3 BASIC METHODOLOGIES OF ENGINEERING ECONOMIC ANALYSIS

3.1 Determining Minimum Attractive (Acceptable) Rate of Return (MARR)

Minimum Attractive Rate of Return (MARR) is the lowest rate of return at which a company will consider investing.

Example 3.1

Option 1: ROR = 12.5%
Option 2: ROR = 11.875%
Option 3: ROR = 10.5%
MARR = 15%
Since, ROR < MARR. Therefore, the company would choose not to invest.

3.2 Payback Period Method

- It is the length of time in which an investment pays back its original cost. Thus, its main focus is on cost recovery.
- This method assumes that all cash outflows occur right at the beginning of the project's life followed by a stream of inflows.
- It also assumes that cash inflows occur uniformly over the year.

Payback Rule

If the calculated payback period is less than or equal to some pre-specified payback period, then accept the project. Otherwise reject it.

Advantages and Disadvantages of the Payback Rule

Advantages

- Easy to understand.
- Quick evaluation.
- Adjusts long term cash flow uncertainty (by ignoring them).

Disadvantages

- Ignores time value of money.
- Ignores cash flow beyond payback period.
- Biased against long term projects.

Simple Payback Period

- It does not consider the time value of money.
- It is easy to calculate.
- It is interpreted in years.
- It is calculated by using the following formula.

$$\text{Simple Payback Period} = \frac{\text{Initial investment}}{\text{Annual savings}}$$

Discounted Payback Period

- It is the time period that the project takes to payback its initial investment, taking the time value of money into account.
- Decision rule: Accept the project if it pays back on a discounted basis within the specified time.
- By the time you have discounted the cash flows, you might as well calculate the NPV.

Example 3.2

A company has decided to purchase a new machine cost Rs10, 000 and is likely to bring in after tax cash inflows of Rs 4,000 in the first year, Rs 4,500 in the second year, Rs 10,000 in the third year, and Rs 8,000 in the fourth year. The company has a policy of buying equipment only if the payback period is 3 years or less.

a. Calculate the simple payback period of the machine and state whether the company would buy it or not.
b. Calculate the discounted payback period of the machine by using a discount rate of 10%.

a. Simple Payback Period Method

Year	Net Cash Flow	Cumulative Cash Flow	Remarks
0	–10,000	–10,000	
1	4,000	– 6,000	Not recovered
2	4,500	– 1,500	Not recovered
3	10,000	8,500	Recovered
4	8,000	16,500	

Payback Period $= 2 + \frac{1,500}{10,000} = 2.15$ Years.

Result
Payback Period is less than 3 years so accept the project.

b. Discounted Payback Period Method

Year	Net Cash Flow	Net Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	–10,000	–10,000	–10,000	
1	4,000	3,636	– 6,364	Not recovered
2	4,500	3,719	– 2,645	Not recovered
3	10,000	7,513	4,865	Recovered
4	8,000	5,464		

Payback Period $= 2 + \frac{2,645}{7,513} = 2.35$ Years.

Result
Payback Period is less than 3 years so accept the project.

3.3 Equivalent Worth Methods

3.3.1. Present Worth Method

Net Present Value (NPV)

Net Present Value is found by subtracting the present value of the after-tax outflows from the present value of the after-tax inflows.

Advantages

- Easy to understand and communicate.

Disadvantages

- Does not distinguish between investing and borrowing.
- IRR may not exist, or there may be multiple IRRs.
- Problems with mutually exclusive investments.

Decision Criteria

1. If NPV > 0, accept the project.
2. If NPV < 0, reject the project.
3. If NPV = 0, technically indifferent.

Example 3.3

Investment of Rs 9,000 net cash flows of Rs 5,090, Rs 4,500 and Rs 4,000 at the end of years 1, 2 and 3 respectively. Assume required rate of return is 10% per year. What is the net present value of the project?

Solution:

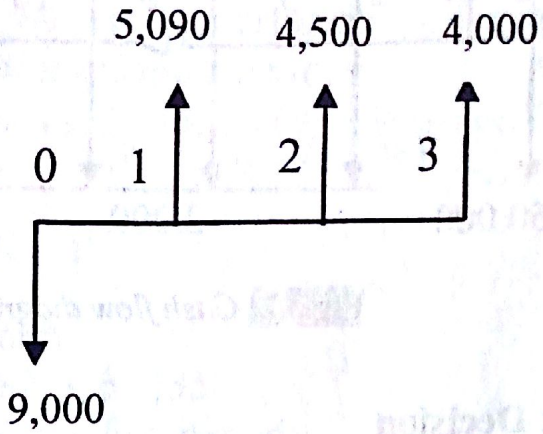


Fig.3.1: *Cash Flow Diagram.*

Given,

Initial Investment (P) = Rs 9,000

Rate of Return (i) = 10%

We know,

$$NPW = \frac{A_0}{(1+i)^0} + \frac{A_1}{(1+i)^1} + \frac{A_2}{(1+i)^2} + \ldots\ldots + \frac{A_n}{(1+i)^n}$$

$$NPW = -\frac{9000}{(1+0.1)^0} + \frac{5090}{(1+0.1)^1} + \frac{4500}{(1+0.1)^2} + \frac{4000}{(1+0.1)^3} = \text{Rs } 2{,}351.54$$

