

UNIT 3

INTRODUCTION TO COST ESTIMATION

Elements of cost estimation:

For the purpose of calculations, the total cost of the product is divided into the following:

(A) Material cost, (B) Labour cost, (C) Other expenses.

(A) Material Cost

Material cost consists of the cost of materials which are used in the manufacture of product. It is divided into the following

(a) Direct material cost: It is the cost of those materials which are directly used for the manufacture of the product and become a part of the finished product. This expenditure can be directly allocated and charged to the manufacture of a specific product or job and includes the scrap and waste that has been cut away from original bar or casting.

The procedure for calculating the direct material cost is as follows:

- (i) From the product drawing, make a list of all the components required to make the final product.
- (ii) Calculate the volume of each component from the drawing dimensions after adding machining allowances, wherever necessary.
- (iii) The volume of component multiplied by the density of material used gives the weight of the material per component.
- (iv) Add process rejection and other allowances like cutting allowance to get the gross weight per component.
- (v) Multiply the gross weight by the cost of material per unit weight to get the cost of raw material per component.
- (vi) The cost of raw material for all the components is, similarly, calculated and added up which gives the cost of direct material for the product.

(b) Indirect material cost: In addition to direct materials a number of other materials are necessary to help in the conversion of direct materials into final shape. Though these materials are consumed in the production, they don't become a part of the finished product and their cost cannot be directly booked to the manufacture of a specific product. Such materials are called indirect materials. The indirect materials include oils, general tools, grease, sand papers, coolants, cotton waste etc. The cost associated with indirect materials is called indirect material cost.

In some cases certain direct materials like nails, screws, glue, putty etc., are used in such small quantity that it is not considered worthwhile to identify and charge them as direct materials. In such cases these materials are also charged as indirect materials.

Depending upon the product manufactured, the same may be direct materials for one concern and indirect materials for others.

(B) Labour Cost

It is the expenditure made on the salaries, wages, overtime, bonuses, etc. of the employees of the enterprise. It can be classified as:

(a) Direct labour cost: Direct labours are the one who actually works and processes the materials to convert it into the final shape. The cost associated with direct labour is called direct labour cost. The direct labour cost can be identified and allocated to the manufacture of a specific product. Examples of the direct labour are the workers operating lathes, milling machines or welders, or assemblers in assembly shop. The direct labour cost may be allocated to a product or job on the basis of time spent by a worker on a job.

(b) Indirect labour cost: Indirect labours are the one who is not directly employed in the manufacturing of the product but his services are used in some indirect manner.

The indirect labour includes supervisors, inspectors, foreman, storekeeper, gatekeeper, maintenance staff, crane driver etc. The cost associated with indirect labour is called indirect labour cost. The indirect labour costs cannot be identified with a particular job or product but are charged on the total number of products made during a particular period in a plant.

To make the concept of direct and indirect labour cost clear, consider an operator working on a drilling machine. The operator in this case is direct labour whereas the man supervising the job, inspector and store man supplying the material are indirect labour.

(c) Other Expenses

In addition to the material cost and labour cost, several other expenses such as rent of building, depreciation of plant and machinery, cost of packing materials, transport and distribution expenses, wages and salaries of administrative staff and executives are also incurred by the manufacturer. All this expenditure including the indirect material cost and indirect labour cost is called other expenses.

We can say that except direct material and direct labour costs all other expenditure incurred by the manufacturer is known as -Other Expenses||.

Expenses are further classified as :

(a) Direct expenses: Direct expenses include all that expenditure which can be directly allocated and charged to a particular job. The direct expenses include cost of special jigs or fixtures, patterns, tooling's made for job, or cost of research and development work done for that specific job.

(b) Indirect expenses: Except direct expenses, all other indirect expenditure incurred by the manufacturer is called indirect expenses. The indirect expenses are also called overhead expenses or on-cost.

The indirect expenses are further classified as:

(i) Factory expenses.

(ii) Administrative expenses.

(iii) Selling and distribution expenses.

(i) Factory expenses: Factory expenses comprise of the indirect expenses incurred from the receipt of the order to the completion of production. In addition to indirect material and indirect labour cost it includes rent of factory building, license fee, electricity and telephone bills of factory, insurance charges etc.

Factory expenses are also called -Works expenses, or -Factory or Works overhead.

