contractor the maximum amount of cash required and when it will be required. Thus, the contractor can make arrangements to secure the required cash.
- It provides a reliable indicator to lending institutions that loans made can be repaid according to an agreed program.
- It ensures that cash resources are fully utilized to the benefit of the owner and investors in the company.

The three main ingredients in determination of cash flow are:

- Expenses (cash out) which represents the aggregate of the payments which the contractor will make over a period of time for all resources used in the project such as labor, equipment, material, and subcontractors.
- Income (cash in) that represents the receipts a contractor will receive over a period of time for the work he/she has completed.
- Timing of payments: in cash flow analysis, we are interested in the timing of payments related to the work done by the contractor.

#### **8.2.1 Construction Project Costs**

In preparing the cash flow for a project, it is necessary to compute the costs that must be expended in executing the works using activities durations and their direct and indirect costs. The principal components of a contractor's costs and expenses result from the use of labors,

materials, equipment, and subcontractors. Additional general overhead cost components include taxes, premiums on bonds and insurance, and interest on loans. The sum of a project's direct costs and its allocated indirect costs is termed the project cost.

The costs that spent on a specific activity or project can be classified as;

- *Fixed cost*: costs that spent once at specific point of time (e.g., the cost of purchasing equipment, etc.)
- *Time-related cost*: costs spent along the activity duration (e.g., labor wages, equipment rental costs, etc.)
- *Quantity-proportional cost*: costs changes with the quantities (e.g., material cost)

#### *Project direct costs*

The costs and expenses that are incurred for a specific activity are termed direct costs. These costs are estimates based on detailed analysis of contract activities, the site conditions, resources productivity data, and the method of construction being used for each activity. A breakdown of direct costs includes labor costs, material costs, equipment costs, and subcontractor costs. Activities' direct costs are estimated as presented previously in chapter 3.

#### *Project indirect costs*

Other costs such as the overhead costs are termed indirect costs. Part of the company's indirect costs is allocated to each of the company's projects. The indirect costs always classified to: project (site) overhead; and General (head-office) overhead.

#### Project overhead

Project overhead are site-related costs and includes the cost of items that can not be directly charged to a specific work element and it can be a fixed or time-related costs. These include the costs of site utilities, supervisors, housing and feeding of project staff, parking facilities, offices, workshops, stores, and first aid facility. Also, it includes plants required to support working crews in different activities.

A detailed analysis of the particular elements of site-related costs is required to arrive at an accurate estimate of these costs. However, companies used to develop their own forms and checklists for estimating these costs. Site overhead costs are estimated to be between 5% - 15% of project total direct cost.

#### General overhead

The costs that can not be directly attributed a specific project called general overhead. These are the costs that used to support the overall company activities. They represent the cost of the head-office expenses, managers, directors, design engineers, schedulers, etc. Continuous observations of the company expenses will give a good idea of estimating reasonable values

for the general overhead expenses. Generally, the general overhead for a specific contract can be estimated to be between 2% - 5% of the contract direct cost.

The amount of the general overhead that should be allocated to a specific project equals:

$$\frac{\text{Project direct cost} \times \text{general overhead of the company in a year}}{\text{Expected sum of direct costs of all projects during the year}}$$

Having defined the direct costs, indirect costs, then the project total cost equals the sum of both direct and indirect costs.

When studying cash flow, it is very important to determine the actual dates when the expenditures (cost) will take place. At that time, the expenditures will be renamed as the expenses. Figure 8.1 illustrates the difference between the costs and the expenses. As shown in the figure, they are the same except the expenses are shifted (delayed) than the costs.

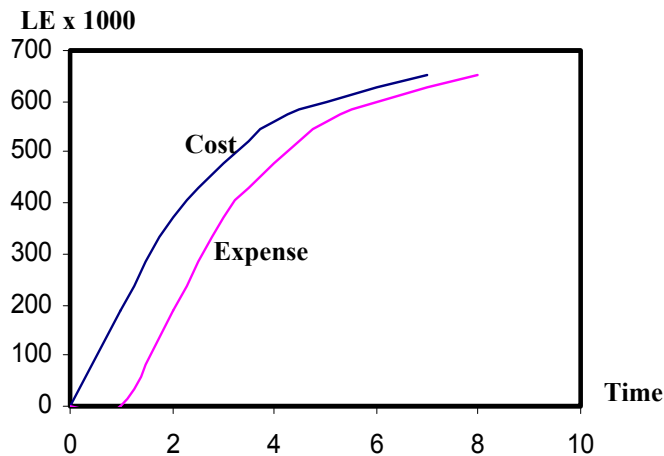


Figure 8.1: Project cost and expense curves

### Example 8.1

Consider the construction of 8-week foundation activity with operation cost of LE8800. The operation cost is broken down into the following elements:

- Labor                      LE1600    paid weekly
- Plant                      LE4000    paid weekly after 4 weeks credit facility
- Materials                LE800     paid weekly after 5 weeks credit facility
- Subcontractors        LE2400    paid weekly after 3 weeks credit facility

Determine the expenses (cash out) of this activity.

### Solution

A time-scaled plan is developed for this activity for the payments for labor, plant, material, and subcontractors. The cost will be plotted weekly with the delay specified in Example 8.1.

Operation	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Labor	-	200	200	200	200	200	200	200	200				
Plant	-	-	-	-	500	500	500	500	500	500	500	500	
Material	-	-	-	-	-	100	100	100	100	100	100	100	100
Subcontractors	-	-	-	300	300	300	300	300	300	300	300		
Total payment (Expense)	-	200	200	500	1000	1100	1100	1100	1100	900	900	600	100

### 8.2.2 The S-Curve

The curve represents the cumulative expenditures of a project direct and indirect costs over time is called the S-curve as it takes the S-shape as shown in Figure 8.2. In many contracts, the owner requires the contractor to provide an S-curve of his estimated progress and costs across the life of the project. This S-shaped curve results because early in the project, activities are mobilizing and the expenditure curve is relatively flat. As many other activities come on-line, the level of expenditures increases and the curve has a steeper middle section. Toward the end of a project, activities are winding down and expenditures flatten again (Figure 8.2). The S-Curve is one of the most commonly techniques to control the project costs.

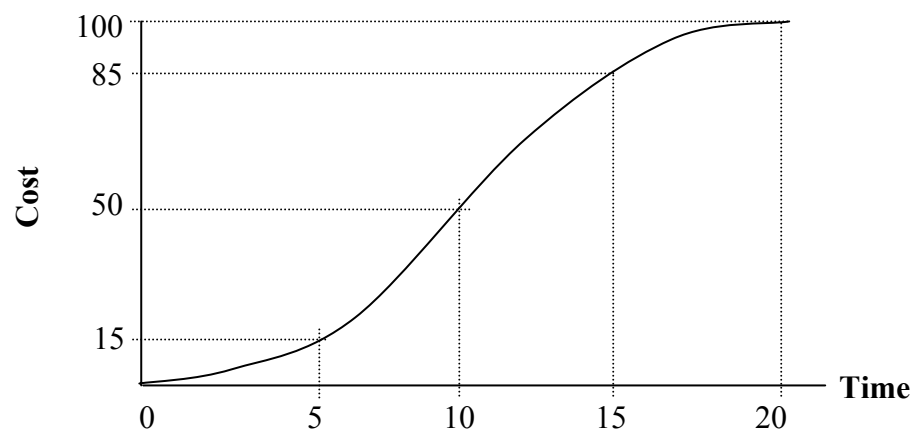


Figure 8.2: A sample S-curve

An S-curve for a project can be developed using the following steps:

- Constructing a simple bar chart for all the tasks of the project.

- Assigning costs to each task using task duration.
- Plotting the cumulative amounts of expenditures versus time by smoothly connecting the projected amounts of expenditures over time.

### Example 8.2

Consider the project shown in Figure 8.3. The costs of activities are assumed as shown in Table 8.1. The indirect costs of tasks are calculated considering a daily cost of LE500. It is required to draw the S-curve of the total cost of the project.

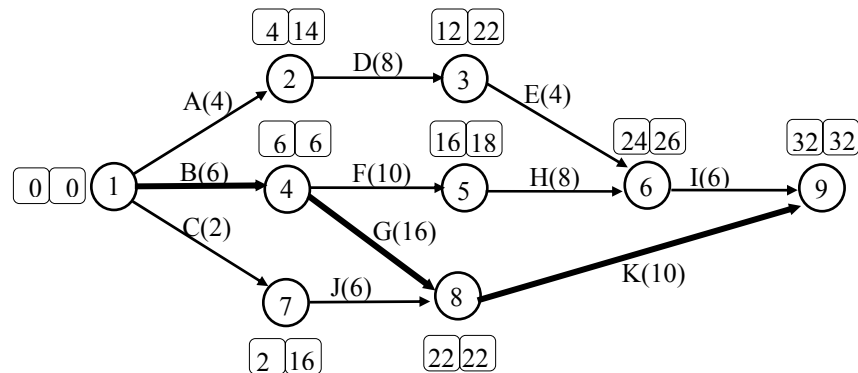


Figure 8.3: Project network of Example 8.2

Table 8.1: Cost data of Example 8.2

Activity	Duration	Direct Cost	Indirect Cost	Total Cost
A	4	2,000	2,000	4,000
B	6	9,000	3,000	12,000
C	2	3,000	1,000	4,000
D	8	12,000	4,000	16,000
E	4	18,000	2,000	20,000
F	10	15,000	5,000	20,000
G	16	8,000	8,000	16,000
H	8	20,000	4,000	24,000
I	6	9,000	3,000	12,000
J	6	9,000	3,000	12,000
K	10	5,000	5,000	10,000

### Solution

The S-curve is calculated based on the project's bar chart and the expenditures of each activity. As illustrated in Figure 8.3, the eleven activities of this project are scheduled across a 32-day time span. A bar chart representation of these activities is drawn in Figure 8.4 showing the total costs associated with each activity above each activity's bar. The figure shows the total

expenditures and the cumulative bi-daily expenditures across the life of the project. The S-curve of the cumulative expenditures over time is plotted in Figure 8.5.

