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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

EC T82 Industrial Management and Engineering Economics

IV YEAR/ VIII SEM

UNIT - I

Introduction to Economics:– *Flow in an Economy, Law of supply and Demand, Concept of Engineering Economics – Engineering Efficiency, Economic Efficiency, Scope of Engineering Economics, Elements of costs, Marginal Cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-Even Analysis, P/V ratio, Elementary Economics Analysis-Function, Aims, Value Engineering procedure, Interest Formulas and their Applications – Time Value of Money, Single Payment Compound Amount Factor, Single Payment Present Worth Factor, Equal Payment Series, Compound Amount Factor, Equal Payment Series Sinking Fund Factor, Equal Payment Series Present Worth Factor, Equal Payment Series Capital Recovery Factor, Uniform Gradient Series Annual Equivalent Factor, Effective Interest Rate, Examples in all the methods.*

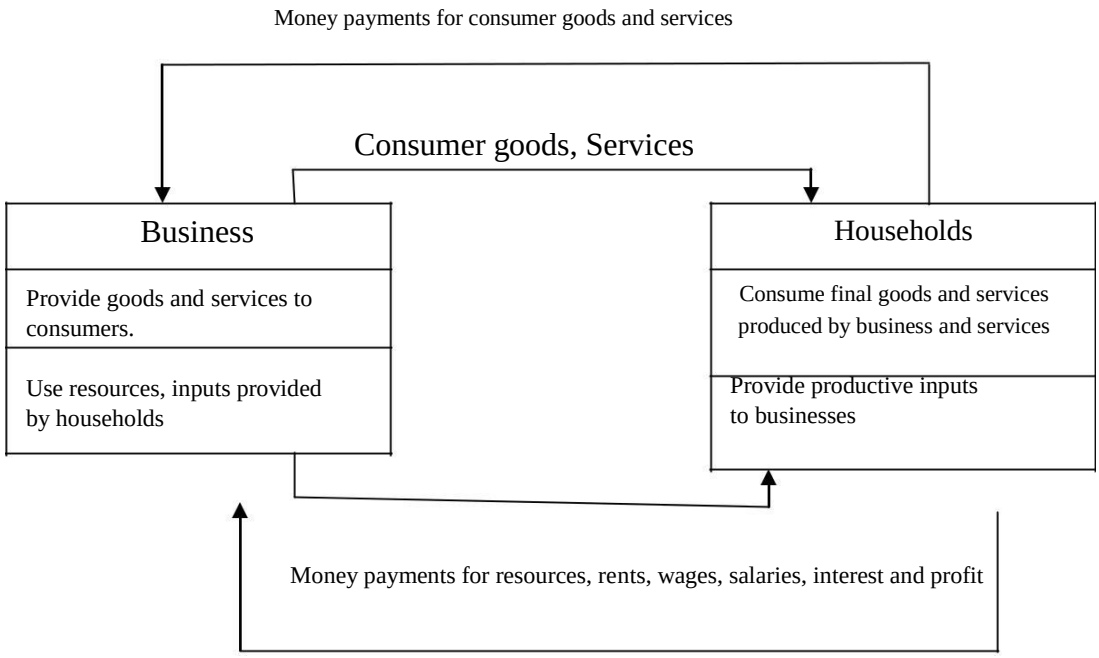
Economics:

Economics is the science that deals with the production and consumption of goods and services and the distribution and rendering of these for human welfare. The following are the economic goals;

- A high level of employment
- Price stability
- Efficiency
- An equitable distribution of income
- Growth

Flow in an Economy;

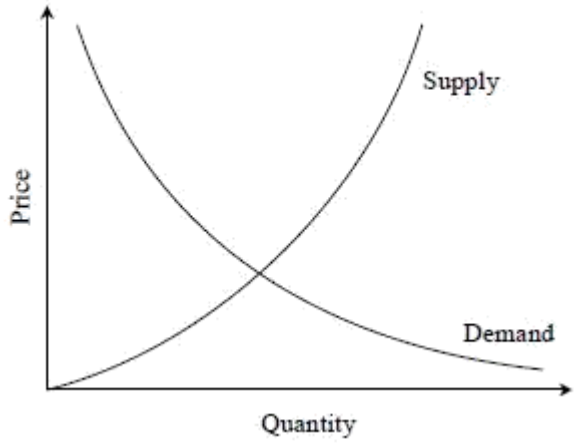
The flow of goods, services, resources and money payments in a simple economy are shown in below diagram. Households and business are the two major entities in a simple economy. Business organizations use various economics resources like land, labour and capital which will be used by them. Business organizations make payment of money to the households for receiving various resources. The households in turn make payment of money to business organization for receiving consumer goods and services. This cycle shows the interdependence between the two major entities in a simple economy



Law of supply and Demand

An interesting aspect of the economy is that the demand and supply of a product are interdependent and they are sensitive with the respect to the price of that product. The interrelationships between them are shown in above diagram.

And also it is clear that when there is a decrease in the price of a product, the demand for product increases and its supply decreases. Also, the product is more in demand for the product increases. At the same time, lowering of the price of the product makes the producers restrain from releasing more quantities of the product in the market. Hence the supply of the product is decreased. The point of intersection of the supply curve and the demand curve is known as the equilibrium point. At the price corresponding to this point, the quantity of supply is equal to the quantity of demand. Hence this point is called equilibrium point.



Factors influencing demand

The shape of the demand curve is influenced by the following factors;

- Income of the people
- Prices of related goods
- Tastes of consumers

If the income level of the people increases significantly, then their purchasing power will naturally improve. This would definitely shift the demand curve to the north east direction. A converse situation will shift the demand curve to the south west direction.

If, for instance the price of television sets is lowered drastically its demand would naturally go up. As a result, the demand for its associated product, namely VCDs, would also increase. Hence the prices of related foods influence the demand of products.

Over a period of time, the preferences of the people for a particular product may increase, which in turn, will affect the demand. For instance diabetic people prefer to have sugar free products. If the incidence of diabetes rises naturally there will be increased demand for sugar free products.

Factors influencing supply

The shape of the supply curve is affected by the following factors:

1) Cost of the inputs 2) Technology 3) Weather 4) Prices of related goods

If the cost of inputs increases, then naturally, the cost of the product will go up. In such a situation, at the prevailing price of the product the profit margin per unit will be less. The producers will then reduce the production quantity, which in turn will affect the supply of the product. For instance if the prices of fertilizers and cost of labor are increased significantly in agriculture the profit margin per bag of paddy will be reduced. So, the farmers will reduce the area of cultivation, and hence the quantity of supply of paddy will be reduced at the prevailing prices of the paddy.

If there is advancement in technology used in manufacture of the product in the long run, there will be a reduction in the production cost per unit. This will enable the manufacturer to have a greater profit margin per unit at the prevailing price of the product. Hence, the producer will be tempted to supply more quantity to the market.

Weather also has a direct bearing on the supply of products. For example demand for woolen products will increase during winter. This means the prices of woolen goods will be increased in winter. So, naturally, manufacturers will supply more volume of woolen goods during winter.

Again take the case of television sets. If the price of TV sets is lowered significantly then its demand would naturally go up. As a result, the demand for associated products like VCDs would also go up. Over a period of time, this will lead to an increase in the price of VCDs, which would result in more supply of VCD‘s

CONCEPT OF ENGINEERING ECONOMICS

Science is a field of study where the basic principles of different physical systems are formulated and tested. Engineering is the application of science. It establishes varied applications systems based on different scientific principles.

It is clear that price has a major role in deciding the demand and supply of the product. Hence from the organizations point of view, efficient and effective functioning of the organization would certainly help it to provide goods/services at a lowe cost which in turn will enable it to fix a lower price for its goods or services.

The following discusses the different types of efficiency and their impact on the operation of businesses and the definition and scope of engineering economics.

Types of Efficiency

Efficiency of a system is generally defined as the ratio of its output to input. The efficiency can be classified into technical efficiency and economic efficiency.

Technical Efficiency

It is the ratio of the output to input of a physical system. The physical system may be a diesel engine, a machine working in a shop floor, furnanceetc,

$$\text{Technical efficiency (\%)} = \frac{\text{Output}}{\text{Input}} \times 100$$

The technical efficiency of a diesel engine is as follows

$$\text{Technical efficiency (\%)} = \frac{\text{Heat equivalent of mechanical energy produced}}{\text{Heat equivalent of fuel used}} \times 100$$

In practice technical efficiency can never be more than 100% . This is mainly due to frictional loss and incomplete combustion of fuel, which are considered to be unavoiadable phenomena in the working of a diesel engine.

Economic efficiency

Economic efficiency is the ratio of output to input of a business system.

$$\text{Economic efficiency (\%)} = \frac{\text{Output}}{\text{Input}} \times 100 = \frac{\text{Worth}}{\text{Cost}} \times 100$$

Worth is the annual revenue generated by way of operating the business and cost is the total annual expenses incurred in carrying out the business. For the survival and growth of any business the economic efficiency should be more than 100%.

Economic efficiency is also called productivity. There are several wazs of improving productivity.

- Increased output for the same input
- Decreased output for the same output
- By a proporionate increase in the output which is more than the proportionate increase in the input

- By a proportionate decrease in the input which is more than the proportionate decrease in the output

- Through simultaneous increase in the output with decrease in the input.

*Increased output for the same input.*In this strategy, the output is increased whilekeeping the input constant. Let us assume that in a steel plant, the layout of the existing facilities is not proper. By, slightly altering the location of the billet-making section., and bringing it closer to the furance which produces hot metal , the scale formation at the top of ladles will be considerably reduced. The molten metal is usually carried in ladles to the billet-making section. In the lng run, this would give more yield in terms of tonnes of billet produced. In this exercise, there is no extra cost involved. The only task is the relocation of the billet-making facility wich involves an insignficant cost.

Decreased input for the same out put. In this strategy, the input is decreased to producethe same output .let us assume that there exists a substitue raw material to manfacture a product and it is available at a lower price. If we can identify such a material and use it for manfacturing the product then certainly it will reduce the input. In this excerise, the job of the purchase department is to identify an alternate subsitute material. The process of identification does not involve any extra cost. So, the productivity ratio will increase because of the decreased input by way of using cheaper raw materials to produce the same output.

Less proportionate increase in output is more than that of the input. consider theexample of introducing a new product into the existing product mix of an organization. Let us assume that the existing facilities are not fully utilized an the R&D wing of the company has identified a new product which has a very good market and which can be manfactured with the surplus facilities of the organization. If the new product is taken up for production, it will lead to

- An increase in the revenus of the organiyation by way of selling the new product in addition to the existing product mix and

- An increase in the material cost and operation and maintenance cost of machineries because of producing the new product.

If we examine these these two increase closely, the proportionate increase in the revenue will be more than the proprotionate increase in the input cost. Hence, there will be a net increase in the productivity ratio.

When proportionate decrease in input is more than that of the output. let us consider the converse of the pervious example, i.e dropping an uneconomical product from the existing product mix. This will result in the following:

- A decrease in the revenue of the organization
- A decrease in the material cost, and operation and maintenance cost of machinery

If we closely examine these two decreases, we will se that the proportionate decrease in the input cost will more than the proportionate decrease in the revenue. Hence, there will be net increase in the productivity ratio.

Simultaneous increase in output and decrease in input. Let us assume that there are advanced automated technologies like robots and automated guided vehicle system (AGVS, available in the market which can be employed in the organization we are interested in. If we employ these modern tools, then:

- There will be drastic reduction in the operation cost, initially; the cost on equipment would be very high. But in the long run, the reduction in the operation cost would break-even the high initial investment and offer more savings on the input.
- These advanced facilities would help in producing more products because they do not experience fatigue. The increased production will yield more revenue.
- In this example in the long run, there is an increase in the revenue and a decrease in the input. hence, the productivity ratio will increase at a faster rate.

1.2.2 Definition and scope of engineering economics

As stated earlier, efficient functioning of any business organization would enable it to provide goods/services at a lower price. In the process of managing organizations, the managers at different levels should take appropriate economic decisions which will help in minimizing investment, operating and maintenance expenditures besides increasing the revenue, savings and other related gains of the organization.

Definition

Engineering economics deals with the methods that enable one to take economic decisions towards minimizing costs and /or maximizing benefits to business organizations.

Scope

The issues that covered in this book are elementary economic analysis, interest formulae, bases for comparing alternatives, present worth method, future worth method, annual equitant method, rate of return method, replacement analysis, depreciation, evaluation of public alternatives, inflation adjusted investment decisions, make or buy decisions, inventory control, project management, value engineering and linear programming

1.3 ELEMENTS OF COSTS

Cost can be broadly classified into variable cost and overhead cost. Variable cost varies with the volume of production while overhead cost is fixed, irrespective of the production volume.

Variable cost can be further classified into direct material cost, direct labour cost, and direct expenses. The overhead cost can be classified into factory overhead, administration overhead, selling overhead, and distribution overhead.

Direct material costs are those costs of materials that are used to produce the product. Direct labour cost is the amount of wages paid to the direct labour involved in the production activities. Direct expenses are those expenses that vary in relation to the production volume, other than the direct material costs and direct labour costs.

Overall cost is the aggregate of indirect material costs, indirect labour costs and indirect expenses. Administration overhead includes all the costs that are incurred in administering the business. Selling overhead is the total expense that is incurred in the promotional activities and the expenses relating to sales force. Distribution overhead is the total cost of shipping the items from the factory site to the customer sites

The selling price of a product is derived as shown below:

a) Direct material costs + Direct labour costs+ Direct expenses= Prime cost

b) Prime cost+ Factory overhead = Factory cost.

c) Factory cost+ office and administrative overhead = cost of production.

d) cost of production +opening finished stock- Closing finished stock = cost of goods sold.

e) cost of goods sold + selling and distribution overhead = cost of sales

f) cost of sales + profit = sales

g) sales/ Quantity sold = selling price per unit

in the above calculations, if the opening finished stock is equal to the closing finished stock, then the cost of production is equal to the cost of goods sold.

1.4 OTHER COSTS/ REVENUES

The following are the costs/revenue other than the costs which are presented in the previous section:

- Marginal cost
- Marginal revenue
- Sunk cost
- Opportunity cost

Marginal cost:

Marginal cost of a product is the cost of producing an additional unit of that product. Let the cost of producing 20 units of a product be Rs.10,000, and the cost of producing 21 units of the same product be Rs. 10045. Then the marginal cost of producing the 21 units is Rs.45.

Marginal revenue:

Marginal revenue of a product is the incremental revenue of selling an additional unit of that product. Let the revenue of selling 20 units of a product be Rs.15,000 and the revenue selling 21 units of the same product be Rs.15085. then, the marginal revenue of selling the 21st unit is Rs. 85.

Sunk Cost:

This is known as the past cost of an equipment/asset. Let us assume that an equipment has been purchased for Rs 1,00,000 about three years back. If it is considered for replacement, then its present value is not Rs. 100000. Instead, its present market value should be taken as the present value of the equipment for further analysis. So, the purchase value of the equipment in the past is known as its sunk cost. The sunk cost should not be considered for any analysis done from nowonwards.

Opportunity Cost

In practice, if an alternative (X) is selected from a set of competing alternatives(X, Y), then the corresponding investment in the selected alternative is not available for any other purpose. If the same money is invested in some other alternative (Y), it may fetch some return. Since the money is invested in the selected alternative(X), one has to forego the return form the other alternative (Y). The amount that is foregone by not investing in the other alternative(Y) is known as opportunity cost of the selected alternative(X). So the opportunity cost of an alternative is the return that will be foregone by not investing the same money in another alternative.

Consider that a person has invested a sum of Rs 50, 000 in shares. Let the expected annual return by this alternative be rs 7500. If the same amount is invested in fixed deposit, a bank will pay a return of 18%. Then, the corresponding total return per year for the investment in the bank is rs 9000. This return is greater than the return from shares. The foregone excess return of rs 1500 by way of not investing in the bank is the opportunity cost of investing in shares.

BREAK EVEN ANALYSIS

The main objective of break even analysis is to find the cutt off production volume from where a firm will make profit. Let

, s = selling price per unit

, v = variable cost per unit

FC = fixed cost per period

Q = volume of production

The total sales revenue (s) of the firm is given by the following formula;

$S = s \times Q$

The total cost of the firm for a given production volume is given as

TC = Total variable cost + Fixed cost

$= v \times Q + FC$

The linear plots of the above two equations are shows in below diagram. The intersection point of the total sales revenue line and the total cost line is called the break

even point. The corresponding volume of production on the X axis us known as break even sales quantity. At the intersection point, the total cost is equal to the total revenue. This point is also called as no loss or no gain situation. For any production quantity which is less than the break even quantity, the total cost is more than the total revenue. Hence, the firm will be making loss. For any production quantity which is more thatn the break even quantity, the total revenue will be more than the total cost. Hence, the firm will be making profit.

Profit = Sales - (Fixed cost + Variable cost)

= s x Q - (FC + v x Q)

The formulae to find the break even quantity and break even sales quantity

$$\text{Break-even quantity} = \frac{\text{Fixed cost}}{\text{Selling price/unit} - \text{Variable cost/unit}}$$

$$= \frac{FC}{s - v} \text{ (in units)}$$

$$\text{Break-even sales} = \frac{\text{Fixed cost}}{\text{Selling price/unit} - \text{Variable cost/unit}} \times \text{Selling price/unit}$$

$$= \frac{FC}{s - v} \times s \text{ (Rs.)}$$

The contribution is the difference between the sales and the variable costs. The margin of safty is the sales over and above the break even sales. The formulae to compute these values are

Contribution = Sales – Variable costs

Contribution /unit = Selling Price/ unit - Variable cost/unit

M. S = Actual Sales – Break even sales

$$= \frac{\text{Profit}}{\text{Contribution}} \times \text{sales}$$

M.S as a per cent of sales = (M.S/ Sales) x 100

EXAMPLE 1.1 Alpha Associates has the following details:
Fixed cost = Rs. 20,00,000; Variable cost per unit = Rs. 100; Selling price per unit = Rs. 200
Find
(a) The break-even sales quantity,
(b) The break-even sales
(c) If the actual production quantity is 60,000, find (i) contribution; and
(ii) margin of safety by all methods.

Solution
Fixed cost (FC) = Rs. 20,00,000
Variable cost per unit (v) = Rs. 100
Selling price per unit (s) = Rs. 200.

$$\text{(a) Break-even quantity} = \frac{FC}{s - v} = \frac{20{,}00{,}000}{200 - 100}$$

$$= 20{,}00{,}000/100 = 20{,}000 \text{ units}$$

$$\text{(b) Break-even sales} = \frac{FC}{s - v} \times s \text{ (Rs.)}$$

$$= \frac{20{,}00{,}000}{200 - 100} \times 200$$

$$= \frac{20{,}00{,}000}{100} \times 200 = \text{Rs. } 40{,}00{,}000$$

$$\text{(c) (i) Contribution} = \text{Sales} - \text{Variable cost}$$

$$= s \times Q - v \times Q$$

$$= 200 \times 60{,}000 - 100 \times 60{,}000$$

$$= 1{,}20{,}00{,}000 - 60{,}00{,}000$$

$$= \text{Rs. } 60{,}00{,}000$$

= Rs. 60,00,000

(ii) Margin of safety

METHOD I

M.S. = Sales – Break-even sales

= 60,000 × 200 – 40,00,000

= 1,20,00,000 – 40,00,000 = Rs. 80,00,000

METHOD II

$$\text{M.S.} = \frac{\text{Profit}}{\text{Contribution}} \times \text{Sales}$$

Profit = Sales – $(FC + v \times Q)$

= 60,000 × 200 – (20,00,000 + 100 × 60,000)

= 1,20,00,000 – 80,00,000

= Rs. 40,00,000

$$\text{M.S.} = \frac{40,00,000}{60,00,000} \times 1,20,00,000 = \text{Rs. } 80,00,000$$

$$\text{M.S. as a per cent of sales} = \frac{80,00,000}{1,20,00,000} \times 100 = 67\%$$

PROFIT/VOLUME RATIO (*P/V* RATIO)

P/*V* ratio is a valid ratio which is useful for further analysis. The different formulae forthe *P*/*V* ratio are as follows:

$$P/V \text{ ratio} = \frac{\text{Contribution}}{\text{Sales}} = \frac{\text{Sales} - \text{Variable costs}}{\text{Sales}}$$

The relationship between BEP and *P*/*V* ratio is as follows:

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}}$$

The following formula helps us find the M.S. using the *P*/*V* ratio:

$$\text{M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}}$$

EXAMPLE 1.2 Consider the following data of a company for the year 1997:

Sales = Rs. 1,20,000 Fixed cost = Rs. 25,000 Variable cost = Rs. 45,000
Find the following:
(a) Contribution (b) Profit (c) BEP (d) M.S.

Solution

(a) Contribution = Sales – Variable costs
= Rs. 1,20,000 – Rs. 45,000
= Rs. 75,000

(b) Profit = Contribution – Fixed cost
= Rs. 75,000 – Rs. 25,000
= Rs. 50,000

(c) BEP

$$P/V \text{ ratio} = \frac{\text{Contribution}}{\text{Sales}}$$

$$= \frac{75{,}000}{1{,}20{,}000} \times 100 = 62.50\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{25{,}000}{62.50} \times 100 = \text{Rs. } 40{,}000$$

$$\text{M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}} = \frac{50{,}000}{62.50} \times 100 = \text{Rs. } 80{,}000$$

EXAMPLE 1.3 Consider the following data of a company for the year 1998:Sales = Rs. 80,000; Fixed cost = Rs. 15,000; Variable cost = 35,000
Find the following:
(a) Contribution (b) Profit (c) BEP (d) M.S.
Solution;

(a) Contribution = Sales – Variable costs
= Rs. 80,000 – Rs. 35,000
= Rs. 45,000

(b) Profit = Contribution – Fixed cost
= Rs. 45,000 – Rs. 15,000
= Rs. 30,000

(c) BEP

$$P/V \text{ ratio} = \frac{\text{Contribution}}{\text{Sales}} = \frac{45{,}000}{80{,}000} \times 100 = 56.25\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{15{,}000}{56.25} \times 100 = \text{Rs. } 26{,}667$$

$$\text{(d) M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}} = \frac{30{,}000}{56.25} \times 100 = \text{Rs. } 53{,}333.33$$

ELEMENTARY ECONOMIC ANALYSIS

Whether it is a business situation or a day to day event in somebody‘s personal life, there are a large number of economic decisions making involved. One can manage many of these decision problem by sing simple economic analysis. For example an industry can source its raw materials from a nearby place or from a far off place. In this problem the following factors will affect the decisions.

- Price of the raw materials
- Transportation cost of the raw materials
- Availability of the raw materials
- Quality of the raw materials

Consider the alternative of sourcing raw materials from a nearby place with the following characteristics;

- The raw material is more costly in the nearby area
- The availability of the raw material is not sufficient enough to support the operation of the industry throughout the year
- The raw material requires pre-processing before it is used in the production process. This would certainly add cost to the product
- The cost of transportation is minimal under this alternative

On the other hand, consider another alternative of sourcing the raw materials form a far off place with the following characteristics;

- The raw materials is less costly at the far off the place

- The cost of transportation is very high
- The availability of the raw material at this site is abundant and it can support the plant throughout the year.
- The raw material from this site does not require any pre-processing before using it for production

EXAMPLES FOR SIMPLE ECONOMIC ANALYSIS

In this section, the concept of simple economic analysis is illustrated using suitable examples in the following areas:

- Material selection for a product
- Design selection for a product
- Design selection for a process industry
- Building material selection for construction activities
- Process planning/Process modification

Material Selection for a Product/Substitution of Raw Material

The cost of a product can be reduced greatly by substitution of the raw materials. Among various elements of cost, raw material cost is most significant and it forms a major portion of the total cost of any product. So, any attempt to find a suitable raw material will bring a reduction in the total cost in any one or combinations of the following ways:

- Cheaper raw material price
- Reduced machining/process time
- Enhanced durability of the product

Therefore, the process of raw material selection/substitution will result in finding an alternate raw material which will provide the necessary functions that are provided by the raw material that is presently used. In this process, if the new raw material provides any additional benefit, then it should be treated as its welcoming feature

EXAMPLE 2.1 In the design of a jet engine part, the designer has a choice ofspecifying either an aluminium alloy casting or a steel casting. Either material will provide equal service, but the aluminium casting will weigh 1.2 kg as compared with 1.35 kg for the steel casting. The aluminium can be cast for Rs. 80.00 per kg. and the steel one for Rs. 35.00 per kg. The cost of machining per unit is Rs. 150.00 for aluminium and Rs. 170.00 for steel. Every kilogram of excess weight is associated with a penalty of Rs. 1,300 due to increased fuel consumption. Which material should be specified and what is the economic advantage of the selection per unit?

Solution

(a) Cost of using aluminium metal for the jet engine part:

Weight of aluminium casting/unit = 1.2 kg
Cost of making aluminium casting = Rs. 80.00 per kg
Cost of machining aluminium casting per unit = Rs. 150.00
Total cost of jet engine part made of aluminium/unit
= Cost of making aluminium casting/unit + Cost of machining aluminium casting/unit = 80 x 1.2 + 150 = 96 + 150
= Rs. 246

(b) Cost of jet engine part made of steel/unit:

Weight of steel casting/unit = 1.35 kg
Cost of making steel casting = Rs. 35.00 per kg
Cost of machining steel casting per unit = Rs. 170.00
Penalty of excess weight of steel casting = Rs. 1,300 per kg

Total cost of jet engine part made of steel/unit
= Cost of making steel casting/unit + Cost of machining steel casting/unit + Penalty for excess weight of steel casting
= 35 x 1.35 + 170 + 1,300(1.35 – 1.2)
= Rs. 412.25

DECISION The total cost/unit of a jet engine part made of aluminium is less than that for an engine made of steel. Hence, aluminium is suggested for making the jet engine part.

The economic advantage of using aluminium over steel/unit is Rs. 412.25 – Rs. 246 = Rs. 166.25

EXAMPLE 2.2 A company manufactures dining tables which mainly consist of awooden frame and a table top. The different materials used to manufacture the tables and their costs are given in Table 2.1.

Table 2.1 Data for Example 2.2

Description of item	*Quantity*	*Cost*
Wood for frame and legs	0.1 m^3	Rs. 12,000/m^3
Table top with sunmica finish	1	Rs. 3,000
Leg bushes	4	Rs. 10/bush
Nails	100 g	Rs. 300/kg
Total labour	15 hr	Rs. 50/hr

In view of the growing awareness towards deforestation and environmental conservation, the company feels that the use of wood should be minimal. The wooden top therefore could be replaced with a granite top. This would require additional wood for the frame and legs to take the extra weight of the granite top. The materials and labour requirements along with cost details to manufacture a table with granite top are given in Table 2.2.

Table 2.2 Data for Example 2.2

Description of item	*Quantity*	*Cost*
Wood for frame and legs	0.15 m^3	Rs. 12,000/m^3
Granite table top	1.62 m^2	Rs. 800/m^2
Leg bushes	4	Rs. 25/bush
Nails	50 g	Rs. 300/kg
Total labour	8 hr	Rs. 50/hr

If the cost of the dining table with a granite top works out to be lesser than that of the table with wooden top, the company is willing to manufacture dining tables with granite tops. Compute the cost of manufacture of the table under each of the alternatives described above and suggest the best alternative. Also, find the economic advantage of the best alternative.

Solution *(a) Cost of table with wooden top*

Cost of wood for frame and legs = 12,000 x 0.1 = Rs. 1,200

Cost of wooden top = Rs. 3,000

Cost of bushes	= 10 x 4	= Rs. 40
Cost of nails	= 300 x (100/1,000)	= Rs. 30
Cost of labour	= 50 x 15	= Rs. 750
		Total = Rs. 5,020

(b) Cost of table with granite top

Cost of wood for frame and legs	= 12,000 x 0.15 = Rs. 1,800
Cost of granite top	= 800 x1.62 = Rs. 1,296
Cost of bushes	= 25 x 4 = Rs. 100
Cost of nails	= 300x (50/1,000) = Rs. 15
Cost of labour	= 50x 8 = Rs. 400
	Total = Rs. 3,611

The cost of a table with granite top works out to be less than that of a table with a wooden top. Hence, the table with granite top should be selected by the manufacturer.

(c) Economic advantage

Cost of a table with wooden top = Rs. 5,020
Cost of a table with granite top = Rs. 3,611

Economic advantage of table with granite top = Rs. 1,409

Design Selection for a Product

The design modification of a product may result in reduced raw material requirements, increased machinability of the materials and reduced labour. Design is an important factor which decides the cost of the product for a specified level of performance of that product. The elementary economic analysis applied to the selection of design for a product is illustrated with two example problems.

EXAMPLE 2.3

Two alternatives are under consideration for a tapered fastening pin. Either design will serve the purpose and will involve the same material and manufacturing cost except for the lathe and grinder operations.

Design A will require 16 hours of lathe time and 4.5 hours of grinder time per 1,000 units. Design B will require 7 hours of lathe time and 12 hours of grinder time per 1,000 units. The operating cost of the lathe including labour is Rs. 200 per hour. The operating cost of the grinder including labour is Rs. 150 per hour. Which design should be adopted if 1,00,000 units are required per year and what is the economic advantage of the best alternative?

Solution

Operating cost of lathe including labour = Rs. 200 per hr

Operating cost of grinder including labour = Rs. 150 per hr

(a) Cost of design A

No. of hours of lathe time per 1,000 units = 16 hr

No. of hours of grinder time per 1,000 units = 4.5 hr

Total cost of design A/1,000 units = Cost of lathe operation per 1,000 units + Cost of grinder operation per 1,000 units

= 16 x 200 + 4.5 x 150

= Rs. 3,875

Total cost of design A/1,00,000 units = 3,875 x 1,00,000/1,000 = Rs. 3,87,500

(b) Cost of design B

No. of hours of lathe time per 1,000 units = 7 hr

No. of hours of grinder time per 1,000 units = 12 hr

Total cost of design B/1,000 units = Cost of lathe operation/1,000 units + Cost of grinder

operation/1,000 units

= 7 x 200 + 12 x 150

= Rs. 3,200

DECISION The total cost/1,00,000 units of design B is less than that of design A. Hence, design B is recommended for making the tapered fastening pin.

Economic advantage of the design B over design A per 1,00,000 units
= Rs. 3,87,500 – Rs. 3,20,000
= Rs. 67,500.

Building material selection for construction activities

The sourcing of raw materials will have a significant effect on the cost of any product. Hence it is assumed that the price of raw materials is location dependent. While sourcing a raw material, the cost of transportation is to be considered in conjunction with the price of raw material.

EXAMPLE 2.5 In the design of buildings to be constructed in Alpha State, the designeris considering the type of window frame to specify. Either steel oraluminium window frames will satisfy the design criteria. Because of the remote location of the building site and lack of building materials in Alpha State, the window frames will be purchased in Beta State and transported for a distance of 2,500 km to the site. The price of window frames of the type required is Rs. 1,000 each for steel frames and Rs. 1,500 each for aluminium frames. The weight of steel window frames is 75 kg each and that of aluminium window frame is 28 kg each. The shipping rate is Re 1 per kg per 100 km. Which designshould be specified and what is the economic advantage of the selection?

Solution

Distance between Alpha State and Beta State = 2,500 km
Transportation cost = Re 1/kg/100 km
(a) Steel window frame
Price of steel window frame/unit = Rs 1,000
Weight of steel window frame/unit = 75 kg

Total cost of steel window frame/unit = Price of steel window frame/unit + Transportation cost of steel window frame/unit

= 1,000 + (75 x2,500 x 1)/100
= Rs. 2,875

(b) Aluminium window frame
Price of aluminium window frame/unit = Rs. 1,500
Weight of aluminium window frame/unit = 28 kg

Total cost of aluminium window frame/unit = Price of aluminium window

frame/unit+Transportation cost of aluminium window frame/unit

= 1,500 + (28 x 2,500x 1)/100
= Rs. 2,200

DECISION The total cost/unit of the aluminium window frame is less than that of steel window frame. Hence, aluminium window frame is recommended. The economic advantage/unit of the aluminium window frame over thesteel window frame

= Rs. 2,875 – 2,200
= Rs. 675

Process Planning /Process Modification

While planning for a new component, a feasible sequence of operations with the least cost of processing is to be considered. The process sequence of a component which has been planned in the past is not static. It is always subject to modification with a view to minimize the cost of manufacturing the component. So, the objective of process planning/process modification is to

identify the most economical sequence of operations to produce a component.