Since, NPV > 0, therefore accept the project **Ans.**

Example 3.4

A construction enterprise is investigating the purchase of a new dump truck. Interest rate is 9%. The cash flow for the dump truck is as follows: First cost = Rs50,000, annual operating cost = Rs2,000, annual income = Rs 9,000, salvage value is Rs10,000, life = 10 years.

a. *Is this investment worth undertaking?*
b. *What should be the minimum annual benefit for making it a worthy of investment at 9% rate of return?*

Solution: Given,

First Cost = P = Rs 50,000

Net Annual Income = A = 9,000 – 2,000 = Rs7,000,

Salvage Value = SV = Rs 10,000

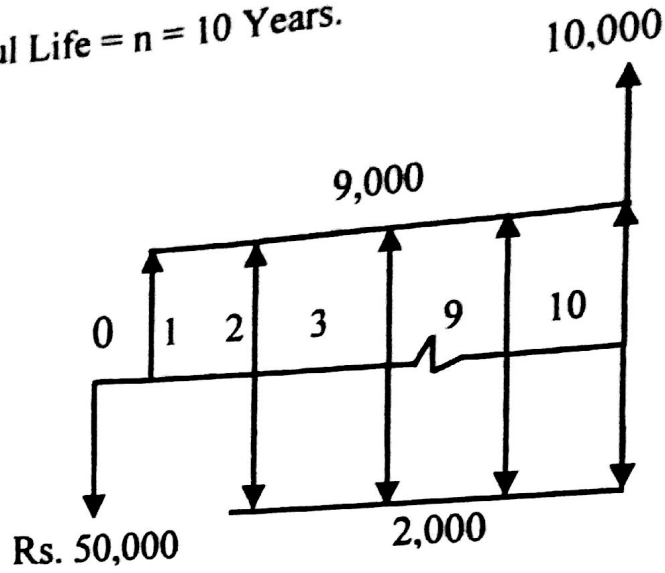


Fig. 3.2 *Cash flow diagram.*

a. Investment Decision

Net present worth (NPW) = present worth of benefits – present worth of costs.

Present worth of benefits (PW_B) = 9,000(P/A, 9%, 10)
= 9,000 (6.4177)
= Rs 57,759.3

Present worth of costs (PW_C)

= 50,000 + 2,000 (P/A, 9%, 10) – 10,000 (P/F, 9%, 10)
= 50,000 + 2,000(6.4177) – 10,000 (0.4224)
= Rs 58,611.4

Net present worth (NPW) = $PW_B - PW_C$
= 57,759.3 – 58,611.4
= – Rs 852.1

Since, NPW < 0.Therefore, do not invest **Ans.**

b. Minimum Annual Benefit

Present worth of benefits = A (P/A, 9%, 10)
= A (6.4177).....(1)

Present worth of costs

= 50,000 + 2,000(P/A, 9%, 10) – 10,000(P/F, 9%, 10)
= 50,000 + 2,000(6.4177) – 10,000(0.4224)
= Rs 58,611.4.....(2)

On equating equations (1) and (2)

A (6.4177) = Rs 58, 611.4
Or, A = Rs 9,132.77
Therefore, minimum annual benefits = A = Rs 9,132.77 **Ans.**

3.3.2 Future Worth Method

- Future worth is the equivalent worth of all cash flows at the end of study period of a project.
- It is useful when we need to calculate equivalent worth of a project at the end of investment period.
- It is computed by using the following expression.

$$FW = P_0 (1+i)^{N-0} + P_1 (1+i)^{N-1} + P_2 (1+i)^{N-2} + \ldots + P_N (1+i)^{N-n}$$

$$= \sum_{n=0}^{N} P_n \ (F/P, i\%, N-n)$$

Where, FW = future worth.
N = compounding period.
n = each compounding period.
i = effective interest rate.
$P_0, P_1, P_2 \ldots\ldots P_N$ = cash flow in each period.