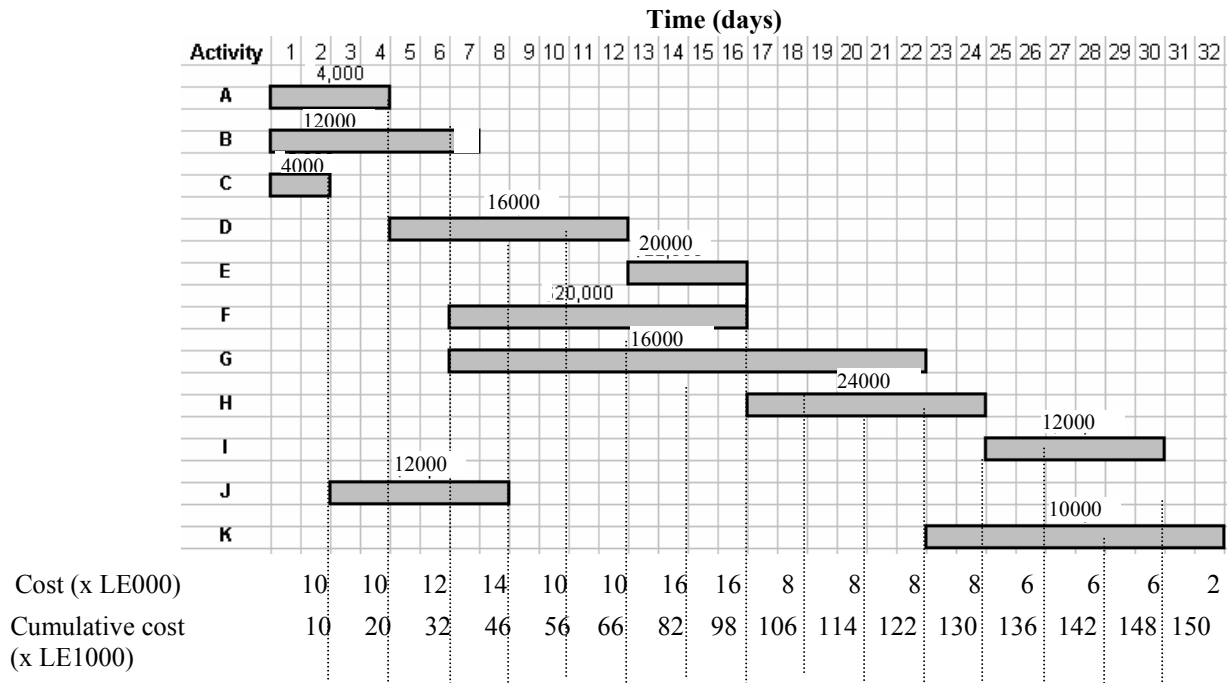


Figure 8.4: Project bar chart of Example 8.2

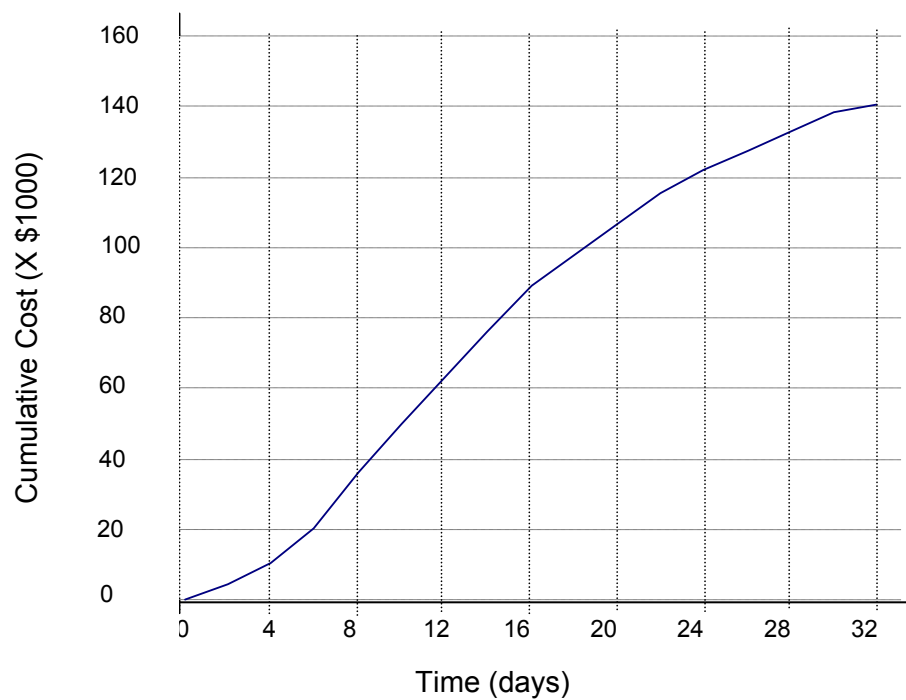


Figure 8.5: The S-Curve for the Example Project

### 8.2.3 Project Income (Cash-in)

The flow of money from the owner to the contractor is in the form of progress payments. Estimates of work completed are made by the contractors periodically (usually monthly), and are verified by the owner's representative. Depending on the type of contract (e.g., lump sum, unit price, etc.), these estimates are based on evaluations of the percentage of total contract completion or actual field measurements of quantities placed. Owners usually retain 10% of all validated progress payment claims submitted by contractors. The accumulated retainage payments are usually paid to the contractor with the last payment. As opposed the expenses presented in Figure 8.1 with smooth profile, the revenue will be a stepped curve. Also, when the contractor collects his/her money it is named project income (cash in) as shown in Figure 8.6.

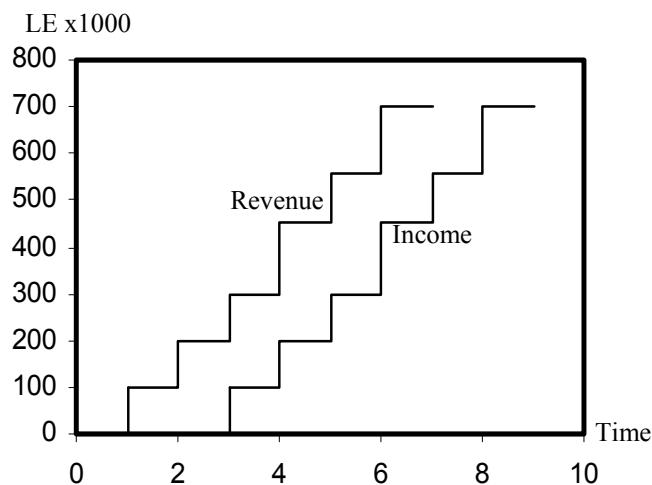


Figure 8.6: Project revenue and income curves

The time period shown in Figure 8.6 represents the time intervals at which changes in income occur. When calculating contract income it is necessary to pay attention to the retention and/or the advanced payment to the contractor if any.

#### Retention

Retention is the amount of money retained by the owner from every invoice, before a payment is made to the contractor. This is to ensure that the contractor will continue the work and that no problems will arise after completion. This retainage amount ranges from 5% to 10% and hold by the owner from every invoice till the end of the contract. The whole amount will be paid to the contractor at the end of the contract.

#### Advanced payment

This is amount of money paid to the contractor for mobilization purposes. Then, it is deducted from contract progress payment. Applying this strategy improves the contractor cash flow and prevents him/her from loading the prices at the beginning of the contract. This

strategy, however, may be used only in projects that require expensive site preparation, temporary facilities on site, and storage of expensive materials at the beginning of the project.

### 8.2.4 Calculating Contract Cash Flow

Having determined the contract expenses and income as presented in the previous section, it is possible to calculate the contract cash flow. If we plotted the contract expense and income curves against each other, then the cash flow is the difference between the points of both curves. Figure 8.7 shows the cash flow of a specific contract. The hatched area represents the difference between the contractor's expense and income curves, i.e., the amount that the contractor will need to finance. The larger this area, the more money to be financed and the more interest charges are expected to cost the contractor.