(ii) Administrative expenses: Administrative expenses or office expenses include the expenditure incurred on control and administration of the factory. It includes the salaries of office and administrative staff, rent of office building, postage and telephone charges, water and electricity charges for office, Director's fee, legal and audit charges etc. Administrative expenses are also known as Administrative overheads '.

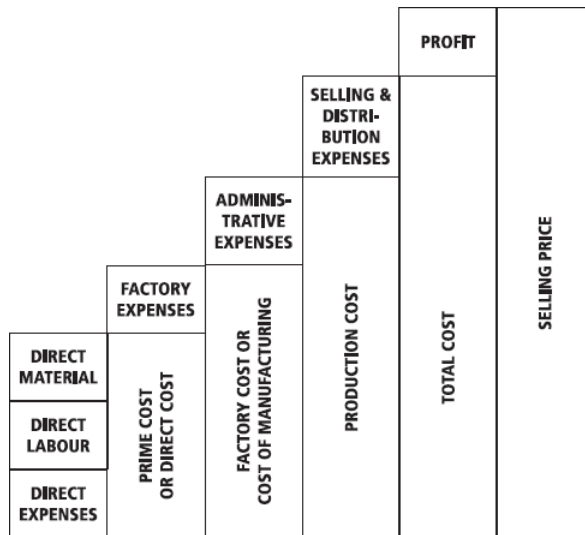
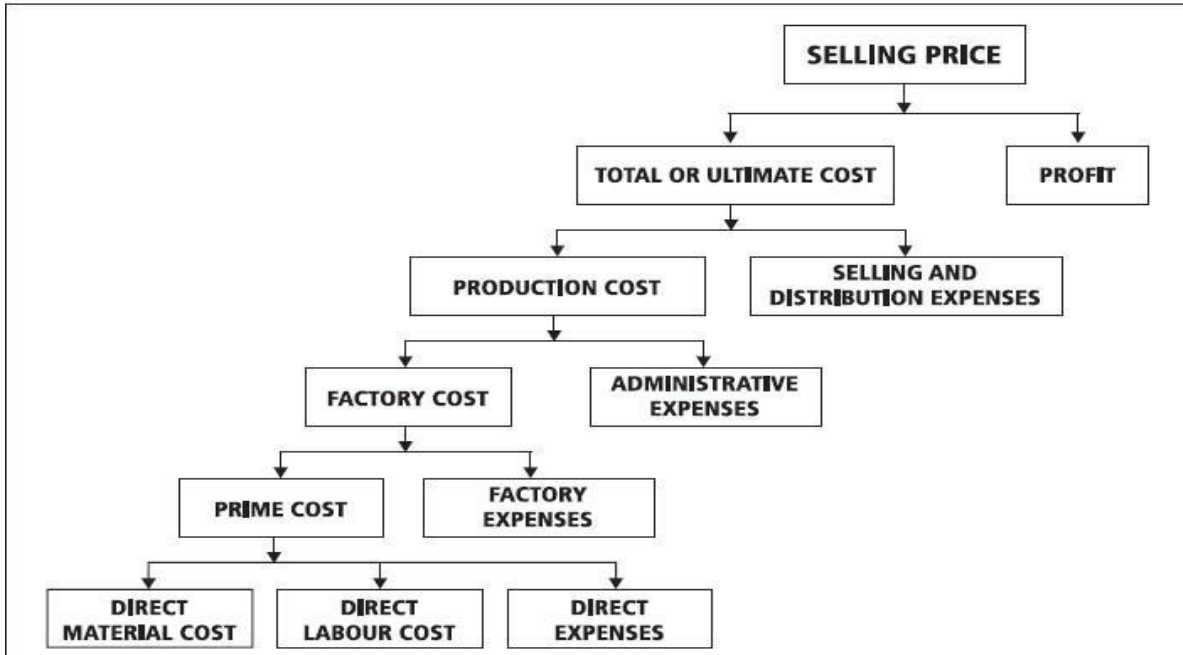
(c) Selling and distribution expenses: This is the expenditure incurred on Sales Department for selling the product, *i.e.*, wages, salaries, commission and travelling allowances of salesmen and officers in Sales Department, cost of advertisement, packing, delivery and distribution expenses, rent of warehouses etc.