Decision Rule

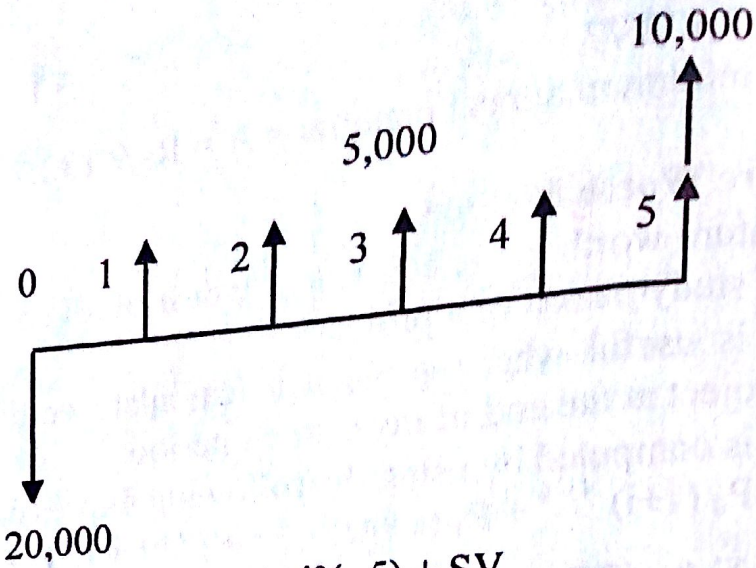
1. If FW > 0 accept the project.
2. If FW = 0 remain indifference.
3. If FW < 0 reject the project.

Example 3.5

Consider a machine cost Rs 20,000 and expected to save Rs 5,000 per year from its operation for the period of 5years. The salvage value at the end of 5 years is Rs 10,000. Is it worthwhile to purchase the machine? Justify by using future worth formulation. Take MARR= 10%.

Solution: Given,

Investment = P = Rs 20,000
Annual Revenue = A= Rs 5,000
Salvage Value = SV= Rs 10,000
Useful Life = n = 5 Years
MARR = i =10%
Future Worth = FW = ?



FW = – P (F/P, i%, n) + A (F/A, i%, 5) + SV
= – 20,000 (F/P, 10%, 5) + 5,000 (F/A, 10%, 5) +10,000
= – 20,000 (1.611) + 5,000 (6.105) +10,000
= Rs 8,305

Since, FW > 0, therefore it is worthwhile to purchase the machine Ans.

3.3.3 Annual Worth Method

Advantages and Uses of Annual Worth

- Popular analysis technique.
- Easily understood and results are reported in amount/time period.
- Eliminates the LCM problem associated with the present worth method and only have to evaluate one life cycle of a project.
- Applicable to a variety of engineering economy studies.
- Asset replacement and retention time studies to minimize overall annual costs.
- Breakeven analysis and make or buy decisions.
- Studies dealing with manufacturing costs.
- Economic value added analysis.

AW Calculations

- AW = PW (A/P, i%, n)
- AW = FW (A/F, i %, n)

Equivalent Annual Cost

- Cash Flow analysis approach where the cash flows are converted to their respective equal, end of period amounts.
- The result is reported in terms of amount/period.
- Variant of the present worth approach.

- Popular with some managers who tend to think in terms of amount/year, amount/months, etc.

Decision Rule

1. If AW > 0 accept the project.
2. If AW = 0 remain indifference.
3. If AW < 0 reject the project.

Capital Recovery

- Capital costs such as land, building, equipment, etc. are one time cost and invested in initial period.
- For annual equivalent analysis, these costs are converted into annual basis over the life of the project. This annual equivalent costs are known as capital recovery and it is denoted by CR.
- Capital recovery covers depreciation of capital assets and interest on invested capital.
- Capital recovery cost is calculated by using the following expressing.

CR = I (A/P, i%, n) – SV (A/F, i%, n)

Where, I = initial cost.

SV = salvage value.

n = useful life.

Example 3.6

Consider a machine cost Rs 20,000 and expected to save Rs 5,000 per year from its operation for the period of 5years. The salvage value at the end of 5 years is Rs 10,000. Is it worthwhile to purchase the machine? Justify by using annual worth formulation. Take MARR= 10%. Also calculate the CR cost of this machine.

Solution: Given,

Investment = P = Rs 20,000

Annual Revenue = A= Rs 5,000

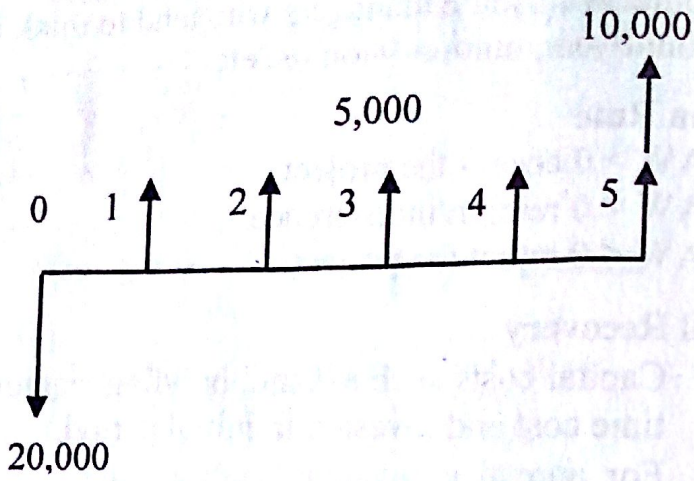
Salvage Value = SV= Rs 10,000

Useful Life = n = 5 Years

MARR = i = 10%

Auture Worth = AW = ?