The steps in process planning are as follows;

1. Analyze the part drawing to get an overall picture of what is required
2. Make recommendations to or consult with product engineers on product design changes
3. List the basic operations required to produce the part to the drawings or specifications
4. Determine the most practical and economical manufacturing method and the form or tooling required for each operations
5. Devise the best way to combine the operations and put them in sequence.
6. Specify the gauging required for the process.

EXAMPLE 2.6 The process planning engineer of a firm listed the sequences ofoperations as shown in Table 2.3 to produce a component.

Table 2.3 Data for Example 2.6

Sequence	*Process sequence*
1	Turning – Milling – Shaping – Drilling
2	Turning – Milling – Drilling
3	All operations are performed with CNC machine

The details of processing times of the component for various operations and their machine hour rates are summarized in Table 2.4.

Table 2.4 Machine Hour Rates and Processing Times (minutes) for Example 2.6

Operation	*Machine hour rate* (Rs.)	*Process sequence*		
		1	2	3
Turning	200	5	5	–
Milling	400	8	14	–
Shaping	350	10	–	–
Drilling	300	3	3	–
CNC operations	1,000	–	–	8

Find the most economical sequence of operations to manufacture the component.

Solution *(a) Cost of component using process sequence 1*. The process sequence 1of the component is as follows:

Turning – Milling – Shaping – Drilling

The calculations for the cost of the above process sequence are summarized in Table 2.5.

Table 2.5 Workings for Process Sequence 1

Operation No.	*Operation*	*Time*		*Machine hour rate*	*Cost*
		(min)	(hr)	(Rs.)	(Rs.)
1	Turning	5	0.083	200	16.60
2	Milling	8	0.133	400	53.20
3	Shaping	10	0.167	350	58.45
4	Drilling	3	0.050	300	15.00
				Total:	143.25

(b) Cost of component using process sequence 2. The process sequence 2 of thecomponent is as follows:
Turning – Milling – Drilling

The calculations for the cost of the above process sequence are given in Table 2.6.

Table 2.6 Workings for Process Sequence 2

Operation No.	*Operation*	*Time*		*Machine hour rate*	*Cost*
		(min)	(hr)	(Rs.)	(Rs.)
1	Turning	5	0.083	200	16.60
2	Milling	14	0.233	400	93.20
3	Drilling	3	0.050	300	15.00
				Total:	124.80

(c) Cost of component using process sequence 3. The process sequence 3 of thecomponent is as follows:

Only CNC operations

The calculations for the cost of the above process sequence are summarized in Table 2.7

Table 2.7 Workings for Process Sequence 3

Operation No.	*Operation*	*Time*		*Machine hour rate*	*Cost*
		(min)	(hr)	(Rs.)	(Rs.)
1	CNC operations	8	0.133	1,000	133

The process sequence 2 has the least cost. Therefore, it should be selected for manufacturing the component.

Make or Buy Decision;

In the process of carrying out business activities of an organization, a component/product can be made within the organization or bought from a subcontractor. Each decision involves its own costs. So, in a given situation, the organization should evaluate each of the above make or buy alternatives and then select the alternative which results in the lowest cost. This is an important decision since it affects the productivity of the organization. In the long run, the make or buy decision is not static. The make option of a component/product may be economical today; but after some time, it may turn out to be uneconomical to make the same.

CRITERIA FOR MAKE OR BUY

Criteria for make

The following are the criteria for make:

1. The finished product can be made cheaper by the firm than by outside suppliers.
2. The finished product is being manufactured only by a limited number of outside firms which are unable to meet the demand.
3. The part has an importance for the firm and requires extremely close quality control.
4. The part can be manufactured with the firm‘s existing facilities and similar to other items in which the company has manufacturing experience.

Criteria for buy

The following are the criteria for buy:

1. Requires high investments on facilities which are already available at suppliers plant.
2. The company does not have facilities to make it and there are more profitable opportunities for investing company‘s capital.
3. Existing facilities of the company can be used more economically to make other parts.
4. The skill of personnel employed by the company is not readily adaptable to make the part.
5. Patent or other legal barriers prevent the company for making the part.
6. Demand for the part is either temporary or seasonal.

APPROACHES FOR MAKE OR BUY DECISION

Types of analysis followed in make or buy decision are as follows:

1. Simple cost analysis
2. Economic analysis
3. Break-even analysis

Simple Cost Analysis

EXAMPLE 13.1 A company has extra capacity that can be used to produce asophisticated fixture which it has been buying for Rs. 900 each. If the company makes the fixtures, it will incur materials cost of Rs. 300 per unit, labour costs of Rs. 250 per unit, and variable overhead costs of Rs. 100 per unit. The annual fixed cost associated with the unused capacity is Rs. 10,00,000.Demand over the next year is estimated at 5,000 units. Would it be profitable forthe company to make the fixtures?

We assume that the unused capacity has alternative use.

Cost to make

Variable cost/unit = Material + labour + overheads

= Rs. 300 + Rs. 250 + Rs. 100

= Rs. 650

Total variable cost = (5,000 units) (Rs. 650/unit)

= Rs. 32,50,000

Add fixed cost associated with unused capacity + Rs. 10,00,000

Total cost = Rs. 42,50,000

Cost to buy

Purchase cost = (5,000 units) (Rs. 900/unit)

= Rs. 45,00,000

Add fixed cost associated

with unused capacity + Rs. 10,00,000

Total cost = Rs. 55, 00,000

The cost of making fixtures is less than the cost of buying fixtures from outside. Therefore, the organization should make the fixtures.

Economic Analysis

The following inventory models are considered to illustrate this concept:

- Purchase model
- Manufacturing model

The formulae for EOQ and total cost (TC) for each model are given in the following table:

Purchase model	*Manufacturing model*
$Q1 = \sqrt{\frac{2C_oD}{C_c}}$	$Q2 = \sqrt{\frac{2C_oD}{C_c\,(1 - r/k)}}$
$TC = D \times P + \frac{DC_o}{Q1} + \frac{Q1 \times C_c}{2}$	$TC = D \times P + \frac{DC_o}{Q2}$
	$+ C_c\,(k - r)\,\frac{Q2}{2 * k}$

Where

D = demand/year

P = purchase price/unit

Cc = carrying cost/unit/year

Co = ordering cost/order or set-up cost/set-up

k = production rate (No. of units/year)

r = demand/year

$Q1$ = economic order size

$Q2$ = economic production size

TC = total cost per year

EXAMPLE 13.2 An item has a yearly demand of 2,000 units. The different costs inrespect of make and buy are as follows. Determine the best option.

	Buy	*Make*
Item cost/unit	Rs. 8.00	Rs. 5.00
Procurement cost/order	Rs. 120.00	
Set-up cost/set-up		Rs. 60.00
Annual carrying cost/ item/year	Rs. 1.60	Rs. 1.00
Production rate/year		8,000 units

Buy option

D = 2,000 units/year

Co = Rs. 120/order

Cc = Rs. 1.60/unit/year

$$Q1 = \sqrt{\frac{2C_oD}{C_c}} = \sqrt{\frac{2 \times 2{,}000 \times 120}{1.60}}$$

$$= 548 \text{ units (approx.)}$$

$$TC = DP + \frac{DC_o}{Q1} + \frac{Q1C_c}{2}$$

$$= 2{,}000 \times 8 + \frac{2{,}000 \times 120}{548} + \frac{548 \times 1.60}{2}$$

$$= \text{Rs. } 16{,}876.36$$

Make option

Co = Rs. 60/set-up

r = 2,000 units/year

Cc = Re 1/unit/year

k = 8,000 units/year

$$Q2 = \sqrt{\frac{2C_o r}{C_c[1-(r/k)]}}$$

$$= \sqrt{\frac{2 \times 60 \times 2{,}000}{10(1-2{,}000/8{,}000)}} = 566 \text{ units (approx.)}$$

$$TC = DP + \frac{D \times C_o}{Q2} + C_c\,(k-r)\,\frac{Q2}{2 \times k}$$

$$= 2{,}000 \times 5.00 + \frac{2{,}000 \times 60}{566} + 1.0\,(8{,}000 - 2{,}000)\,\frac{566}{2 \times 8{,}000}$$

$$= \text{Rs. } 10{,}424.26$$

Result: The cost of making is less than the cost of buying. Therefore, the firm shouldgo in for the making option.

VALUE ANALYSIS/ VALUE ENGINEERING

Value Analysis is the systematic application of recognized techniques which identify the function of a product or service, establish a monetary value for the function and provide the necessary function reliably at the lowest overall cost.

WHEN TO APPLY VALUE ANALYSIS

One can definitely expect very good results by initiating a VA programme if one or more of the following symptoms are present:

1. Company‘s products show decline in sales.

2. Company‘s prices are higher than those of its competitors.

3. Raw materials cost has grown disproportionate to the volume of production.

4. New designs are being introduced.

5. The cost of manufacture is rising disproportionate to the volume of production.

6. Rate of return on investment has a falling trend.

7. Inability of the firm to meet its delivery commitments.

Value Analysis vs. Value Engineering

Often the terms *value analysis* and *value engineering* are used synonymously.

Though the philosophy underlying the two is same, i.e. identification of unnecessary cost, yet they are different. The difference lies in the time and the stage at which the techniques are applied.

Value analysis is the application of a set of techniques to an existing product with aview to improve its value. It is thus a remedial process. *Value engineering* is the application of exactly the same set of techniques to a new product at the design stage, project concept or preliminary design when no hardware exists to ensure that bad features are not added. *Value engineering,* therefore, is a preventive process.

Value

The term ‗value' is used in different ways and, consequently, has different meanings. The designer equates the value with reliability; a purchase person with price paid for the item; a production person with what it costs to manufacture, and a sales person with what the customer is willing to pay. Value, in value investigation, refers to ―economic value‖, which itself can be divided into four types: cost value, exchange value, use value, and esteem value. These are now briefly described.

Cost value. It is the summation of the labour, material, overhead and all other elementsof cost required to produce an item or provide a service compared to a base.

Exchange value. It is the measure of all the properties, qualities and features of theproduct, which make the product possible of being traded for another product or for money. In a conventional sense, *exchange value* refers to the price that a purchaser will offer for the product, the price being dependent upon satisfaction (value) which he derives from the product. Value derived from the product consists of two parts ―use value‖ and ―esteem value‖, which are now described.

Use value. It is known as the function value. The *use value* is equal to the value of thefunctions performed. Therefore, it is the price paid by the buyer (buyer's view), or the

cost incurred by the manufacturer (manufacturer‘s view) in order to ensure that the product performs its intended functions efficiently. The use value is the fundamental form of economic value. An item without ―use value‖ can have neither ―exchange value‖ nor ―esteem value‖

Esteem value. It involves the qualities and appearance of a product (like a TV set),which attract persons and create in them a desire to possess the product. Therefore, *esteem value* is the price paid by the buyer or the cost incurred by the manufacturerbeyond the use value.

PERFORMANCE;

The performance of a product is the measure of functional features and properties that make it suitable for a specific purpose. Appropriate performance requires that

(a) the product reliably accomplish the intended use of work or service requirement (functional requirements),

(b) the product provide protection against accident, harmful effects on body and danger to human life (safety requirements),

(c) the product give trouble-free service cover during its specified life span (reliability requirements),

(d) service and maintenance work can be carried out on the product with ease and with simple tools (maintainability requirements), and

(e) appearance of the product creates an impression on the buyer and induces in him or her the desire to own the product (appearance requirements).

Performance and cost must be interwoven. Desired performance at the least cost should be achieved by selecting appropriate materials and manufacturing operations, which is the measure of value. Therefore, the value of the product is the ratio of performance (utility) to cost. Thus,

$$\text{Value} = \frac{\text{Performance (utility)}}{\text{Cost}}$$

Value can be increased by increasing the utility for the same cost or by decreasing the cost for the same utility. Satisfactory performance at lesser cost through identification and development of low cost alternatives is the philosophy of Value analysis.

FUNCTION

Function is the purpose for which the product is made. Identification of the basic functions and determination of the cost currently being spent on them are the two major considerations of value analysis.

Functional Analysis of Some Parts of a Bus Driver Cabin

Component of study	*Functional analysis*	
	Verb	*Noun*
Steering wheel	Control	Direction
Gear box	Change	Speed
Brake system	Stop	Vehicle
Wiper	Clear	Water
Horn	Make	Sound
Side mirror	Show	Side traffic

Classification of the functions

Rarely do all functions assume equal importance. Usually, some functions are more important than others. Functions can be classified into the following three categories:

1. Primary function
2. Secondary function
3. Tertiary function

Primary functions are the basic functions for which the product is specially designed toachieve. Primary functions, therefore, are the most essential functions whose non-performance would make the product worthless, e.g. a photo frame exhibits photographs, a chair supports weight, a fluorescent tube gives light.

Secondary functions are those which, if not in-built, would not prevent the device fromperforming its primary functions, e.g., arms of a chair provide support for hands. Secondary functions are usually related to convenience. The product can still work and fulfill its intended objective even if these functions are not in-built and yet they may be necessary to sell the product.

Tertiary functions are usually related to esteem appearance. For example, Sunmica topof a table gives esteem appearance for the table.

Let us consider a single example of painting a company bus to explain all the above three functions. Here, the primary function of painting is to avoid corrosion. The secondary function is to identify the company to which the bus belongs by the colour of the paint (e.g. blue colour for Ashok Leyland Ltd.). The tertiary function is to impart a very good appearance to the bus by using brilliant colours.

AIMS

The aims of value engineering are as follows:

1. Simplify the product.
2. Use (new) cheaper and better materials.
3. Modify and improve product design.
4. Use efficient processes.
5. Reduce the product cost.
6. Increase the utility of the product by economical means.
7. Save money or increase the profits.

The value content of each piece of a product is assessed using the following questions:

1. Does its use contribute to value?

2. Is its cost proportionate to its usefulness?

3. Does it need all its features?

These three questions pertain to the function of the part which may decide the elimination of parts.

- Is there anything better for the intended use?
- Can company or vendor standard be used?
- Can a usable part be made by a lower-cost method?
- Is it made with the proper tooling, considering volume?
- Does the part yield suitable profit?
- Can another vendor furnish the same at a lower cost?

VALUE ENGINEERING PROCEDURE

The basic steps of value engineering are as follows:

(a) Blast

(i) Identify the product.

(ii) Collect relevant information.

(iii) Define different functions.

(b) Create

(iv) Different alternatives.

(v) Critically evaluate the alternatives.

(c) Refine

(vi) Develop the best alternative.

(vii) Implement the alternative.

Step 1: Identify the product

First, identify the component for study. In future, any design change should add value and it should not make the product as obsolete one. Value engineering can be applied to a product as a whole or to sub-units.

Step 2: Collect relevant information.

Information relevant to the following must be collected:

_ Technical specifications with drawings

_ Production processes, machine layout and instruction sheet

_ Time study details and manufacturing capacity

_ Complete cost data and marketing details

_ Latest development in related products

Step 3: Define different functions

Identify and define the primary, secondary and tertiary functions of the product or parts of interest. Also, specify the value content of each function and identify the high cost areas.

Step 4: Different alternatives

Knowing the functions of each component part and its manufacturing details, generate the ideas and create different alternatives so as to increase the value of the product. Value engineering should be done after a **brain storming** session. All feasible or non-feasible suggestions are recorded without any criticism; rather, persons are encouraged to express their views freely.

Step 5: Critically evaluate the alternatives.

Different ideas recorded under step 4 are compared, evaluated and critically assessed for their virtues, validity and feasibility as regards their financial and technical

requirements. The ideas technically found and involving lower costs are further developed.

Step 6: Develop the best alternative.

Detailed development plans are made for those ideas which emerged during step 5 and appear most suitable and promising. Development plans comprise drawing the sketches, building of

models, conducting discussions with the purchase section, finance section, marketing division, etc.

Step 7: Implement the alternative.

The best alternative is converted into a proto-type manufacturing model which ultimately goes into operation and itsresults are recorded.

ADVANTAGES AND APPLICATION AREAS

Advantages

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The advantages of value engineering are as follows:

- It is a much faster cost reduction technique.
- It is a less expensive technique.
- It reduces production costs and adds value to sales income of the product.

Applications

The various application areas of value engineering are machine tool industries, industries making accessories for machine tools, auto industries, import substitutes, etc.

INTEREST FORMULAS AND THEIR APPLICATIONS

INTRODUCTION

Interest rate is the rental value of money. It represents the growth of capital per unit period. The period may be a month, a quarter, semiannual or a year. An interest rate 15% compounded annually means that for every hundred rupees invested now, an amount of Rs. 15 will be added to the account at the end of the first year. So, the total amount at the end of the first year will be Rs. 115. At the end of the second year, again 15% of Rs. 115, i.e. Rs. 17.25 will be added to the account. Hence the total amount at the end of the second year will be Rs. 132.25. The process will continue thus till the specified number of years.

TIME VALUE OF MONEY

If an investor invests a sum of Rs. 100 in a fixed deposit for five years with an interest rate of 15% compounded annually, the accumulated amount at the end of every year will be as shown in Table 3.1.

Table 3.1 Compound Amounts

(amount of deposit = Rs. 100.00)

Year end	*Interest* (Rs.)	*Compound amount* (Rs.)
0		100.00
1	15.00	115.00
2	17.25	132.25
3	19.84	152.09
4	22.81	174.90
5	26.24	201.14

The formula to find the future worth in the third column is

$$F = P \ X(1 + i)n$$

Where

P = principal amount invested at time 0,

F = future amount

i= interest rate compounded annually

n = period of deposit.

The maturity value at the end of the fifth year is Rs. 201.14. This means that the amount Rs. 201.14 at the end of the fifth year is equivalent to Rs. 100.00 at time 0 (i.e. at present). This is diagrammatically shown in Fig. 3.1. This explanation assumes that the inflation is at zero percentage.

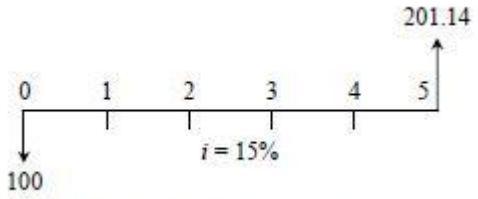


Fig. 3.1 Time value of money.

Alternatively, the above concept may be discussed as follows: If we want Rs. 100.00 at the end of the *n*th year, what is the amount that we should deposit now at a given interest rate, say 15%? A detailed working is shown in Table 3.2.

Table 3.2 Present Worth Amounts

(rate of interest = 15%)

End of year (n)	*Present worth*	*Compound amount after n year(s)*
0		100
1	86.96	100
2	75.61	100
3	65.75	100
4	57.18	100
5	49.72	100
6	43.29	100
7	37.59	100
8	32.69	100
9	28.43	100
10	24.72	100

The formula to find the present worth in the second column is

$$P = \frac{F}{(1+i)^n}$$

From Table 3.2, it is clear that if we want Rs. 100 at the end of the fifth year, we should now deposit an amount of Rs. 49.72. Similarly, if we want Rs. 100.00 at the end of the 10th year, we should now deposit an amount of Rs. 24.72.

INTEREST FORMULAS

While making investment decisions, computations will be done in many ways. To simplify all these computations, it is extremely important to know how to use interest formulas more effectively. Before discussing the effective application of the interest formulas for investment-decision making, the various interest formulas are presented first.

Interest rate can be classified into *simple interest rate* and *compound interest rate*.

In simple interest, the interest is calculated, based on the initial deposit for every interest period. In this case, calculation of interest on interest is not applicable. In compound interest, the interest for the current period is computed based on the amount (principal plus interest up to the end of the previous period) at the beginning of the current period.

The notations which are used in various interest formulae are as follows:

P = principal amount

n = No. of interest periods

i= interest rate (It may be compounded monthly, quarterly, semiannually or annually)

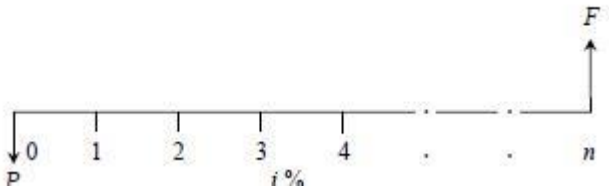
F = future amount at the end of year n

A = equal amount deposited at the end of every interest period

G = uniform amount which will be added/subtracted period after period to/ from the amount of deposit A1 at the end of period 1

Single-Payment Compound Amount

Here, the objective is to find the single future sum (F) of the initial payment (P) made at time 0 after n periods at an interest rate i compounded every period. The cash flow diagram of this situation is shown in Fig. 3.2



The formula to obtain the single-payment compound amount is

$$F = P(1+i)n = P(F/P, i, n)$$

where

$(F/P, i, n)$ is called as single-payment compound amount factor.

EXAMPLE 3.1 A person deposits a sum of Rs. 20,000 at the interest rate of18% compounded annually for 10 years. Find the maturity value after 10 years.

Solution

P = Rs. 20,000 i= 18% compounded annually n = 10 years

$F = P(1+i)n = P(F/P, i, n)$

= 20,000 $(F/P, 18\%, 10)$

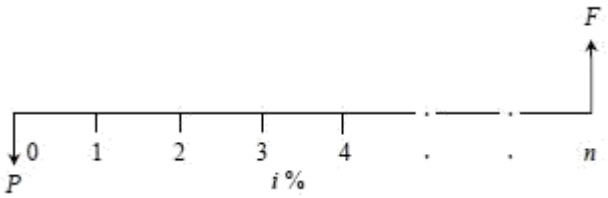
= 20,000 x 5.234 = Rs. 1,04,680

The maturity value of Rs. 20,000 invested now at 18% compounded yearly is equal to Rs. 1,04,680 after 10 years.

Single-Payment Present Worth Amount

Here, the objective is to find the present worth amount (P) of a single future sum (F) which will be received after n periods at an interest rate of i compounded at the end of every interest period.

The corresponding cash flow diagram is shown in Fig. 3.3.



Cash flow diagram of single-payment present worth amount.

The formula to obtain the present worth is

$$P = \frac{F}{(1+i)^n} = F(P/F, i, n)$$

Where

(P/F, i, n) is termed as *single-payment present worth factor.*

EXAMPLE 3.2 A person wishes to have a future sum of Rs. 1,00,000 for hisson‘s education after 10 years from now. What is the single-payment that he should deposit now so that he gets the desired amount after 10 years? The bank gives 15% interest rate compounded annually.

Solution

F = Rs. 1,00,000

i= 15%, compounded annually

n = 10 years

$P = F/(1+i)n = F(P/F,i, n)$

= 1,00,000 (P/F, 15%, 10)

= 1,00,000 x 0.2472

= Rs. 24,720

The person has to invest Rs. 24,720 now so that he will get a sum of Rs. 1,00,000 after 10 years at 15% interest rate compounded annually.

Equal-Payment Series Compound Amount

In this type of investment mode, the objective is to find the future worth of *n* equal payments which are made at the end of every interest period till the end of the *n*th interest period at an interest rate of *i* compounded at the end of each interest period. The corresponding cash flow diagram is shown in Fig. 3.4.

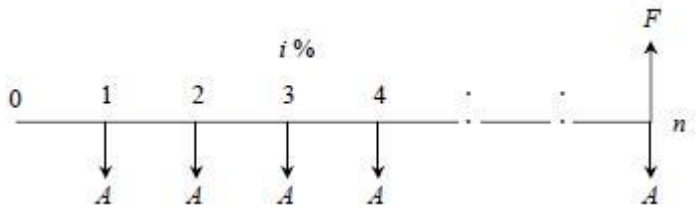


Fig. 3.4 Cash flow diagram of equal-payment series compound amount.In Fig. 3.4,

A = equal amount deposited at the end of each interest period

n = No. of interest periods

i= rate of interest

F = single future amount

The formula to get *F* is

$$F = A\,\frac{(1+i)^n - 1}{i} = A(F/A, i, n)$$

where (*F*/*A*, *i*, *n*) is termed as *equal-payment series compound amount factor*.

EXAMPLE 3.3 A person who is now 35 years old is planning for his retired life. Heplans to invest an equal sum of Rs. 10,000 at the end of every year forthe next 25 years starting from the end of the next year. The bank gives 20% interest rate, compounded annually. Find the maturity value of his account when he is 60 years old.

Solution

A = Rs. 10,000

n = 25 years

i= 20%

F = ?

The corresponding cash flow diagram is shown in Fig. 3.5.

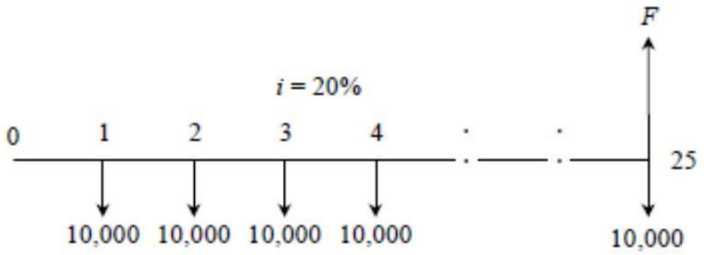


Fig. 3.5 Cash flow diagram of equal-payment series compound amount.

$$F = A\,\frac{(1+i)^n - 1}{i}$$

= $A(F/A,i, n)$

= 10,000(F/A, 20%, 25)

= 10,000 x 471.981

= Rs. 47,19,810

The future sum of the annual equal payments after 25 years is equal to Rs. 47,19,810.

Equal-Payment Series Sinking Fund

In this type of investment mode, the objective is to find the equivalent amount (A) that should be deposited at the end of every interest period for n interest periods to realize a future sum (F) at the end of the nth interest period at an interest rate of i. The corresponding cash flow diagram is shown in Fig. 3.6.

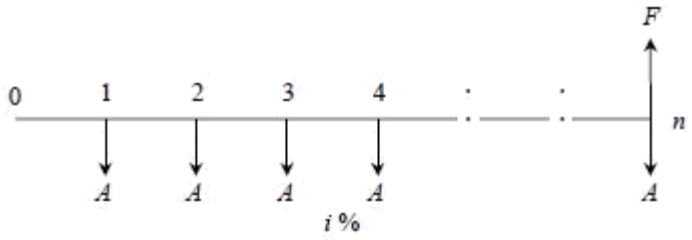


Fig. 3.6 Cash flow diagram of equal-payment series sinking fund.

In Fig. 3.6,
A = equal amount to be deposited at the end of each interest period n = No. of interest periods
i= rate of interest
F = single future amount at the end of the nth period

The formula to get F is

$$A = F\frac{i}{(1+i)^n - 1} = F(A/F, i, n)$$

where
$(A/F, i, n)$ is called as *equal-payment series sinking fund factor*.

EXAMPLE 3.4 A company has to replace a present facility after 15 years at an outlayof Rs. 5,00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years.

Solution
F = Rs. 5,00,000, n = 15 years i= 18% A = ?

The corresponding cash flow diagram is shown in Fig. 3.7.

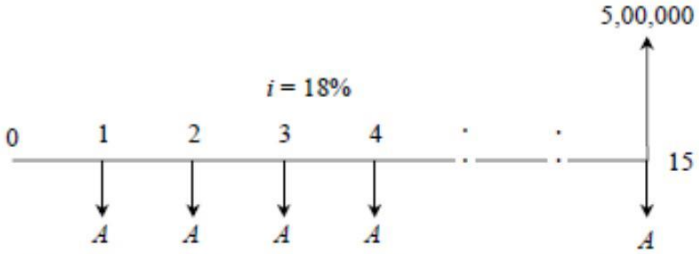


Fig. 3.7 Cash flow diagram of equal-payment series sinking fund.

$$A = F\frac{i}{(1+i)^n - 1} = F(A/F, i, n)$$

= 5,00,000(*A*/*F*, 18%, 15)

= 5,00,000 x 0.0164

= Rs. 8,200

The annual equal amount which must be deposited for 15 years is Rs. 8,200

Equal-Payment Series Present Worth Amount

The objective of this mode of investment is to find the present worth of an equal payment made at the end of every interest period for *n* interest periods at an interest rate of*i* compounded at the end of every interest period.

The corresponding cash flow diagram is shown in Fig. 3.8. Here

P = present worth
A = annual equivalent payment*i*= interest rate
n = No. of interest periods

The formula to compute *P* is

$$P = A\frac{(1+i)^n - 1}{i(1+i)^n} = A(P/A, i, n)$$

where

$(P/A, i, n)$ is called *equal-payment series present worth factor.*

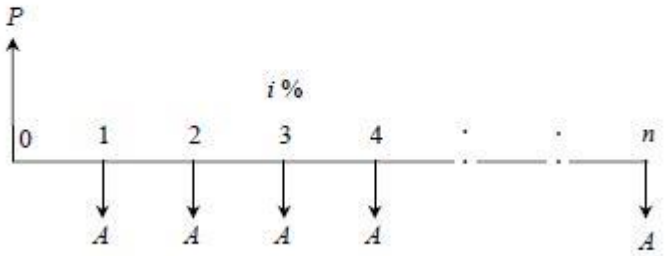
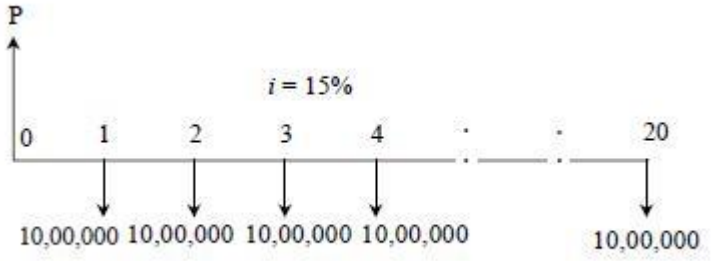


Fig. 3.8 Cash flow diagram of equal-payment series present worth amount.

EXAMPLE 3.5 A company wants to set up a reserve which will help the company tohave an annual equivalent amount of Rs. 10,00,000 for the next 20 years towards its employees welfare measures. The reserve is assumed to grow at the rate of 15% annually. Find the single-payment that must be made now as the reserve amount.

Solution
A = Rs. 10,00,000,i= 15%, n = 20 years P = ?

The corresponding cash flow diagram is illustrated in Fig. 3.9.



3.9 Cash flow diagram of equal-payment series present worth amount.

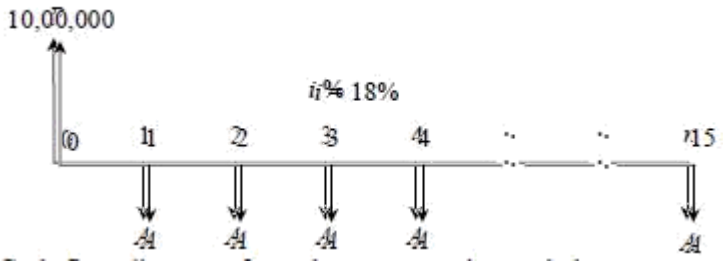
$$P = A\frac{(1+i)^n - 1}{i(1+i)^n} = A(P/A, i, n)$$

= 10,00,000 x (P/A, 15%, 20)
= 10,00,000 x 6.2593
= Rs. 62,59,300

The amount of reserve which must be set-up now is equal to Rs. 62,59,300.

Equal-Payment Series Capital Recovery Amount

The objective of this mode of investment is to find the annual equivalent amount (A) which is to be recovered at the end of every interest period for n interest periods for a loan (P) which is sanctioned now at an interest rate of $i$compounded at the end of every interest period (see Fig. 3.10).



Cash flow diagram of equal-payment series capital recovery amount

In Fig. 3.10,
P = present worth (loan amount)
A = annual equivalent payment (recovery amount)i= interest rate
n = No. of interest periods
The formula to compute P is as follows:

$$A = P\frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

where,

(A/P, i, n) is called *equal-payment series capital recovery factor*.

EXAMPLE 3.6 A bank gives a loan to a company to purchase an equipment worth Rs. 10,00,000 at an interest rate of 18% compounded annually. This amount should be repaid in 15 yearly equal installments. Find the installment amount that the company has to pay to the bank.

Solution

P = Rs. 10,00,000,i= 18% n = 15 years A = ?

The corresponding cash flow diagram is shown in Fig. 3.11.