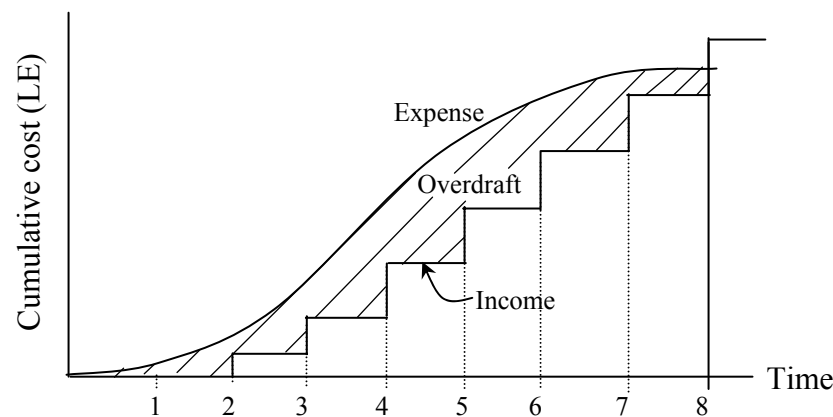


Figure 8.7: Cash flow based on monthly payments

The contractor may request an advanced or mobilization payment from the owner. This shifts the position of the income profile so that no overdraft occurs as shown in Figure 8.8.

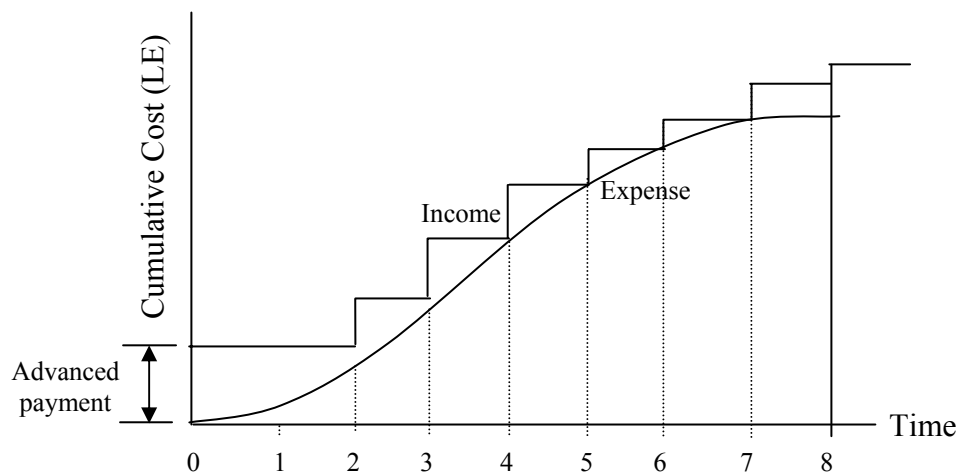


Figure 8.8: Effect of advanced payment on improving cash flow



In case of less number of payments (two or three payments) along the contract period, this will lead to increase the overdraft as shown in [Figure 8.9](#).

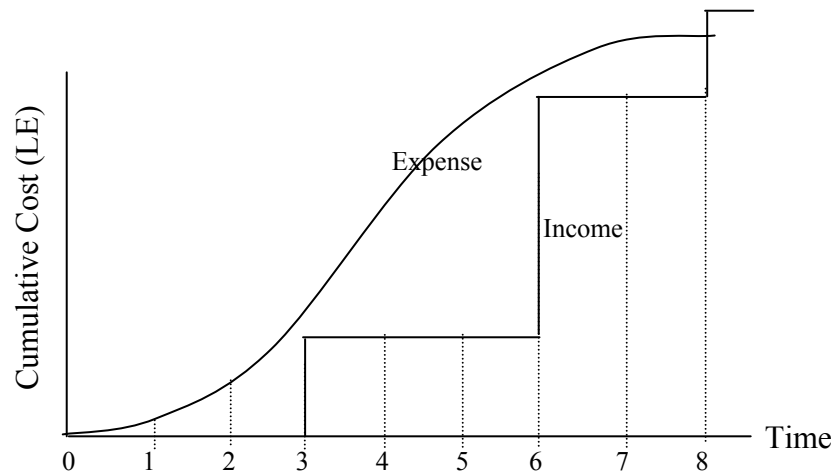


Figure 8.9: Effect of receiving two payments on cash flow

Form the previous study, the factors that affect the project finance (cash flow) are and should considered when calculating the cash flow:

- The project bar chart (project schedule).
- Activities' direct and indirect cost.
- Contractor method of paying his/her expenses.
- Contractor's markup (mainly the profit margin).
- Retention amount and its payback time.
- Time of payment delay by owner.
- Advanced or mobilization payment.

The cash flow calculations are made as described in the following steps:

- Perform project schedule and determine project and activities timing.
- Draw bar chart based on early or late timings.
- Calculate the cost per time period.
- Calculate the cumulative cost.
- Adjust the cost according the method of paying it to produce the expenses.
- Calculate the cumulative revenue (revenue = cost x (1 + markup)).
- Adjust the revenue based on the retention and delay of owner payment to determine the income.
- Calculate the cash flow (cash flow = income – expense) at the contract different times.

### Example 8.3

To illustrate the steps of cash flow calculations, consider the same project presented in [Figure 8.3](#). The total cost of the activities is presented in [Table 8.1](#).

In this project, the markup equals 5% and the contractor will pay his expenses immediately. Retention is 10% and will be paid back with the last payment. The calculations will be made every 8 days, i.e., the contractor will receive his/her payment every 8-days (time period). Owner's payment is delayed one period, while the contractor will submit the first invoice after the first period. No advanced payment is given to the contractor.

### ***Solution***

The project revenue of each activity is calculated as revenue = cost (1 + markup) as shown in [Table 8.2](#). The activities timing is presented in Example 8.2.

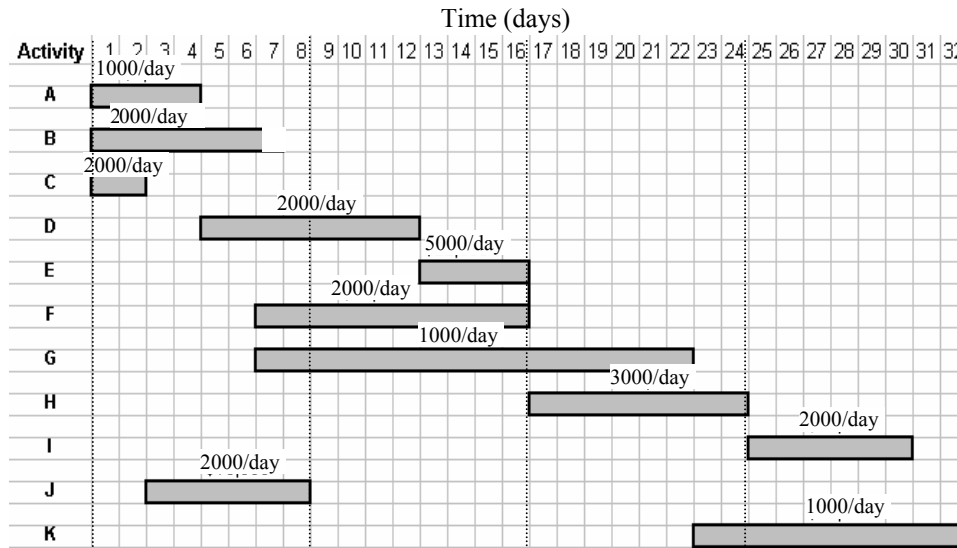
Table 8.2 Project cost and revenue

Activity	Duration (day)	Total Cost (LE x 1000)	Total Revenue (LE x 1000)
<b>A</b>	4	04.00	04.20
<b>B</b>	6	12.00	12.60
<b>C</b>	2	04.00	04.20
<b>D</b>	8	16.00	16.80
<b>E</b>	4	20.00	21.00
<b>F</b>	10	20.00	21.00
<b>G</b>	16	16.00	16.80
<b>H</b>	8	24.00	25.20
<b>I</b>	6	12.00	12.60
<b>J</b>	6	12.00	12.60
<b>K</b>	10	10.00	10.50

By summing up the activities cost and revenue, then the contract total cost equals LE 150,000 and the total revenue equals LE 157,500. By considering that both the cost and the revenue are evenly distributed over the activities durations. The calculations are presented as shown in [Figure 8.10](#). The calculations will be made every 8-days period.

As shown in [Figure 8.10](#), the project duration is divided into four periods each one equals 8 days. In addition, one period is added after project completion. Simple calculations are then performed with the top four rows showing the project expenses. The next five rows for income, and the last row for cash flow. As shown, after summing up the costs it became direct expenses to the contractor as there is no delay in paying them.

The expected owner payments are then added up to from the project revenue. The retention is subtracted from the owner payment and will be paid back to the contractor with the last payment (row 7 in [Figure 8.10](#)). Then, the revenue is delayed by one period to form the contractor income. The calculations in the last row are the difference between the project income and project expense. Having two values in some periods shows the sudden change of the cash flow as the contractor receives more payments from the owner. For example, in the second period, just before the contractor receive his/her payment the cash flow was (0 – 98,000 = - 98,000 LE). As the contractor receives a payment of LE 43,470, the cash flow improves and becomes -54,530 (43,470 – 98,000).