Capital Recovery Cost= CR = ?



AW = – P (A/P, i%, n) + A +SV (A/F, i%, n)
= – 20,000 (A/P, 10%, 5) + 5,000 +10,000(A/F, 10%, 5)
= – 20,000 (0.2638) + 5,000 +10,000 (0.1638)
= Rs 1362

Since, AW > 0, therefore it is worthwhile to purchase the machine Ans.

CR = I (A/P, i%, n) – SV (A/F, i%, n)
= 20,000 (A/P, 10%, 5) – 10,000 (A/F, 10%, 5)
= 20,000 (0.3155) – 10,000 (0.2155)= Rs 4,155 **Ans.**

Example 3.7

Consider a project with Rs 3,000 annual operating cost and Rs 5,000 investment required each 5 years. i = 10%. Calculate the equivalent annual worth of the project.

Solution:

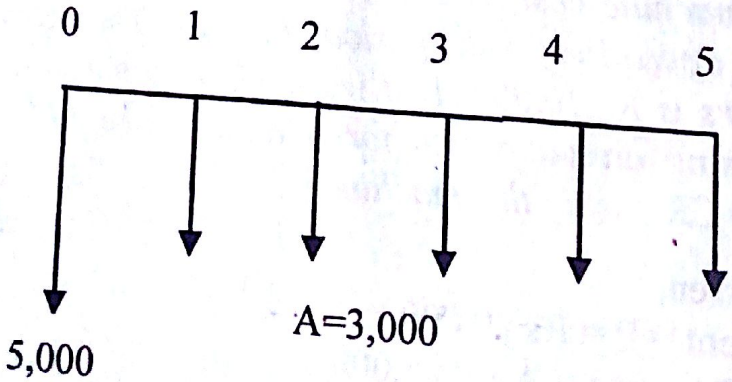


Fig. 3.3: *Cash Flow Diagram.*

Equivalent Annual Cost (EAC) = 3,000.+ 5,000 (A/P, 10%, 5)
= 3,000 + 5,000 (0.2638)
= Rs 4,319/yr **Ans.**

3.4 Rate of Return Methods

Rate of Return

Rate of Return (ROR) is defined as the interest rate earned on the unpaid balance of an installment loan. It is a relative percentage method which measures the annual rate of return as a percentage of investment over the life of a project.

Steps to Determine ROR for a Single Investment

Step 1: Take the amounts to the same point in time using the compound interest formulas.

Step 2: Equate the sum of the revenues to the sum of the costs at that point in time and solve for i.

3.4.1 Internal Rate of Return Method (IRR)

- It is the discount rate that will equate the present value of the outflows with the present value of the inflows.
- It determines the interest rate (i) that yields a future worth equal to zero over the planning horizon.
- It is the rate of interest earned on the unrecovered balance of the investment.
- It is a very popular discrete cash flow method.
- It is calculated by using the following expression.

$$\sum_{t=0}^{n} A_t \left\{ \frac{(1+i)^{n-t}}{(1+i)^t} \right\} = 0$$

IRR is that i that makes the NPV = 0

Decision Rule

- Accept the project if the IRR is greater than the required rate of return. Otherwise, reject the project.

Advantages

- Easy to understand and communicate.

Disadvantages

- Does not distinguish between investing and borrowing.
- IRR may not exist or there may be multiple IRR.
- Problems with mutually exclusive investments.

Example 3.8

A company purchases a piece of construction equipment for rental purposes. The expected income is Rs 3,100 annually for its useful life of 15 years. Expenses are estimated to be Rs355 annually. If the purchase price is Rs 25,000 and there is no salvage value, what is the prospective rate of return, neglecting taxes?

Solution: Given,

Initial investment = P = Rs 25,000
Income/yr = R = Rs 3,100
Useful life = n =15 years
Expenses/yr = E = Rs 355
Salvage value = SV = Rs 0
Rate of Return = i =?