Fig. 3.11 Cash flow diagram of equal-payment series capital recovery amount.

$$A = P\frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

= 10,00,000 _ (A/P, 18%, 15)
= 10,00,000 _ (0.1964)
= Rs. 1,96,400

The annual equivalent installment to be paid by the company to the bank is Rs. 1,96,400.

Uniform Gradient Series Annual Equivalent Amount

The objective of this mode of investment is to find the annual equivalent amount of a series with an amount $A1$ at the end of the first year and with an equal increment (G) at the end of each of the following $n - 1$ years with an interest rate i compounded annually.

The corresponding cash flow diagram is shown in Fig. 3.12.

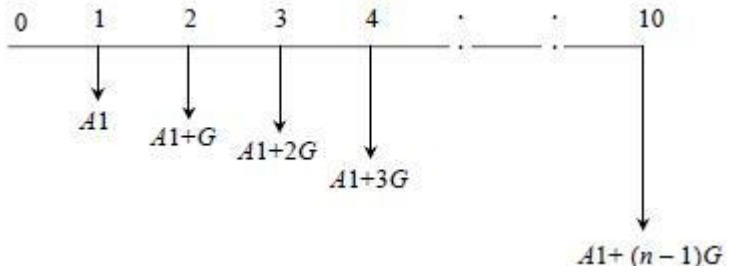


Fig. 3.12 Cash flow diagram of uniform gradient series annual equivalent amount.

The formula to compute A under this situation is

$$A = A1 + G\frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$
$$= A1 + G\,(A/G, i, n)$$

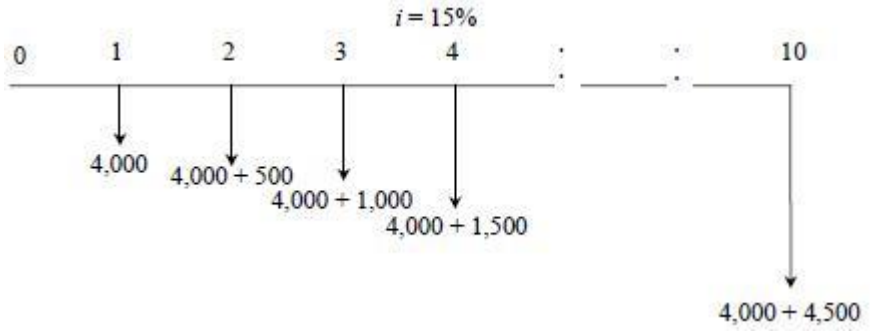
where
$(A/G, i, n)$ is called uniform gradient series factor.

EXAMPLE 3.7 A person is planning for his retired life. He has 10 more years ofservice. He would like to deposit 20% of his salary, which is Rs. 4,000, at the end of the first year, and thereafter he wishes to deposit the amount with an annual increase of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series.

Solution

Here, $A1$ = Rs. 4,000 G = Rs. 500 i = 15% n = 10 years A = ? &F= ?

The cash flow diagram is shown in Fig. 3.13.



Cash flow diagram of uniform gradient series annual equivalent amount.

$$A = A1 + G\frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$
$$= A1 + G(A/G, i, n)$$

= 4,000 + 500(*A*/*G*, 15%, 10)
= 4,000 + 500 x 3.3832
= Rs. 5,691.60

This is equivalent to paying an equivalent amount of Rs. 5,691.60 at the end of every year for the next 10 years. The future worth sum of this revised series at the end of the 10th year is obtained as follows:

F =*A*(*F*/*A*,*i*, *n*)

= *A*(*F*/*A*, 15%, 10)

= 5,691.60(20.304)

= Rs. 1,15,562.25

At the end of the 10th year, the compound amount of all his payments will be Rs. 1,15,562.25.

EXAMPLE 3.8 A person is planning for his retired life. He has 10 more years ofservice. He would like to deposit Rs. 8,500 at the end of the first year and thereafter he wishes to deposit the amount with an annual decrease of Rs. 500for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series.

Solution Here,
*A*1 = Rs. 8,500, *G* =–Rs. 500, *i*= 15% , *n* = 10 years, *A* = ? & *F* = ?

The cash flow diagram is shown in Fig. 3.14.

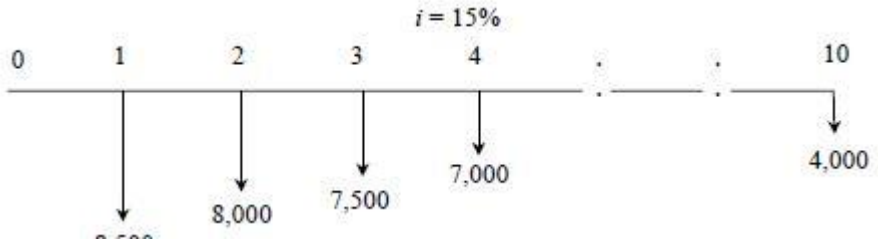


Fig. 3.14 Cash flow diagram of uniform gradient series annual equivalent amount.

$$A = A1 - G\frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$
$$= A1 - G\,(A/G, i, n)$$
$$= 8{,}500 - 500(A/G, 15\%, 10)$$
$$= 8{,}500 - 500 \times 3.3832$$
$$= \text{Rs. } 6{,}808.40$$

This is equivalent to paying an equivalent amount of Rs. 6,808.40 at the end of every year for the next 10 years.

The future worth sum of this revised series at the end of the 10th year is obtained as follows:

$F = A(F/A, i, n)$
$= A(F/A, 15\%, 10)$

= 6,808.40(20.304)
= Rs. 1,38,237.75

At the end of the 10th year, the compound amount of all his payments is Rs. 1,38,237.75.

3.3.8 Effective Interest Rate

Let i be the nominal interest rate compounded annually. But, in practice, the compounding may occur less than a year. For example, compounding may be monthly, quarterly, or semi-annually. Compounding monthly means that the interest is computed at the end of every month. There are 12 interest periods in a year if the interest is compounded monthly. Under such situations, the formula to compute the effective interest rate, which is compounded annually, is

where,
i= the nominal interest rate
C = the number of interest periods in a year.

EXAMPLE 3.9 A person invests a sum of Rs. 5,000 in a bank at a nominal interest rateof 12% for 10 years. The compounding is quarterly. Find the maturity amount of the deposit after 10 years.

Solution

P = Rs. 5,000, n= 10 years, i= 12% (Nominal interest rate), F = ?

METHOD 1

No. of interest periods per year = 4

No. of interest periods in 10 years = 10 _ 4 = 40

Revised No. of periods (No. of quarters), N = 40

Interest rate per quarter, r = 12%/4

= 3%, compounded quarterly.

$F = P(1 + r)N$ = 5,000(1 + 0.03)40

= Rs. 16,310.19

METHOD 2

No. of interest periods per year, C = 4

Effective interest rate, $R = (1 + i/C)C - 1$

= (1 + 12%/4)4 – 1

= 12.55%, compounded annually.

$F = P(1 + R)n$ = 5,000(1 + 0.1255)10

= Rs. 16,308.91

UNIT – II

Methods of Comparison of Alternatives: Present Worth Method (Revenue Dominated Cash Flow Diagram, Cost Dominated Cash Flow Diagram), Future Worth Method (Revenue Dominated Cash Flow Diagram, Cost Dominated Cash Flow Diagram), Annual Equivalent Method (Revenue Dominated Cash Flow Diagram, Cost Dominated Cash Flow Diagram), Rate of Return Method, Examples in all the methods

BASES FOR COMPARISON OF ALTERNATIVES

In most of the practical decision environments, executives will be forced to select the best alternative from a set of competing alternatives. Let us assume that an organization has a huge sum of money for potential investment and there are three different projects whose initial outlay and annual revenues during their lives are known. The executive has to select the best alternative among these three competing projects

There are several bases for comparing the worthiness of the projects. These bases are:

1. Present worth method
2. Future worth method
3. Annual equivalent method
4. Rate of return method

PRESENT WORTH METHOD OF COMPARISON

INTRODUCTION

In this method of comparison, the cash flows of each alternative will be reduced to time zero by assuming an interest rate i. Then, depending on the type of decision, the best alternative will be selected by comparing the present worth amounts of the alternatives.

The sign of various amounts at different points in time in a cash flow diagram is to be decided based on the type of the decision problem. In a cost dominated cash flow diagram, the costs (outflows) will be assigned with positive sign and the profit, revenue, salvage value (all inflows), etc. will be assigned with negative sign. In a revenue/profit-dominated cash flow diagram, the profit, revenue, salvage value (all inflows to an organization) will be assigned with positive sign. The costs (outflows) will be assigned with negative sign.

In case the decision is to select the alternative with the minimum cost, then the alternative with the least present worth amount will be selected. On the other hand, if the decision is to select the alternative with the maximum profit, then the alternative with the maximum present worth will be selected.

REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in Fig. 4.1.

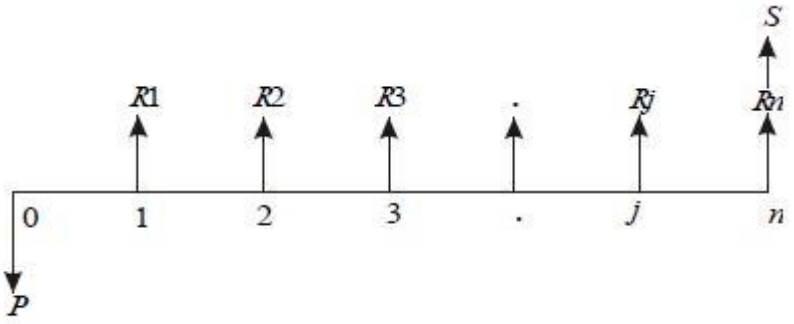


Fig. 4.1 Revenue-dominated cash flow diagram.

In Fig. 4.1, *P* represents an initial investment and *Rj* the net revenue at the end of the *j*th year. The interest rate is *i*, compounded annually. *S* is the salvagevalue at the end of the *n*th year.

To find the present worth of the above cash flow diagram for a given interest rate, the formula is

$PW(i) = -P + R1[1/(1+i)1] + R2[1/(1+i)2] + ...$

$+ Rj[1/(1+i)\,j] + Rn[1/(1+i)n] + S[1/(1+i)n]$

In this formula, expenditure is assigned a negative sign and revenues are assigned a positive sign.

If we have some more alternatives which are to be compared with this alternative, then the corresponding present worth amounts are to be computed and compared. Finally, the alternative with the maximum present worth amount should be selected as the best alternative.

COST-DOMINATED CASH FLOW DIAGRAM (April 2017)

A generalized cost-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in Fig. 4.2.

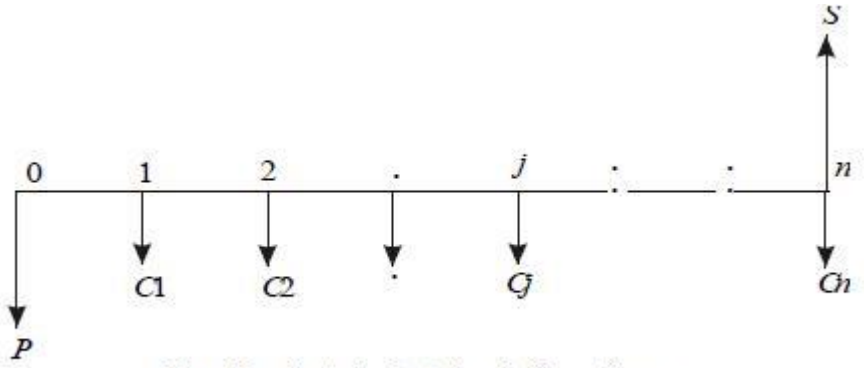


Fig. 4.2 Cost-dominated cash flow diagram.

In Fig. 4.2, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year, and S the salvage value at the end of the nth year.

To compute the present worth amount of the above cash flow diagram for a given interest rate i, we have the formula

$PW(i) = P + C1[1/(1+i)1] + C2[1/(1+i)2] + ... + Cj[1/(1+i)\,j] +$
$Cn[1/(1+i)n] - S[1/(1+i)n]$

In the above formula, the expenditure is assigned a positive sign and the revenue a negative sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding present worth amounts are to be computed and compared. Finally, the alternative with the minimum present worth amount should be selected as the best alternative.

4.4 EXAMPLES

In this section, the concept of present worth method of comparison applied to the selection of the best alternative is demonstrated with several illustrations.

EXAMPLE 4.1 Alpha Industry is planning to expand its production operation.It hasidentified three different technologies for meeting the goal. The initialoutlay and annual revenues with respect to each of the technologies aresummarized in Table 4.1. Suggest the best technology which is to beimplemented based on the present worth method of comparison assuming 20% interest rate, compounded annually.

Table 4.1

	Initial outlay (Rs.)	*Annual revenue* (Rs.)	*Life* (years)
Technology 1	12,00,000	4,00,000	10
Technology 2	20,00,000	6,00,000	10
Technology 3	18,00,000	5,00,000	10

Solution In all the technologies, the initial outlay is assigned a negative sign and theannual revenues are assigned a positive sign.

TECHNOLOGY 1

Initial outlay, P = Rs. 12,00,000

Annual revenue, A = Rs. 4,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is as shown in Fig. 4.3.

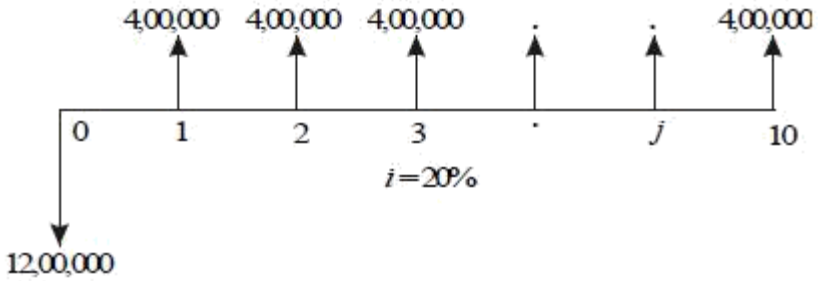


Fig. 4.3 Cash flow diagram for technology 1.

The present worth expression for this technology is

$PW(20\%)1 = -12,00,000 + 4,00,000 \times (P/A, 20\%, 10)$

$= -12,00,000 + 4,00,000 \times (4.1925)$

$= -12,00,000 + 16,77,000$

= Rs. 4,77,000

TECHNOLOGY 2

Initial outlay, P = Rs. 20,00,000

Annual revenue, A = Rs. 6,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is shown in Fig. 4.4.

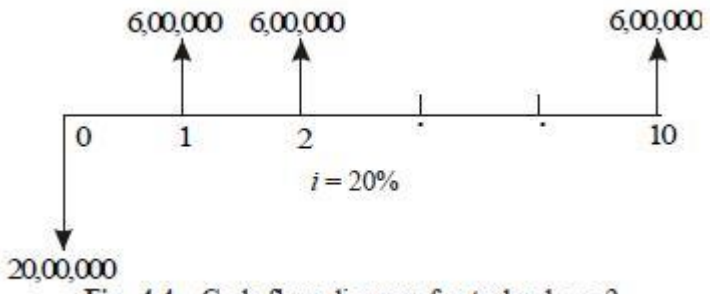


Fig. 4.4 Cash flow diagram for technology 2.

The present worth expression for this technology is

$PW(20\%)2 = -20,00,000 + 6,00,000 \times (P/A, 20\%, 10)$

$= -20,00,000 + 6,00,000 \times (4.1925)$

$= -20,00,000 + 6,00,000 \times (4.1925)$

$= -20,00,000 + 25,15,500$

= Rs. 5,15,500

TECHNOLOGY 3

Initial outlay, P = Rs. 18,00,000

Annual revenue, A = Rs. 5,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is shown in Fig. 4.5

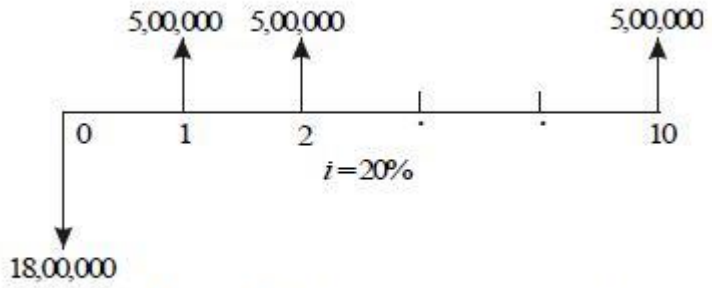


Fig. 4.5 Cash flow diagram for technology 3.

The present worth expression for this technology is

$PW(20\%)3 = -18,00,000 + 5,00,000 \times (P/A, 20\%, 10)$

$= -18,00,000 + 5,00,000 \times (4.1925)$

$= -18,00,000 + 20,96,250$

= Rs. 2,96,250

From the above calculations, it is clear that the present worth of technology 2 is the highest among all the technologies. Therefore, technology 2 is suggested for implementation to expand the production.

EXAMPLE 4.2 An engineer has two bids for an elevator to be installed in a newbuilding. The details of the bids for the elevators are as follows:

Bid	*Engineer's estimates*		
	Initial cost (Rs.)	*Service life* (years)	*Annual operations & maintenance cost* (Rs.)
Alpha Elevator Inc.	4,50,000	15	27,000
Beta Elevator Inc.	5,40,000	15	28,500

Determine which bid should be accepted, based on the present worth method of comparison assuming 15% interest rate, compounded annually.

Solution

Bid 1: Alpha Elevator Inc.

Initial cost, P = Rs. 4,50,000
Annual operation and maintenance cost, A = Rs. 27,000
Life = 15 years
Interest rate, i = 15%, compounded annually

The cash flow diagram of bid 1 is shown in Fig. 4.6.

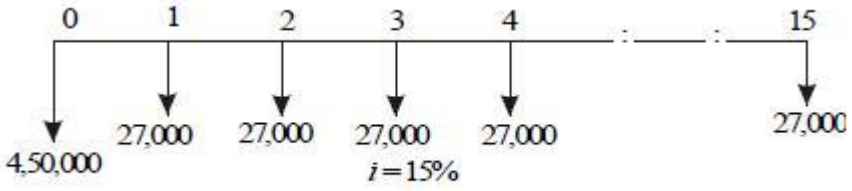


Fig. 4.6 Cash flow diagram for bid 1.

The present worth of the above cash flow diagram is computed as follows:

$PW(15\%) = 4,50,000 + 27,000(P/A, 15\%, 15)$
$= 4,50,000 + 27,000 \times 5.8474$
$= 4,50,000 + 1,57,879.80$
$=$ Rs. 6,07,879.80

Bid 2: Beta Elevator Inc.

Initial cost, P = Rs. 5,40,000
Annual operation and maintenance cost, A = Rs. 28,500
Life = 15 years
Interest rate, i = 15%, compounded annually.

The cash flow diagram of bid 2 is shown in Fig. 4.7.

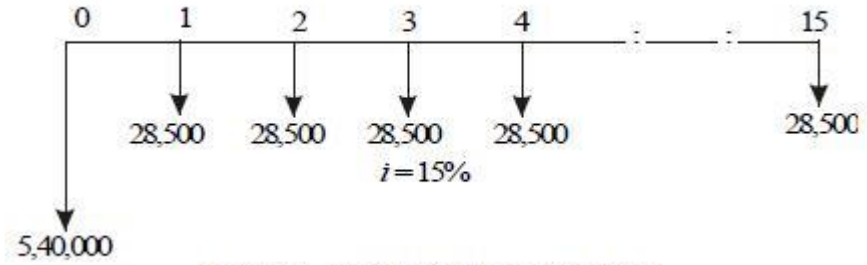


Fig. 4.7 Cash flow diagram for bid 2.

The present worth of the above cash flow diagram is computed as follows:

$PW(15\%) = 5,40,000 + 28,500(P/A, 15\%, 15)$
$= 5,40,000 + 28,500 \times 5.8474$
$= 5,40,000 + 1,66,650.90$
$=$ Rs. 7,06,650.90

The total present worth cost of bid 1 is less than that of bid 2. Hence, bid 1 is to be selected for implementation. That is, the elevator from Alpha Elevator Inc. is to be purchased and installed in the new building.

EXAMPLE 4.3 Investment proposals A and B have the net cash flows as follows:

Proposal	*End of years*				
	0	1	2	3	4
A (Rs.)	–10,000	3,000	3,000	7,000	6,000
B (Rs.)	–10,000	6,000	6,000	3,000	3,000

Compare the present worth of A with that of B at i = 18%. Which proposalshould be selected?

Solution

Present worth of A at *i* = 18%. The cash flow diagram of proposal A is shown in Fig.4.8.

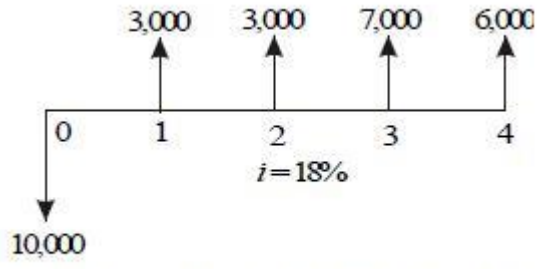


Fig. 4.8 Cash flow diagram for proposal A.

The present worth of the above cash flow diagram is computed as

$$PW\text{A}(18\%) = -10{,}000 + 3{,}000(P/F, 18\%, 1) + 3{,}000(P/F, 18\%, 2) + 7{,}000(P/F, 18\%, 3) + 6{,}000(P/F, 18\%, 4)$$
$$= -10{,}000 + 3{,}000\,(0.8475) + 3{,}000(0.7182) + 7{,}000(0.6086) + 6{,}000(0.5158)$$
$$= \text{Rs. } 2{,}052.10$$

Present worth of B at *i* = 18%. The cash flow diagram of the proposal B is shown inFig. 4.9.

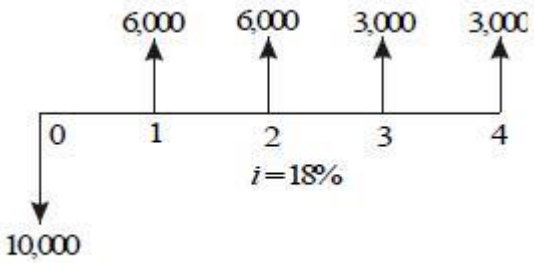


Fig. 4.9 Cash flow diagram for proposal B.

The present worth of the above cash flow diagram is calculated as

$$PW\text{B}(18\%) = -10{,}000 + 6{,}000(P/F, 18\%, 1) + 6{,}000(P/F, 18\%, 2) + 3{,}000(P/F, 18\%, 3) + 3{,}000(P/F, 18\%, 4)$$
$$= -10{,}000 + 6{,}000(0.8475) + 6{,}000(0.7182) + 3{,}000(0.6086) + 3{,}000(0.5158)$$
$$= \text{Rs. } 2{,}767.40$$

At *i* = 18%, the present worth of proposal B is higher than that of proposal A. Therefore, select proposal B.

EXAMPLE 4.4 A granite company is planning to buy a fully automated granite cuttingmachine. If it is purchased under down payment, the cost of the machine is Rs. 16,00,000. If it is purchased under installment basis, the company has to pay 25% of the cost at the time of purchase and the remaining amount in 10 annual equal installments of Rs. 2,00,000 each. Suggest the best alternative for the company using the present worth basis at i = 18%, compounded annually.

Solution There are two alternatives available for the company:
1. Down payment of Rs. 16,00,000
2. Down payment of Rs. 4,00,000 and 10 annual equal installments of Rs. 2,00,000 each

Present worth calculation of the second alternative. The cash flow diagram of thesecond alternative is shown in Fig. 4.10.

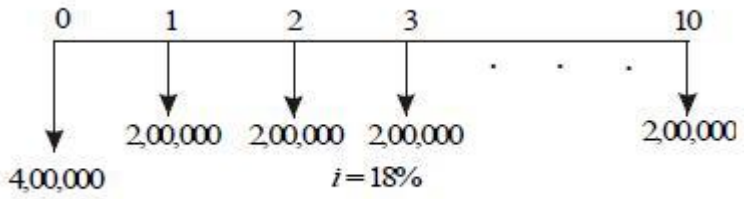


Fig. 4.10 Cash flow diagram for the second alternative.

The present worth of the above cash flow diagram is computed as
$PW(18\%) = 4,00,000 + 2,00,000(P/A, 18\%, 10)$
= 4,00,000 + 2,00,000 x 4.4941
= Rs. 12,98,820

The present worth of this option is Rs. 12,98,820, which is less than the first option of complete down payment of Rs. 16,00,000. Hence, the company should select the second alternative to buy the fully automated granite cutting machine.

EXAMPLE 4.5 A finance company advertises two investment plans. In plan 1, the company pays Rs. 12,000 after 15 years for every Rs. 1,000 invested now. In plan 2, for everyRs. 1,000 invested, the company pays Rs. 4,000 at the end of the 10th year and Rs. 4,000 at the end of 15th year. Select the best investment plan from the investor‘s point of view at i = 12%, compounded annually.

Solution *Plan 1.*The cash flow diagram for plan 1 is illustrated in Fig. 4.11.

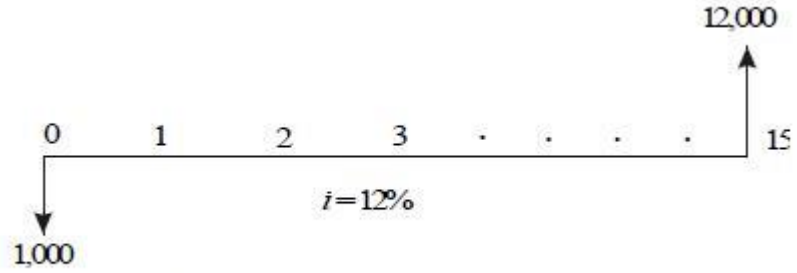


Fig. 4.11 Cash flow diagram for plan 1.

The present worth of the above cash flow diagram is calculated as

$$PW(12\%) = -1{,}000 + 12{,}000(P/F, 12\%, 15)$$
$$= -1{,}000 + 12{,}000(0.1827)$$
$$= \text{Rs. } 1{,}192.40$$

*Plan 2.*The cash flow diagram for plan 2 is shown in Fig. 4.12.

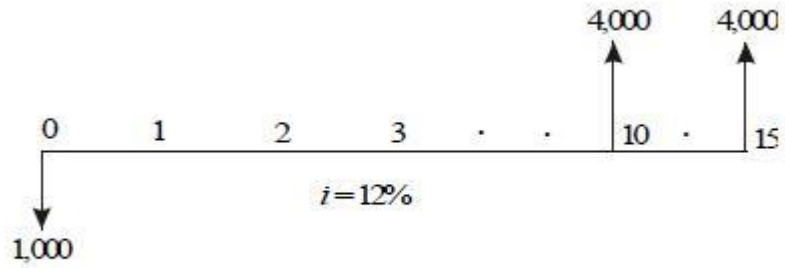


Fig. 4.12 Cash flow diagram for plan 2.

The present worth of the above cash flow diagram is computed as

$PW(12\%) = -1{,}000 + 4{,}000(P/F, 12\%, 10) + 4{,}000(P/F, 12\%, 15)$

$= -1{,}000 + 4{,}000(0.3220) + 4{,}000(0.1827)$

$= \text{Rs. } 1{,}018.80$

The present worth of plan 1 is more than that of plan 2. Therefore, plan 1 is the best plan from the investor‘s point of view.

EXAMPLE 4.6 Novel Investment Ltd. accepts Rs. 10,000 at the end of every year for20 years and pays the investor Rs. 8,00,000 at the end of the 20th year. Innovative Investment Ltd. accepts Rs. 10,000 at the end of every year for 20 years and pays the investor Rs. 15,00,000 at the end of the 25th year. Which is the best investment alternative? Use present worth base with i = 12%.

Solution *Novel Investment Ltd's plan.*The cash flow diagram of Novel Investment Ltd's plan is shown in Fig. 4.13.

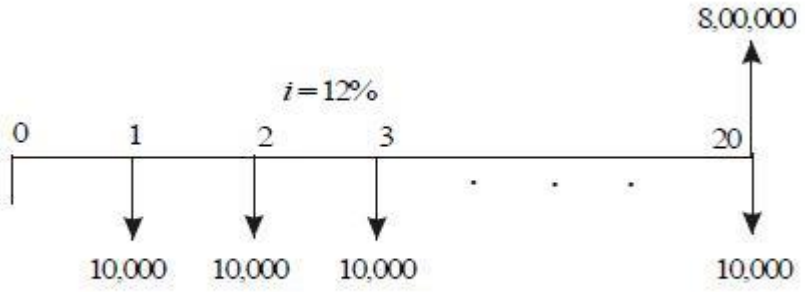


Fig. 4.13 Cash flow diagram for Novel Investment Ltd.

The present worth of the above cash flow diagram is computed as

$PW(12\%) = -10{,}000(P/A, 12\%, 20) + 8{,}00{,}000(P/F, 12\%, 20)$
$= -10{,}000(7.4694) + 8{,}00{,}000(0.1037)$
= Rs. 8,266

*Innovative Investment Ltd's plan.*The cash flow diagram of the Innovative Investment Ltd's plan is illustrated in Fig. 4.14.

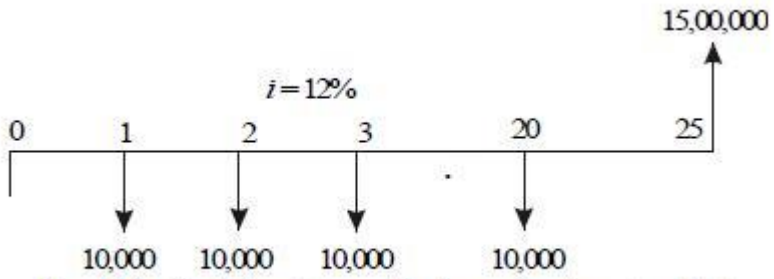


Fig. 4.14 Cash flow diagram for Innovative Investment Ltd.

The present worth of the above cash flow diagram is calculated as

$PW(12\%) = -10{,}000(P/A, 12\%, 20) + 15{,}00{,}000(P/F, 12\%, 25)$
$= -10{,}000(7.4694) + 15{,}00{,}000(0.0588)$
= Rs. 13,506

The present worth of Innovative Investment Ltd‘s plan is more than that of Novel Investment Ltd‘s plan. Therefore, Innovative Investment Ltd‘s plan is the best from investor‘s point of view.

EXAMPLE 4.7 A small business with an initial outlay of Rs. 12,000 yields Rs. 10,000during the first year of its operation and the yield increases by Rs. 1,000 from its second year of operation up to its 10th year of operation. At the end of the life of the business, the salvage value is zero. Find the present worth of the business by assuming an interest rate of 18%, compounded annually.

Solution

Initial investment, P = Rs. 12,000

Income during the first year, A = Rs. 10,000

Annual increase in income, G = Rs. 1,000 n

= 10 years

i= 18%, compounded annually

The cash flow diagram for the small business is depicted in Fig. 4.15.

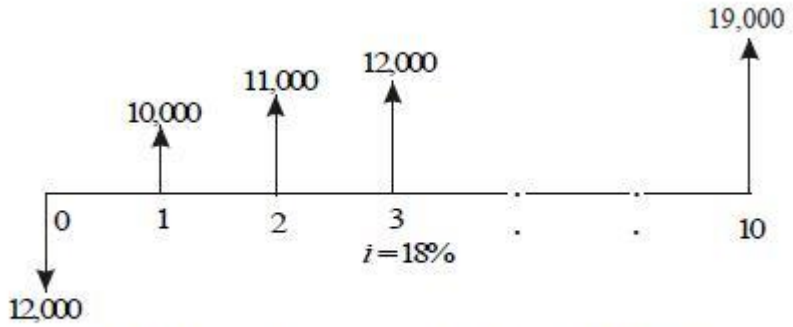


Fig. 4.15 Cash flow diagram for the small business.

The equation for the present worth is

$PW(18\%) = -12{,}000 + (10{,}000 + 1{,}000 \times (A/G, 18\%, 10)) \times (P/A, 18\%, 10)$

$= -12{,}000 + (10{,}000 + 1{,}000 \times 3.1936) \times 4.4941$

$= -12{,}000 + 59{,}293.36$

= Rs. 47,293.36

The present worth of the small business is Rs. 47,293.36.

FUTURE WORTH METHOD

INTRODUCTION

In the future worth method of comparison of alternatives, the future worth of various alternatives will be computed. Then, the alternative with the maximum future worth of net revenue or with the minimum future worth of net cost will be selected as the best alternative for implementation.

REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the future worth method of comparison is presented in Fig. 5.1.

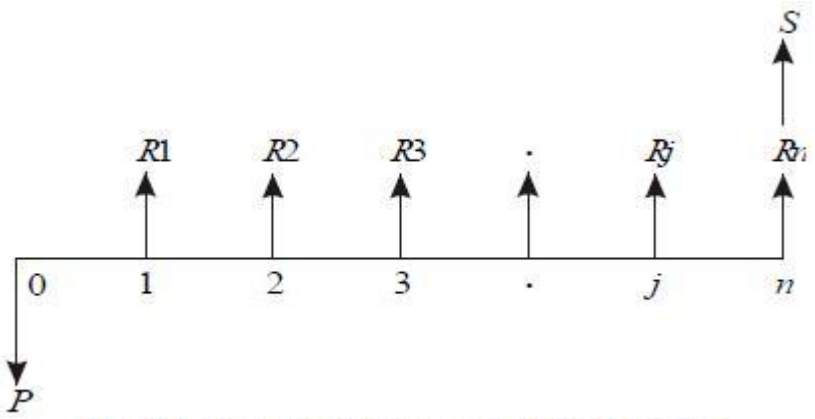


Fig. 5.1 Revenue-dominated cash flow diagram.

In Fig. 5.1, P represents an initial investment, Rj the net-revenue at the end of the jth year, and S the salvage value at the end of the nth year.

The formula for the future worth of the above cash flow diagram for a given interest rate, i is

$$FW(i) = -P(1+i)^n + R1(1+i)^{n-1} + R2(1+i)^{n-2} + \ldots$$

$$+ Rj(1+i)^{n-j} + \ldots + Rn + S$$

In the above formula, the expenditure is assigned with negative sign and the revenues are assigned with positive sign.

If we have some more alternatives which are to be compared with this alternative, then the corresponding future worth amounts are to be computed and compared. Finally, the alternative with the maximum future worth amount should be selected as the best alternative.

COST-DOMINATED CASH FLOW DIAGRAM

A generalized cost-dominated cash flow diagram to demonstrate the future worth method of comparison is given in Fig. 5.2.

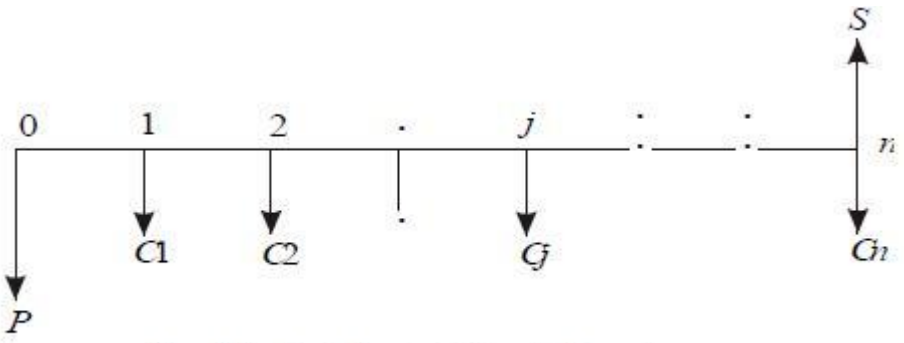


Fig. 5.2 Cost-dominated cash flow diagram.

In Fig. 5.2, *P* represents an initial investment, *Cj* the net cost of operation and maintenance at the end of the *j*th year, and *S* the salvage value at the end of the *n*th year.

The formula for the future worth of the above cash flow diagram for a given interest rate, *i* is

$$FW(i) = P(1+i)n + C1(1+i)n-1 + C2(1+i)n-2 + ...$$

$$+ Cj(1+i)n-j + ... + Cn - S$$

In this formula, the expenditures are assigned with positive sign and revenues with negative sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding future worth amounts are to be computed and compared. Finally, the alternative with the minimum future worthamount should be selected as the best alternative.

5.4 EXAMPLES

In this section, several examples highlighting the applications of the future worth method of comparison are presented.

EXAMPLE 5.1 Consider the following two mutually exclusive alternatives:

	End of year				
Alternative	0	1	2	3	4
A (Rs.)	−50,00,000	20,00,000	20,00,000	20,00,000	20,00,000
B (Rs.)	−45,00,000	18,00,000	18,00,000	18,00,000	18,00,000

At i = 18%, select the best alternative based on future worth method of comparison.

Solution Alternative A

Initial investment, P = Rs. 50,00,000

Annual equivalent revenue, A = Rs. 20,00,000

Interest rate, i = 18%, compounded annually

Life of alternative A = 4 years

The cash flow diagram of alternative A is shown in Fig. 5.3.

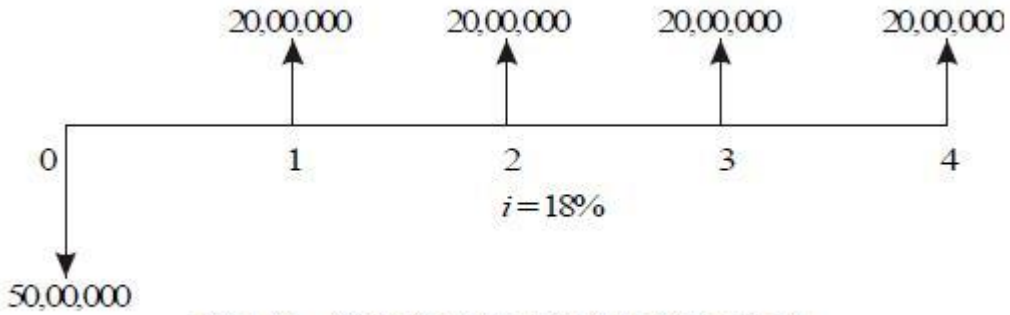


Fig. 5.3 Cash flow diagram for alternative A.

The future worth amount of alternative B is computed as

FWA(18%) =–50,00,000(F/P, 18%, 4) + 20,00,000(F/A, 18%, 4)= –50,00,000(1.939) + 20,00,000(5.215)

= Rs. 7,35,000

Alternative B

Initial investment, P = Rs. 45,00,000

Annual equivalent revenue, A = Rs. 18,00,000

Interest rate, i = 18%, compounded annually

Life of alternative B = 4 years

The cash flow diagram of alternative B is illustrated in Fig. 5.4.

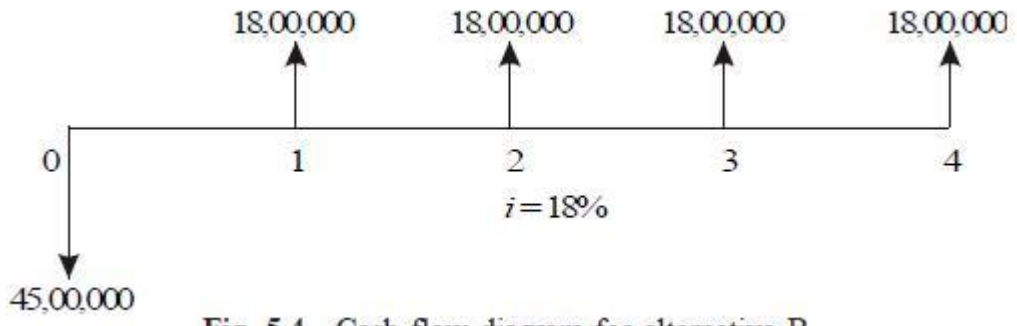


Fig. 5.4 Cash flow diagram for alternative B.

The future worth amount of alternative B is computed as

$$FW\text{B}(18\%) = -45,00,000(F/P, 18\%, 4) + 18,00,000\,(F/A, 18\%, 4)$$
$$= -45,00,000(1.939) + 18,00,000(5.215)$$
$$= \text{Rs. } 6,61,500$$

The future worth of alternative A is greater than that of alternative B. Thus, alternative A should be selected.

EXAMPLE 5.2 A man owns a corner plot. He must decide which of the severalalternatives to select in trying to obtain a desirable return on his investment. After much study and calculation, he decides that the two best alternatives are as given in the following table:

	Build gas station	*Build soft ice-cream stand*
First cost (Rs.)	20,00,000	36,00,000
Annual property taxes (Rs.)	80,000	1,50,000
Annual income (Rs.)	8,00,000	9,80,000
Life of building (years)	20	20
Salvage value (Rs.)	0	0

Evaluate the alternatives based on the future worth method at $i = 12\%$.

***Alternative 1*—Build gas station**

First cost = Rs. 20,00,000

Net annual income = Annual income – Annual property tax

= Rs. 8,00,000 – Rs. 80,000

= Rs. 7,20,000

Life = 20 years

Interest rate = 12%, compounded annually

The cash flow diagram for this alternative is depicted in Fig. 5.5.

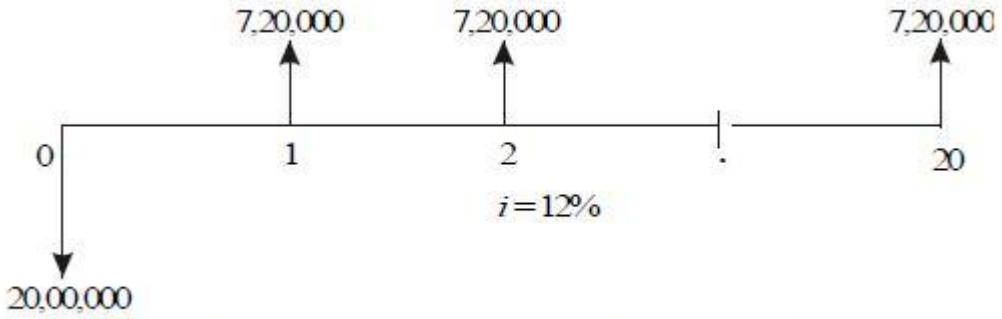


Fig. 5.5 Cash flow diagram for alternative 1.

The future worth of alternative 1 is computed as

$FW1(12\%) = -20,00,000\ (F/P, 12\%, 20) + 7,20,000\ (F/A, 12\%, 20)$

$= -20,00,000(9.646) + 7,20,000\ (72.052)$

= Rs. 3,25,85,440

***Alternative 2*—Build soft ice-cream stand**

First cost = Rs. 36,00,000

Net annual income = Annual income – Annual property tax

= Rs. 9,80,000 – Rs. 1,50,000

= Rs. 8,30,000

Life = 20 years

Interest rate = 12%, compounded annually

The cash flow diagram for this alternative is shown in Fig. 5.6.

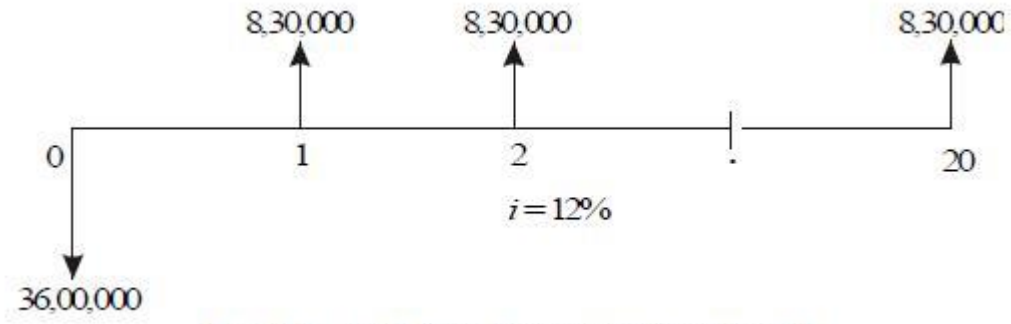


Fig. 5.6 Cash flow diagram for alternative 2.

The future worth of alternative 2 is calculated as

$FW2(12\%) = -36,00,000(F/P, 12\%, 20) + 8,30,000\ (F/A, 12\%, 20)$

$= -36,00,000\ (9.646) + 8,30,000\ (72.052)$

= Rs. 2,50,77,560

The future worth of alternative 1 is greater than that of alternative 2. Thus, building the gas station is the best alternative.

EXAMPLE 5.3 The cash flow diagram of two mutually exclusive alternatives are givenin Figs. 5.7 and 5.8.

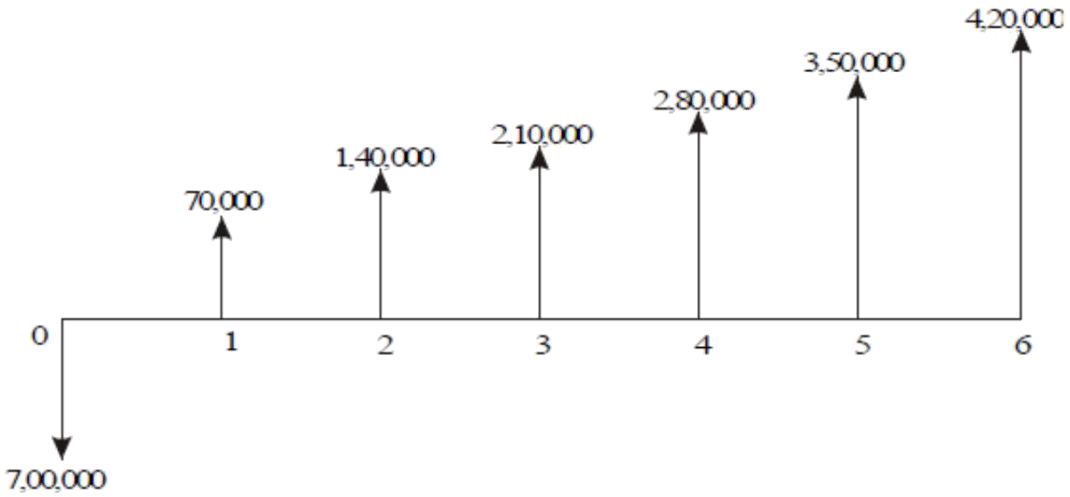


Fig. 5.8 Cash flow diagram for alternative 2.

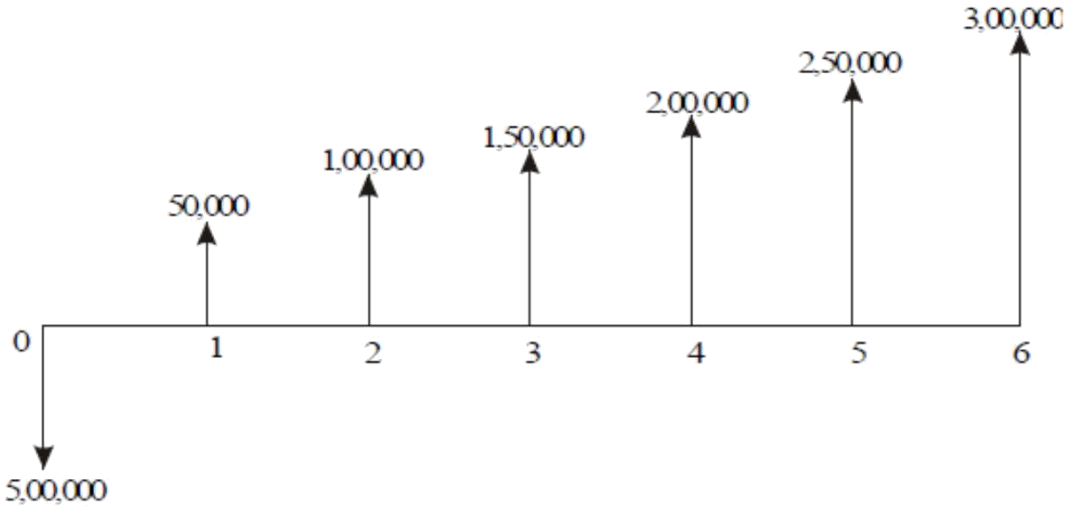


Fig. 5.7 Cash flow diagram for alternative 1.

(a) Select the best alternative based on future worth method at i = 8%.

(b) Rework part (a) with i = 9% and 20%

(*a*) *Evaluation at* i = *8%*

***Alternative 1*—This comes under equal payment gradient series.**

P = Rs. 5,00,000

$A1$ = Rs. 50,000

G = Rs. 50,000

i= 8% n = 6 years

The formula for the future worth of alternative 1 is

$FW1(8\%) = -P(F/P, 8\%, 6) + [A1 + G(A/G, 8\%, 6)] \times (F/A, 8\%, 6)$

= – 5,00,000(1.587) + [50,000 + 50,000(2.2764)] x 7.336

= – 79,35,000 + 1,63,820 x 7.336

= –79,35,000 + 12,01,784

= Rs. 4,08,283.52

***Alternative 2*—This comes under equal payment gradient series.**

P = Rs. 7,00,000

$A1$ = Rs. 70,000

G = Rs.

70,000i= 8%

n = 6 years

The formula for the future worth of alternative 2 is

$FW2(8\%) = -P(F/P, 8\%, 6) + [A1 + G(A/G, 8\%, 6)] \times (F/A, 8\%, 6)$

$FW2(8\%)$ =–7,00,000 x 1.587 + [70,000 + 70,000 x2.2764] x7.336

= –11,10,900 + 16,82,497

= Rs. 5,71,596.93

The future worth of alternative 2 is more than that of alternative 1.

Therefore, alternative 2 must be selected.

(*b*) *(i) Evaluation at*i *= 9%:Alternative 1*

P = Rs. 5,00,000 $A1$ = Rs. 50,000 G = Rs. 50,000 n = 6 years

The formula for the future worth of alternative 1 is as follows:

$FW1(9\%) = -P(F/P, 9\%, 6) + [A1 + G(A/G, 9\%, 6)] \times (F/A, 9\%, 6)$

= – 5,00,000 (1.677) + [50,000 + 50,000 (2.2498)] x7.523

= – 8,38,500 + 12,22,412.27

= Rs. 3,83,912.27

Alternative 2

P = Rs. 7,00,000 $A1$ = Rs. 70,000 G = Rs. 70,000 n = 6 years

The formula for the future worth of the alternative 2 is

$FW2(9\%) = -P(F/P, 9\%, 6) + [A1 + G(A/G, 9\%, 6)] \times (F/A, 9\%, 6)$

= –7,00,000 x 1.677 + [70,000 + 70,000 x 2.2498] x 7.523

= –11,73,900 + 17,11,377.18

= Rs. 5,37,477.18

The future worth of alternative 2 is more than that of alternative 1.
Therefore, alternative 2 must be selected

(ii) Evaluation at i = 20%: **Alternative 1**
P = Rs. 5,00,000 A1 = Rs. 50,000 G = Rs. 50,000 n = 6 years

The formula for the future worth of alternative 1 is

$FW1(20\%) = -P(F/P, 20\%, 6) + [A1 + G(A/G, 20\%, 6)] \times (F/A, 20\%, 6)$

= –5,00,000(2.986) + [50,000 + 50,000 (1.9788)] x 9.93

= –14,93,000 + 14,78,974.20

= Rs. –14,025.80

The negative sign of the future worth amount indicates that alternative 1 incurs loss.

Alternative 2

P = Rs. 7,00,000 $A1$ = Rs. 70,000 G = Rs. 70,000 n = 6
yearsThe formula for the future worth of alternative 2 is

$FW2(20\%) = -P(F/P, 20\%, 6) + [A1 + G(A/G, 20\%, 6)] \_ (F/A, 20\%, 6)$

= –7,00,000 _ 2.986 + [70,000 + 70,000 _ 1.9788] _ 9.93

= –20,90,200 + 20,70,563.88

= Rs. –19,636.12

The negative sign of the above future worth amount indicates that alternative 2 incurs loss. Thus, none of the two alternatives should be selected.

EXAMPLE 5.4 M/S Krishna Castings Ltd. is planning to replace its annealing furnace. It has received tenders from three different original manufacturers of annealing furnace. The details are as follows.

	Manufacturer		
	1	2	3
Initial cost (Rs.)	80,00,000	70,00,000	90,00,000
Life (years)	12	12	12
Annual operation and maintenance cost (Rs.)	8,00,000	9,00,000	8,50,000
Salvage value after 12 years	5,00,000	4,00,000	7,00,000

Which is the best alternative based on future worth method at i = 20%?

Solution Alternative 1—Manufacturer 1
First cost, P = Rs. 80,00,000 Life, n = 12 years

Annual operating and maintenance cost, A = Rs. 8,00,000
Salvage value at the end of furnace life = Rs. 5,00,000
The cash flow diagram for this alternative is shown in Fig. 5.9.

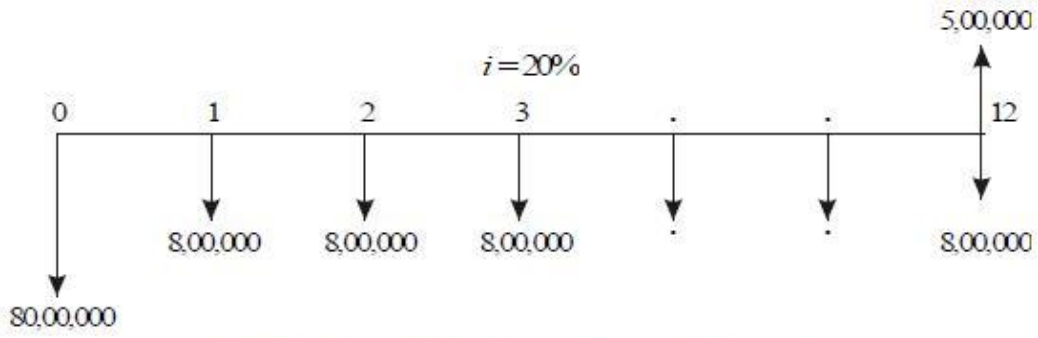


Fig. 5.9 Cash flow diagram for manufacturer 1.

The future worth amount of alternative 1 is computed as

$FW1(20\%)$ = 80,00,000 (F/P, 20%, 12) + 8,00,000 (F/A, 20%, 12)–5,00,000
= 80,00,000(8.916) + 8,00,000 (39.581) – 5,00,000
= Rs. 10,24,92,800

Alternative 2— Manufacturer 2
First cost, P = Rs. 70,00,000
Life, n = 12 years
Annual operating and maintenance cost, A = Rs. 9,00,000
Salvage value at the end of furnace life = Rs. 4,00,000

The cash flow diagram for this alternative is given in Fig. 5.10.

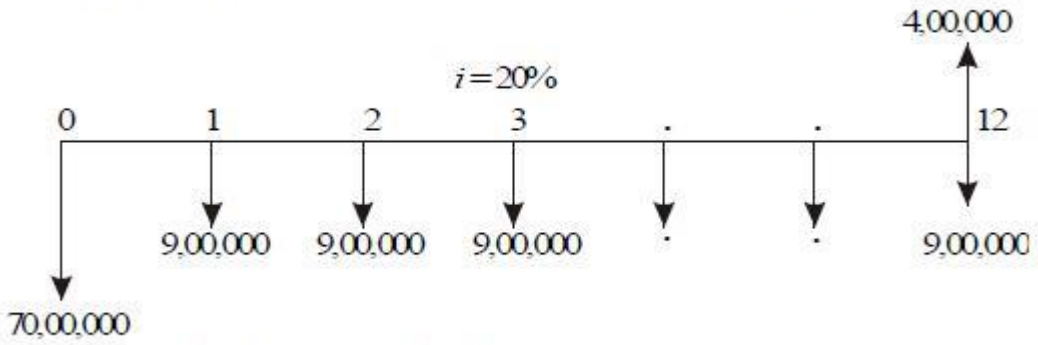


Fig. 5.10 Cash flow diagram for manufacturer 2.

The future worth amount of alternative 2 is computed as

$FW2(20\%) = 70,00,000(F/P, 20\%, 12) + 9,00,000(F/A, 20\%, 12) – 4,00,000$

$= 70,00,000(8.916) + 9,00,000\ (39.581) – 4,00,000$

= Rs. 9,76,34,900

Alternative 3—Manufacturer 3
First cost, *P* = Rs. 90,00,000
Life, *n* = 12 years

Annual operating and maintenance cost, *A* = Rs. 8,50,000
Salvage value at the end of furnace life = Rs. 7,00,000

The cash flow diagram for this alternative is illustrated in Fig. 5.11.

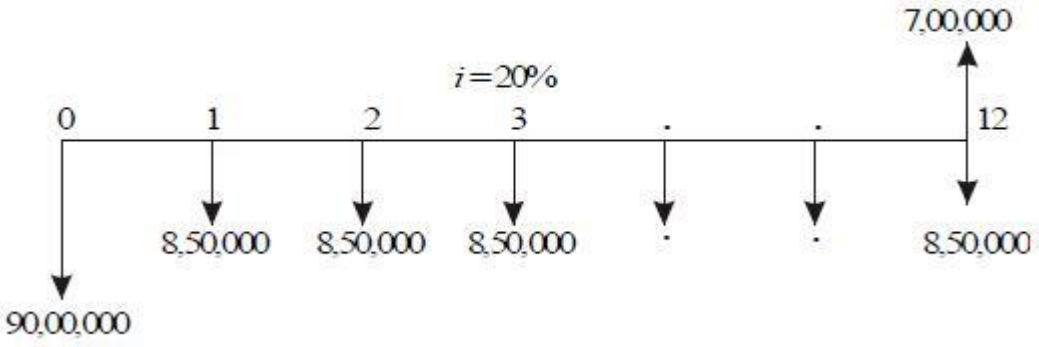


Fig. 5.11 Cash flow diagram for manufacturer 3.

The future worth amount of alternative 3 is calculated as

$FW3(20\%) = 90,00,000(F/P, 20\%, 12) + 8,50,000(F/A, 20\%, 12) – 7,00,000$

$= 90,00,000(8.916) + 8,50,000\ (39.581) – 7,00,000$

= Rs. 11,31,87,850

The future worth cost of alternative 2 is less than that of the other two alternatives. Therefore, M/s. Krishna castings should buy the annealing furnace from manufacturer 2.

EXAMPLE 5.5 A company must decide whether to buy machine *A* or machine *B*:

	Machine A	*Machine B*
Initial cost	Rs. 4,00,000	Rs. 8,00,000
Useful life, in years	4	4
Salvage value at the end of machine life	Rs. 2,00,000	Rs. 5,50,000
Annual maintenance cost	Rs. 40,000	0

At 12% interest rate, which machine should be selected? (Use future worth method of comparison).

Solution Machine A

Initial cost of the machine, P = Rs. 4,00,000
Life, n = 4 years
Salvage value at the end of machine life, S = Rs. 2,00,000
Annual maintenance cost, A = Rs. 40,000
Interest rate, i = 12%, compounded annually.
The cash flow diagram of machine *A* is given in Fig. 5.12.

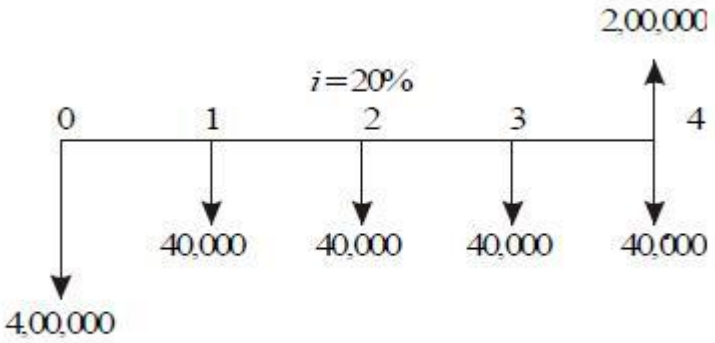


Fig. 5.12 Cash flow diagram for machine *A*.

The future worth function of Fig. 5.12 is
$FWA(12\%) = 4,00,000 \times (F/P, 12\%, 4) + 40,000 \times (F/A, 12\%, 4) - 2,00,000$
$= 4,00,000 \times (1.574) + 40,000 \times (4.779) - 2,00,000$
= Rs. 6,20,760

Machine B
Initial cost of the machine, P = Rs. 8,00,000
Life, n = 4 years
Salvage value at the end of machine life, S = Rs. 5,50,000
Annual maintenance cost, A = zero.
Interest rate, i = 12%, compounded annually.
The cash flow diagram of the machine B is illustrated in Fig. 5.13.

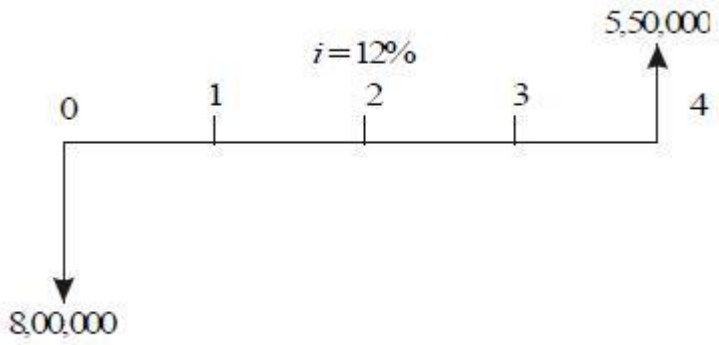


Fig. 5.13 Cash flow diagram for machine B.

The future worth function of Fig 5.13 is

$FWB(12\%) = 8,00,000 \times (F/P, 12\%, 4) - 5,50,000$

$= 8,00,000 \times (1.574) - 5,50,000$

= Rs. 7,09,200

The future worth cost of machine A is less than that of machine B. Therefore, machine A should be selected.

ANNUAL EQUIVALENT METHOD

INTRODUCTION

In the annual equivalent method of comparison, first the annual equivalent cost or the revenue of each alternative will be computed. Then the alternative with the maximum annual equivalent revenue in the case of revenue-based comparison or with the minimum annual equivalent cost in the case of costbased comparison will be selected as the best alternative.

REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is presented in Fig. 6.1.

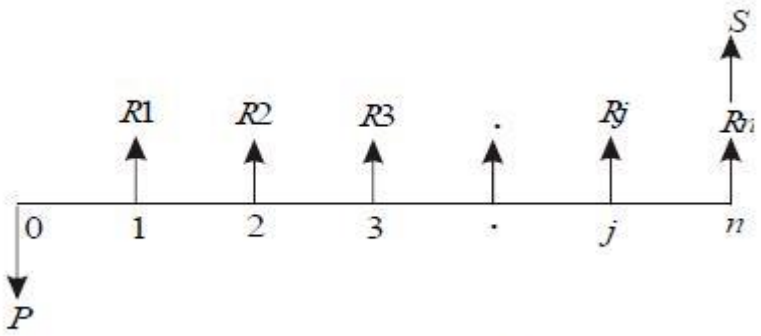


Fig. 6.1 Revenue-dominated cash flow diagram.

In Fig. 6.1, P represents an initial investment, Rj the net revenue at the end of the jth year, and S the salvage value at the end of the nth year.

The first step is to find the net present worth of the cash flow diagram using the following expression for a given interest rate, i:

$$PW(i) = -P + R1/(1+i)1 + R2/(1+i)2 + ...$$

$$+ Rj/(1+i)\,j + ... + Rn/(1+i)n + S/(1+i)n$$

In the above formula, the expenditure is assigned with a negative sign and the revenues are assigned with a positive sign.

In the second step, the annual equivalent revenue is computed using the following formula:

$$A = PW(i)\ \frac{i(1+i)^n}{(1+i)^n - 1}$$
$$= PW(i)\ (A/P, i, n)$$

where $(A/P, i, n)$ is called *equal payment series capital recovery factor*.

If we have some more alternatives which are to be compared with this alternative, then the corresponding annual equivalent revenues are to be computed and compared. Finally, the alternative with the maximum annual equivalent revenue should be selected as the best alternative.

COST-DOMINATED CASH FLOW DIAGRAM

A generalized cost-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is illustrated in Fig. 6.2.

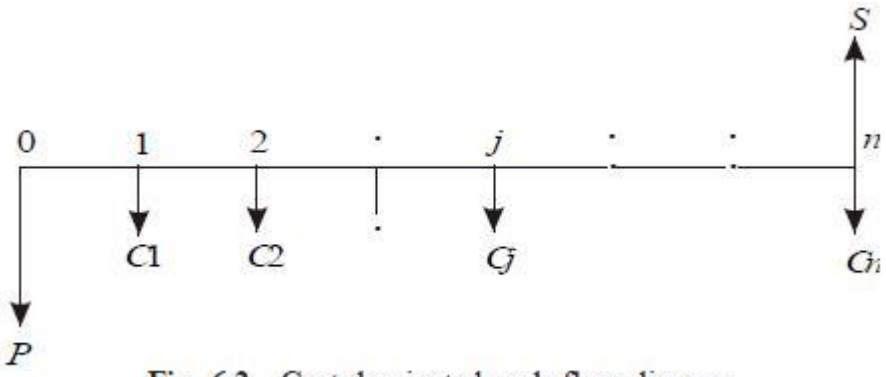


Fig. 6.2 Cost-dominated cash flow diagram.