1. Cost/2 days x LE1000	10	10	12	14	10	10	16	16	8	8	8	8	6	6	6	2	-	-	-	-
2. Cost each period x LE1000	46				52				32				20				-			
3. Cumulative cost x LE1000	46				98				130				150				150			
4. Cumulative Expense x 1000	46				98				130				150				150			
5. Revenue = row 3 x 1.05	48.3				54.6				33.6				21				-			
6. Revenue - retention = row 5 x 0.9	43.47				49.14				30.24				18.90				-			
7. Retention x LE1000	-				-				-				-				15.75			
8. Cumulative revenue x LE1000	43.47				92.61				122.85				141.75				157.50			
9. Cumulative income x LE1000	-				43.47				92.61				122.85				157.50			
10. Cumulative cash flow x LE1000 = row 9 - row 4	-46				-98/-54.53				-86.53/-37.39				-57.39/-27.15				-27.15/+7.5			

Figure 8.10: Cash flow calculations of Example 8.3

As seen from Figure 8.10, the maximum overdraft money (maximum cash) is LE 98,000 and will be needed at the 16<sup>th</sup> day of the project. Thus shows the importance of studying the contract cash flow. Accordingly, the contractor can make his arrangements to secure the availability of this fund on the specified time.

Figure 8.11 shows the contract expense and income curves. These curves will be needed to calculate the contractor cost of borrowing or investment of the overdraft money (area between expense and income). Figure 8.12 shows the contract net cash flow.

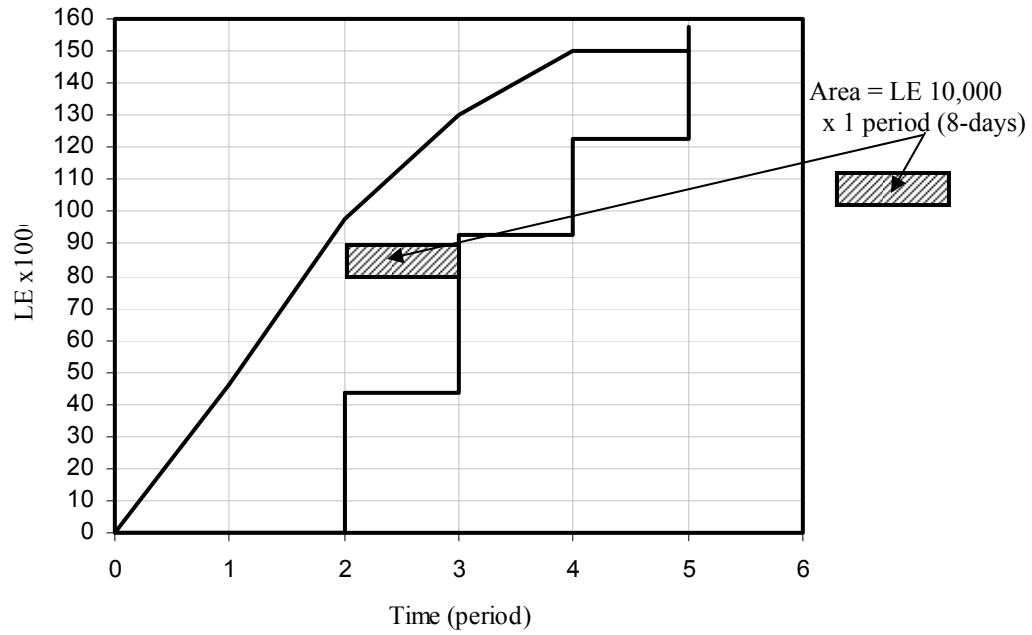


Figure 8.11: Expense and income curves for Example 8.3

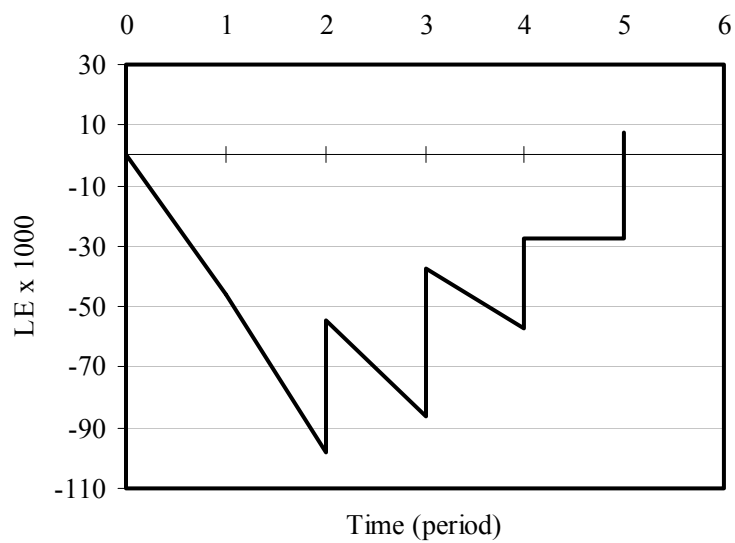


Figure 8.12: Contract net cash flow

### **8.2.5 Minimizing Contractor Negative Cash Flow**

It is very essential to the contractor to minimize his/her negative cash flow because this may hinder him/her during performing the contract due to lack of financial resources. Among the procedures the contractor may follow to minimize negative cash flow is:

- Loading of rates, in which the contractor increases the prices of the earlier items in the bill of quantities. This ensures more income at the early stages of the project. However, this technique might represent a risk to the contractor or the owner.
- Adjustment of work schedule to late start timing in order to delay payments. In this case, the contractor should be aware that in this case in delay might happen will affect the project completion time and may subject him/her to liquidated damages.
- Reduction of delays in receiving revenues.
- Asking for advanced or mobilization payment.
- Achievement of maximum production in the field to increase the monthly payments.
- Increasing the mark up and reducing the retention.
- Adjust the timing of delivery of large material orders to be with the submittal of the monthly invoice.
- Delay in paying labor wages, equipment rentals, material suppliers and subcontractors.

### **8.2.6 Cost of Borrowing (Return on Investment))**

Cash requirements (negative cash flows) during a project result in a contractor either having to borrow money to meet his/her obligation or using funds from the company reserves, which may have been more profitably if employed elsewhere. Accordingly, there should be a charge against the project for the use of these funds.

One of the methods to determine the amount of interest to be charged during a contract is to calculate the area between the expenses and income curves. To simplify the calculations, the area is calculated in terms of units of LE x time period (money x time). The time may be in days, weeks, months, etc. The underneath the expense curve is considered as negative area (negative cash), while the area above the expense curve is considered positive area (positive cash). The total net number of area units is calculated and multiplied by the value of the unit and the result is multiplied by the interest rate or rate of investment.

$$\text{Cost of borrowing} = \text{net area} \times \text{interest rate} \quad (8.1)$$

Note that, the interest rate should be calculated in the same time period as the time period of the unit areas. For example, if the units' areas are calculated in LE.month, then the interest rate should be in months.

#### **Example 8.4**

Consider example 8.3, it is required to calculate the cost of borrowing if the interest rate is 1% every time period (8-days).

**Solution**

Referring to Figure 8.11, the approximate number of unit areas between the expense and the income curves equals 24 units. Each unit equals LE 10,000 time period.

Then, the cost of borrowing =  $24 \times 100000 \times 0.01 = \text{LE } 2400$ .

This value must be added to the contract price.

**Example 8.5**

The expense and income curves for a specific contract are shown in Figure 8.13. During construction, money will be borrowed from the bank as required at an interest rate of 15% per year. Income from project earns an interest of 12% per year. Calculate the net interest to be charged to the project.

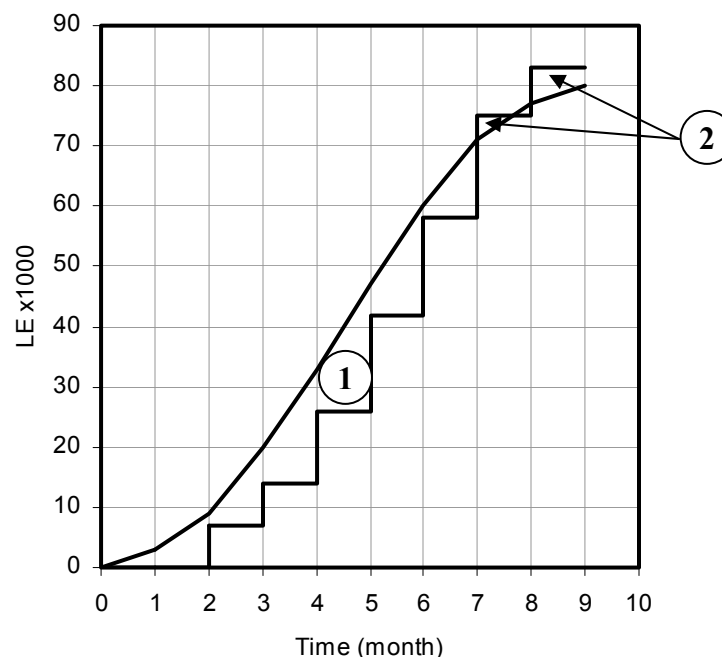


Figure 8.13: Cash flow diagram for Example 8.5

**Solution**

- Each square represents LE 10000 month
- Note that the interest rate is given per year and the square area is measured in month, then, it is required to calculate the interest per month by dividing by 12.