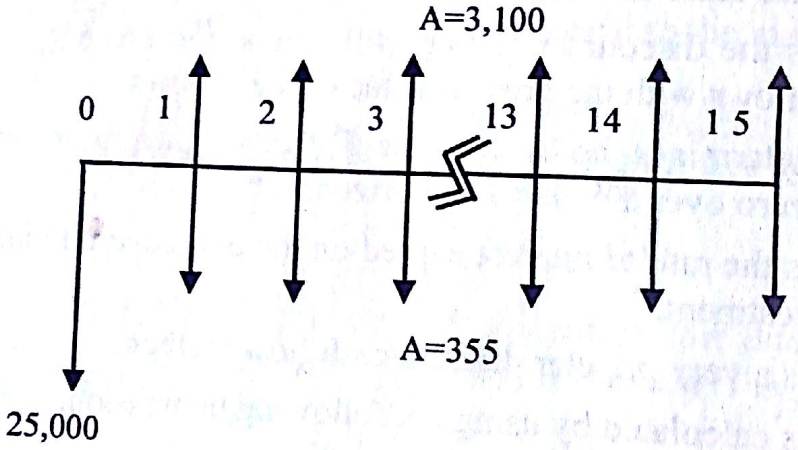


Fig. 3.4: *Cash Flow Diagram.*

The rate of return can be viewed as the effective annual interest rate that makes the present worth of the investment equal to zero.

$$\sum P = 0 = -P + (R - E)(P/A, i\%, 15)$$
$$= -25,000 + (3,100 - 355)(P/A, i\%, 15)$$
$$= -25,000 + 2,745(P/A, i\%, 15)$$

Table 3.1: Value of Present Worth by Trial and Error.

SN	When interest (i)	Present Worth (PW)
1	6% (x_1)	$-25,000 + 2,745(9.7122) = \mathbf{1,659.98}$ (y_1)
2	8% (x_2)	$-25,000 + 2,745(8.5595) = \mathbf{-1,504.17}$ (y_2)
3	i = ? (x)	0 (y)

Using linear interpolation

$$\frac{x_2 - x_1}{y_2 - y_1} = \frac{x - x_1}{y - y_1}$$

$$\frac{8-6}{-1504.17-1659.98} = \frac{x-6}{0-1659.98}$$

$x = 7.049\%$

Therefore, IRR = x = 7.049% **Ans.**

3.4.2 External/Modified Rate of Return Method (ERR)

- It equates future worth of positive cash flows using the MARR to the ~~future~~ present worth of negative cash flows using the ERR.

Calculation of ERR

Step 1: All cash inflows are discounted to period zero at ϵ % per compounding period.

Step 2: All cash outflows are compounded to period at N at ϵ %.

Step 3: ERR is the interest rate that equivalence between the two quantities.

$$\sum_{t=0}^{n} R_t (1+r)^{n-t} = \sum_{t=0}^{n} C_t (1+i)^{n-t}$$

Where, R_t = positive-valued cash flow.
C_t = absolute value of a negative-valued cash flow.
r = MARR
i = ERR

This method is useful to avoid the multiple root problem of the IRR.

Example 3.9

Find the ERR when ϵ = 15%

End of Year	*Annual Cash Flow*
0	*– 60,000*
1	*20,000*
2	*40,000*
3	*– 50,000*
4	*50,000*
5	*70,000*

Solution:

Step 1: Discounting all the cash outflows to the present at ϵ = 15%

PW = 60,000 + 50,000 (P/F, 15%, 3)
= 60,000 + 50,000 (0.6575)
= Rs 92,875

Step 2: Compounding all the cash inflows to the future at ϵ=15%

FW = 20,000 (F/P, 15%, 4) + 40,000 (F/P, 15%, 3)
+ 50,000(F/P, 15%, 1) +70,000
= 20,000 (1.7490) + 40,000 (1.5209) + 50,000(1.1500) +70,000
= Rs 2,23,316

Step 3: Establishing equivalence between two equations
92,875 (F/P, i'%, 5) = 2,23,316
$(1 + i')^5 = 2.404 = 19.18\%$
Therefore, external rate of return ERR =19.18% **Ans.**

3.5 Public Sector Economic Analysis (Benefit Cost Ratio Method)

Benefit-cost Analysis

- The benefit-cost analysis method is mainly used for economic evaluation of public projects which are mostly funded by government organizations.
- In addition, this method can also used for economic evaluation of alternatives for private projects.
- The main objective of this method is used to find out desirability of public projects as far as the expected benefits on the capital investment are concerned.
- As the name indicates, this method involves the calculation of ratio of benefits to the costs involved in a project.
- The benefit-cost ratio is generally designated as **B/C ratio.**
- The benefit-cost ratio of projects is determined in different forms as:
  a. Conventional benefit-cost ratio and
  b. Modified benefit-cost ratio.