In Fig. 6.2, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year, and S the salvage value at the end of the nth year.

The first step is to find the net present worth of the cash flow diagram using the following relation for a given interest rate, *i*.

$PW(i) = P + C1/(1 + i)1 + C2/(1 + i)2 + ...$

$+ Cj/(1 + i)\, j + ... + Cn/(1 + i)n - S/(1 + i)n$

In the above formula, each expenditure is assigned with positive sign and the salvage value with negative sign. Then, in the second step, the annual equivalent cost is computed using the following equation:

$$A = PW(i)\ \frac{i(1+i)^n}{(1+i)^n - 1}$$

$$= PW(i)\ (A/P, i, n)$$

where $(A/P, i, n)$ is called as equal-payment series capital recovery factor.

As in the previous case, if we have some more alternatives which are to be compared with this alternative, then the corresponding annual equivalent costsare to be computed and compared. Finally, the alternative with the minimum annual equivalent cost should be selected as the best alternative.

If we have some non-standard cash flow diagram, then we will have to follow the general procedure for converting each and every transaction to time zero and then convert the net present worth into an annual equivalent cost/ revenue depending on the type of the cash flow diagram. Such procedure is tobe applied to all the alternatives and finally, the best alternative is to be selected.

ALTERNATE APPROACH

Instead of first finding the present worth and then figuring out the annual equivalent cost/revenue, an alternate method which is as explained below can be used. In each of the cases presented in Sections 6.2 and 6.3, in the first step, one can find the future worth of the cash flow diagram of each of the alternatives.

Then, in the second step, the annual equivalent cost/revenue can be obtained by using the equation:

$$A = F\frac{i}{(1+i)^n - 1}$$
$$= F(A/F, i, n)$$

where $(A/F, i, n)$ is called *equal-payment series sinking fund factor*.

EXAMPLES

In this section, the application of the annual equivalent method is demonstrated with several numerical examples.

EXAMPLE 6.1 A company provides a car to its chief executive. The owner of the company is concerned about the increasing cost of petrol. The cost per litre of petrol for the first year of operation is Rs. 21. He feels that the cost of petrol will be increasing by Re.1 every year. His experience with his company car indicates that it averages 9 km per litre of petrol. The executive expects to drive an average of 20,000 km each year for the next four years. What is the annual equivalent cost of fuel over this period of time?. If he is offered similar service with the same quality on rental basis at Rs. 60,000 per year, should the owner continue to provide company car for his executive or alternatively provide a rental car to his executive? Assume i = 18%. If the rental car is preferred, then the company car will find some other use within the company

Solution

Average number of km run/year = 20,000 km
Number of km/litre of petrol = 9 km

Therefore,
Petrol consumption/year = 20,000/9 = 2222.2 litre
Cost/litre of petrol for the 1st year = Rs. 21
Cost/litre of petrol for the 2nd year = Rs. 21.00 + Re. 1.00 = Rs. 22.00
Cost/litre of petrol for the 3rd year = Rs. 22.00 + Re. 1.00 = Rs. 23.00
Cost/litre of petrol for the 4th year = Rs. 23.00 + Re. 1.00 = Rs. 24.00
Fuel expenditure for 1st year = 2222.2 _ 21 = Rs. 46,666.20

Fuel expenditure for 2nd year = 2222.2 _ 22 = Rs. 48,888.40
Fuel expenditure for 3rd year = 2222.2 _ 23 = Rs. 51,110.60
Fuel expenditure for 4th year = 2222.2 _ 24 = Rs. 53,332.80

The annual equal increment of the above expenditures is Rs. 2,222.20 (G).

The cash flow diagram for this situation is depicted in Fig. 6.3.

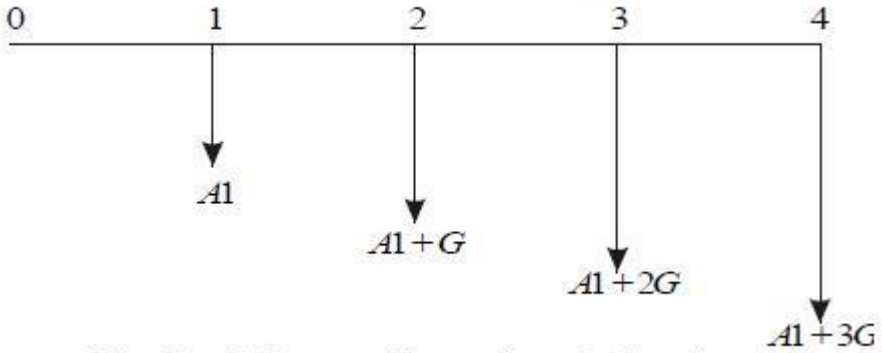


Fig. 6.3 Uniform gradient series cash flow diagram.

In Fig. 6.3, $A1$ = Rs. 46,666.20 and G = Rs. 2,222.20

$A = A1 + G(A/G, 18\%, 4)$
$= 46,666.20 + 2222.2(1.2947)$
$=$ Rs. 49,543.28

The proposal of using the company car by spending for petrol by the company will cost an annual equivalent amount of Rs. 49,543.28 for four years. This amount is less than the annual rental value of Rs. 60,000. Therefore, the company should continue to provide its own car to its executive.

EXAMPLE 6.2 A company is planning to purchase an advanced machine centre. Three original manufacturers have responded to its tender whose particulars are tabulated as follows:

Manufacturer	*Down payment* (Rs.)	*Yearly equal installment* (Rs.)	*No. of installments*
1	5,00,000	2,00,000	15
2	4,00,000	3,00,000	15
3	6,00,000	1,50,000	15

Determine the best alternative based on the annual equivalent method by assuming i = 20%, compounded annually.

Solution Alternative 1

Down payment, P = Rs. 5,00,000

Yearly equal installment, A = Rs. 2,00,000

n = 15 years

i= 20%, compounded annually

The cash flow diagram for manufacturer 1 is shown in Fig. 6.4.

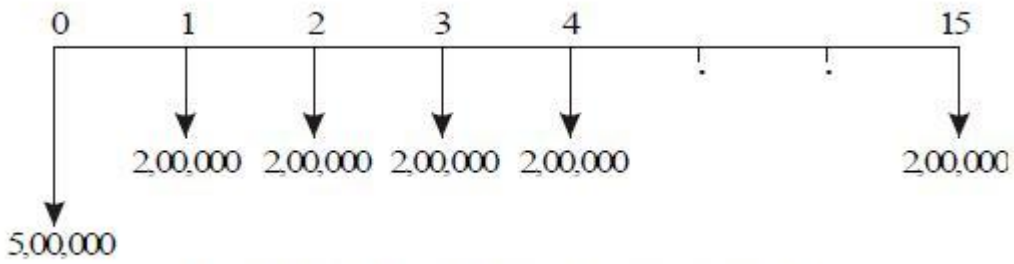


Fig. 6.4 Cash flow diagram for manufacturer 1.

The annual equivalent cost expression of the above cash flow diagram is $AE1(20\%) = 5,00,000(A/P, 20\%, 15) + 2,00,000$
$= 5,00,000(0.2139) + 2,00,000$
$= 3,06,950$

Alternative 2

Down payment, P = Rs. 4,00,000

Yearly equal installment, A = Rs. 3,00,000

n = 15 years

i= 20%, compounded annually

The cash flow diagram for the manufacturer 2 is shown in Fig. 6.5.

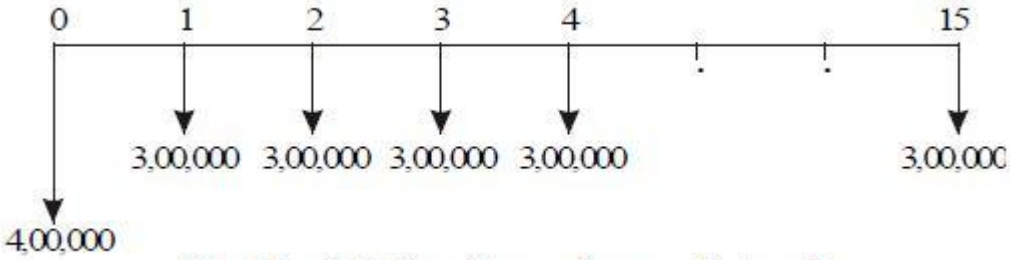


Fig. 6.5 Cash flow diagram for manufacturer 2.

The annual equivalent cost expression of the above cash flow diagram is

$AE2(20\%) = 4{,}00{,}000(A/P, 20\%, 15) + 3{,}00{,}000$

$= 4{,}00{,}000(0.2139) + 3{,}00{,}000$
$=$ Rs. 3,85,560.

Alternative 3
Down payment, P = Rs. 6,00,000
Yearly equal installment, A = Rs.
1,50,000n = 15 years
i= 20%, compounded annually
The cash flow diagram for manufacturer 3 is shown in Fig. 6.6.

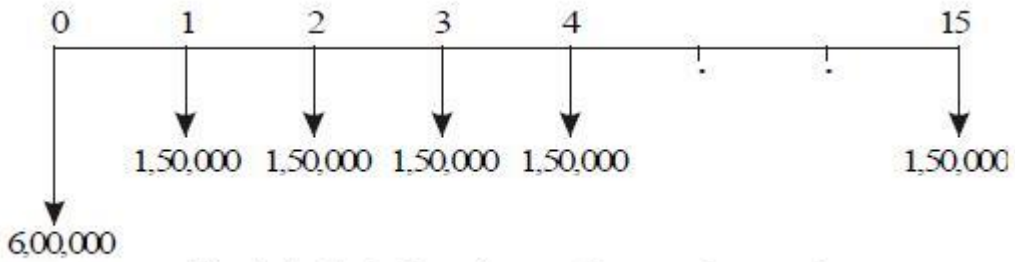


Fig. 6.6 Cash flow diagram for manufacturer 3.

The annual equivalent cost expression of the above cash flow diagram is

$AE3(20\%) = 6{,}00{,}000(A/P, 20\%, 15) + 1{,}50{,}000$

$= 6{,}00{,}000(0.2139) + 1{,}50{,}000$

$=$ Rs. 2,78,340.

The annual equivalent cost of manufacturer 3 is less than that of manufacturer 1 and manufacturer 2. Therefore, the company should buy the advanced machine centre from manufacturer 3.

EXAMPLE 6.3 A company invests in one of the two mutually exclusive alternatives. The life of both alternatives is estimated to be 5 years with the following investments, annual returns and salvage values.

	Alternative	
	A	B
Investment (Rs.)	– 1,50,000	– 1,75,000
Annual equal return (Rs.)	+ 60,000	+ 70,000
Salvage value (Rs.)	+ 15,000	+ 35,000

Determine the best alternative based on the annual equivalent method by assuming i = 25%.

Solution Alternative A

Initial investment, P = Rs. 1,50,000 , Annual equal return, A = Rs. 60,000

Salvage value at the end of machine life, S = Rs. 15,000

Life = 5 years, Interest rate, i = 25%, compounded annually

The cash flow diagram for alternative A is shown in Fig. 6.7.

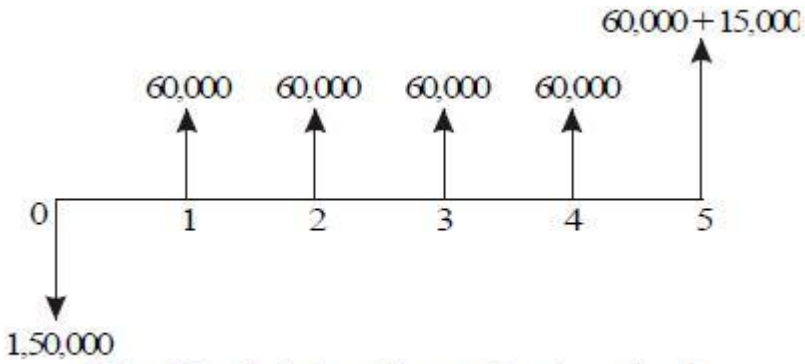


Fig. 6.7 Cash flow diagram for alternative A.

The annual equivalent revenue expression of the above cash flow diagram is as follows:

AEA(25%) =–1,50,000(A/P, 25%, 5) + 60,000 + 15,000(A/F, 25%, 5)

= –1,50,000(0.3718) + 60,000 + 15,000(0.1218)

= Rs. 6,057

Alternative B

Initial investment, P = Rs. 1,75,000

Annual equal return, A = Rs. 70,000

Salvage value at the end of machine life, S = Rs. 35,000

Life = 5 years

Interest rate, i = 25%, compounded annually

The cash flow diagram for alternative B is shown in Fig. 6.8.

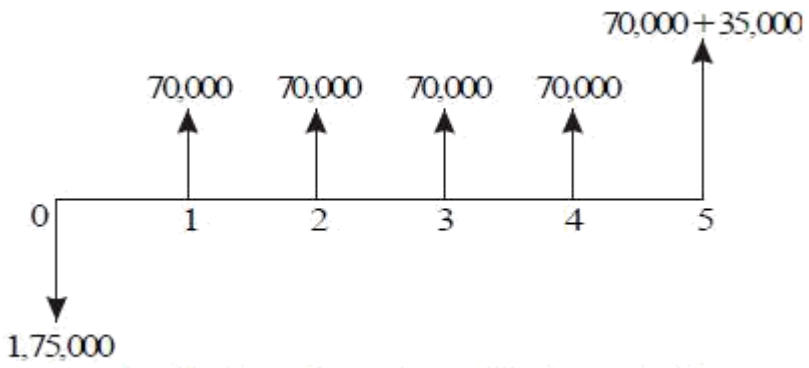


Fig. 6.8 Cash flow diagram for alternative B.

The annual equivalent revenue expression of the above cash flow diagram is

$AE\text{B}(25\%) = -1,75,000(A/P, 25\%, 5) + 70,000 + 35,000(A/F, 25\%, 5)$

$= -1,75,000(0.3718) + 70,000 + 35,000(0.1218)$

= Rs. 9,198

The annual equivalent net return of alternative B is more than that of alternative A. Thus, the company should select alternative B.

EXAMPLE 6.4 A certain individual firm desires an economic analysis to determinewhich of the two machines is attractive in a given interval of time. The minimum attractive rate of return for the firm is 15%. The following data are to be used in the analysis:

	Machine X	*Machine Y*
First cost	Rs. 1,50,000	Rs. 2,40,000
Estimated life	12 years	12 years
Salvage value	Rs. 0	Rs. 6,000
Annual maintenance cost	Rs. 0	Rs. 4,500

Which machine would you choose? Base your answer on annual equivalent cost.

Solution Machine X

First cost, P = Rs. 1,50,000

Life, n = 12 years

Estimated salvage value at the end of machine life, S = Rs. 0.

Annual maintenance cost, A = Rs. 0.

Interest rate, i = 15%, compounded annually.

The cash flow diagram of machine X is illustrated in Fig. 6.9.

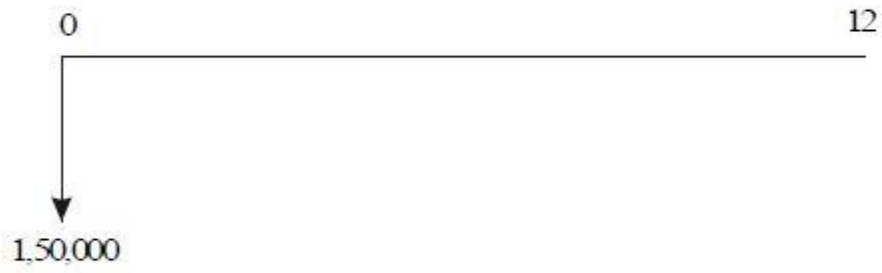


Fig. 6.9 Cash flow diagram for machine X.

The annual equivalent cost expression of the above cash flow diagram is

AEX(15%) = 1,50,000(A/P, 15%,

12)= 1,50,000(0.1845)

= Rs. 27,675

Machine Y

First cost, P = Rs.

2,40,000 Life, n = 12 years

Estimated salvage value at the end of machine life, S = Rs. 60,000

Annual maintenance cost, A = Rs. 4,500

Interest rate, i = 15%, compounded annually.

The cash flow diagram of machine Y is depicted in Fig. 6.10.

The annual equivalent cost expression of the above cash flow diagram is

AEY(15%) = 2,40,000(A/P, 15%, 12) + 4,500–6,000(A/F, 15%,

12)= 2,40,000(0.1845) + 4,500 – 6,000(0.0345)

= Rs. 48,573

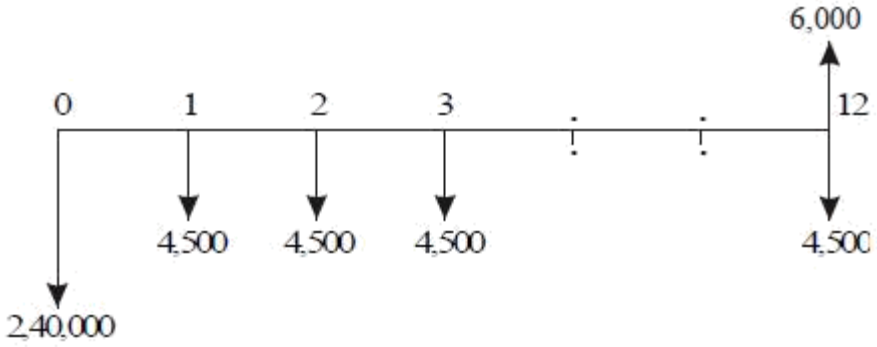


Fig. 6.10 Cash flow diagram for machine Y.

The annual equivalent cost of machine X is less than that of machine Y. So, machine X is the more cost effective machine.

EXAMPLE 6.5 Two possible routes for laying a power line are under study.Data on theroutes are as follows:

		Around the lake	*Under the lake*
Length		15 km	5 km
First cost	(Rs.)	1,50,000/km	7,50,000/km
Useful life	(years)	15	15
Maintenance cost	(Rs.)	6,000/km/yr	12,000/km/yr
Salvage value	(Rs.)	90,000/km	1,50,000/km
Yearly power loss	(Rs.)	15,000/km	15,000/km

If 15% interest is used, should the power line be routed around the lake or under the lake?

Solution Alternative 1— Around the lake

First cost = 1,50,000 x 15 = Rs. 22,50,000

Maintenance cost/yr = 6,000 x15 = Rs. 90,000

Power loss/yr = 15,000 x 15 = Rs. 2,25,000

Maintenance cost and power loss/yr = Rs. 90,000 + Rs.

2,25,000 = Rs. 3,15,000

Salvage value = 90,000 x 15 = Rs. 13,50,000

The cash flow diagram for this alternative is shown in Fig. 6.11

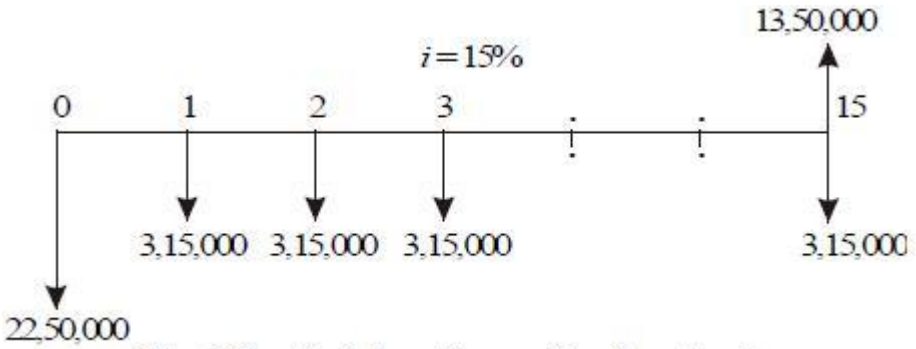


Fig. 6.11 Cash flow diagram for alternative 1

The annual equivalent cost expression of the above cash flow diagram is

$AE1(15\%) = 22,50,000(A/P, 15\%, 15) + 3,15,000 – 13,50,000(A/F, 15\%, 15)$

$= 22,50,000(0.1710) + 3,15,000 – 13,50,000(0.0210)$

= Rs. 6,71,400

Alternative 2—Under the lake

First cost = 7,50,000 x 5 = Rs. 37,50,000

Maintenance cost/yr = 12,000 x5 = Rs. 60,000

Power loss/yr = 15,000 x5 = Rs. 75,000

Maintenance cost and power loss/yr = Rs. 60,000 + Rs.

75,000 = Rs. 1,35,000

Salvage value = 1,50,000 x 5 = Rs. 7,50,000

The cash flow diagram for this alternative is shown in Fig. 6.12.

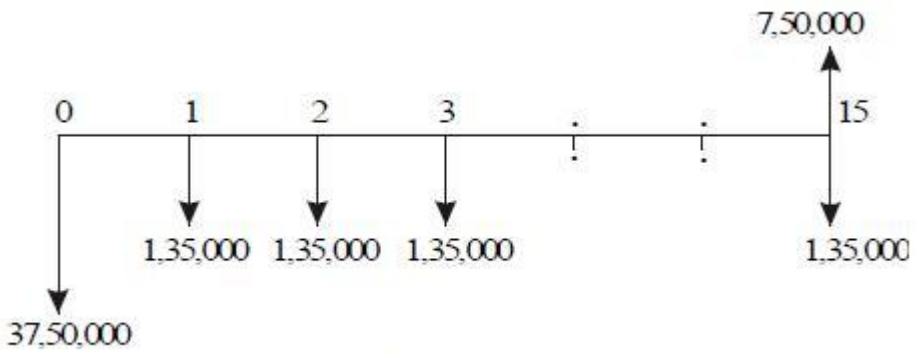


Fig. 6.12 Cash flow diagram for alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$AE2(15\%) = 37,50,000(A/P, 15\%, 15) + 1,35,000–7,50,000(A/F, 15\%, 15)$

$= 37,50,000(0.1710) + 1,35,000 – 7,50,000(0.0210)$

= Rs. 7,60,500

The annual equivalent cost of alternative 1 is less than that of alternative 2. Therefore, select the route around the lake for laying the power line.

EXAMPLE 6.6 A suburban taxi company is analyzing the proposal of buying cars withdiesel engines instead of petrol engines. The cars average 60,000 km a year with a useful life of three years for the petrol taxi and four years for the diesel taxi. Other comparative details are as follows:

	Diesel	*Petrol*
Vehicle cost (Rs.)	3,90,000	3,60,000
Fuel cost per litre (Rs.)	8	20
Mileage in km/litre	30	20
Annual repairs (Rs.)	9,000	6,000
Annual insurance premium (Rs.)	15,000	15,000
Resale value at the end of vehicle life (Rs.)	60,000	90,000

Determine the more economical choice if interest rate is 20%, compounded annually.

Solution Alternative 1— Purchase of diesel taxi

Vehicle cost = Rs. 3,90,000

Life = 4 years

Number of litres/year 60,000/30 = 2,000 litres

Fuel cost/yr = 2,000 x 8 = Rs. 16,000

Fuel cost, annual repairs and insurance premium/yr

= Rs. 16,000 + Rs. 9,000 + Rs. 15,000 = Rs. 40,000

Salvage value at the end of vehicle life = Rs. 60,000

The cash flow diagram for alternative 1 is shown in Fig. 6.13.

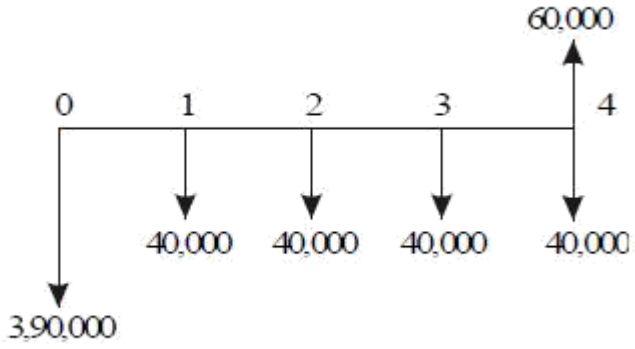


Fig. 6.13 Cash flow diagram for alternative 1.

The annual equivalent cost expression of the above cash flow diagram is

$AE(20\%) = 3,90,000(A/P, 20\%, 4) + 40,000–60,000(A/F, 20\%, 4)$

$= 3,90,000(0.3863) + 40,000 – 60,000(0.1863)$

= Rs. 1,79,479

Alternative 2— Purchase of petrol taxi

Vehicle cost = Rs. 3,60,000

Life = 3 years, Number of litres/year 60,000/20 = 3,000 litres

Fuel cost/yr = 3,000 x 20 = Rs. 60,000

Fuel cost, annual repairs and insurance premium/yr

= Rs. 60,000 + Rs. 6,000 + Rs. 15,000 = Rs. 81,000

Salvage value at the end of vehicle life = Rs. 90,000

The cash flow diagram for alternative 2 is shown in Fig. 6.14.

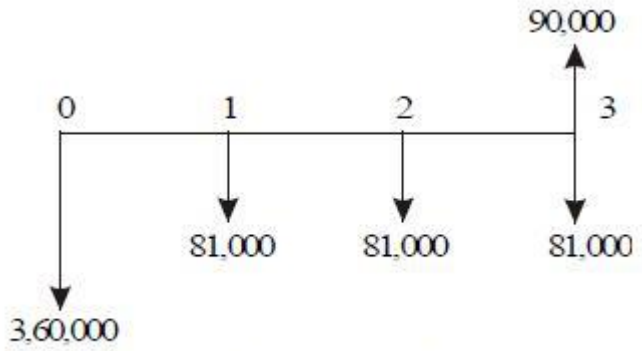


Fig. 6.14 Cash flow diagram for alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$AE(20\%) = 3{,}60{,}000(A/P, 20\%, 3) + 81{,}000 – 90{,}000(A/F, 20\%, 3)$

$= 3{,}60{,}000(0.4747) + 81{,}000 – 90{,}000(0.2747)$

= Rs. 2,27,169

The annual equivalent cost of purchase and operation of the cars with diesel engine is less than that of the cars with petrol engine. Therefore, the taxi company should buy cars with diesel engine. (*Note:* Comparison is done on common multiple lives of 12 years.)

EXAMPLE 6.7 Ramu, a salesman, needs a new car for use in his business. He expectsthat he will be promoted to a supervisory job at the end of third year and so his concern now is to have a car for the three years he expects to be ―on the road‖. The company will reimburse their salesman each month the fuel cost and maintenance cost. Ramu has decided to drive a low-priced automobile. He finds, however, that there are two different ways of obtaining the automobile. In either case, the fuel cost and maintenance cost are borne by the company.

(a) Purchase for cash at Rs. 3,90,000.

(b) Lease a car. The monthly charge is Rs. 10,500 on a 36-month lease payable at the end of each month. At the end of the three-year period, the car is returned to the leasing company. Ramu believes that he should use a 12% interest rate compounded monthly in determining which alternative to select. If the car could be sold for Rs. 1,20,000 at the end of the third year, which option should he use to obtain it?

Alternative 1—Purchase car for cash

Purchase price of the car = Rs. 3,90,000

Life = 3 years = 36 months

Salvage value after 3 years = Rs. 1,20,000

Interest rate = 12% (nominal rate, compounded annually) = 1% compounded monthly

The cash flow diagram for alternative 1 is shown in Fig. 6.15.

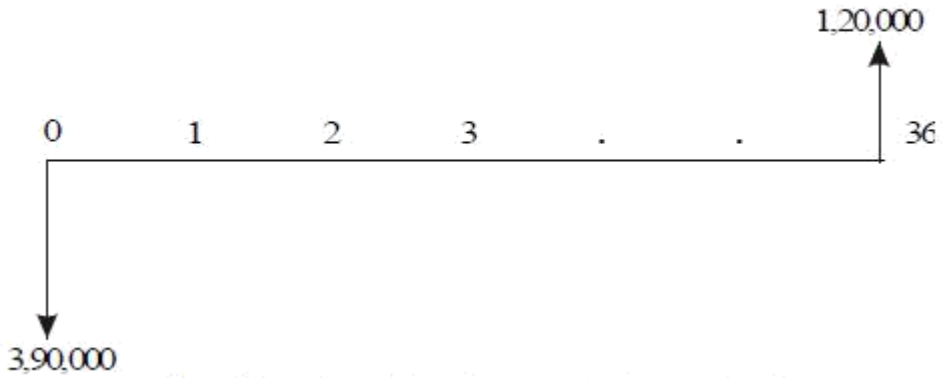


Fig. 6.15 Cash flow diagram for alternative 1.

The monthly equivalent cost expression [*ME*(1%)] of the above cash flow diagram is

ME(1%) = 3,90,000(*A*/*P*, 1%, 36)–1,20,000(*A*/*F*, 1%, 36)

= 3,90,000(0.0332) – 1,20,000(0.0232)

= Rs. 10,164

Alternative 2—Use of car under lease

Monthly lease amount for 36 months = Rs. 10,500

The cash flow diagram for alternative 2 is illustrated in Fig. 6.16.

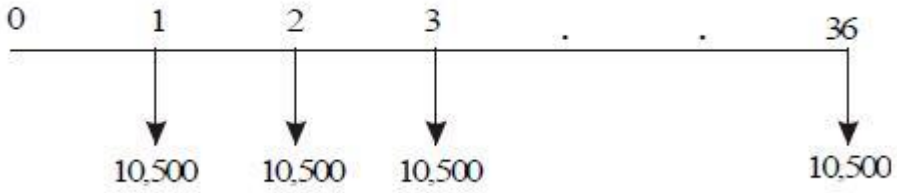


Fig. 6.16 Cash flow diagram for alternative 2.

Monthly equivalent cost = Rs.10,500.

The monthly equivalent cost of alternative 1 is less than that of alternative 2. Hence, the salesman should purchase the car for cash.

EXAMPLE 6.8 A company must decide whether to buy machine A or machine B.

	Machine A	*Machine B*
Initial cost (Rs.)	3,00,000	6,00,000
Useful life (years)	4	4
Salvage value at the end of machine life (Rs.)	2,00,000	3,00,000
Annual maintenance (Rs.)	30,000	0

At 15% interest rate, which machine should be purchased?

Solution Machine A

Initial cost = Rs. 3,00,000

Useful life (years) = 4

Salvage value at the end of machine life = Rs. 2,00,000

Annual maintenance = Rs. 30,000

Interest rate = 15%, compounded annually

The cash flow diagram of machine A is depicted in Fig. 6.17.

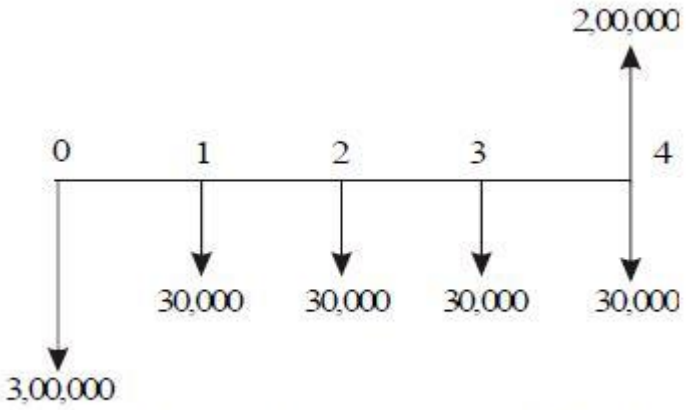


Fig. 6.17 Cash flow diagram for machine A.

The annual equivalent cost expression of the above cash flow diagram is

$AE(15\%) = 3,00,000(A/P, 15\%, 4) + 30,000–2,00,000(A/F, 15\%, 4)$

$= 3,00,000(0.3503) + 30,000 – 2,00,000(0.2003)$

= Rs. 95,030

Machine B

Initial cost = Rs. 6,00,000

Useful life (years) = 4

Salvage value at the end of machine life = Rs. 3,00,000

Annual maintenance = Rs. 0.

Interest rate = 15%, compounded annually

The cash flow diagram of machine B is illustrated in Fig. 6.18.