COST OF PRODUCT (LADDER OF COSTS)

The components of cost discussed above can be grouped as follows :

1. Prime cost = Direct material cost + Direct labour cost + Direct expenses
2. Factory cost = Prime cost + Factory expenses
3. Production cost = Factory cost + Administrative expenses
4. Total or Ultimate cost = Production cost + Selling and distribution expenses.
5. Selling price = Ultimate cost + Profit

The above relations can be illustrated on a chart (Ladder of costs) Fig. 3.2



Example 1: Calculate prime cost, factory cost, production cost, total cost and selling price per item from the data given below for the year 2003-04.

	Rs.
Cost of raw material in stock as on 1-04-2003	
25,000	
Raw material purchased	40,000
Direct <u>labour</u> cost	14,000
Direct expenses	1,000
Factory/Works overhead	9,750
Administrative expenditure	6,500
Selling and distribution expenses	3,250
No. of items produced	650
Cost of raw material in stock as on 31-03-2004	15,000

Net profit/item is 10 percent of total cost of the product.

Solution: For 650 units produced during 2003-04

(i) Direct material used = Stock of raw material on 1-04-2003 + raw material purchased

$$\begin{aligned}
 & \quad \quad \quad - \text{Stock of raw material on 31-03-2004} \\
 & = 25,000 + 40,000 - 15,000 \\
 & = \text{Rs. } 50,000
 \end{aligned}$$

(ii) Direct labour = Rs. 14,000

(iii) Direct expenses = Rs. 1,000

$$\begin{aligned}
 \text{Prime cost} & = 50,000 + 14,000 + 1,000 \\
 & = \text{Rs. } 65,000
 \end{aligned}$$

$$\begin{aligned}
 \text{Factory cost} & = \text{Prime cost} + \text{Factory expenses} \\
 & = 65,000 + 9,750 \\
 & = \text{Rs. } 74,750
 \end{aligned}$$

$$\begin{aligned}
 \text{Production cost} & = \text{Factory cost} + \text{Administrative expenses} \\
 & = 74,750 + 6,500 \\
 & = \text{Rs. } 81,250
 \end{aligned}$$

$$\begin{aligned}
 \text{Total cost} & = \text{Production cost} + \text{Selling expenses} \\
 & = 81,250 + 3,250 \\
 & = \text{Rs. } 84,500
 \end{aligned}$$

$$\begin{aligned}
 \text{Selling price} & = 84,500 + 10 \text{ percent of } 84,500 \\
 & = 84,500 \times 1.10 = \text{Rs. } 92,950
 \end{aligned}$$

$$\begin{aligned}\text{Selling price} &= 84,500 + 10 \text{ percent of } 84,500 \\ &= 84,500 \times 1.10 = \text{Rs. } 92,950\end{aligned}$$

$$\text{Prime cost/item} = 65,000 / 650 = \text{Rs. } 100$$

$$\text{Factory cost/item} = 74,750 / 650 = \text{Rs. } 115$$

$$\text{Production cost/item} = 81,250 / 650 = \text{Rs. } 125$$

$$\text{Total cost/item} = 84,500 / 650 = \text{Rs. } 130$$

$$\text{Selling price/item} = 92,950 / 650 = \text{Rs. } 143$$

Example 2: From the following data for a sewing machine manufacturer, prepare a statement showing prime cost, Works/factory cost, production cost, total cost and profit.

	Rs.
Value of stock of material as on 1-04-2003	26,000
Material purchased	2, 74,000
Wages to <u>labour</u>	1, 20,000
Depreciation of plant and machinery	8,000
Depreciation of office equipment	2,000
Rent, taxes and insurance of factory	
16,000	
	Rs.
General administrative expenses	3,400
Water, power and telephone bills of factory	9,600
Water, lighting and telephone bills of office	2,500
Material transportation in factory	2,000
Insurance and rent of office building	2,000
Direct expenses	5,000
Commission and pay of salesman	10,500
Repair and maintenance of plant	1,000

Salary of office staff	60,000
Value of stock of material as on 31-03-2004	36,000
Sale of products	6,36,000

Solution:

(i) Material cost = Opening stock value + Material purchases – Closing balance

$$= 26,000 + 2, 74,000 - 36,000$$

$$= \text{Rs. } 2, 64,000$$

$$\text{Prime cost} = \text{Direct material cost} + \text{Direct } \underline{\text{labour}} \text{ cost} + \text{Direct expenses}$$

$$= 2, 64,000 + 1, 20,000 + 5,000$$

$$= \text{Rs. } 3, 89,000$$

(ii) Factory overheads are:

Rent, taxes and insurance of factory	Rs.
16,000	

Depreciation of plant and machinery	8,000
Water, power and telephone bill of factory	9,600
Material transportation in factory	2,000
Repair and maintenance of plant	1,000
Work Manager Salary	30,000
Factory overheads or Factory cost	66,600

$$\begin{aligned}\text{Factory cost} &= \text{Prime cost} + \text{Factory expenses} \\ &= 3,89,000 + 66,600 \\ &= \text{Rs. } 4,55,600\end{aligned}$$

(iii) Administrative/office expenses are:

	<i>Rs.</i>
Depreciation of office equipment	2,000
General administrative expenses	3,400
Water, lighting and telephone bills of office	2,500
Rent, insurance and taxes on office building	2,000
Salary of office staff	60,000
Total	69,900

$$\begin{aligned}\text{Production cost} &= \text{Factory cost} + \text{Office expenses} \\ &= \text{Rs. } 4,55,600 + \text{Rs. } 69,900 \\ &= \text{Rs. } 5,25,500\end{aligned}$$

(iv) Selling overheads are:

Commission and pay to salesmen = Rs. 10,500

$$\begin{aligned}\text{Total cost} &= \text{Production cost} + \text{Selling expenses} \\ &= 5,25,500 + 10,500 \\ &= \text{Rs. } 5,36,000\end{aligned}$$

$$\begin{aligned}\text{(v) Profit} &= \text{Sales} - \text{Total cost} = 6,36,000 - 5,36,000 \\ &= \text{Rs. } 1,00,000\end{aligned}$$

Example 4: A factory is producing 1000 high tensile fasteners per hour on a machine. The material cost is Rs. 375, labour cost is Rs. 245 and direct expense is Rs. 80. The factory on cost is 150 Percent of the total labour cost and office on cost is 30 percent of the factory cost. If the selling price of each fastener is Rs. 1.30, calculate whether there is loss or gain and by what amount?

Solution : For 1000 fasteners

Material cost = Rs. 375.00

Labour cost = Rs. 245.00

Direct expenses = Rs. 80.00

Factory on cost = 150 percent of labour cost

$$= 245 \times 1.5$$

$$= \text{Rs. } 367.50$$

Factory cost = 375 + 245 + 80 + 367.50

$$= \text{Rs. } 1,067.50$$

Office on cost = 30 percent of factory cost

$$= \frac{30}{100} \times (1,067.50)$$

$$= \text{Rs. } 320.25$$

Total cost for 1000 fasteners = 1,067.50 + 320.25

$$= \text{Rs. } 1387.75$$

$$\text{Cost per fastener} = \frac{1387.75}{1000}$$

$$= \text{Rs. } 1.387 = \text{Rs. } 1.39$$

Selling price = Rs. 1.30

As selling price is lower than total cost per fastener, the management will suffer a loss.

$$\text{Loss per fastener} = (1.39 - 1.30) = \text{Rs. } 0.09$$

$$\text{Loss per 1000 fastener} = 0.09 \times 1000 = \text{Rs. } 90$$

Example 7 : The catalogue price of a certain gadget is Rs. 1,050, the discount allowed to distributors being 20 percent. Data collected for a certain period shows that the selling price and factory cost are equal. The relation between material cost, labour cost and factory on cost (overhead expenses) are in the ratio 1 : 2 : 3. If the labour cost is Rs. 200, what profit is being made on the gadget?

Solution:

Catalogue Price = Rs. 1,050

$$\begin{aligned} \text{Distributors discount} &= 20\% = \frac{20}{100} \times (1,050) \\ &= \text{Rs. 210} \end{aligned}$$

$$\begin{aligned} \text{Selling price} &= 1,050 - 210 \\ &= \text{Rs. 840} \end{aligned}$$

Labour cost = Rs. 200

$$\begin{aligned} \text{Material cost} &= \times \frac{1}{2} \times (200) \\ &= \text{Rs. 100} \end{aligned}$$

$$\begin{aligned} \text{Factory on cost} &= \frac{3}{2} \times (200) \\ &= \text{Rs. 300} \end{aligned}$$

$$\text{Factory cost} = 200 + 100 + 300 = \text{Rs. 600}$$

$$\begin{aligned} \text{It is given that selling price} &= \text{Factory cost} \\ &= \text{Rs. 600} \end{aligned}$$

$$\begin{aligned} \text{Selling price} &= \text{Total cost} + \text{Profit} \\ 840 &= 600 + \text{Profit} \end{aligned}$$

$$\begin{aligned} \text{Profit} &= 840 - 600 \\ &= \text{Rs. 240} \end{aligned}$$

Profit = Rs. 240 per gadget.