a. Conventional B/C Ratio

- The disbenefits associated with the project are subtracted from the benefits in the numerator of the ratio to obtain the net benefit associated with the project.
- Similarly, the equivalent worth of salvage value of the initial investment is subtracted from equivalent worth of cost in the denominator of the ratio.
- The total cost mainly consists of initial cost (initial capital investment) plus the operating and maintenance cost.
- **Thus the expression for conventional benefit-cost ratio (B/C Ratio) is mentioned as follows:**

$$\text{Conv. B/C ratio} = \frac{\text{PW (B)}}{\text{PW (I)} - \text{PW (SV)} + \text{PW(O \& M)}}$$

b. Modified B/C Ratio

- In the modified benefit-cost ratio method, the operating and maintenance cost is subtracted from the benefits in the numerator of the ratio.
- In other words, operating and maintenance cost is considered similar to the disbenefits.
- **The expression for modified benefit-cost ratio using PW is given as follows:**

$$\text{Modified B/C ratio} = \frac{\text{PW (B)} - \text{PW (O \& M)}}{\text{PW (I)} - \text{PW (SV)}}$$

Example 3.10

Find benefit cost ratio by using PW and AW method where,
Investment = Rs 90,000
Annual Revenue = Rs 50,000
Annual Cost = Rs 2,000
Salvage Value = Rs 20,000
MARR = 12%
Useful Life = 10 years

Solution:

For PW Method

PW (I) = 90,000
PW (O& M) = 2,000 (P/A, 12%, 10) = 2,000(5.6502) = 11,300.4
PW (B) = 50,000 (P/A, 12%, 10) = 50,000(5.6502) = 2,82,510
PW (SV) = 20,000(P/F, 12%, 10) = 20,000(0.3220) = 6440

$$\text{Conv. B/C ratio} = \frac{\text{PW of benefits}}{\text{PW (I)} - \text{PW(SV)} + \text{PW of 0 and M costs}}$$

$$\text{Conv. B/C ratio} = \frac{2,82,510}{90,000 - 6,440 + 11,300.4}$$

$$= 2.978 > 1 \textbf{ Justified}$$

$$\text{Modified B/C ratio} = \frac{\text{PW of benefits} - \text{PW O \& M}}{\text{PW (I)} - \text{PW(SV)}}$$

$$\text{Modified B/C ratio} = \frac{2,82,510 - 11,300.4}{90,000 - 6,440}$$

$$= \textbf{3.24 > 1 Justified.}$$

For AW Method

CR = 90,000 (A/P, 12%, 10) – 20,000 (A/F, 12%, 10)

$$= 90,000\ (0.1770) - 20,000\ (0.0570) = \text{Rs } 14,790$$

$$\text{Conv. B/C ratio} = \frac{\text{AW (B)}}{\text{CR} + \text{AW (O \& M)}}$$

$$\text{Conv. B/C ratio} = \frac{50,000}{14,790 + 2,000} = \mathbf{2.978 > 1\ Justified.}$$

$$\text{Modified B/C ratio} = \frac{\text{AW of benefits} - \text{AW (O \& M)}}{\text{CR}}$$

$$= \frac{50,000 - 2,000}{14,790} = \mathbf{3.24 > 1\ Justified.}$$

3.6 Introduction to Lifecycle Costing

Life Cycle Costing

In the past, economic assessment of alternative designs, construction, or investments has been based on initial (first) cost which ignores the total cost incurred for the investment throughout its lifetime. The concept of life cycle costing provides an economic tool which takes into account total costs for an investment during its life span. Life cycle costing can be defined as an economic assessment of alternative designs, construction, or other investments considering all significant costs of initial costs and ownership costs over economic life of each alternative. **The life cycle costing analysis cannot be carried out without considering the following:**

- Total costs.
- Concept of the time value of money.
- Initial costs: Including initial construction cost, design cost, land cost and finance cost.
- Ownership Costs: Including operating costs (maintenance, repairs and utility bills).
- Replacement Costs: Cost of replacing the project after it runs its economic life.
- The concept of the time value of money. The value of money today is not equal to the same amount of money in the past or in the future. This concept considers the following: initial costs (P) (present value), discount or interest rate (i %), life time of an investment (n).

3.7 Introduction to Financial and Economic Analysis

Financial and economic analysis is required to determine the feasibility of the project.

Financial Analysis

- It performs cost and benefit analysis from the perspective of beneficiaries.
- Main financial statements for financial analysis are cash flow, balance sheet, profit and loss account, etc.
- It provides financing plan for the proposed investment.
- It facilitates on operation and control of the project by providing management information.

Economic Analysis

- It performs cost and benefits analysis from the perspective of nation.
- It determines the impact of the project on various sectors of the economy of the society.
- It provides the information for decision rule.
- It facilitates to improve the design of the project.

Table 3.2: Comparison between Financial and Economic Analysis.