Negative area, area 1 (income curve below expense curve)

- No. of negative squares = 5.7
- Interest charge =  $5.7 \times 10000 \times 0.15 / 12 = \text{LE } 712.5$

Positive area, area 2 (income curve above expense curve)

- No. of positive squares = 0.6
- Interest charge =  $0.6 \times 10000 \times 0.12 / 12 = \text{LE } 60$

Net interest to be charged to the project =  $712.5 - 60 = \text{LE } 652.5$

### Example 8.6

Table 8.3 shows a contractor's project budget and profit distribution for a newly awarded contract. The contractor will receive monthly payment less 10% retention and will be paid to the contractor one month later. Half the retention is released on project completion and the other half is released six months later. To reduce administrative costs, the owner proposed to the contractor that measurements and payments be made every two months with a delay of one month before the contractor receives payment. It is required:

- Prepare graphs of cumulative cash out and expenses for both monthly and bi-monthly measurements. Assume an average payment delay of one month of the contractor's cost.
- Calculate the maximum amount of capital needed to execute the project with monthly and bi-monthly measurements.
- Calculate the cost of borrowing for extra funding needed, if the measurement is made bi-monthly. Given that the investment rate is 15% per annum.

Table 8.3: Budgeted value and profit distribution of Example 8.6

Month	1	2	3	4	5	6	7	8	9	10
Value of work each month (LE x1000)	3	4	5	8	8	8	7	6	5	2
Profit (% of value)	15	15	10	10	10	10	10	10	5	5

### Solution

The calculations of the project's cash in and cash out passed on monthly and bi-monthly measurements are presented in Table 8.4. As shown, the time scale of Table 8.4 is 16 months. As given in the example, the project duration is 10 months, and half of the retention will be paid after six month of project completion. The total project value is LE 56,000. Then the total retention is LE 5,600 ( $0.10 \times 56,000$ ).

The cumulative expense and income curves are shown in Figure 8.14.

- The maximum cash needed in case of monthly measurement is LE 6850 at month 6 and 7 immediately before payment is received as shown in row k of Table 8.4.
- The maximum cash needed in case of bi-monthly measurement is LE 14050 at month 7 immediately before payment is received as shown in row l of Table 8.4.

The extra fund required to finance the project if measurements and payments are made every two months is represented by the shaded area on Figure 8.14.

Table 8.4: Cash in and cash out calculations of Example 8.6

<b>a. Month</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>
b. Monthly value of work (LE x1000)	3	4	5	8	8	8	7	6	5	2	-	-	-	-	-	-
c. Monthly value – retention = 0.9b (LE x1000)	2.7	3.6	4.5	7.2	7.2	7.2	6.3	5.4	4.5	1.8	-	-	-	-	-	-
d. Retention (LE x 1000)	-	-	-	-	-	-	-	-	-	-	2.8	-	-	-	-	2.8
d. Cumulative value (LE x 1000)	2.7	6.3	10.8	18	25.2	32.4	38.7	44.1	48.6	50.4	50.4	50.4	50.4	50.4	50.4	50.4
<b>e. Cumulative income on monthly measurements (LE x1000)</b>	<b>-</b>	<b>2.7</b>	<b>6.3</b>	<b>10.8</b>	<b>18</b>	<b>25.2</b>	<b>32.4</b>	<b>38.7</b>	<b>44.1</b>	<b>48.6</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>56</b>
<b>f. Cumulative income on bi-monthly measurements (LE x1000)</b>	<b>-</b>	<b>-</b>	<b>6.3</b>	<b>6.3</b>	<b>18</b>	<b>18</b>	<b>32.4</b>	<b>32.4</b>	<b>44.1</b>	<b>44.1</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>53.2</b>	<b>56</b>
g. Profit (% of value)	15%	15%	10%	10%	10%	10%	10%	10%	5%	5%	-	-	-	-	-	-
h. Cost = b(1-g) (LE x1000)	2.55	3.4	4.5	7.2	7.2	7.2	6.3	5.4	4.75	1.9	-	-	-	-	-	-
i. Cumulative cost (LE x1000)	2.55	5.95	10.45	17.65	24.85	32.05	38.35	43.75	48.5	50.4	-	-	-	-	-	-
<b>j. Cumulative expense (LE x1000)</b>	<b>-</b>	<b>2.55</b>	<b>5.95</b>	<b>10.45</b>	<b>17.65</b>	<b>24.85</b>	<b>32.05</b>	<b>38.35</b>	<b>43.75</b>	<b>48.5</b>	<b>50.4</b>	<b>50.4</b>	<b>50.4</b>	<b>50.4</b>	<b>50.4</b>	<b>50.4</b>
<b>k. Cash flow monthly measurements = e - j (LE x 1000)</b>	<b>0</b>	<b><u>-2.55</u> 0.15</b>	<b><u>-32.5</u> 0.35</b>	<b><u>-4.15</u> 0.35</b>	<b><u>-6.85</u> 0.35</b>	<b><u>-6.85</u> 0.35</b>	<b><u>-6.85</u> 0.35</b>	<b><u>-5.95</u> 0.35</b>	<b><u>-5.05</u> 0.35</b>	<b><u>-4.4</u> 0.1</b>	<b><u>-1.8</u> 2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>5.6</b>
<b>l. Cash flow bi-monthly measurements = f - j (LE x 1000)</b>	<b>0</b>	<b>-2.55</b>	<b><u>-5.95</u> 0.35</b>	<b>-4.15</b>	<b><u>-11.35</u> 0.35</b>	<b>-6.85</b>	<b><u>-14.05</u> 0.35</b>	<b>-5.95</b>	<b><u>-11.35</u> 0.35</b>	<b>-4.4</b>	<b><u>-6.3</u> 2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>5.6</b>



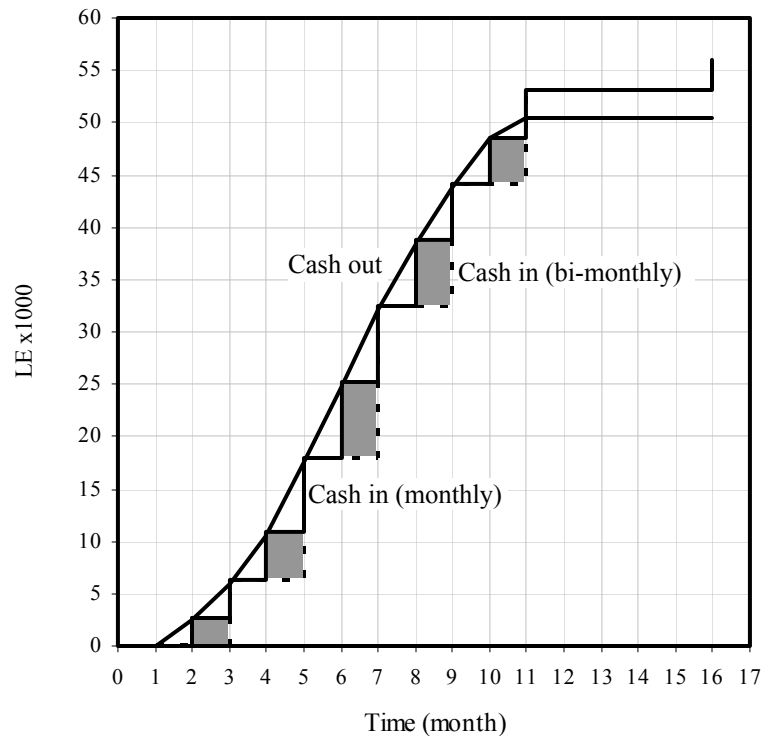


Figure 8.14: Cash out and cash in based on monthly and bi-monthly measurement intervals

$$\begin{aligned}
 \text{The extra financed area (shaded area on Figure 8.14)} &= 2.7 \times 1 \\
 &+ (10.8 - 6.3) \times 1 \\
 &+ (25.2 - 18.0) \times 1 \\
 &+ (38.7 - 32.4) \times 1 \\
 &+ (48.6 - 44.1) \times 1 \\
 &= 2.7 + 4.5 + 7.2 + 6.3 + 4.5 \\
 &= 25.2 \times 1000 \text{ LE.month}
 \end{aligned}$$

Interest charge of extra funding =  $25.2 \times 1000 \times 0.15 / 12 = \text{LE } 315$ .

### 8.3 Project Cash Flow

The project cash flow deals with the whole life of the project not the construction period only. Thus, project cash flow studies the project finance from the feasibility studies phase till the operation phase. In this case, the time is much longer than that of the contract. At the early stage of a project, the project experience negative cash flow as there is no income in these stages. In the operation stage, the revenue will increase than the expenses. Atypical project cash flow is shown in Figure 8.15. When comparing the economics of projects, the cumulative cash flow provides indicators for such comparison as payback period, profit, and the maximum capital. These indicators called the profitability indicators.