TYPES OF COST ESTIMATES

One classification system for cost estimates is based on design level when the product is designed. The three levels of design considered are :

- (i) Conceptual design,
- (ii) Preliminary design, and

(iii) Detailed design.

The conceptual design stage is that stage at which only the functional requirements are considered by the designer using techniques such as feature-based design and/or solid modelling and a rough magnitude of estimate can be obtained. Geometry of parts and materials are not known at this stage.

The accuracy of conceptual cost estimates are approximately – 30% to + 50%.

The cost estimation methods used at this level are

- (a) Factor method,
- (b) Material cost method, and
- (c) Function method.

(a) Factor Method of Cost Estimation

According to this method:

Estimated cost of an item = Factor for total cost estimate × Amount of major cost item
some examples of factor are:

- (i) Cost of construction per km of highway.
- (ii) Cost of fabricated component per kg of casting.
- (iii) Cost of house construction per SQ.M. of livable space.

(b) Material Cost Method of Estimation

Material cost method predicts the total cost of the product based on the ratio of the material cost of the product to the material cost share of the total cost.

According to this method:

Material cost of the item being estimated

Estimated cost of an item = Material cost share of item being estimated (in %)

(c) Function Method of Cost Estimation

This method is also referred to as **Parametric cost estimating**.

This method is similar to the factor method, but more variables are used. Function method uses a mathematical expression with constants and parameters derived for specific process, such as casting or machining or for specific classes of parts based on material, size, weight or other cost parameters.

According to this method:

Estimated cost of an item = $G \times (a + b) + (R \times c) + (N \times d)$ where G = Weight of the item, kg

a = Material cost per kg

b = Tolerance cost per, kg

R = Weight of material Removed, kg

c = Cost per kg of material removed

N = No. of dimensions of a product surface

d = Cost per dimension

(The above is an example of function method for a machined component). Other types of cost estimates are based on the following:

(i) Product comparison: The new product is compared with existing products (of similar function, design etc.) and adjustments/modifications are made for the differences.

(ii) Data base calculations: The product cost estimate is determined from cost data bases which a company is expected to maintain over a period of time (Historical Cost Data Base).

(iii) Detailed cost functions and/or parametric cost estimation: The product cost estimate is determined using parametric cost estimation technique. All variables or parameters of process, part features and other cost parameters are considered in cost estimation.

METHODS OF COST ESTIMATES

There are different methods of estimates of cost. These are in addition to conventional method of estimating of cost such as calculating material cost, labour cost, factory expenses and overhead expenses and adding all these cost elements.

The methods of estimates are:

1. Conceptual Cost Estimating

It is estimating during the conceptual design stage. In the conceptual design stage, the geometry of parts and materials have not been specified, unless they dictate essential product functions. In the conceptual design stage, the costs associated with a change in the design are low. In the conceptual design stage, the incurred costs are only 5 to 7% of the total cost whereas the committed costs are 75 to 85% of the total cost.

The accuracy of the conceptual cost estimate depends on the accuracy of the data base. The accuracy of conceptual cost estimating is approximately – 30% to + 50%. Accuracy in conceptual cost estimating is important since at the conceptual design stage only significant cost savings can occur.

Conceptual cost estimating methods include:

(a) Expert opinion,

(b) Analogy methods, and Formula based methods.

(a) Conceptual Method Based on Expert Opinion

If back-up and/or historical cost data are not available, getting expert opinion is the only way for estimating cost.

The disadvantages of this method are

- (i) The estimate is subjected to bias.
- (ii) The estimate can't be quantified accurately.
- (iii) The estimate may not reflect the complexity of the product or project.
- (iv) Reliable data base for future estimates are not possible.