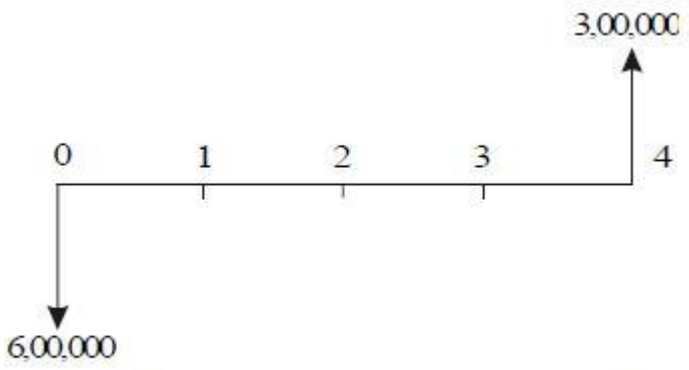


Fig. 6.18 Cash flow diagram for machine B.

The annual equivalent cost expression of the above cash flow diagram is

$AE(15\%) = 6,00,000(A/P, 15\%, 4) – 3,00,000(A/F, 15\%, 4)$

$= 6,00,000(0.3503) – 3,00,000(0.2003)$

= Rs. 1,50,090

Since the annual equivalent cost of machine A is less than that of machine B, it is advisable to buy machine A.

EXAMPLE 6.9 JothiLakshimi has arranged to buy some home recording equipment.She estimates that it will have a five year useful life and no salvage value at the end of equipment life. The dealer, who is a friend has offered JothiLakshimi two alternative ways to pay for the equipment.

(a) Pay Rs. 60,000 immediately and Rs. 15,000 at the end of one year.

(b) Pay nothing until the end of fourth year when a single payment of Rs. 90,000 must be made.

If JothiLakshimi believes 12% is a suitable interest rate, which alternative is the best for her?

Solution Alternative 1

Down payment = Rs. 60,000

Payment after one year = Rs. 15,000

The cash flow diagram for alternative 1 is shown in Fig. 6.19.

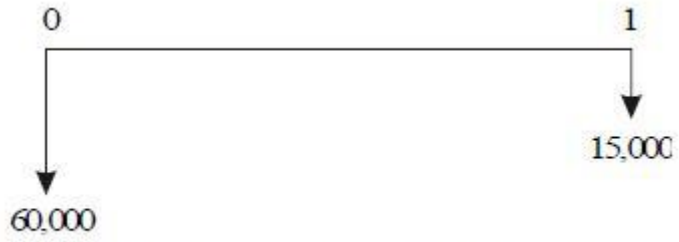


Fig. 6.19 Cash flow diagram for alternative 1.

The present worth equation of the above cash flow diagram is

$PW(12\%) = 60{,}000 + 15{,}000(P/F, 12\%, 1)$

$= 60{,}000 + 15{,}000(0.8929)$

$= 73{,}393.50$

The above present worth is represented in Fig. 6.20.

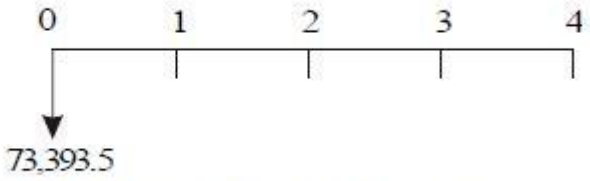


Fig. 6.20 Resultant cash flow diagram.

The annual equivalent expression of the above cash flow diagram is

$AE(12\%) = 73{,}393.5(A/P, 12\%, 4)$

$= 73{,}393.5(0.3292)$

= Rs. 24,161.14

Alternative 2

Payment after four years = Rs. 90,000

The cash flow diagram for alternative 2 is shown in Fig. 6.21.

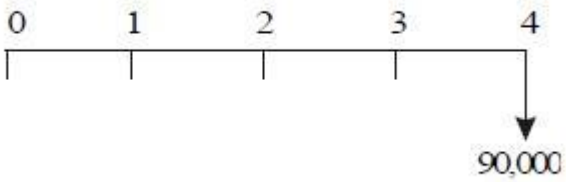


Fig. 6.21 Cash flow diagram of alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$AE(12\%) = 90{,}000(A/F, 12\%, 4)$

$= 90{,}000(0.2092)$

$= \text{Rs. } 18{,}828$

The annual equivalent cost of alternative 2 is less than that of alternative 1. Hence, Jothi Lakshimi should select alternative 2 for purchasing the home equipment.

EXAMPLE 6.10 A transport company has been looking for a new tyre for its truck and has located the following alternatives:

Brand	*Tyre warranty* (months)	*Price per tyre* (Rs.)
A	12	1,200
B	24	1,800
C	36	2,100
D	48	2,700

If the company feels that the warranty period is a good estimate of the tyre life and that a nominal interest rate (compounded annually) of 12% is appropriate, which tyre should it buy?

Solution In all the cases, the interest rate is 12%. This is equivalent to 1% permonth.

Brand A

Tyre warranty = 12 months

Price/tyre = Rs. 1,200

The cash flow diagram for brand A is shown in Fig. 6.22.

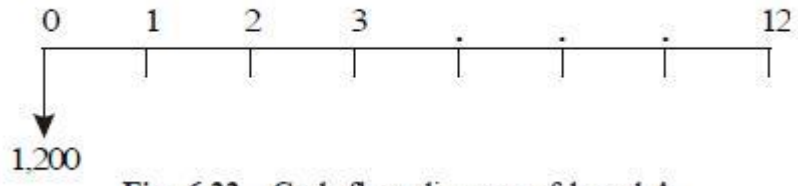


Fig. 6.22 Cash flow diagram of brand A.

The annual equivalent cost expression of the above cash flow diagram is

$AE(1\%) = 1{,}200(A/P, 1\%, 12)$

$= 1{,}200(0.0888)$

= Rs. 106.56

Brand B

Tyre warranty = 24 months

Price/tyre = Rs. 1,800

The cash flow diagram for brand B is shown in Fig. 6.23.

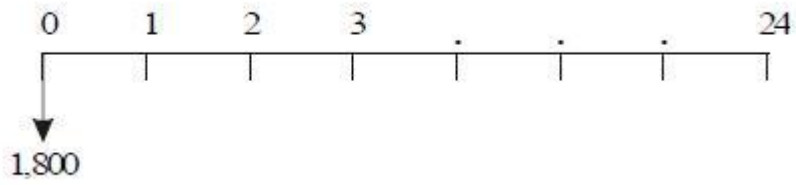


Fig. 6.23 Cash flow diagram of brand B.

The annual equivalent cost expression of the above cash flow diagram is

$AE(1\%) = 1{,}800(A/P, 1\%, 24)$

$= 1{,}800(0.0471)$

= Rs. 84.78

Brand C

Tyre warranty = 36 months

Price/tyre = Rs. 2,100

The cash flow diagram for brand C is shown in Fig. 6.24.

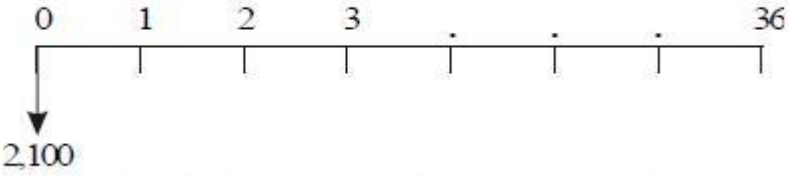


Fig. 6.24 Cash flow diagram of brand C.

The annual equivalent expression of the above cash flow diagram is

$AE(1\%) = 2{,}100(A/P, 1\%, 36)$

$= 2{,}100(0.0332)$

= Rs. 69.72

Brand D

Tyre warranty = 48 months

Price/tyre = Rs. 2,700

The cash flow diagram for brand D is shown in Fig. 6.25.

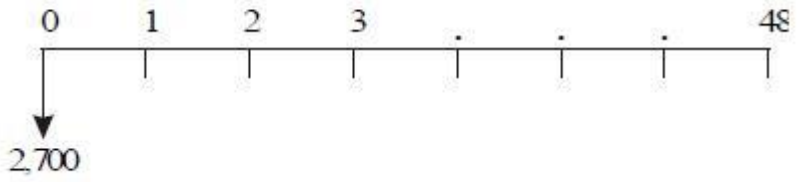


Fig. 6.25 Cash flow diagram of brand D.

The annual equivalent cost expression of the above cash flow diagram is

$AE(1\%) = 2{,}700(A/P, 1\%, 48)$

$= 2{,}700\ (0.0263)$

= Rs. 71.01

Here, minimum common multiple lives of tyres is considered. This is 144 months. Therefore, the comparison is made on 144 month‘s basis. The annual equivalent cost of brand C is less than that of other brands. Hence, it should be used in the vehicles of the trucking company. It should be replaced four times during the 144-month period

RATE OF RETURN METHOD

INTRODUCTION

The rate of return of a cash flow pattern is the interest rate at which the present worth of that cash flow pattern reduces to zero. In this method of comparison, the rate of return for each alternative is computed. Then the alternative which has the highest rate of return is selected as the best alternative. In this type of analysis, the expenditures are always assigned with a negative sign and the revenues/inflows are assigned with a positive sign.

A generalized cash flow diagram to demonstrate the rate of return method of comparison is presented in Fig. 7.1.

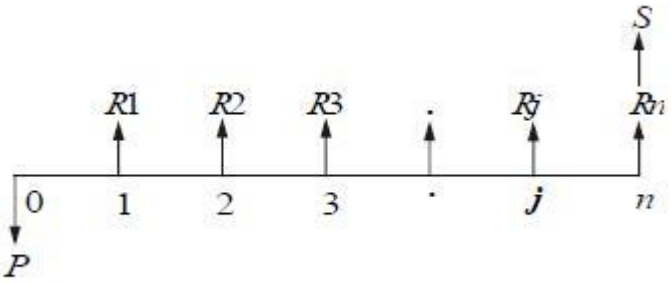


Fig. 7.1 Generalized cash flow diagram.

In the above cash flow diagram, *P* represents an initial investment, *Rj* the net revenue at the end of the *j*th year, and *S* the salvage value at the end of the *n*th year.

The first step is to find the net present worth of the cash flow diagram using the following expression at a given interest rate, *i*.

$$PW(i) = -P + R1/(1+i)1 + R2/(1+i)2 + ...$$
$$+ Rj/(1+i)\,j + ... + Rn/(1+i)n + S/(1+i)n$$

Now, the above function is to be evaluated for different values of *i* until the present worth function reduces to zero, as shown in Fig. 7.2.

In the figure, the present worth goes on decreasing when the interest rate is increased. The value of *i* at which the present worth curve cuts the *X*-axis is the rate of return of the given proposal/project. It will be very difficult to find the exact value of *i* at which the present worth function reduces to zero.

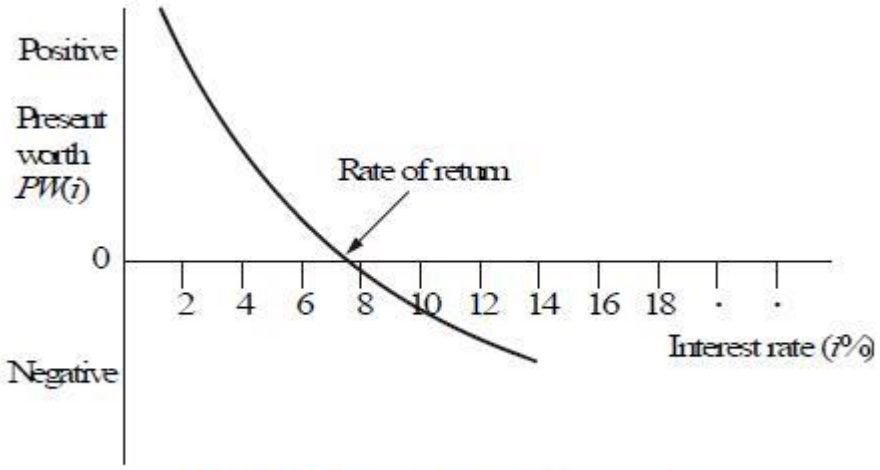


Fig. 7.2 Present worth function graph.

So, one has to start with an intuitive value of *i* and check whether the present worth function is positive. If so, increase the value of *i* until *PW*(*i*) becomes negative. Then, the rate of return is determined by interpolation method in the range of values of *i* for which the sign of the present worth function changes from positive to negative.

EXAMPLES

In this section, the concept of rate of return calculation is demonstrated with suitable examples.

EXAMPLE 7.1 A person is planning a new business. The initial outlay and cash flowpattern for the new business are as listed below. The expected life of the business is five years. Find the rate of return for the new business.

Period	0	1	2	3	4	5
Cash flow (Rs.)	−1,00,000	30,000	30,000	30,000	30,000	30,000

Solution

Initial investment = Rs. 1,00,000

Annual equal revenue = Rs. 30,000

Life = 5 years

The cash flow diagram for this situation is illustrated in Fig. 7.3.

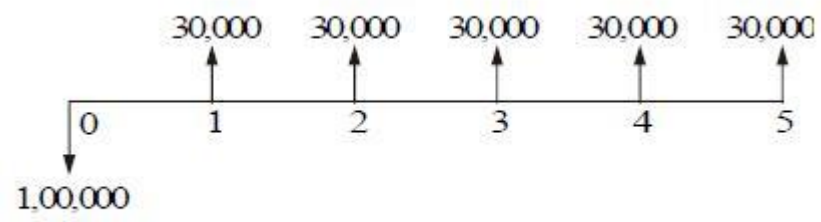


Fig. 7.3 Cash flow diagram.

The present worth function for the business is

$PW(i) = -1,00,000 + 30,000(P/A,i, 5)$

When $i = 10\%$,

$PW(10\%) = -1,00,000 + 30,000(P/A, 10\%, 5)$

$= -1,00,000 + 30,000(3.7908)$

= Rs. 13,724.

When $i = 15\%$,

$PW(15\%) = -1,00,000 + 30,000(P/A, 15\%, 5)$

$= -1,00,000 + 30,000(3.3522)$

= Rs. 566.

When $i = 18\%$,

$PW(18\%) = -1,00,000 + 30,000(P/A, 18\%, 5)$

$= -1,00,000 + 30,000(3.1272)$

= Rs. – 6,184

$$i = 15\% + \frac{566 - 0}{566 - (-6184)} \times (3\%)$$

$$= 15\% + 0.252\%$$

$$= 15.252\%$$

Therefore, the rate of return for the new business is 15.252%.

EXAMPLE 7.2 A company is trying to diversify its business in a new product line. The life of the project is 10 years with no salvage value at the end of its life. The initial outlay of the project is Rs. 20,00,000. The annual net profit is Rs. 3,50,000. Find the rate of return for the new business.

Solution

Life of the product line (n) = 10 years

Initial outlay = Rs. 20,00,000

Annual net profit = Rs. 3,50,000

Scrap value after 10 years = 0

The cash flow diagram for this situation is shown in Fig. 7.4.

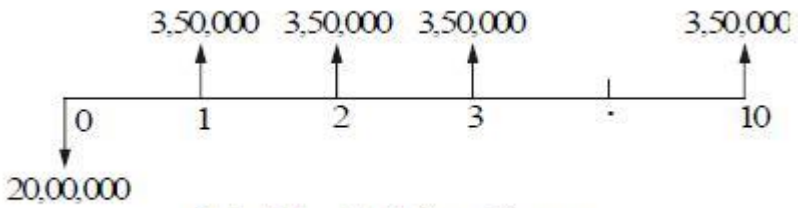


Fig. 7.4 Cash flow diagram.

The formula for the net present worth function of the situation is

$PW(i) = -20,00,000 + 3,50,000(P/A, i, 10)$

When $i = 10\%$,

$PW(10\%) = -20,00,000 + 3,50,000(P/A, 10\%, 10)$

$= -20,00,000 + 3,50,000(6.1446)$

= Rs. 1,50,610.

When $i = 12\%$,

$PW(12\%) = -20,00,000 + 3,50,000(P/A, 12\%, 10)$

$= -20,00,000 + 3,50,000(5.6502)$

= Rs. –22,430.

$$i = 10\% + \frac{1,50,610 - 0}{1,50,610 - (-22,430)} \times (2\%)$$

= 11.74 %

Therefore, the rate of return of the new product line is 11.74%

EXAMPLE 7.3 A firm has identified three mutually exclusive investment proposalswhose details are given below. The life of all the three alternatives is estimated to be five years with negligible salvage value. The minimum attractive rate of return for the firm is 12%.

	Alternative		
	*A*1	*A*2	*A*3
Investment	Rs. 1,50,000	Rs. 2,10,000	Rs. 2,55,000
Annual net income	Rs. 45,570	Rs. 58,260	Rs. 69,000

Find the best alternative based on the rate of return method of comparison.

Solution

Calculation of rate of return for alternative *A*1

Initial outlay = Rs. 1,50,000

Annual profit = Rs. 45,570

Life = 5 years

The cash flow diagram for alternative *A*1 is shown in Fig. 7.5.

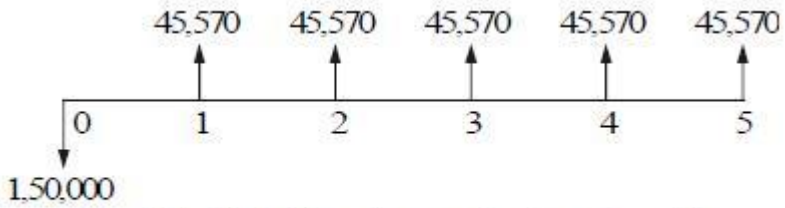


Fig. 7.5 Cash flow diagram for alternative *A*1.

The formula for the net present worth of alternative *A*1 is given as

$PW(i) = -1,50,000 + 45,570(P/A,i, 5)$

When $i = 10\%$,

$PW(10\%) = -1,50,000 + 45,570(P/A, 10\%, 5)$

$= -1,50,000 + 45,570(3.7908)$

= Rs. 22,746.76

When i = 12%,

$PW(12\%) = -1,50,000 + 45,570(P/A, 12\%, 5)$

= –1,50,000 + 45,570(3.6048)

= Rs. 14,270.74

When i = 15%,

$PW(15\%) = -1,50,000 + 45,570(P/A, 15\%, 5)$

= –1,50,000 + 45,570(3.3522)

= Rs. 2,759.75

When i = 18%,

$PW(18\%) = -1,50,000 + 45,570(P/A, 18\%, 5)$

= –1,50,000 + 45,570(3.1272)

= Rs. –7,493.50

Therefore, the rate of return of the alternative $A1$ is

$$i = 15\% + \frac{2,759.75 - 0}{2,759.75 - (-7,493.50)} \times (3\%)$$

$$= 15\% + 0.81\%$$

$$= 15.81\%$$

Calculation of rate of return for alternative $A2$

Initial outlay = Rs. 2,10,000

Annual profit = Rs. 58,260

Life of alternative $A2$ = 5 years

The cash flow diagram for alternative $A2$ is shown in Fig. 7.6.

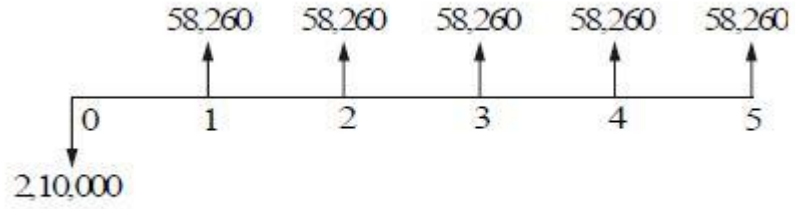


Fig. 7.6 Cash flow diagram for alternative $A2$.

The formula for the net present worth of this alternative is

$PW(i) = -2,10,000 + 58,260\ (P/A,i,\ 5)$

When $i = 12\%$,

$PW(12\%) = -2,10,000 + 58,260(P/A,\ 12\%,\ 5)$

$= -2,10,000 + 58,260(3.6048)$

= Rs. 15.65

When $i = 13\%$,

$PW(13\%) = -2,10,000 + 58,260(P/A,\ 13\%,\ 5)$

$= -2,10,000 + 58,260\ (3.5172)$

= Rs. –5,087.93

Therefore, the rate of return of alternative *A*2 is

$$i = 12\% + \frac{15.65 - 0}{15.65 - (-5,087.93)} \times (1\%)$$

$$= 12\% + 0\%$$

$$= 12\%$$

Calculation of rate of return for alternative *A*3

Initial outlay = Rs. 2,55,000

Annual profit = Rs. 69,000

Life of alternative *A*3 = 5 years

The cash flow diagram for alternative *A*3 is depicted in Fig. 7.7.

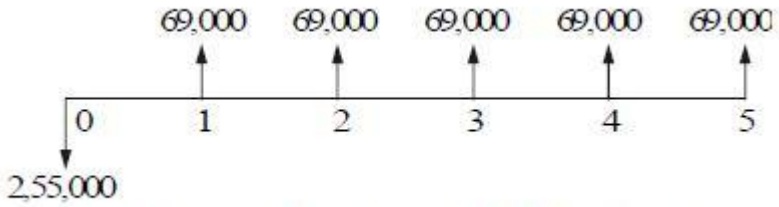


Fig. 7.7 Cash flow diagram for alternative *A*3.

The formula for the net present worth of this alternative *A*3 is

$PW(i) = -2,55,000 + 69,000(P/A,i, 5)$

When $i = 11\%$,

$PW(11\%) = -2,55,000 + 69,000(P/A, 11\%, 5)$

$= -2,55,000 + 69,000\ (3.6959)$

= Rs. 17.1

When $i = 12\%$,

$PW(12\%) = -2,55,000 + 69,000(P/A, 12\%, 5)$

$= -2,55,000 + 69,000\ (3.6048)$

= Rs. – 6,268.80

Therefore, the rate of return for alternative *A*3 is

$$i = 11\% + \frac{17.1 - 0}{17.1 - (-6,268.80)} \times 1\%$$

$$= 11\%$$

The rates of return for the three alternatives are now tabulated

Alternative	*A*1	*A*2	*A*3
Rate of return	15.81%	12%	11%

From the above data, it is clear that the rate of return for alternative *A*3 is less than the minimum attractive rate of return of 12%. So, it should not be considered for comparison. The remaining two alternatives are qualified for consideration. Among the alternatives *A*1 and *A*2, the rate of return of alternative *A*1 is greater than that of alternative *A*2. Hence, alternative *A*1 should be selected.

EXAMPLE 7.4 For the cash flow diagram shown in Fig. 7.8, compute the rate ofreturn. The amounts are in rupees.

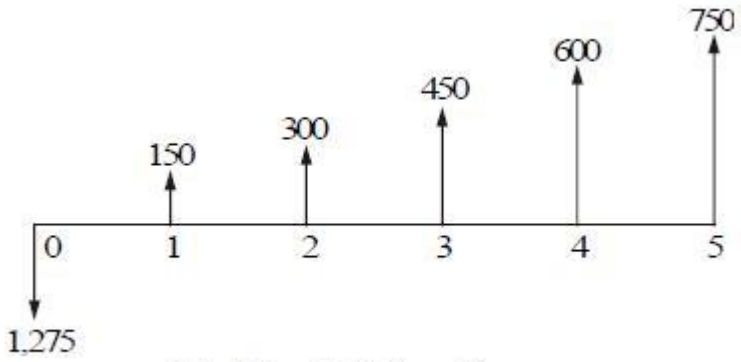


Fig. 7.8 Cash flow diagram.

Solution For the positive cash flows of the problem,

$A1$ = Rs. 150, G = Rs. 150

The annual equivalent of the positive cash flows of the uniform gradient series is given by

$A = A1 + G(A/G, i, n)=$

$150 + 150(A/G, i, 5)$

The formula for the present worth of the whole diagram = $–1,275 + [150 + 150(A/G, i, 5)] \_ (P/A, i, 5)$

$PW(10\%) = –1,275 + [150 + 150(A/G, 10\%, 5)] \_\_ (P/A, 10\%, 5)= –1,275 + [150 + 150(1.8101)] \_ (3.7908)$

= Rs. 322.88

$PW(12\%) = –1,275 + [150 + 150(A/G, 12\%, 5)] \_ (P/A, 12\%, 5)= –1,275 + [150 + 150(1.7746)] \_ (3.6048)$

= Rs. 225.28

$PW(15\%) = –1,275 + [150 + 150(A/G, 15\%, 5)] \_ (P/A, 15\%, 5)= –1,275 + [150 + 150(1.7228)] \_ (3.3522)$

= Rs. 94.11

$PW(18\%) = –1,275 + [150 + 150(A/G, 18\%, 5)] \_ (P/A, 18\%, 5)= –1,275 + [150 + 150(1.6728)] \_ (3.1272)$

= Rs. –21.24

Therefore, the rate of return for the cash flow diagram is

$$i = 15\% + \frac{94.11 - 0}{94.11 - (-21.24)} \times 3\%$$

$$= 15\% + 2.45\% = 17.45\%$$

EXAMPLE 7.5 A company is planning to expand its present business activity. It hastwo alternatives for the expansion programme and the corresponding cash flows are tabulated below. Each alternative has a life of five years and a negligible salvage value. The minimum attractive rate of return for the company is 12%. Suggest the best alternative to the company.

	Initial investment (Rs.)	*Yearly revenue* (Rs.)
Alternative 1	5,00,000	1,70,000
Alternative 2	8,00,000	2,70,000

Solution Alternative 1

Initial outlay = Rs. 5,00,000

Annual revenue = Rs. 1,70,000

Life of alternative 1 = 5 years

The cash flow diagram for alternative 1 is illustrated in Fig. 7.9.

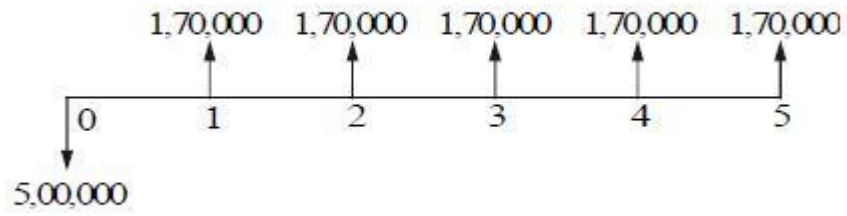


Fig. 7.9 Cash flow diagram for alternative 1.

The formulae for the net present worth of alternative 1 are as follows:

$PW1(i) = -5,00,000 + 1,70,000(P/A,i, 5)$

$PW1(15\%) = -5,00,000 + 1,70,000(P/A, 15\%, 5)$

$= -5,00,000 + 1,70,000(3.3522)$

= Rs. 69,874

$PW1(17\%) = -5,00,000 + 1,70,000(P/A, 17\%, 5)$

$= -5,00,000 + 1,70,000(3.1993)$

= Rs. 43,881

$PW1(20\%) = -5,00,000 + 1,70,000(P/A, 20\%, 5)$

$= -5,00,000 + 1,70,000(2.9906)$

= Rs. 8,402

$PW1(22\%) = -5,00,000 + 1,70,000(P/A, 22\%, 5)$

$= -5,00,000 + 1,70,000(2.8636)$

= Rs. –13,188

Therefore, the rate of return of alternative 1 is

$$i = 20\% + \frac{8,402 - 0}{8,402 - (-13,188)} \times 2\%$$

$$= 20.78\%$$

Alternative 2

Initial outlay = Rs. 8,00,000
Annual revenue = Rs. 2,70,000
Life = 5 years

The cash flow diagram for alternative 2 is depicted in Fig. 7.10.

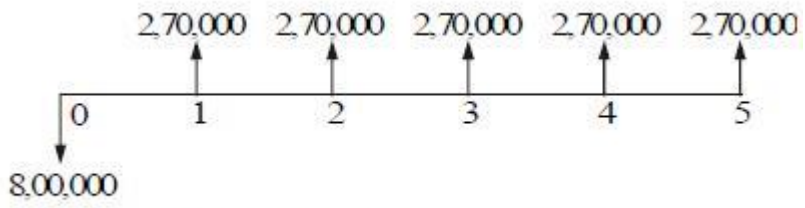


Fig. 7.10 Cash flow diagram for alternative 2.

The formula for the net present worth of alternative 2 is:

$PW2(i) = –8,00,000 + 2,70,000(P/A,i, 5)$

$PW2(20\%) = –8,00,000 + 2,70,000(P/A, 20\%, 5)$

$= – 8,00,000 + 2,70,000(2.9906)$

= Rs. 7,462

$PW2(22\%) = –8,00,000 + 2,70,000 (P/A, 22\%, 5)$

$= – 8,00,000 + 2,70,000 (2.8636)$

= Rs. –26,828

Thus, the rate of return of alternative 2 is

$$i = 20\% + \frac{7,462 - 0}{7,462 - (-26,828)} \times 2\%$$

$$= 20.435\%$$

Since the rate of return of alternative 1 is greater than that of the alternative 2, select alternative 1.

UNIT – III

Depreciation: Introduction, Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation/Annuity Method of Depreciation, Service Output Method of Depreciation, Evaluation of Public Alternatives- Introduction, Examples, Inflation Adjusted Decisions – Procedure to Adjust Inflation, Examples on comparison of alternatives and Determination of Economics Life of asset.

DEPRECIATION

INTRODUCTION

Any equipment which is purchased today will not work for ever. This may be due to wear and tear of the equipment or obsolescence of technology. Hence, it is to be replaced at the proper time for continuance of any business. The replacement of the equipment at the end of its life involves money. This must be internally generated from the earnings of the equipment. The recovery of money from the earnings of an equipment for its replacement purpose is called *depreciation fund* since we make an assumption that the value of the equipment decreases with the passage of time. Thus, the word ―depreciation‖ means *decrease* in value of any physical asset with the passage of time.

METHODS OF DEPRECIATION

There are several methods of accounting depreciation fund. These are as follows:

1. Straight line method of depreciation
2. Declining balance method of depreciation
3. Sum of the years—digits method of depreciation
4. Sinking-fund method of depreciation
5. Service output method of depreciation

Straight Line Method of Depreciation

In this method of depreciation, a fixed sum is charged as the depreciation amount throughout the lifetime of an asset such that the accumulated sum at the end of the life of the asset is exactly equal to the purchase value of the asset. Here, we make an important assumption that inflation is absent.

Let

P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

B_t = book value of the asset at the end of the period t,

D_t = depreciation amount for the period t.

The formulae for depreciation and book value are as follows:

$$D_t = (P - F)/n$$

$$B_t = B_{t-1} - D_t = P - t \times [(P - F)/n]$$

EXAMPLE 9.1 A company has purchased an equipment whose first cost is Rs. 1,00,000 with an estimated life of eight years. The estimated salvage value of the equipment at the end of its lifetime is Rs. 20,000. Determine the depreciation charge and book value at the end of various years using the straight line method of depreciation.

Solution

P = Rs. 1,00,000

F = Rs. 20,000

n = 8 years

$D_t = (P - F)/n$

$= (1,00,000 - 20,000)/8$

$=$ Rs. 10,000

In this method of depreciation, the value of D_t is the same for all the years. The calculations pertaining to B_t for different values of t are summarized in Table 9.1.

Table 9.1 D_t and B_t Values under Straight line Method of Depreciation

End of year (t)	*Depreciation* (D_t)	*Book value* ($B_t = B_{t-1} - D_t$)
0		1,00,000
1	10,000	90,000
2	10,000	80,000
3	10,000	70,000
4	10,000	60,000
5	10,000	50,000
6	10,000	40,000
7	10,000	30,000
8	10,000	20,000

If we are interested in computing D_t and B_t for a specific period (t), the formulae can be used. In this approach, it should be noted that the depreciation is the same for all the periods.

9.2.2 Declining Balance Method of Depreciation

In this method of depreciation, a constant percentage of the book value of the previous period of the asset will be charged as the depreciation amount for the current period. This approach is a more realistic approach, since the depreciation charge decreases with the life of the asset which matches with the earning potential of the asset. The book value at the end of the life of the asset may not be exactly equal to the salvage value of the asset. This is a major limitation of this approach.

Let

P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

B_t = book value of the asset at the end of the period t,

K = a fixed percentage, and

D_t = depreciation amount at the end of the period t.