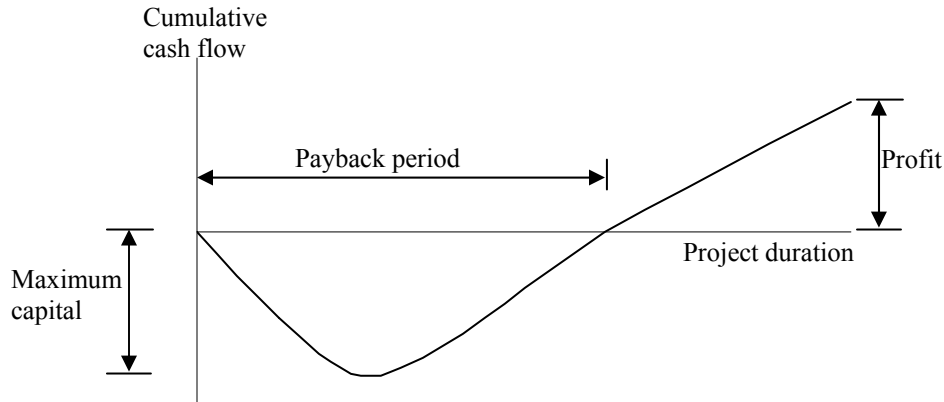


Figure 8.15: Typical project cash flow

### 8.3.1 Project Profitability Indicators

#### Profit

It is the difference between total payments and total revenue without the effect of time on the value of money. When comparing alternatives, the project with the maximum profit is ranked the best.

#### Maximum capital

It is the maximum demand of money, i.e., the summation of all negative cash (expenditures). The project with minimum capital required is ranked the best.

#### Payback period

It is the length of time that it takes for a capital budgeting project to recover its initial cost, where the summation of both cash out and cash in equals zero. When comparing alternatives, the project with the shortest payback period is ranked the best.

### Example 8.7

Two projects A and B have annual net cash flows as show in [Table 8.5](#). Assume all cash flows occur at the year-end. Establish the ranking of the projects in order of attractiveness to the company using:

- a. Maximum capital needed    b. Profit    c. Payback period

Table 8.5: Net cash flow of Example 8.7

Year	1	2	3	4	5	6	7	8
Project A (LE x 1000)	-10	-40	-30	20	60	20	15	30
Project B (LE x1000)	-30	-80	30	50	10	20	40	40

**Solution**

The cumulative cash flow is first calculated as shown in Table 8.6.

Table 8.5: Cumulative cash flow of Example 8.7

Year	1	2	3	4	5	6	7	8
Project A (LE x 1000)	-10	-50	-80	-60	0	20	35	65
Project B (LE x 1000)	-30	-110	-80	-30	-20	0	40	80

The cumulative cash flow of projects A and B are shown in Figure 8.16. From the figure the following indicators are drawn:

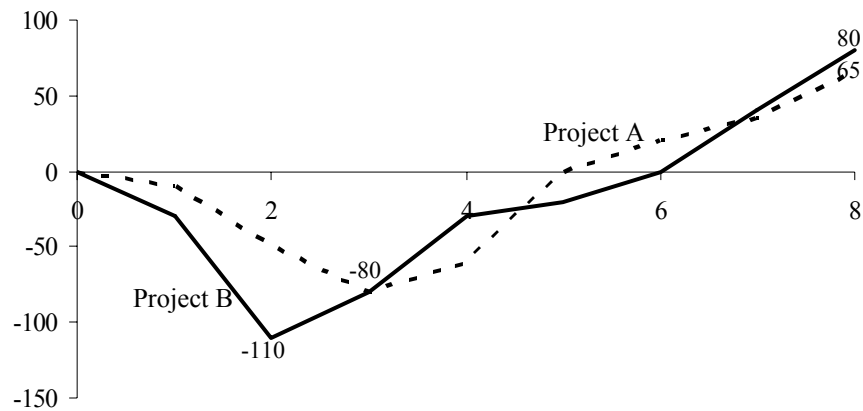


Figure 8.16: Cumulative net cash flow of Example 8.16

- Maximum capital: project A (LE 80,000) is better than project B (LE 110,000) because it needs less capital.
- Profit: Project B (LE 80,000) is more profitable than project A (LE 65,000).
- Payback period: Project A (5 years) is better than project B (6 years) because it has a shorter payback period.

#### 8.4 Discounted Cash Flow

The value of money is dependent on the time at which it is received. A sum of money on hand today is worth more than the same sum of money to be received in the future because the money on hand today can be invested to earn interest to gain more than the same money in the future. Thus, studying the present value of money (or the discounted value) that will be received in the future is very important. This concept will be demonstrated in the following subsections.

### 8.4.1 Present Value

Present value (PV) describes the process of determining what a cash flow to be received in the future is worth in today's pounds. Therefore, the Present Value of a future cash flow represents the amount of money today which, if invested at a particular interest rate, will grow to the amount of the future cash flow at that time in the future. The process of finding present values is called Discounting and the interest rate used to calculate present values is called the discount rate.

To illustrate this concept, if you were to invest LE 100 today with an interest rate of 10% compounded annually, this investment will grow to LE 110 [ $100 \times (1 + 0.1)$ ] in one year. The investment earned LE 10. At the end of year two, the current balance LE 110 will be invested and this investment will grow to LE 121 [ $110 \times (1 + 0.1)$ ]. Accordingly, investing a current amount of money, P, for one year, with interest rate (r) will result in a future amount, C using the following equation.

$$C = P \cdot (1 + r) \quad (8.2)$$

If P is invested for n years then the future amount C will equals.

$$C = P \cdot (1 + r)^n \quad (8.3)$$

In contrary to the [Equation 8.3](#), the present value (the discounted value), P, of a future some of money, C, that will be received after n years if the discount rate is r is calculated as follow:

$$P = C / (1 + r)^n \quad (8.4)$$

For example, the present value of \$100 to be received three years from now is \$75.13 if the discount rate is 10% compounded annually.

#### Example 8.8

Find the present value of the following cash flow stream given that the interest rate is 10%.



#### Solution

$$PV = \frac{100}{(1 + .10)^1} + \frac{200}{(1 + .10)^2} + \frac{200}{(1 + .10)^3} + \frac{300}{(1 + .10)^4} = \$611.37$$

### 8.4.2 Net Present Value (NPV)

Net present value (NPV) is the summation of all PV of cash flows of the project, where expenses are considered negative and incomes are considered positive. A project will be considered profitable and acceptable if it gives a positive NPV. When comparing projects, the project with the largest (positive) NPV should be selected.

#### Example 8.9

The Table below illustrates the net cash flow of two projects over 5 years. Using the NPV, which project would you prefer if the discount rate 10%.

Year	0	1	2	3	4	5
Project A (LE )	-1000	500	400	200	200	100
Project B (LE )	-1000	100	200	200	400	700

#### Solution

$$\text{Project A: } NPV = -1000 + \frac{500}{(1 + .10)^1} + \frac{400}{(1 + .10)^2} + \frac{200}{(1 + .10)^3} + \frac{200}{(1 + .10)^4} + \frac{100}{(1 + .10)^5} = \$134.08$$

$$\text{Project B: } NPV = -1000 + \frac{100}{(1 + .10)^1} + \frac{200}{(1 + .10)^2} + \frac{200}{(1 + .10)^3} + \frac{400}{(1 + .10)^4} + \frac{700}{(1 + .10)^5} = \$114.31$$

From the results of the NPV, project A should be chosen since it has the larger NPV.

### 8.4.3 Internal Rate of Return (IRR)

The internal rate of return (IRR) of a capital budgeting project is the discount rate (r) at which the NPV of a project equals zero. The IRR decision rule specifies that a project with an IRR greater than the minimum return on capital should be accepted. When choosing among alternative projects, the project with the highest IRR should be selected (as long as the IRR is greater than the minimum acceptable return of capital). The IRR is assumed to be constant over the project life.

#### Example 8.10

Calculate the IRR for both projects presented in Example 8.9, and compare among them using the resulted IRR. Assume the return on capital equals 10%.

#### Solution

$$\begin{aligned} \text{Project A: } 0 &= -1000 + \frac{500}{(1 + IRR)^1} + \frac{400}{(1 + IRR)^2} + \frac{200}{(1 + IRR)^3} + \frac{200}{(1 + IRR)^4} + \frac{100}{(1 + IRR)^5} \\ \therefore IRR &= 16.82\% \end{aligned}$$

Project B: 
$$0 = -1000 + \frac{100}{(1 + \text{IRR})^1} + \frac{200}{(1 + \text{IRR})^2} + \frac{200}{(1 + \text{IRR})^3} + \frac{400}{(1 + \text{IRR})^4} + \frac{700}{(1 + \text{IRR})^5}$$

$\therefore \text{IRR} = 13.28\%$

Both projects are acceptable as they produce IRR greater than the return (cost) on capital. However, when comparing them, Project A should be chosen since it has the higher IRR.

## 8.5 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 8.17). Estimating activities direct costs presented previously in chapter 3. Estimating indirect costs presented earlier in this chapter.