In spite of these disadvantages, the expert opinion is useful when historical data base is not available. It is also useful to verify cost estimate arrived at using other methods of conceptual estimating (like analogy methods and formula based methods).

(b) Conceptual Method Based on Analogy

Analogy estimating derives the cost of a new product based on past cost data of similar products.

Cost adjustments are made depending on the differences between the new and previous product/system. Analogy estimating requires that the products be analogous or similar and products manufactured using similar facilities or technology. If the technology changes, the analogy estimating relationship has to be changed to reflect the changes in technology. Another limitation of this method is that analogy estimates often omit an important detail that makes cost considerably higher than the original cost estimates.

(c) Conceptual Method Based on Formula

There are formula based methods that are primarily used in the conceptual cost estimating. These are:

- (i) Factor method,
- (ii) Material cost method,
- (iii) Function method, and
- (iv) Cost-size relationship.

These methods are known as **Global cost estimation methods** and they generally use one of the above methods only.

(i) Factor method

This is the simplest method, but it can give reliable estimates if the data are kept up-to-date, taking into consideration factors such as inflation, and environmental issues which tend to increase the cost.

(ii) Material cost method

Material cost method is justified since the material cost is the largest cost item in the prime cost of many manufacturing companies.

According to this method :

$$\text{Estimated cost of an item} = \frac{\text{Material cost of the item being estimated}}{\text{Material cost share of item being estimated in \%}}$$

(iii) Function method

In function method more variables are used and the expressions are non-linear. The function is basically a mathematical expression with constants and variables that provides a mathematical function for the cost estimate. One expression is given below : Cost of turbo fan engine development, (in Rs. Lakhs).

(iv) Method based on cost-size relationships

Another approach to the determination of conceptual costing is by considering the cost-size relationships. In this approach, one can compare the cost of different designs on a relative basis or on an actual cost basis. Expression has been developed from data on investment castings and for machined parts.

The cost-size relationship in respect of investment casting is given below as an example : Relative cost of an investment casting of volume $V \text{ cm}^3 = 5.0 V^{0.6}$

Where

5.0 represent cost of 1 cm^3 investment casting

V , Volume of investment costing, cm^3

0.6, size cost exponent for investment casting (the relationship is less than linear).

Data requirements and sources of information for cost estimation

1. Man-hour cost (Labour rate) *i.e.*, hourly cost of skilled, semi-skilled and unskilled labours of the company.
2. Machine-hour cost for different types of equipment and machinery available in the company.
3. Material cost in respect of commercially available materials in the market:
 - Cost in Rs. per kg for different categories of materials like ferrous, non-ferrous, special steel etc., for rods of different diameters and for different thicknesses in respect of flats/sheet metals.
4. Scarp rates *i.e.*, scarp values of different materials in Rs. per kg.
5. In respect of welding operations, information such as electrode cost, gas cost, flux cost, power cost, etc.
6. Set-up time for different processes.
7. % allowances to be added for computing standard time, relaxation

allowance, process allowance, special allowance as % of normal time as per the policy of the management.

8. Standard time for different types of jobs, if available.

9. Overhead charges in terms of % direct labour cost or overhead rate in Rs. per hr.

10. Life in years permitted for various types of equipment and machines available in the plant for calculation of depreciation, for cost recovery and for calculation of machine — hour rate.

11. Data base of cost calculations carried out by the company in respect of earlier products or jobs (Historical cost data).

12. Cost data of products available in the market similar to the ones manufactured by the company.

13. Budget estimates prepared by the company for new projects/products.

BASIC STEPS IN COST ESTIMATION

The basic steps in the cost estimation of any product are given below:

1. Make thorough study of cost estimation request to understand it fully.

2. Make an analysis of the product and prepare a bill of materials.

3. Make separate lists of parts to be purchased from the market and parts to be manufactured in plant.

4. Determine the cost of parts to be purchased from outside.

5. Estimate the material cost for the parts/components to be manufactured in plant.

6. Make manufacturing process plan for the parts to be manufactured in plant.

7. Estimate the machining time for each operation listed in the manufacturing process plan.
8. Multiply each operation time by the labour wage rate and add them up to find direct labour cost.
9. Add the estimate of step 4, 5, and 8 to get prime cost of component.
10. Apply overhead costs to get the total cost of the component.

The selling price of the component is estimated by adding profit to the total cost obtained in step 10.