The formulae for depreciation and book value are as follows:

$$D_t = K \times B_{t-1}$$

$$B_t = B_{t-1} - D_t = B_{t-1} - K \times B_{t-1}$$

$$= (1 - K) \times B_{t-1}$$

The formulae for depreciation and book value in terms of P are as follows:

$$D_t = K(1 - K)^{t-1} \times P$$

$$B_t = (1 - K)^t \times P$$

While availing income-tax exception for the depreciation amount paid in each year, the rate K is limited to at the most $2/n$. If this rate is used, then the corresponding approach is called the *double declining balance method of depreciation.*

EXAMPLE 9.3 Consider Example 9.1 and demonstrate the calculations of the declining balance method of depreciation by assuming 0.2 for K.

Solution

P = Rs. 1,00,000

F = Rs. 20,000

n = 8 years

K = 0.2

The calculations pertaining to D_t and B_t for different values of t are summarized in Table 9.2 using the following formulae:

$$D_t = K \times B_{t-1}$$

$$B_t = B_{t-1} - D_t$$

Table 9.2 D_t and B_t according to Declining Balance Method of Depreciation

End of year (n)	*Depreciation* (D_t)	*Book value* (B_t)
0		1,00,000.00
1	20,000.00	80,000.00
2	16,000.00	64,000.00
3	12,800.00	51,200.00
4	10,240.00	40,960.00
5	8,192.00	32,768.00
6	6,553.60	26,214.40
7	5,242.88	20,971.52
8	4,194.30	16,777.22

If we are interested in computing D_t and B_t for a specific period t, the respective formulae can be used.

9.2.3 Sum-of-the-Years-Digits Method of Depreciation

In this method of depreciation also, it is assumed that the book value of the asset decreases at a decreasing rate. If the asset has a life of eight years, first the sum of the years is computed as

$$\text{Sum of the years} = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8$$
$$= 36 = n(n + 1)/2$$

The rate of depreciation charge for the first year is assumed as the highest and then it decreases. The rates of depreciation for the years 1–8, respectively are as follows: 8/36, 7/36, 6/36, 5/36, 4/36, 3/36, 2/36, and 1/36.

For any year, the depreciation is calculated by multiplying the corresponding rate of depreciation with $(P - F)$.

$$D_t = \text{Rate} \times (P - F)$$
$$B_t = B_{t-1} - D_t$$

The formulae for D_t and B_t for a specific year t are as follows:

$$D_t = \frac{n - t + 1}{n(n + 1)/2} (P - F)$$

$$B_t = (P - F) \frac{(n - t)}{n} \frac{(n - t + 1)}{(n + 1)} + F$$

EXAMPLE 9.5 Consider Example 9.1 and demonstrate the calculations of the sum-of-the-years-digits method of depreciation.

Solution

P = Rs. 1,00,000

F = Rs. 20,000

n = 8 years

$$\text{Sum} = n(n + 1)/2 = 8 \times 9/2 = 36$$

The rates for years 1–8, are respectively 8/36, 7/36, 6/36, 5/36, 4/36, 3/36, 2/36 and 1/36.

The calculations of D_t and B_t for different values of t are summarized in Table 9.3 using the following formulae:

$$D_t = \text{Rate} \times (P - F)$$

$$B_t = B_{t-1} - D_t$$

Table 9.3 D_t and B_t under Sum-of-the-years-digits Method of Depreciation

End of year (n)	*Depreciation* (D_t)	*Book value* (B_t)
0		1,00,000.00
1	17,777.77	82,222.23
2	15,555.55	66,666.68
3	13,333.33	53,333.35
4	11,111.11	42,222.24
5	8,888.88	33,333.36
6	6,666.66	26,666.70
7	4,444.44	22,222.26
8	2,222.22	20,000.04

If we are interested in calculating D_t and B_t for a specific t, then the usage of the formulae would be better.

9.2.4 Sinking Fund Method of Depreciation

In this method of depreciation, the book value decreases at increasing rates with respect to the life of the asset. Let

P = first cost of the asset,

F = salvage value of the asset,

n = life of the asset,

i = rate of return compounded annually,

A = the annual equivalent amount,

B_t = the book value of the asset at the end of the period t, and

D_t = the depreciation amount at the end of the period t.

The loss in value of the asset $(P - F)$ is made available an the form of cumulative depreciation amount at the end of the life of the asset by setting up an equal depreciation amount (A) at the end of each period during the lifetime of the asset.

$$A = (P - F) \times [A/F, i, n]$$

The fixed sum depreciated at the end of every time period earns an interest at the rate of i% compounded annually, and hence the actual depreciation amount will be in the increasing manner with respect to the time period. A generalized formula for D_t is

$$D_t = (P - F) \times (A/F, i, n) \times (F/P, i, t - 1)$$

The formula to calculate the book value at the end of period t is

$$B_t = P - (P - F)\ (A/F, i, n)\ (F/A, i, t)$$

The above two formulae are very useful if we have to calculate D_t and B_t for any specific period. If we calculate D_t and B_t for all the periods, then the tabular approach would be better.

EXAMPLE 9.7 Consider Example 9.1 and give the calculations regarding the sinking fund method of depreciation with an interest rate of 12%, compounded annually.

Solution

P = Rs. 1,00,000

F = Rs. 20,000

n = 8 years

i = 12%

$$\begin{aligned} A &= (P - F) \times [A/F, 12\%, 8] \\ &= (1{,}00{,}000 - 20{,}000) \times 0.0813 \\ &= \text{Rs. } 6{,}504 \end{aligned}$$

In this method of depreciation, a fixed amount of Rs. 6,504 will be depreciated at the end of every year from the earning of the asset. The depreciated amount will earn interest for the remaining period of life of the asset at an interest rate of 12%, compounded annually. For example, the calculations of net depreciation for some periods are as follows:

Depreciation at the end of year 1 (D_1) = Rs. 6,504.

Depreciation at the end of year 2 (D_2) = 6,504 + 6,504 × 0.12

= Rs. 7,284.48

Depreciation at the end of the year 3 (D_3)

$$= 6{,}504 + (6{,}504 + 7{,}284.48) \times 0.12$$

$$= \text{Rs. } 8{,}158.62$$

Depreciation at the end of year 4 (D_4)

$$= 6{,}504 + (6{,}504 + 7{,}284.48 + 8{,}158.62) \times 0.12$$

$$= \text{Rs. } 9{,}137.65$$

These calculations along with book values are summarized in Table 9.4.

Table 9.4 D_t and B_t according to Sinking Fund Method of Depreciation

End of year t	*Fixed depreciation* (Rs.)	*Net depreciation* D_t (Rs.)	*Book value* B_t (Rs.)
0	6,504	–	1,00,000.00
1	6,504	6,504.00	93,496.00
2	6,504	7,284.48	86,211.52
3	6,504	8,158.62	78,052.90
4	6,504	9,137.65	68,915.25
5	6,504	10,234.17	58,681.08
6	6,504	11,462.27	47,218.81
7	6,504	12,837.74	34,381.07
8	6,504	14,378.27	20,002.80
		$B_t = B_{t-1} - D_t$	

9.2.5 Service Output Method of Depreciation

In some situations, it may not be realistic to compute depreciation based on time period. In such cases, the depreciation is computed based on service rendered by an asset. Let

P = first cost of the asset

F = salvage value of the asset

X = maximum capacity of service of the asset during its lifetime

x = quantity of service rendered in a period.

Then, the depreciation is defined per unit of service rendered:

$$\text{Depreciation/unit of service} = (P - F)/X$$

$$\text{Depreciation for } x \text{ units of service in a period} = \frac{P - F}{X}(x)$$

EXAMPLE 9.9 The first coat of a road laying machine is Rs. 80,00,000. Its salvage value after five years is Rs. 50,000. The length of road that can be laid by the machine during its lifetime is 75,000 km. In its third year of operation, the length of road laid is 2,000 km. Find the depreciation of the equipment for that year.

Solution

P = Rs. 80,00,000

F = Rs. 50,000

X = 75,000 km

x = 2,000 km

$$\text{Depreciation for } x \text{ units of service in a period} = \frac{P - F}{X}x$$

$$\text{Depreciation for year 3} = \frac{(80{,}00{,}000 - 50{,}000)}{75{,}000} \times 2{,}000$$

$$= \text{Rs. } 2{,}12{,}000$$

EVALUATION OF PUBLIC ALTERNATIVES

In evaluating alternatives of private organizations, the criterion is to select the alternative with the maximum profit. The profit maximization is the main goal of private organizations while providing goods/services as per specifications to their customers. But the same criterion cannot be used while evaluating public alternatives. Examples of some public alternatives are constructing bridges, roads, dams, establishing public utilities, etc.

The main objective of any public alternative is to provide goods/services to the public at the minimum cost. In this process, one should see whether the benefits of the public activity are at least equal to its costs. If yes, then the public activity can be undertaken for implementation. Otherwise, it can be cancelled. This is nothing but taking a decision based on Benefit-Cost ratio (BC) given by

$$\text{BC ratio} = \frac{\text{Equivalent benefits}}{\text{Equivalent costs}}$$

The benefits may occur at different time periods of the public activity. For the purpose of comparison, these are to be converted into a common time base (present worth or future worth or annual equivalent). Similarly, the costs consist of initial investment and yearly operation and maintenance cost. These are to be converted to a common time base as done in the equivalent benefits. Now the ratio between the equivalent benefits and equivalent costs is known as the "Benefit-Cost ratio". If this ratio is at least one, the public activity is justified; otherwise, it is not justified. Let

B_P = present worth of the total benefits

B_F = future worth of the total benefits

B_A = annual equivalent of the total benefits

P = initial investment

P_F = future worth of the initial investment

P_A = annual equivalent of the initial investment

C = yearly cost of operation and maintenance

C_P = present worth of yearly cost of operation and maintenance

C_F = future worth of yearly cost of operation and maintenance

$$\text{BC ratio} = \frac{B_P}{P + C_P} = \frac{B_F}{P_F + C_F} = \frac{B_A}{P_A + C}$$

EXAMPLE 10.1 In a particular locality of a state, the vehicle users take a roundabout route to reach certain places because of the presence of a river. This results in excessive travel time and increased fuel cost. So, the state government is planning to construct a bridge across the river. The estimated initial investment for constructing the bridge is Rs. 40,00,000. The estimated life of the bridge is 15 years. The annual operation and maintenance cost is Rs. 1,50,000. The value of fuel savings due to the construction of the bridge is Rs. 6,00,000 in the first year and it increases by Rs. 50,000 every year thereafter till the end of the life of the bridge. Check whether the project is justified based on BC ratio by assuming an interest rate of 12%, compounded annually.

Solution

Initial investment = Rs. 40,00,000
Annual operation and maintenance = Rs. 1,50,000
Annual fuel savings during the first year = Rs. 6,00,000
Equal increment in fuel savings in the following years = Rs. 50,000
Life of the project = 15 years
Interest rate = 12%

The cash flow diagram of the project is shown in Fig. 10.1.

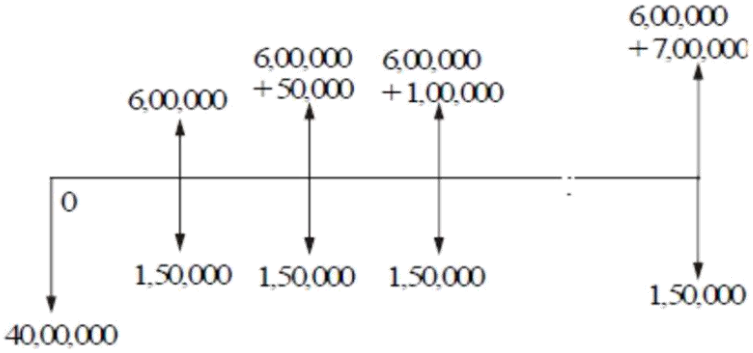


Fig. 10.1 Cash flow diagram for constructing bridge.

Total present worth of costs = Initial investment (P)
+ Present worth of annual operating and maintenance cost (C_P) = $P + C_P$
= Rs. 40,00,000 + 1,50,000 × (P/A, 12%, 15)
= Rs. 40,00,000 + 1,50,000 × 6.8109
= Rs. 50,21,635

Total present worth of fuel savings (B_P):

$A1$ = Rs. 6,00,000
G = Rs. 50,000
n = 15 years
i = 12%

Annual equivalent fuel savings (A) $= A1 + G\,(A/G, 12\%, 15)$
$= 6,00,000 + 50,000\ (4.9803)$
$=$ Rs. 8,49,015

Present worth of the fuel savings (B_P) $= A(P/A, 12\%, 15)$
$= 8,49,015\ (6.8109)$
$=$ Rs. 57,82,556

$$\text{BC ratio} = \frac{B_P}{P + C_P} = \frac{57,82,556}{50,21,635} = 1.1515$$

Since the BC ratio is more than 1, the construction of the bridge across the river is justified.

INFLATION ADJUSTED DECISION;

A general inflationary trend in the cost of goods is common everywhere due to various interacting factors. If the rate of inflation is very high, it will produce extremely serious consequences for both individuals and institutions.

Inflation is the rate of increase in the prices of goods per period. So, it has a compounding effect. Thus, prices that are inflated at a rate of 7% per year will increase 7% in the first year, and for the next year the expected increase will be 7% of these new prices. The same is true for succeeding years and hence the rate of inflation is compounded in the same manner that an interest rate is compounded. If the average inflation over six years period is 7%, then the prices at the beginning of the seventh year would be 150% that of the first year by assuming 100% for the prices at the beginning of the first year of the six-year period.

If economic decisions are taken without considering the effect of inflation into account, most of them would become meaningless and as a result the organizations would end up with unpredictable return.

But there is always difficulty in determining the rate of inflation. The world-wide trend/wish is to curtail inflation. But due to various reasons, it is very difficult to have zero inflation. For practical decision making, an average estimate may be assumed depending on the period of the proposals under consideration. Hence, we need a procedure which will combine the effects of inflation rate and interest rate to take realistic economic decision.

11.2 PROCEDURE TO ADJUST INFLATION

A procedure to deal with this situation is summarized now.

1. Estimate all the costs/returns associated with an investment proposal in terms of today's rupees.
2. Modify the costs/returns estimated in step 1 using an assumed inflation rate so that at each future date they represent the costs/returns at that date in terms of the rupees that must be expended/received at that time, respectively.
3. As per our requirement, calculate either the annual equivalent amount or future amount or present amount of the cash flow resulting from step 2 by considering the time value of money.

EXAMPLE 11.1 Suppose a 40-year old man is planning for his retirement. He plans to retire at the age of 60 and estimates that he can live comfortably on Rs. 24,000 per year in terms of today's rupee value. He can invest his savings at 15% compounded annually. Assume an average inflation rate of 9% for the next 30 years.

What equal amount should he save each year until he retires so that he can make withdrawals at the end of each year commencing from the end of the 21st year from now that will allow him to live as comfortably as he desires for 10 years beyond his retirement?

Solution

Step 1. The estimated future requirement per year in terms of today's rupees from his age 61 through 70 is Rs. 24,000.

Step 2. Modification of the costs estimated in step 1 is summarized in Table 11.1. The formula which is given below is used to get future equivalent of Rs. 24,000 with the inflation of 9% per year (IR-inflation rate).

$$F = P\,(1 + IR)^n$$

Table 11.1 Inflated Future Requirements

End of year	*Age* (years)	*Inflated value of Rs. 24,000 at each year end*
21	61	$24{,}000 \times (1 + 0.09)^{21}$ = Rs. 1,46,611
22	62	$24{,}000 \times (1 + 0.09)^{22}$ = Rs. 1,59,806
23	63	$24{,}000 \times (1 + 0.09)^{23}$ = Rs. 1,74,189
24	64	$24{,}000 \times (1 + 0.09)^{24}$ = Rs. 1,89,866
25	65	$24{,}000 \times (1 + 0.09)^{25}$ = Rs. 2,06,954
26	66	$24{,}000 \times (1 + 0.09)^{26}$ = Rs. 2,25,580
27	67	$24{,}000 \times (1 + 0.09)^{27}$ = Rs. 2,45,882
28	68	$24{,}000 \times (1 + 0.09)^{28}$ = Rs. 2,68,011
29	69	$24{,}000 \times (1 + 0.09)^{29}$ = Rs. 2,92,132
30	70	$24{,}000 \times (1 + 0.09)^{30}$ = Rs. 3,18,424

Step 3. Now, the calculation of the equivalent amount of cash flow as per the requirement is presented.

The overall cash flow diagram for the savings and withdrawal in terms of future rupees is shown in Fig. 11.1.

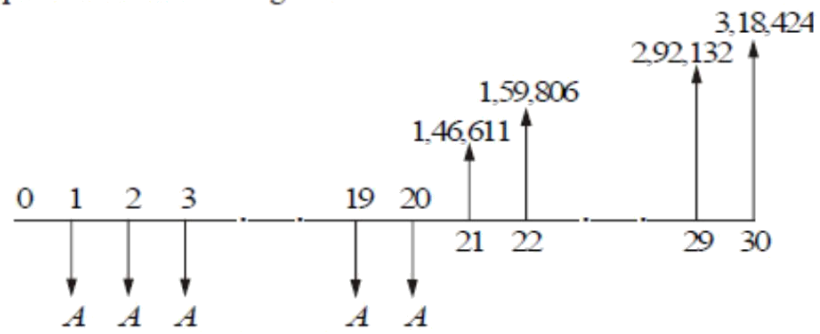


Fig. 11.1 Overall cash flow diagram.

The sum of the present equivalents of the year end withdrawals from the year 21 to 30 is computed by assuming the end of the year 20 as the base (time zero) and it is shown at the end of the year 20 in Fig. 11.2. The method of computing the present equivalent of the withdrawals is as follows:

$$\begin{aligned} PW(i = 15\%) = {} & 1{,}46{,}611/(1 + 0.15)^1 + 1{,}59{,}806/(1 + 0.15)^2 \\ & + 1{,}74{,}189/(1 + 0.15)^3 + 1{,}89{,}866/(1 + 0.15)^4 \\ & + 2{,}06{,}954/(1 + 0.15)^5 + 2{,}25{,}580/(1 + 0.15)^6 \\ & + 2{,}45{,}882/(1 + 0.15)^7 + 2{,}68{,}011/(1 + 0.15)^8 \\ & + 2{,}92{,}132/(1 + 0.15)^9 + 3{,}18{,}424/(1 + 0.15)^{10} \\ = {} & \text{Rs. } 10{,}13{,}631. \end{aligned}$$

= Rs. 10,13,631.

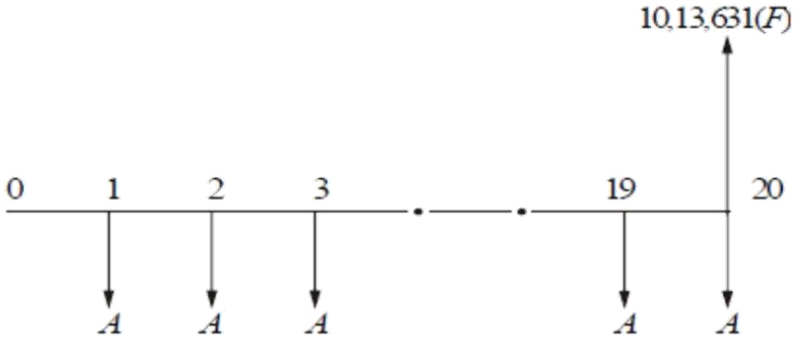


Fig. 11.2 Equivalent cash flow diagram.

The annual equivalent amount (A), which should be invested from the end of year 1 (age 41) to year 20 (age 60), is computed using the following formula.

$$\begin{aligned} A &= F(A/F, 15\%, 20) \\ &= 10{,}13{,}631 \times (0.0098) \\ &= \text{Rs. } 9{,}934 \end{aligned}$$

Recommendation: The person has to invest an amount of Rs. 9,934 at the end of every year starting from his age 41 (year 1) through 60 (year 20) which will enable him to make withdrawals at the end of every year starting from his age 61 (year 21) through 70 (year 30) as shown in the Table 11.1 (also in Fig. 11.1).

11.3 INFLATION ADJUSTED ECONOMIC LIFE OF MACHINE

(Panneerselvam, 1998)

In any industrial/service organization, equipment/machinery forms an important element. The productivity of any organization is a function of many factors. It is largely affected by efficient and effective use of machinery and equipment. So, operations and maintenance of these equipment are very important to the organization.

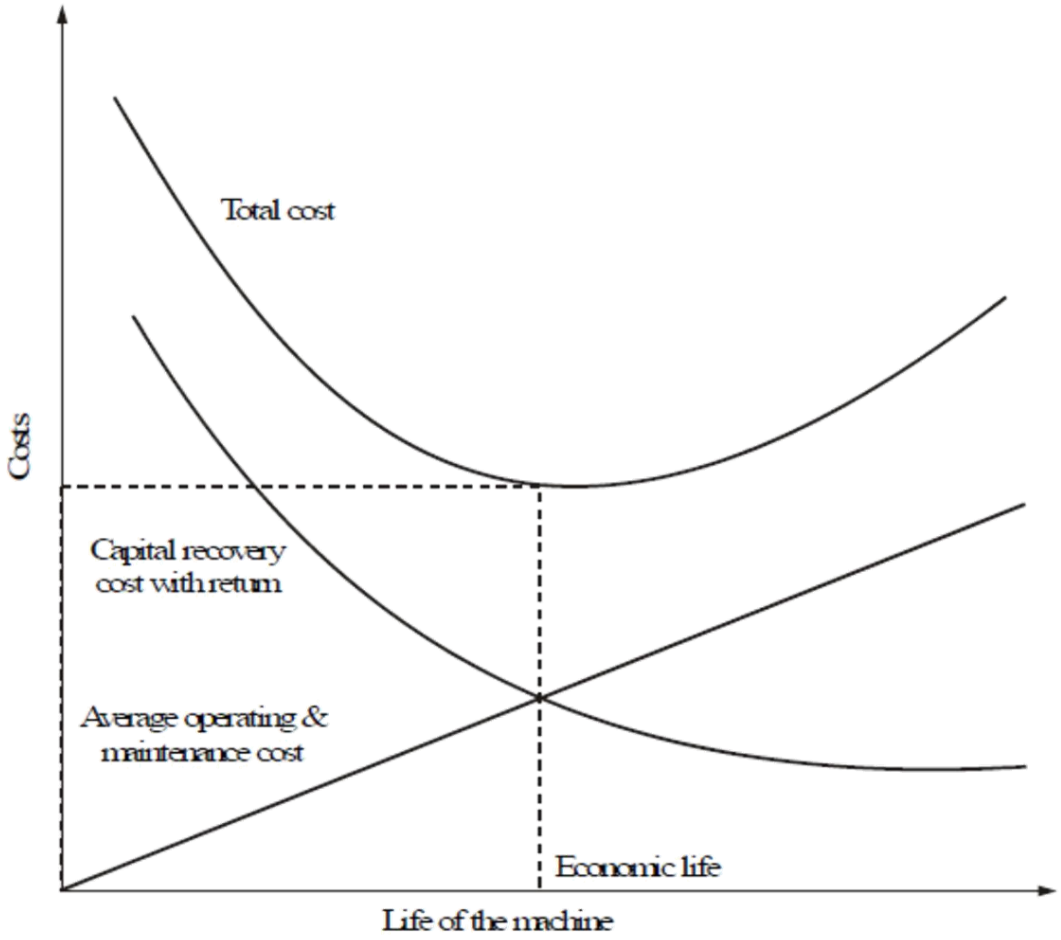
A machine which is purchased today cannot be used forever. It has a definite economic lifetime. After the economic life, the machine should be replaced with a substitute machine with similar operational capabilities. This kind of analysis is called *replacement analysis*.

The elements of costs involved in the replacement analysis are as follows:

1. Purchase cost (initial cost)
2. Annual operation and maintenance cost
3. Salvage value at the end of every year, if it is significant

From Fig. 11.3, it is clear that the sum of operation and maintenance cost increases with the life of the machine. But the capital recovery with return decreases with the life of the machine. The total cost of the machine goes on decreasing initially but it starts increasing after some years. The year with the minimum total cost is called as the economic life of the machine.

The trade-off between different cost elements is shown in Fig. 11.3.



11.3.1 Limitation of Existing Model

In the case where the machine is replaced due to wear and tear, the following costs are considered (refer Chapter 8):

1. Initial cost
2. Operation and maintenance cost
3. Salvage value

In the existing model to deal with this type of replacement analysis, the different cost elements are estimated without taking the effect of inflation into account.

The annual cost of operation and maintenance of the machine will increase with the age of the machine due to decline in efficiency of the machine. In the existing model, this increase in the operation and maintenance cost is taken into account. But the increase in the operation and maintenance cost due to inflation is not considered. Similarly, in the existing model, the salvage value is estimated without taking into account the effect of inflation.

To highlight this particular fact on salvage value, an example is now given.

The internal combustion engines (R.A. Lister) which were made in England during pre-independence of India are still functioning well. Their resale value is going up year after year. This may be partly due to inflation and partly due to good quality of the engine parts. So, consideration of the effect of the inflation on the economic life of the machine is a realistic approach.

In replacement analysis, a discount rate is usually assumed to reflect the time value of money. First the concept of replacement analysis is demonstrated without taking the inflation into account. Then, the same is demonstrated by taking the effect of inflation into account. At the end, a comparison between the two models is presented.

11.3.2 Economic Life Determination without Inflationary Effect

The determination of economic life of a machine without considering the effect of inflation is demonstrated using the following example.

EXAMPLE 11.2 A machine costs Rs. 5,00,000. Its annual operation cost during the first year is Rs. 40,000 and it increases by Rs. 5,000 every year thereafter. The maintenance cost during the first year is Rs. 60,000 and it increases by Rs. 6,000 every year thereafter. The resale value of the machine is Rs. 4,00,000 at the end of the first year and it decreases by Rs. 50,000 every year thereafter. Assume an interest rate (discounting factor) of 20%.

The method of finding the economic life of the machine with a discounting factor of 20% at zero inflation rate is summarized in Table 11.2. From the table it is clear that the total annual equivalent cost is minimum if the machine is used for 14 years. Hence, the economic life of the machine is 14 years.

11.3.3 Economic Life Determination with Inflationary Effect

The illustration in Section 11.3.2 is reconsidered for analyzing the effect of inflation on the economic life of the machine. An average annual inflation rate of 6% is assumed for discussion. The corresponding steps are explained in Table 11.3.

From the Table 11.3, it is clear that the total annual equivalent cost is minimum if the machine is used for three years. Thus, the economic life of the machine is three years.

Table 11.2 Determination of Economic Life of the Machine without Inflation

End of year (n) (1)	*Operation cost* (2) (Rs.)	*Maintenance cost* (3) (Rs.)	*Operation & maint. cost* (2) + (3) (4) (Rs.)	*P/F, i, n* (i = 20%) (5)	*Present worth of column 4* (4) × (5) (6) (Rs.)	*Cumulative of column* (6) (7) (Rs.)	*Salvage value* (S) (8) (Rs.)	*Present worth of salvage value* (8) × (5) (9) (Rs.)	*Total present worth* 5,00,000 + *Column* 7 – 9 (10) (Rs.)	*A/P, i, n* (i = 20%) (11)	*Annual equivalent amount* (10) × (11) (12) (Rs.)
1	40,000	60,000	1,00,000	0.8333	83,330.00	83,330.00	4,00,000	3,33,320.00	2,50,010.00	1.2000	3,00,012.00
2	45,000	66,000	1,11,000	0.6945	77,089.50	1,60,419.50	3,50,000	2,43,075.00	4,17,344.50	0.6546	2,73,193.70
3	50,000	72,000	1,22,000	0.5787	70,601.40	2,31,020.90	3,00,000	1,73,610.00	5,57,410.90	0.4747	2,64,602.90
4	55,000	78,000	1,33,000	0.4823	64,145.90	2,95,166.80	2,50,000	1,20,575.00	6,74,591.80	0.3863	2,60,594.80
5	60,000	84,000	1,44,000	0.4019	57,873.60	3,53,040.40	2,00,000	80,380.00	7,72,660.40	0.3344	2,58,377.60
6	65,000	90,000	1,55,000	0.3349	51,909.50	4,04,949.90	1,50,000	50,235.00	8,54,714.90	0.3007	2,57,012.70
7	70,000	96,000	1,66,000	0.2791	46,330.60	4,51,280.50	1,00,000	27,910.00	9,23,370.50	0.2774	2,56,142.90
8	75,000	1,02,000	1,77,000	0.2326	41,170.20	4,92,450.70	50,000	11,630.00	9,80,820.70	0.2606	2,55,601.80
9	80,000	1,08,000	1,88,000	0.1938	36,434.40	5,28,885.10	0	0.00	10,28,885.00	0.2481	2,55,266.30
10	85,000	1,14,000	1,99,000	0.1615	32,138.50	5,61,023.60	0	0.00	10,61,023.00	0.2385	2,53,054.10
11	90,000	1,20,000	2,10,000	0.1346	28,266.00	5,89,289.60	0	0.00	10,89,289.00	0.2311	2,51,734.80
12	95,000	1,26,000	2,21,000	0.1122	24,796.20	6,14,085.80	0	0.00	11,14,085.00	0.2253	2,51,003.50
13	1,00,000	1,32,000	2,32,000	0.0935	21,692.00	6,35,777.80	0	0.00	11,35,777.00	0.2206	2,50,552.50
14	1,05,000	1,38,000	2,43,000	0.0779	18,929.70	6,54,707.50	0	0.00	11,54,707.00	0.2169	2,50,456.00***
15	1,10,000	1,44,000	2,54,000	0.0649	16,484.60	6,71,192.10	0	0.00	11,71,192.00	0.2139	2,50,517.90

***Total annual equivalent cost is minimum if the machine is used for 14 years.

Table 11.3 Determination of Economic Life of the Machine with Inflationary Effect

End of year (n) (1)	*Operation cost* (2) (Rs.)	*Maintenance cost* (3) (Rs.)	*Sum of operation & maintenance cost* (2) + (3) (4) (Rs.)	*F/P, i, n* (i = 6%) (5)	*Inflated operation & maint. cost* (4) × (5) (6) (Rs.)	*P/F, i, n* (i = 20%) (7)	*Present worth of column* 6 (6) × (7) (8) (Rs.)	*Cumulative of column* (8) (9) (Rs.)	*Salvage value* (S) (10) (Rs.)	*Inflated salvage value* (10) × (5) (11) (Rs.)	*Present worth of column* 11 (11) × (7) (12) (Rs.)	*Total present worth* 5,00,000 + *Column* 9 –12 (13) (Rs.)	*A/P, i, n* (i = 20%) (14)	*Annual equivalent amount of total present worth* (13) × (14) (15) (Rs.)
1	40,000	60,000	1,00,000	1.060	1,06,000	0.8333	88,329.80	88,329.80	4,00,000	4,24,000	3,53,319.20	2,35,010.6	1.2000	2,82,012.70
2	45,000	66,000	1,11,000	1.124	1,24,764	0.6945	86,648.59	1,74,978.30	3,50,000	3,93,400	2,73,216.30	4,01,762.0	0.6546	2,62,993.40
3	50,000	72,000	1,22,000	1.191	1,45,302	0.5787	84,086.26	2,59,064.60	3,00,000	3,57,300	2,06,769.50	5,52,295.1	0.4747	2,62,174.50 ***
4	55,000	78,000	1,33,000	1.262	1,67,846	0.4823	80,952.12	3,40,016.70	2,50,000	3,15,500	1,52,165.60	6,87,851.1	0.3863	2,65,716.80
5	60,000	84,000	1,44,000	1.338	1,92,672	0.4019	77,434.87	4,17,451.60	2,00,000	2,67,600	1,07,548.40	8,09,903.2	0.3344	2,70,831.60
6	65,000	90,000	1,55,000	1.419	2,19,945	0.3349	73,659.58	4,91,111.20	1,50,000	2,12,850	71,283.46	9,19,827.7	0.3007	2,76,592.20
7	70,000	96,000	1,66,000	1.504	2,49,664	0.2791	69,681.22	5,60,792.40	1,00,000	1,50,400	41,976.64	10,18,815.0	0.2774	2,82,619.50
8	75,000	1,02,000	1,77,000	1.594	2,82,138	0.2326	65,625.29	6,26,417.70	50,000	79,700	18,538.22	11,07,879.0	0.2606	2,88,713.40
9	80,000	1,08,000	1,88,000	1.689	3,17,532	0.1938	61,537.70	6,87,955.40	0	0	0.00	11,87,955.0	0.2481	2,94,731.70
10	85,000	1,14,000	1,99,000	1.791	3,56,409	0.1615	57,560.05	7,45,515.50	0	0	0.00	12,45,515.0	0.2385	2,97,055.40

***Total annual equivalent cost is minimum if machine is used for three years.

Comparison of results

The results of the two approaches are summarized in Table 11.4 . From the table, it is clear that the inflation has an effect on the economic life of the machine. Since it is meaningful and realistic to analyze this type of problem by considering the effect of inflation, the second approach should be used for such analysis.