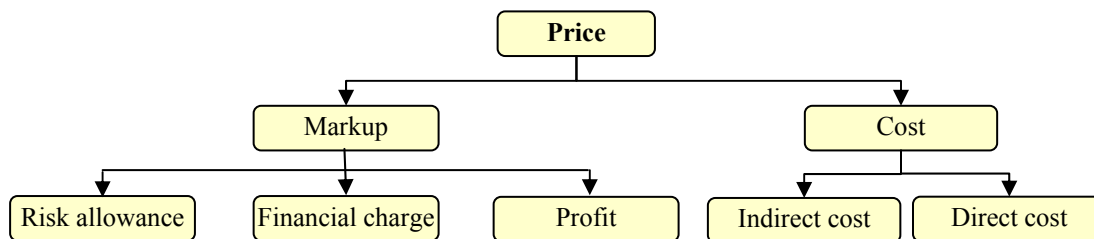


Figure 8.17: Components of a tender price

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 8.17; 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.

### 8.5.1 Estimating Profit Margin

Profit is the reward the contractor expecting to gain from performing a specific contract in return of his efforts and skills. Also, profit is the part of money that the contractor will retain after paying every thing including the taxes, the insurance, etc. Estimating a value for the profit

margin is usually depends on the market conditions. However, the factors that might affect choosing a profit margin values are summarized as follows:

- The contactors' competition to win a project;
- A contractor's desirability for work;
- Volume of work that the contractor has at a certain time;
- Size of the project and its complexity;
- Location of the project; and
- Identity of the client and the engineer.

### **8.5.2 Risk Management**

Uncertainty and risks usually leads to project completion delays and cost overruns. Uncertainty is the gap between the information required to estimate an outcome and the information already possessed by the decision maker. Thus, the early assessment of the risks and uncertainties which would affect the construction of a project may improve the performance in terms of time and money. Risk management is a major step in project planning; however, it is a complex process since the variables are dynamic and dependent on variety of conditions such as: project size, project complexity, location, time of the year, etc. In order to offset the effect of risks time and/or cost contingencies should be added to cover unforeseen occurrences.

We need risk management to minimize management by crisis; minimize surprises and problems; increase probability of project success; and better handle on true costs and schedules by properly estimating contingencies.

Risk management is defined as the process for systematically identifying, analyzing, and responding to risk events throughout the life of a project to obtain the optimum or acceptable degree of risk elimination or control. Accordingly, the major steps of risk management are:

- Identification of risks;
- Responses to avoid, reduce, or transfer risk;
- Analysis and assessment of residual risks after the risk responses; and
- Adding time and /or cost contingency for residual risks in the project estimates.

In general, in risk allocation, the risk should be carried out by the party (client or contractor) who is best able to make the assessment of the risk or uncertainty. If there is any doubt, it should be carried out by the client. This is because, it is better for the client to pay for what does happen rather than for what the contractor thought might happen in these risks.

#### *Risk Identification*

Construction risk is defined as the possibility of undesirable extra cost or delay due to factors having uncertain future outcome. Or it the possibility of suffering loss and the impact that loss has on the involved party. The purpose is to identify all risks to the project/contract and provide a preliminary assessment of their consequences. Identify every factor that may harm the project as potential risk. For example, one may state *"If the lay-down area is not optimized then*

*productivity will be too low;*” “*segmental liners may not be available prior to construction thus delaying project*”. In identifying risks, a number of approaches can be used including: standard checklists; comparison to other projects; expert interviews; and brainstorming sessions.

Main categories of sources of risks are listed along with some examples of each category as follow:

- Administrative: Delay in possesses of site;  
Limited working hours;  
Limited access to the site; and  
Troubles with public services
- Logistical: Shortage or late supply of different resources;  
Site remoteness problems; and  
Difficulties in communications with different parties involved.
- Construction: limited work space;  
Changes in soil condition than the soil report;  
Construction method used;  
Availability of skilled labor;  
Equipment breakdown; and  
Effect of varied weather and environmental conditions on consstruction.
- Physical: Periods of high tides, temperature, etc;  
Placing fill in dry season; and  
Diverting water canals in time of low flow.
- Design: Design incomplete;  
Design changes; and  
Design errors.
- Financial: Inflation which results in reducing the purchasing power of the currency;  
New restrictions applied on importing materials and equipments;  
Exchange rate fluctuation;  
Changes in taxes;  
Availability of funds; and  
Delay payments by client.
- Political: Change of local laws and regulations;  
Inflation which result in reducing the purchasing power of the currency;  
Effect of wars and revolutions; and  
Necessity to use local resources.
- Management: Scheduling errors;  
Space congestion;  
Errors in bill of quantities; and



Estimating of cost and duration based on standard figures.

- Contractual: Contract type and its suitability for undertaken work;  
Co-ordination of work; and  
Liability towards others.
- Disasters: Floods and storms;  
Fires;  
Earthquakes;  
Accidents;  
Diseases; and  
Other acts of GOD.

### *Response to Risk and Uncertainties*

Having identified a list of possible risks and uncertainties that a project may face, management should develop responses to avoid, reduce or transfer these risks. The following list of actions may be taken to reduce or transfer risks:

- Using construction methods which have high degree of success;
- Using extra resources to enhance the construction program to absorb possible delay;
- Securing alternative suppliers and advanced delivery dates for materials;
- Providing temporary roads to give flexibility of operations;
- Allowing free housing near construction site for labors to reduce problems arising from remoteness of job site;
- Locating site facilities away of the working space to give sufficient area for construction works;
- Assuming realistic reduced resources output;
- Maintaining good roads to provide assumed production rates for hauling equipment;
- Using equipments for which spare parts are easily available to reduce shortage of spare parts;
- Providing facilities for mechanical maintenance of equipment; and
- Purchasing insurance to cover the risk of site injuries.

The previously mentioned items are some examples of the actions that may be taken to reduce or transfer the effect of risks. However, some risks will not be eliminated. To deal with residual risks, a detailed risk analysis may be required.

### Time contingency

In addition to the above-mentioned responses to risks, time contingency is one of the contractor's responses to risks and uncertainties. Time contingency is an extra time that added to the contract time to offset the effect of some risks that are known to the contractor in advance such as late delivery of materials. This extra time may be added in two ways:

- A general allowance is added to the overall contract duration when most the activities will be affected by the risk. For example, effect of bad weather which will affect all running activities.
- Allowance is added to a particular activity affected by the risk.

### Cost contingency

Also, the contractor has to assess the risks he/she is going to retain and include appropriate cost contingency allowance to the contract estimate. This allowance can be added as a fixed percentage of money from the direct cost based on the contractor experience. However, this allowance might not be appropriate for the specific risks. Also, it results in a single figure estimate. This method can be used when there is no means for performing risk analysis. The second method is to make a detailed analysis of risks as presented in the next subsection.

### ***Example 8.11***

In a specific, the following risks were identified.

- Client's delays;
- Troubles encountered with public services;
- Late supply of materials; and
- Equipment breakdown.

As a contractor, give your views on the possible responses to deal with them.

### ***Solution***

Contractor's response to the risks:

- Client's delay: the contractor should supply an activity schedule to warn the client and to be an evidence for the delay.
- Troubles encountered with public services: the contractor should use maps of new tools to locate public services. Also, he may use trial pits.
- Late supply of materials: the contractor should secure advanced delivery dates and alternative suppliers.
- Equipment breakdown: the contractor should supply the site with a complete workshop for maintenance of equipment.

### ***Risk Analysis***

After applying the responses to risks mention in the previous section, there are still some residual risks that need risk analysis to assess their impact on the project time and cost. This risk analysis is the process which incorporates uncertainty in a quantitative manner, using probability theory, to evaluate the potential impact of risk. The basic steps of risk analysis are:

- Estimate range of risk variables;

- Choose the appropriate probability distribution which best fit risk variables;
- Define the affected activities by these risk variables; and
- Use a simulation model to evaluate the impact of risks (Monte Carlo Simulation).

This, risk analysis usually includes: sensitivity analysis; and probability analysis.

### Sensitivity analysis

Sensitivity analysis is used to identify those variables which contribute most to the risk of the contract (time and/or cost). The purpose of this analysis is to eliminate those risk variables which have minor impact on the performance criteria and hence reduce problem size and effort. The following procedure for risk sensitivity analysis will be followed:

- Three values of each risk variables occurrence are to be specified: a most likely, an optimistic, and a pessimistic;
- To assess the effect of each risk variable:
  - Set all other risk variables at their most likely value;
  - Determine a value (A) for the performance (cost and/or time) criteria when risk variable under consideration is set at its optimistic value;
  - Determine another value (B) for the performance criteria (cost and/or time) when risk variable under consideration is set at its pessimistic value;
  - The difference between the obtained two values (A – B) of the performance criteria is checked (subjectively).
- Two cases can be encountered:
  - The difference corresponding to a risk variable has a little effect on the performance criteria (time and/or cost). Then, this risk variable can be eliminated from the probability analysis;
  - A significant difference is found, and consequently this risk variable should be included in the probability analysis.