SN	Financial Analysis	Economic Analysis
1.	Financial analysis determines financial feasibility of the project.	Economic analysis determines the best use of resource over project life.
2.	Cost and benefits are considered from the perspective of project unit.	Cost and benefits are considered from the perspective of society.
3.	Financial analysis determines impact of the project on the achievement of beneficiaries' objective to maximize profit.	Economic analysis determines impact of the project on the achievement of national objective such as poverty reduction, employment generation, etc.
4.	Market prices of direct cost and direct benefits considered in financial profitability analysis and measured in monetary units.	Economic analysis takes into account of all tangible and intangible costs and benefits to the society.

Additional Solved Examples

Example 3.1

Find IRR and ERR of the following project. MARR = ϵ = 15% **TU-2071**

Year	*0*	*1*	*3*	*4*	*5*
Cash Flow	*– 50*	*– 10*	*30*	*40*	*50*

Solution:

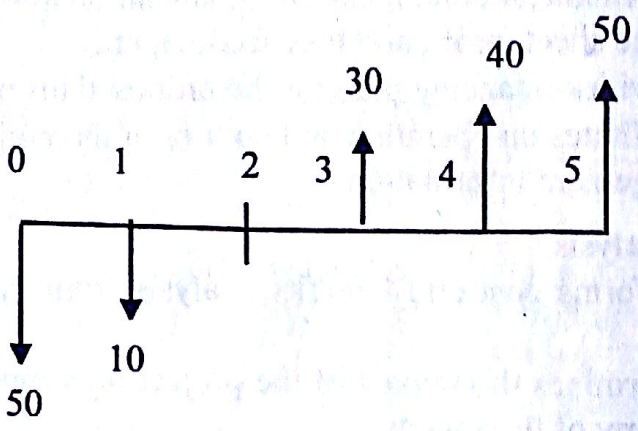


Fig. 3.5 *Cash Flow Diagram.*

a. IRR Calculation

Solution: We have given,

Rate of Return = i = ?

The rate of return can be viewed as the effective annual interest rate that makes the present worth of the investment equal to zero.

$\sum P = 0 = -50 - 10\,(P/F, i\%, 1) + 30\,(P/F, i\%, 3) + 40\,(P/F, i\%, 4) + 50\,(P/F, i\%, 5)$

@ i = 18%

$= -50 - 10\,(0.8475) + 30\,(0.6086) + 40\,(0.5158) + 50\,(0.4371)$

$= 2.27$

@ i = 20%

$= -50 - 10\,(0.8333) + 30\,(0.5787) + 40\,(0.4823) + 50\,(0.4019)$

$= -1.585$

By interpolating, IRR = i = 19.18% **Ans.**

b. ERR Calculation

Step 1: Discounting all the cash outflows to the present at ϵ = 15%.

PW = 50 + 10(P/F, 15%, 1) = 50 + 10(0.8696) = 58.696

Step 2: Compounding all the cash inflows to the future at ϵ = 15%.

FW = 30 (F/P, 15%, 2) + 40 F/P, 15%, 1) + 50
= 30(1.3225) + 40(1.1500) + 50 = 135.675

Step 3: Establishing equivalence between two equations
58.696 (F/P, i' %, 5) =135.675
$(1 + i')^5 = 2.311$
i' = 18.24%
Therefore, external rate of return = 18.24% **Ans.**

Example 3.2

Compute IRR by using trial and error process of the following project. Determine also investment Decision. **TU-2070**

Initial Investment	*25,000*
Annual Revenue	*8,000*
Salvage Value	*5,000*
Useful Life	*5 years*
MARR	*20%*

Solution:
NPW = 0 at the rate of return
NPW = −25,000 + 8,000 (P/A, i%, 5) + 5,000(P/F, i%, 5)
@ i = 20%
NPW = – 25,000 + 8,000 (2.9906) + 5,000 (0.4019) = 934.3
@ i = 22%
NPW = – 25,000 + 8,000 (2.8636) + 5,000 (0.3699) = – 241.7
By interpolating
IRR = 21.58%
Since, IRR = 21.58% >MARR accepted **Ans.**

Examples 3.3

Determine both types of B/C ratio for the given project if interest rate is 11%. **TU-2072**

Investment = Rs 10,000
Annual Benefits = Rs 4,600
Annual Cost = Rs 3,000
Salvage Value = Rs 2,500
Useful Life = 8 years

Solution:

For PW Method
PW (I) = 10,000
PW (O& M) = 3,000 (P/A, 11%, 8) = 3,000 (5.1461) = Rs 15,438.3