Table 11.4 Results of the Two Approaches

Approach	*Minimum annual equivalent cost* (Rs.)	*Corresponding life* (years)
Replacement analysis without inflation effect	2,50,456.00	14
Replacement analysis with inflation effect	2,62,174.50	3

UNIT IV

Principles of management: Basic concepts of management–Scientific management– Henry Fayol's Principles of management– Types and functions of management. Types of Organization –characteristics, merits and demerits. Types of industrial ownership– Characteristics, merits and demerits.

Introduction to Management

Manage = Man (human) +Age (experience)
Simple: The way the human being carryout the work to accomplish his goal.
Meaning: It is variously described as an activity, a process and a group of people vested with the authority to make decision.
Definition of Management:

"Management is what a manager does" - Allen Louis
"Management is an art of getting things done through other people" –Mary Parker Follet.
"Management is to forecast, to plan, to organize, to command, to coordinate and to control –Henry Fayol.
"Management is the art of directing and inspiring people"- James Mooney

Nature of Management

1. Management is an activity:
   A Manager performs a managerial activity. It integrates 5M's for carrying out the operation of an enterprise and for achieving the stated objectives.

INPUT	→	PROCESS	→	OUTPUT
5m goals Men Money firm Machine Materials Method		Planning Organizing staffing Directing Controlling		Achievement of Profit/loss Performance of the

2. Management is goal oriented:
   Management focuses attention on the attainment of the specific objectives. These objectives may be economic, socio-economic. Management at different levels seeks to achieve these in different ways.
3. Management is intangible:
   Management is invisible. It cannot be seen but it can be felt. Its presence is evidenced by the result of its efforts. Thus feeling of management is result-oriented.
4. Management is also like the factors of production:

Management is also considering as a factor of production just like land, labour, capital and Organization. In fact, management combines and co-ordinate all the available resources in the maximum way.

5. Management is the continuous process:
   Management will exist for the everlasting time period. A stage will not be reached where one can say that management is irrelevant.

Levels of Management

The different levels of management may be classified into three categories. They are:

- Top level management
- Middle level management
- Lower level management

Top level management

It consists of owners, board of Directors, Chairman, Managing Director, and Chief Executive Officer and so on. The functions of top management are as follows:

- To establish the basic objectives of the Organization.
- To frame the policies and procedures of the Organization.
- To appoint departmental heads and review their performance for achievement of Organization goal.
- To represent the business outside, particularly in discussing business problem with the government, trade association and so on.
- Shouldering financial responsibilities.
- Expansion of the business

Middle level management

It consists of sales manager, financial manager, production manager, personnel manager R&D manager and so on. The functions of middle level management are as follows:

- Selecting the staff for lower level.
- Framing the policies for the department.
- To act as the coordinating link between the top management and lower level management.
- To conduct training for employee development.
- To in build team spirit among employees.
- To communicate the information

Lower level management

It includes of foremen, supervisors, charge-hands, inspectors and so on. The functions of lower level management are as follows:

- Developing and improving work methods and operations.
- Planning the day today activity.
- Imparting inspection function.

- Updating their report of their performance to the middle level managers.
- Carrying out the assigned task.

14 Principles of Fayol

Classification of business activities

Fayol classified business activities into six groups as given below-

i. Technical (concerning production),
ii. Commercial (involving buying, selling and exchange),
iii. Financial (money transactions),
iv. Security (Protection of assets, safety)
v. Accounting (costing and statistics) and
vi. Managerial (planning, organizing, commanding, co-coordinating and controlling).

General Principles of Management

Fayol developed 14 basic principles of management. This are-

1. Division of Work
2. Authority and Responsibility
3. Discipline
4. Unity of Command
5. Unity of Direction
6. Subordination of Individual Interest to Group
7. Remuneration of Personal
8. Centralization
9. Scalar Chain
10. Order
11. Equity
12. Stability of Tenure of Personnel
13. Initiative
14. Esprit De Corps

These principles have been explained below-

1. **Division of Work:** By this we mean that the total work to be done is divided into small parts, each entrusted to as particular individual. To consider an example, the making of a shirt involves a under of activities to e carried out like cutting the cloth, button stitching, ironing, etc. All these activities will be performed by different individuals and not by one person under division of labor/work.
2. **Authority and Responsibility:** Authority is the official right of the manager. It comes to him by virtue of his official position. Responsibility is the duty or obligation on the part of a subordinate to account for the work done by him.
3. **Discipline:** Fayol calls upon employees to adhere to the agreement reached with the employer in the matter of discipline by being obedient by applying themselves fully in the task understand, by being energetic and so on.
4. **Unity of Command:** According to this principle, an employee should receive orders from one superior only and is accountable to him alone. If there are two superior for an employee, he will not know whom he should report to and whose orders he should carry out first.

5. **Unity of Direction: The** principle of unity of command which says that employees should get orders from one superior only. Unity of direction means that the efforts of all the members of a department are directed towards the attainment of the departmental target.
6. **Subordinate of individual interest to common interest**- The interest of the institution is often ignored in favor of individual interest due to factors like laziness, selfishness etc. constant supervision, fair agreement, firmness and supervisors as role model will certainly help to make Organizational interest prevail over individual interest**.**
7. **Remuneration of personnel**: it holds the principle that remuneration payable to the employees should be fair and should give maximum satisfaction to both the employees and employers.
8. **Centralization**: Concentration of authority at a particular place is centralization. Small concerns generally prefer to have a centralized set up as the orders of the superior can directly conveyed to the subordinates.
9. **Scalar chain**: It is the chain of superiors ranging from the highest to the lowest level in the Organization.
10. **Order**: Fayol talks about two types of order, namely material and social order. Material order means place of everything in its place. It is necessary to avoid loss of material .it is also necessary to keep the material neat and clean. Social order ensures the selection of the right man for the right job.
11. **Equity**: The principle of equity ensures fairness, kindness and justice in treatment of employees by their managers. The manager should be impartial in their dealings with their subordinates.
12. **Stability of tenure of personnel**: According to this principle, stability of tenure is necessary for all. It means that an employee shall not be shifted unnecessarily from one job to another. An employee should be given enough opportunity to learn every aspect of his work.
13. **Initiative**: The freedom to think and act is what is initiative according to fayol.An employee who has the freedom to think and act in Organization will show greater interest in his work and this will lead to a higher level of job satisfaction.

14. Espirit de corps: The work done in any Organization is teamwork. Team spirit and co-operation among the members of an Organization are essential for its success.

SCIENTIFIC MANAGEMENT

According to Taylor, management is 'the art of knowing exactly what you want men to o and seeing that they o it in the best and cheapest way'. His ideas on scientific management were brogue out a book title 'Principles of Scientific Management' n the year 1911.

Techniques of Scientific Management

The following are the important techniques of Scientific Management:

1. Work Study
2. Scientific task planning
3. Scientific selection, placement an training of workers
4. Standardization simplification
5. Mental revolution

Work Study

Works study aims at improving efficiency. Under Scientific Management, the amount of work an average worker can do under standard working condition objectively determined

- The time study is to determine the 'standard time' needed to perform every job.
- Motion study is conducted to know the movements of workers from one place to another during working hour to perform their work
- Methods study aims at determining the most appropriate method of doing any job.
- Fatigue study determines the amount of physical and mental exhaustion cause to the workers by the performance of the task assigned.

Scientific Task Planning

It lays down production targets and ensure their attainment. It ensures quality output.

(i) Routing – concerned with the sequence of production operation

(ii) Scheduling – concerned with issuing orders to carry out the work

(iii) Dispatching – concerned with issuing orders to carry out the work

(iv) Feedback- helps to check whether the work has been done as planned.

Scientific Selection, Placement Training of Workers

Taylor wanted the right man to be appointed ort the right join in very work place. The task o finding the right man should be entrusted only to specialist.

Functional Foremanship

The persons who will work in the production planning department are called by the following:

(i) Route Clerk – his job is to determine the sequence of operations to be performed in any work.

(ii) Instruction car clerk- he will prepare the necessary instructions pertaining to the work an accordingly the workers will performs their duties

(iii) Time and Cost Clerk- he will frame the time-table for doing the various joins. He will also keep the necessary cost records.

The persons who will work in the factory will be identified by the following names:

(i) Gang Boss- his duty is to keep all the materials and tools ready so that the workers can start their work without any delay.

(ii) Speed Boss- he will ensure that each job is done well in time

(iii) Repair Boss – he will keep all the tools and machines in the factory in perfect working condition.

(iv) Inspector- his duty is to ensure that the work is done in accordance with the standard laid down by the planning department.

To co-ordinate the work of all the seven persons mentioned above, Taylor wanted another person who is given the name 'Disciplinarian'.

ORGANIZATION STRUCTURE/TYPES OF ORGANIZATION

An organization structure explains the positions an official relationship between the various individuals working in an organization.(for pictorial representation refer class notes)

Line Organization

The line organization, also known as the 'Military Organization', is the oldest form of Organization. In such Organization, the superior at the top makes decisions communicates his decisions and assigns certain work to his immediate subordinates.

Advantages of Line Organization

- It is very simple to establish line organization.
- There are no complicated relationships in such organization. it can be easily be understood by everyone.
- In such an organization, there is unity of command; i.e. subordinate gets orders from one superior only.
- It is economical.
- It provides scope for better supervision.

Disadvantages' of Line Organization

- It lacks specialization.
- The line managers are also overburdened with lot of work.
- In line organization, there is always downward communication; the subordinates are made to carry out the orders of the superiors. As a result, the subordinates may lose initiative.
- The line managers enjoy monopoly in the matter of decision making. it thus give scope for decisions that are detrimental to the interest of the subordinates.

Functional Organization

It is suitable for large scale establishments. In a functional organization, there will be separate departments to look after different line of activities. Each department will be headed by a manager and will work according to hierarchy.

Advantages of Functional Organization

- It promotes specialization. Each department specializes in a particular line of work.
- There is no overburden of key executives.
- Better control can be exercised over the various activities of the concern.
- Specialization and standardization will result in mass production.

Disadvantages of Functional Organization

- It is always difficult to secure proper co-ordination.

- Functional Organization is also expensive to adopt.
- Any major decision requires the participation of different functional heads. this may lead to delay in arriving at a decision.

Committee Organization

A committee is a group of persons entrusted with certain tasks. The committees members are expected to discuss the problem under consideration in detail and come out with a solution.

Types of Committee

Standing or Permanent committee

A temporary committee is never dissolved. Although there may be changes in membership, the committee remains always. The Board of Directors of a company is an example.

Temporary or Ad hoc Committee

A temporary committee is one that is created for a specific purpose. As soon as the purpose has been accomplished, the committee stands dissolved.

Executive Committee

An executive committee is one that has powers to make important decisions for the enterprise. The Board of Directors of a company has such decisive powers.

Advisory Committee

An advisory committee can only make suggestions. It does not have the powers to make decisions.

Formal Committee

A formal committee is one that is constituted as per the rules and policies of the Organization. It has hierarchy. It functions according to the lines of authority.

Informal Committee

An informal committee is one that is not constituted as per the rules and policies of the organization. Such a committee is the outcome of informal meetings of the workers to discuss their work-related problems.

Advantages of Committee Organization Structure

A committee provides scope for group discussion.
The committee provides scope for proper co-ordination among individuals and groups.
The committee members feel motivated when they participate in decision making.

Disadvantages of Committee Organization Structure

It is an expensive affair.
It takes more time on discussions and deliberations and as the result the decisions get delayed.
There is no fixed responsibility on any member of the committee for the outcome of its decision.

Matrix Organization

Matrix Organization is considered suitable where a large number of small projects will have to be managed. A matrix organization is also known as a ‘multiple command system’ as it has two chains of command i.e., the flow of authority is both vertical as well as horizontal. Separate departments are established for each specified task.

Advantages of Matrix Organization

- It offers the benefits of both functional organization as well as technical specification.
- It can be adapted to suit individual projects.
- It also promotes communication between the various personnel associated with the project.
- It offers greater motivation for the personnel engaged in the project.

Disadvantages of Matrix Organization

- Dual command may result in confusion.
- Quick decision may not be possible in such pattern of organization.
- It also gives scope for conflicts among the personnel and as a result project may get delayed.

Functions of Management

- Planning
- Organizing
- Staffing
- Directing
- Controlling

Planning

It is deciding in advance what should be done in future. It helps to work in a systematic manner.

Key functions of planning

- Identifying the target.
- Collecting all the information needed.
- Finding the alternate course of action.
- Comparing and evaluating the alternate course of action.
- Selecting the best course of action.

Organizing

It is the process of bringing together the necessary resources for the accomplishment of the objectives of the enterprise.

Key functions of Organizing

- Identification of the activities to be performed.
- Grouping of activities into departments or divisions based on their nature.
- Dividing the work into components.
- Assigning of the duties to the subordinates
- Delegation of authority
- Creation of accountability and responsibility.

Staffing

It deals with the selection of the right candidate for the right job at the right time.

Key functions ofStaffing

- Recruitment and selection of employees
- Training
- Wage and salary administration
- Performance appraisal
- Employee promotion, demotion .transfer and termination.

Directing

It deals with guiding and motivating the people to accomplish the task.

Key functions of Directing

- Undertaking supervising
- Issuing orders and giving instructions to subordinates.
- Leadership to guide employees
- Proper communication between the management and employees.

Controlling

It deals with the corrective measures taken for the deviations occurred.

Key functions of controlling

- Establishment of the standards
- Measurement of the actual performance
- Comparing the actual performance with the standard set.
- Finding out deviations and take corrective actions.

Industrial Ownership

The terms **industrial ownership**, business organization, forms of ownership of industry, types of business enterprise, types of ownership etc convey the same meaning. To start a business enterprise the most important thing required is capital.

- Little capital is provided by single individual it is known as individual ownership, individual entrepreneur organization, single ownership, individual proprietorship etc.
- If the capital is provided by two or more persons, it refers to partnership organization.
- If the capital is provided by many persons in the form of shares to an institute with a legal entity it is called a joint stock company

Types of Industrial Ownership

Sole proprietorship

The business started by the individual with his own capital is called Sole proprietor.

Merits

- Easy formation

- Quick decision
- Secrecy can be maintained regarding profit, expenditure, methods of manufacturing.
- Cost of management is very less.

Demerits

- Difficult to raise funds
- Lack of stability
- Unpleasant events in life of proprietor may affect day to day business.

Partnership

Two or more persons join together to form a company and to share the earned profit is called partner.

Types of partner

- **Legal partner:** Partner who has all the rights of all benefits is called as legal partner.
- **Active partner** is the one who invest the amount in the business and carry out the work of business.
- **Sleeping partner** is the one who invest the amount in the business and does not carry out the work of business.
- **Profit sharing** is the one who invest the money and take only the profit from the business.

Merits

- Greater availability of capital.
- Easy expansion of business.
- Working procedure is simple.

Demerits

- Authority being divided.
- Lack of stability
- All will suffer if one go wrong

Joint stock company

It is the association of two or more individuals who join together for profit and agree to supply capital for carrying out the specific business.

Types of joint stock company

Private limited company:

Business started from the Capital collected from private partners is called private limited company and it should have the shareholders from 5 to 50.

Public limited company

Business started from the capital of public is called as public limited company. It can have the end number of shareholders.

Merits

- Huge money can be raised.
- Risk of loss is divided among the members.
- Results in stability, efficiency and flexibility of management.
- Shares are transferrable.

Demerits

- Difficult to maintain secrecy.
- No team spirit.
- Difficult to take decision.

Cooperative Organization

It is the society which provides the goods and services to the members at low cost.

Types of cooperative

- Producer cooperative - For group buying and selling items like milk, fruit, grain etc.
- Cooperative credit- provide loan to the individuals.
- Consumer cooperative – getting things at low cost in retail trade .

Merits

- Overhead expenses are reduced
- No one person can make huge profits.
- It is the democratic far of ownership.

Demerits

- Members in a position take personal advantage.
- Members may not be competent enough to make it a good success.
- Conflict on the issue of sharing responsibility and enjoying authority .

UNIT V

Financial management: Sources of finance (Internal and External)-Types of capital-Working capital-Types of investment- Preparation of Trading, Profit and Loss Account and Balance Sheet Types of Accounting and significance of each types.

MEANING OF FINANCE

Finance also is referred as the provision of money at the time when it is needed. Finance is the science that describes the management, creation and study of money, banking, credit, investments, assets and liabilities. Finance consists of financial systems, which include the public, private and government spaces, and the study of finance and financial instruments, which can relate to countless assets and liabilities.

Objectives Of Financial Management

Profit maximization
Wealth maximization

SOURCES OF FINANCE

There are two main sources of finance; these are internal sources and external sources.

Internal sources include:

- Retained profit - profit made is reinvested into the business.
- Controlling working capital - reducing costs, delaying outflows and speeding up inflows.
- Sale of assets - Assets the company owns can be sold and then leased back which frees up a large amount of capital in the short term.

External sources of finance:

- Increasing trade credit - delaying payments on purchases for as long as possible.
- Factoring - use a company to collect all debts.
- Overdraft - an agreement with a bank to be allowed to overdraw a certain amount.
- Grants - an agreed amount of money given for a special reason by government or other organization.
- Venture capital - people invest in the company when it is unable to float on the stock market.
- Debentures - business equivalent of a mortgage. Loan for a set length of time at a set interest rate.
- Share issues - selling of new shares to raise capital.
- Owner's savings - the owners investing money into the business.
- Bank loans - medium or long term loans but interest is charged.
- Leasing - instead of buying.

TYPES OF FINANCE

Short term finance: sources like trade credit, cash credit, overdraft, bank loan etc. which makemoney available for a shorter period of time are called sources ofshort-term finance.

Short-term finance serves following purposes

1. It facilitates the smooth running of business operations by meeting day to day financial requirements.
2. It enables firms to hold stock of raw materials and finished product.

3. With the availability of short-term finance goods can be sold on credit.
4. Short-term finance becomes more essential when it is necessary to increase the volume of production at a short
5. Short-term funds are also required to allow flow of cash during the operating cycle.

Sources of Short-term Finance

1. Trade credit
2. Bank credit
   – Loans and advances
   – Cash credit
   – Overdraft
   – Discounting of bills
3. Customers' advances
4. Installment credit
5. Loans from bank

1. Trade Credit:refers to credit granted to manufactures and traders by theSuppliers of raw material, finished goods, components, etc.

2. Bank Credit: Commercial banks grant short-term finance to business firms which is known as bank credit.

- **Loans:** When a certain amount is advanced by a bank repayable after a specified period, it is known as bank loan.

- **Cash Credit:** It is an arrangement whereby banks allow the borrower to withdraw money up to a specified limit.

- **Overdraft:** When a bank allows its depositors or account holders to withdraw money in excess of the balance in his account upto a specified limit, it is known as overdraft facility.

3. Customers' Advances

Organization insists their clients to make some advance payment.

4. Installment credit

A small amount of money is paid at the time of delivery and The balance is paid in a number of installments.

5. Loans from Banks are a good source to procure short-termfinance. These banks grant loans for personal as well as business purposes. Membership is the primary condition for securing loan.

Advantages/merits of short-term finance

a) **Economical** : Finance for short-term purposes can be arranged at a short notice and does not involve any cost of raising. The amount of interest payable is also affordable. It is, thus, relatively more economical to raise short-term finance.

b) **Flexibility:** Loans to meet short-term financial need can be raised as and when required. These can be paid back if not required. This provides flexibility.

c) **No interference in management:** The lenders of short-term finance cannot interfere with the management of the borrowing concern. The management has the freedom in decision making.

Disadvantage/Demerits of short-term finance

a) **Fixed Burden:** Borrowings interest has to be paid on short-term loans irrespective of profit or loss earned by the organization. Hence business firms use short-term finance only for temporary purposes.

b) **Charge on assets:** Generally short-term finance is raised on the basis of security of moveable assets. In such a case the borrowing concern cannot raise further loans against the security of these assets nor can these be sold until the loan is cleared (repaid).

c) **Difficulty of raising finance:** When business firms suffer irregular losses of huge amount or market demand is declining or industry is in recession, it loses its creditworthiness. In such circumstances they find it difficult to borrow from banks or other sources of short-term finance.

d) **Uncertainty:** In situation of crisis business firms always face the uncertainty of securing funds from sources of short-term finance. If the amount of finance required is large, it is also more uncertain to get the finance.

LONG TERM FINANCE

Organization requires funds to purchase fixed assets like land, building, machinery and furniture's; these are the foundation of a business. The capital required for these assets is called**fixed capital**. Funds required to purchase these kinds of assets is called long term finance.

Purpose of long term finance:

1. To Finance fixed assets: Business requires fixed assets like machines, Building, furniture etc. Finance required to buy these assets is for a long period, because such assets can be used for a long period and are not for resale.

2. To finance the permanent part of working capital: Business is a continuing activity. It must have a certain amount of working capital which would be needed again and again. This part of working capital is of a fixed or permanent nature. This requirement is also met from long term funds.

3. To finance growth and expansion of business: Expansion of business requires investment of a huge amount ofcapital permanently or for a long period.

Factors determining long-term financial requirements:

The amount required to meet the long term capital needs of a company depends upon on many factors. These are:

- Nature of Business
- Nature of goods produced
- Technology used

Sources of long term finance

Shares: Issue of shares are the main source of long term finance. Shares areissued by joint stock companies to the public. A company divides itscapital into units of a definite face value, say of Rs. 10 each or Rs. 100each. Each unit is called a share. A person holding shares is called ashareholder.

Debentures: The holder's of Debentures are the creditors of the company. Whenever a company wants to borrow a large amount of fund for a long but fixed period, it can borrow from the general public by issuing loan certificates called Debentures. It specifies the terms and conditions, such as rate of interest, time repayment, and security offered, etc.

Public Deposits: It is a very old source of finance in India. When modern banks were not there, people used to deposit their savings with business concerns of good repute. Even today it is a very popular and convenient method of raising medium term finance. It specifies the terms and conditions, such as rate of interest, time repayment, and security offered, etc

Loans from financial Institutions: specialized financial institutions established by the Central and State governments which give long term loans at reasonable rate of interest.

Working Capital

The capital of a business which is used in its day-to-day trading operations, calculated as the current assets minus the current liabilities. Working capital is a measure of both a company's efficiency and its short-term financial health. Working capital is calculated as:

Working Capital = Current Assets - Current Liabilities

Investment:

The amount raised by the investors in the business. An investment is an asset or item that is purchased with the hope that it will generate income or appreciate in the future. In an economic sense, an investment is the purchase of goods that are not consumed today but are used in the future to create wealth. In finance, an investment is a monetary asset purchased with the idea that the asset will provide income in the future or appreciate and be sold at a higher price.

Factors affecting investment decision

- Degree of certainty
- Emotional and intangible factors
- Legal factors
- Availability of funds
- Future earning
- Cost consideration

Investment types

The most common terms that are related to different types of investments:

Ownership Investments

Ownership investments are what comes to mind for most people when the word "investment" is batted around. Ownership investments are the most volatile and profitable class of investment. The following are examples of ownership investments:

Stocks

Stocks are literally certificates that say you own a portion of a company. More broadly speaking, all traded securities, from futures to currency swaps, are ownership investments, even though all you may own is a contract. When you buy one of these investments, you have a right to a portion of a company's value or a right to carry out a certain action (as in a futures contract).

Your expectation of profit is realized (or not) by how the market values the asset you own the rights to. If you own shares in Sony and Sony posts a record profit, other investors are going to want Sony shares too. Their demand for shares drives up the price, increasing your profit if you choose to sell the shares.

Business

The money put into starting and running a business is an investment. Entrepreneurship is one of the hardest investments to make because it requires more than just money. Consequently, it is also an ownership investment with extremely large potential returns. By creating a product or service and selling it to people who want it, entrepreneurs can make huge personal fortunes. Bill Gates, founder of Microsoft and one of the world's richest men, is a prime example.

Real Estate

Houses, apartments or other dwellings that you buy to rent out or repair and resell are investments. The house you live in, however, is a different matter because it is filling a basic need. The house you live in fills your need for shelter and, although it may appreciate over time, it shouldn't be purchased with an expectation of profit. The mortgage meltdown of 2008 and the underwater mortgages it produced are a good illustration of the dangers in considering your primary residence an investment.

Precious Objects

Gold, Da Vinci paintings and a signed LeBron James jersey can all be considered an ownership investment - provided that these are objects that are bought with the intention of reselling them for a profit. Precious metals and collectibles are not necessarily a good investment for a number of reasons, but they can be classified as an investment nonetheless. Like a house, they have a risk of physical depreciation (damage) and require upkeep and storage costs that cut into eventual profits.

Lending Investments

Lending investments allow you to be the bank. They tend to be lower risk than ownership investments and return less as a result. A bond issued by a company will pay a set amount

over a certain period, while during the same period the stock of a company can double or triple in value, paying far more than a bond - or it can lose heavily and go bankrupt, in which case bond holders usually still get their money and the stockholder often gets nothing.

Your Savings Account

Even if you have nothing but a regular savings account, you can call yourself an investor. You are essentially lending money to the bank, which it will dole out in the form of loans. The return is pitiful, but the risk is also next to nil because of the Federal Deposit Insurance Corporation (FDIC).

Bonds

A debt instrument, a bond is essentially a loan that you are giving to the government or an institution in exchange for a pre-set interest rate paid regularly for a specified term. The bond pays interest (a coupon payment) while it's active and expires on a specific date, at which point the total face value of the bond is paid to the investor. If you buy the bond when it is first issued, the face or par value you receive when the bond matures will be the amount of money you paid for it when you made the purchase. In this case, the return you receive from the bond is the coupon, or interest payment. If you purchase or sell a bond between the time it is issued and the time it matures, you may experience losses or gains on the price of the bond itself.

Cash Equivalents

these are investments that are "as good as cash," which means they're easy to convert back into cash.

Trading Account

Trading Account is the first stage in the process of **preparing** final **accounts**.**Trading account** shows the gross profit or gross loss during an accounting year. Its main components are sales, services rendered in the credit side of such sales or services rendered in the debit side.

Profit & Loss Statement

A profit and loss statement (P&L) is a financial statement that summarizes the revenues, costs and expenses incurred during a specific period of time, usually a fiscal quarter or year. These records provide information about a company's ability – or lack thereof – to generate profit by increasing revenue, reducing costs, or both. The P&L statement is also referred to as "statement of profit and loss", "income statement," "statement of operations," "statement of financial results," and "income and expense statement."It is

prepared to ascertain the net profit or net loss made by the company during the accounting period.

The following is the pro-forma of Profit and Loss Account when it is prepared as a separate account:

PROFIT AND LOSS ACCOUNT (Horizontal Form)for the year ended

Balance Sheet

A statement of the assets, liabilities, and capital of a business or other organization at a particular point in time, detailing the balance of income and expenditure over the preceding period. A balance sheet is a financial statement that summarizes a company's assets, liabilities and shareholders' equity at a specific point in time. These three balance sheet segments give investors an idea as to what the company owns and owes, as well as the amount invested by shareholders.

The balance sheet adheres to the following formula:

Assets = Liabilities + Shareholders' Equity

HORIZONTAL FORM OF BALANCE SHEET (In order of Permanence) BALANCE SHEET as at

HORIZONTAL FORM OF BALANCE SHEET (In order of liquidity)

BALANCE SHEET

*as**at.....***

Accounting

It is a systematic process of identifying, recording, measuring, classifying, verifying, summarizing, interpreting and communicating financial information. It reveals profit or loss for a given period, and the value and nature of a firm's assets, liabilities and owners' equity.

Accounting provides information on the

1. resourcesavailable to a firm,
2. Themeansemployedto finance those resources, and
3. Theresultsachieved through their use.

TYPES OF ACCOUNTING

The financial literature classifies accounting into two broad categories, viz, Financial Accounting and Management Accounting. Financial accounting is primarily concerned with the preparation of financial statements whereas management accounting covers areas such as interpretation of financial statements, cost accounting, etc. Both these types of accounting are examined in the following paragraphs.

Financial accounting

As mentioned earlier, financial accounting deals with the preparation of financial statements for the basic purpose of providing information to various interested groups like creditors, banks, shareholders, financial institutions, government, consumers, etc. Financial statements, i.e. the income statement and the balance sheet indicate the way in which the activities of the business have been conducted during a given period of time.

Financial accounting is charged with the primary responsibility of external reporting. The users of information generated by financial accounting, like bankers, financial institutions, regulatory authorities, government, investors, etc. want the accounting information to be consistent so as to facilitate comparison. Therefore, financial accounting is based on certain concepts and conventions which include separate business entity, going concern concept, money measurement concept, cost concept, dual aspect concept, accounting period concept, matching concept, realization concept and conventions of conservatism, disclosure, consistency, etc. All such concepts and conventions would be dealt with detail in subsequent lessons.

The significance of financial accounting lies in the fact that it aids the management in directing and controlling the activities of the firm and to frame relevant managerial policies related to areas like production, sales, financing, etc. However, it suffers from certain drawbacks which are discussed in the following paragraphs.

- The information provided by financial accounting is consolidated in nature. It does not indicate a break-up for different departments, processes, products and jobs. As such, it becomes difficult to evaluate the performance of different sub-units of the organization.
- Financial accounting does not help in knowing the cost behavior as it does not distinguish between fixed and variable costs.
- The information provided by financial accounting is historical in nature and as such the predictability of such information is limited.

The management of a company has to solve certain ticklish questions like expansion of business, making or buying a component, adding or deleting a product line, deciding on alternative methods of production, etc. The financial accounting information is of little help in answering these questions.

The limitations of financial accounting, however, should not lead one to believe that it is of no use. It is the basic foundation on which other branches and tools of accounting analysis are based. It is the source of information, which can be further analyzed and interpreted according to the tailor-made requirements of decision-makers.

Management accounting

Management accounting is ‘tailor-made’ accounting. It facilitates the management by providing accounting information in such a way so that it is conducive for policy making and running the day-to-day operations of the business. Its basic purpose is to communicate the facts according to the specific needs of decision-makers by presenting the information in a systematic and meaningful manner. Management accounting, therefore, specifically helps in planning and control. It helps in setting standards and in case of variances between planned and actual performances, it helps in deciding the corrective action.

An important characteristic of management accounting is that it is forward looking. Its basic focus is one future activity to be performed and not what has already happened in the past.

Since management accounting caters to the specific decision needs, it does not rest upon any well-defined and set principles. The reports generated by a management accountant can be of any duration– short or long, depending on purpose. Further, the reports can be prepared for the organization as a whole as well as its segments.

Cost accounting

One important variant of management accounting is the cost analysis. Cost accounting makes elaborate cost records regarding various products, operations and functions. It is the process of determining and accumulating the cost of a particular product or activity. Any product, function, job or process for which costs are determined and accumulated, are called cost centers.

The basic purpose of cost accounting is to provide a detailed break-up of cost of different departments, processes, jobs, products, sales territories, etc., so that effective cost control can be exercised.

Cost accounting also helps in making revenue decisions such as those related to pricing, product-mix, profit-volume decisions, expansion of business, replacement decisions, etc.

The objectives of cost accounting, therefore, can be summarized in the form of three important statements, viz, to determine costs, to facilitate planning and control of business activities and to supply information for short- and long-term decision.

Cost accounting has certain distinct advantages over financial accounting. Some of them have been discussed succeedingly. The cost accounting system provides data about profitable and non-profitable products and activities, thus prompting corrective measures. It is easier to segregate and analyze individual cost items and to minimize losses and wastages arising from the manufacturing process. Production methods can be varied so as to minimize costs and increase profits. Cost accounting helps in making realistic pricing decisions in times of low demand, competitive conditions, technology changes, etc.

Various alternative courses of action can be properly evaluated with the help of data generated by cost accounting. It would not be an exaggeration if it is said that a cost accounting system ensures maximum utilization of physical and human resources. It checks frauds and manipulations and directs the employer and employees towards achieving the organizational goal.