### Probability analysis

The purpose of the probability analysis is to determine the effect of those risk variables which have a significant impact on the performance criteria of the project. The following procedure for risk probability analysis will be followed

- Consider the risk variables as random variables;
- Specify the suitable probability distribution for each risk variable;
- Use a suitable simulation technique to determine the probability distribution of the performance criteria (Monte Carlo Simulation);
- Cost contingency can be simply calculated after specifying the probability distribution of the performance criteria (Cumulative Probability Distribution as shown in [Figure 8.18](#)) as follows:

- Choose  $p$ ; acceptable probability of project cost (time) overrun;
- Allocate  $p$  on the Cumulative Probability Distribution curve, and determine the corresponding value (target cost);  $D$
- Calculate the cost contingency ( $D - C$ ), where  $C$  is the base contract estimate (time and cost).

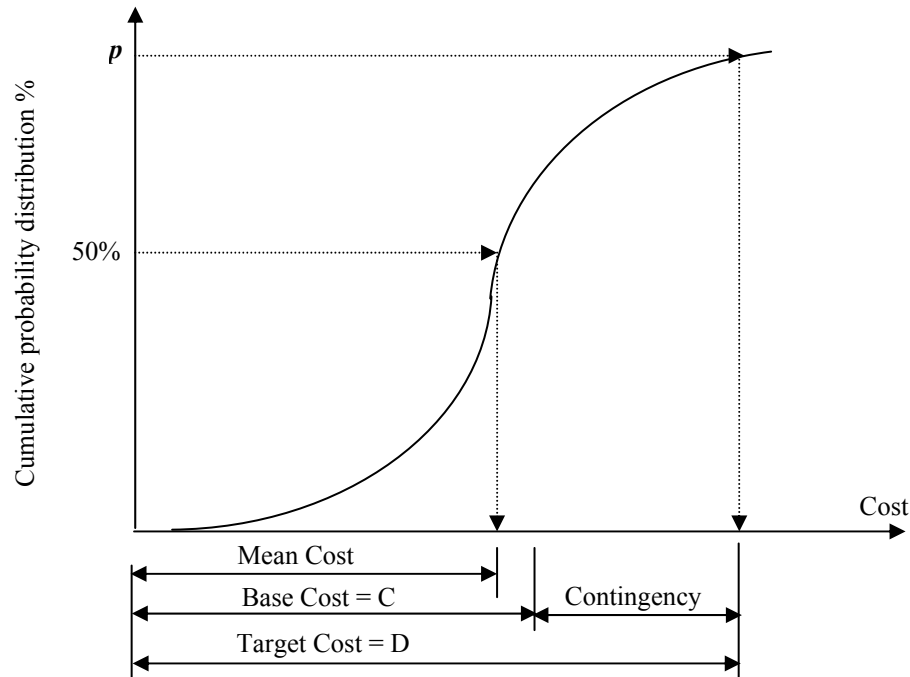


Figure 8.18: Cost contingency

## 8.6 Pricing Policy

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.

### 8.6.1 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.

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

**Example 8.12**

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

$$\begin{aligned}\text{Indirect cost + markup (for the whole contract)} &= \text{Bid price} - \text{direct cost} \\ &= 3,500,000 - 2,800,000 = \text{LE } 700,000\end{aligned}$$

$$\begin{aligned}\text{Then, Indirect cost + markup for activity (a)} &= \frac{400,000}{2,800,000} \times 700,000 = \text{LE } 100,000\end{aligned}$$

$$\begin{aligned}\text{Then, price of activity a} &= \text{its direct cost} + \text{indirect cost} \\ &= 400,000 + 100,000 = \text{LE } 500,000\end{aligned}$$

**8.6.2 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 8.13**

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 8.6](#).

- Compare the cash flow curves for both balanced and unbalanced bids;
- 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 8.6: Data for Example 8.13

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**

Assume each activity with one time unit duration then, the cash flow will be as given in Table 8.7. Also, cash flow curves for both balanced and unbalanced curves are shown in Figure 8.19. It shows that in the unbalanced bid, the contractor will receive more money in the early stages of the contract.

Table 8.7: Cash flow calculations

Time	1	2	3	4	5
Cumulative cash flow (balanced bid)	500	1500	3500	5500	6500
Cumulative cash flow (unbalanced bid)	600	2000	3800	5600	6500

- 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

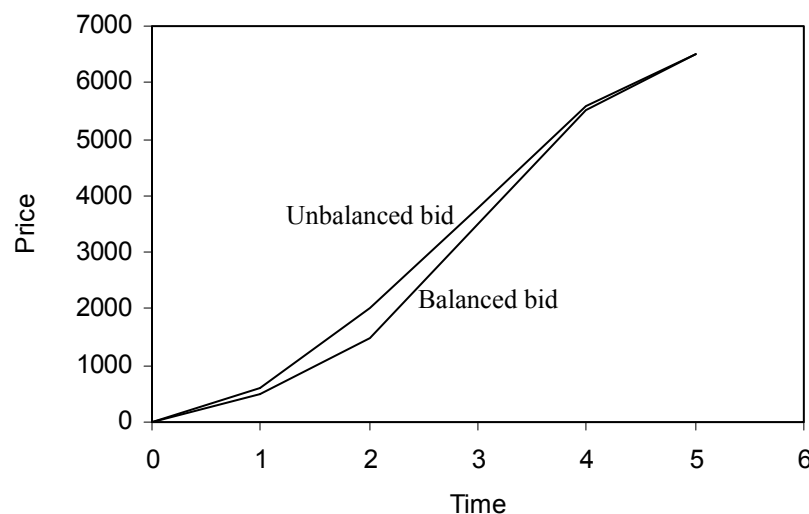


Figure 8.19: Cash flow for balanced and unbalanced bids

- Table 8.8 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.

In another way:

- Total direct cost =  $5200 + 50 \times 8 = 5600$
- Indirect cost & markup for balanced bid =  $7000 - 5600 = 1400 = 25\%$  of direct cost
- Indirect cost & markup for unbalanced bid =  $7200 - 5600 = 1600 = 29\%$  of direct cost

This increase means that the profit of the contractor has been increased and thus represents risk to the owner.

Table 8.8: 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 8.9 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.

In another way:

- Total direct cost =  $5200 + 50 \times 16 = 6000$
- Indirect cost & markup for balanced bid =  $7500 - 6000 = 1500 = 25\%$  of direct cost
- Indirect cost & markup for unbalanced bid =  $7400 - 6000 = 1400 = 23\%$  of direct cost

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

Table 8.9: 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	

### 8.6.3 Method Related Charge

The prices entered in the conventional bill of quantities might not represent the real cost of the work defined in the individual items. This is because not all costs are directly related to the quantity of work completed. Therefore, adjustment of the price due to a change in quantity of a particular item may not represent the real variation in cost. This usually produces unnecessary amount of uncertainty and financial problems in many contracts.

For example, site overheads are mainly time related charge. In the conventional bill of quantities, the cost of site overheads is recovered by spreading it over the quantity proportional rates. If variations occur and the site facilities are required for a longer period of time, there is no systematic way to adjust the contract price.

If the time-related site overhead costs could be entered in the bills of quantities as a time-related charge, then the cash flow pattern would be realistic and the price of this item could be adjusted in case of any variations happened.

Thus, the method related charge is proposed to enable contractors to enter any operation whose cost is time related and not directly linked to the quantities of work being done. It allows the contractor to define fixed and time-related charges that cover charges which are independent of the quantity of work completed. These charges are called method-related charges. [Table 8.10](#) gives an example of these items.

Table 8.9: Effect of change in quantity of activity C

Activity / Resource	Fixed charge	Time-related charge	Unit	Price
Establish site	Fixed	-	Sum	
Site overheads	-	Time-related	Month	
Bulldozers	-	Time-related	Day	
Excavators	-	Time-related	Day	
General overheads	-	Time-related	Month	
-----	-	-	-	
-----	-	-	-	

The main advantages of using the method related charges are:

- Allows a system evaluation of changes.
- It realistically reflects the cost of construction which reduces the effect of inflation.
- No need for loading of rates (unbalanced bidding).
- Improves cash flow.

Figure [8.20](#) shows an actual bill of quantities for a project where safety and health equipment, mobilization, and scaffolds used are listed as separate items in the bill of quantities.



**SCHEDULE NO. 1 STEEL STRUCTURE, WALLS AND CONCRETE FLOOR  
REMEDATION**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Heath Safety Equipment, Monitoring, and Implementation.		Lump Sum		
	Project Site Mobilization and Construction of Decontamination Station.		Lump Sum		
	<b>Subtotal</b>				
2	Steel Structure Decontamination.				
	a) Decontaminate steel structure	1100	Square Meters		
	b) Load and haul debris to Landfill in Alexandria	5	Ton		
	<b>Subtotal</b>				
3	Walls Decontamination and Coating.				
	a) Support walls	1200	Square Meters		
	b) Rolling Scaffold	1200	Square Meters		
	c) Remove existing paint on interior and exterior walls	2950	Square Meters		
	d) Clean all surfaces for painting	2950	Square Meters		
	e) Place a coat of smooth plaster paint	2950	Square Meters		
	f) Load and haul debris to Landfill in Alexandria	15	Ton		
	<b>Subtotal</b>				

Figure 8.20: Bill of quantities showing some items such as scaffold and safety equipment