PW (B) = 4,600 (P/A, 11%, 8) = 4,600(5.1461) = Rs 23,672.06
PW (SV) = 2,500(P/F, 11%, 8) = 2,500(0.4339)= Rs 1,084.75

$$\text{Conv. B/C ratio} = \frac{\text{PW (B)}}{\text{PW (I)} - \text{PW(SV)} + \text{PW(O \& M)}}$$

$$\text{Conv. B/C ratio} = \frac{23,672.06}{10,000 - 1,084.75 + 15,438.3} = 0.97 \text{ Ans.}$$

$$\text{Modified B/C ratio} = \frac{\text{PW (B)} - \text{PW (O \& M)}}{\text{PW (I)} - \text{PW (SV)}}$$

$$\text{Modified B/C ratio} = \frac{23,672.06 - 15,438.3}{10,000 - 1,084.75} = 0.923 \text{ Ans.}$$

Example 3.4

Calculate both types of BC ratio using FW formulation when; initial investment is Rs 50,000, income is Rs 10,000 at the end of 1st year and increasing by 10% per year. Annual expenditure is Rs 2,000 at the end of 1st year and increasing by Rs 200 per year. Useful life is 6 years, salvage value is 20,000, MARR=15%. TU-2071

Solution: Given,

Year	Income	Expenditure
0	-	-
1	10,000	2,000
2	11,000	2,200
3	12,100	2,400
4	13,310	2,600
5	14,641	2,800
6	16,105.1	3,000

Using Future Worth Formulation

FW (I) = P (F/P, 15%, 6) = 50,000(2.3131) = 115655

FW (B) = A (F/P, 15%, 6)
= 10,000(F/P, 15%, 5) +11,000(F/P, 15%, 4) + 1,21,000(F/P, 15%, 3) + 13,310(F/P, 15%, 2) +14,641(F/P, 15%, 1) +16,105.1(F/P, 15%, 0)
= 10,000(2.0114) + 11,000(1.7490) +12,100(1.5209) +13,310(1.3225) + 14,641(1.1500) + 16105.1
= 1,08,300.61

FW (C) = 2,000 (F/A, 15%, 6) + 200 (P/G, 15%, 6) (F/P, 15% 6)
= 2,000 (8.7537) + 200 (7.9368) (2.3131) = 21,178.75

Sv = 20,000

$$\text{Conv. B/C ratio} = \frac{\text{FW (B)}}{\text{FW (I)} - \text{SV} + \text{FW (C)}}$$

$$\text{Conv. B/C ratio} = \frac{1,08,300.61}{1,15,655 - 20,000 + 21,178.75}$$

$$= 0.927 \textbf{ Ans.}$$

$$\text{Modified B/C ratio} = \frac{\text{FW (B)} - \text{FW (C)}}{\text{FW (I)} - \text{SV}}$$

$$\text{Modified B/C ratio} = \frac{1,08,300.61 - 21,178.75}{1,15,655 - 20,000}$$

$$= 0.91 \textbf{ Ans.}$$

Example 3.5

TU-2071

Initial Investment	*6,000*
Annual Benefits	*3,000*
O and M Costs	*1,000*
Salvage Value	*1,500*
MARR	*10%*

a. *Evaluate both types of BC ratio using future worth formulation. Take useful life = 10 years.*

b. *Evaluate both types of payback period. If useful life = 5yeras. (Take standard payback period = 3 years).*

Solution:

a. Future Worth Method

$$\text{Conv. B/C ratio} = \frac{\text{FW of benefits}}{\text{FW (I)} - \text{SV} + \text{FW of O and M costs}}$$

FW of benefits = 3,000 (F/A, 10%, 10)
= 3,000 (15.9374) = 47,812.2

FW (I) = 6,000 (F/P, 10%, 10)
= 6,000 (2.5937) = 15,562.2

FW of (O & M) = 1,000 (F/A, 10%, 10)
= 1,000 (15.9374) = 15.937.40

SV = 1,500

Substituting these values in the above equation

$$\text{Conv. B/C ratio} = \frac{47,812.2}{15,562.2 - 1,500 + 15,937.40}$$

$$= 1.59 \textbf{ Ans.}$$

$$\text{Modified B/C ratio} = \frac{\text{FW of benefits} - \text{FW O \& M}}{\text{FW (I)} - \text{SW}}$$

$$= \frac{47,812.2 - 15,937.40}{15,562.2 - 1,500} = 2.27 \text{ Ans.}$$

b. Pay Back Period

Simple Payback Period Method

Year	Net Cash Flow	Cumulative Cash Flow	Remarks
0	– 6,000	– 6,000	
1	2,000	– 4,000	Not recovered
2	2,000	– 2,000	Not recovered
3	2,000	0	Recovered
4	2,000	2,000	
5	2,000	4,000	

Payback Period = 3 Years.
Since, simple payback period ≤ 3. Therefore, project is accepted Ans.

Discounted Payback Period

Year	Net Cash Flow	Net Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	– 6,000	– 6,000	– 6,000	
1	2,000	1,818	– 4,182	Not recovered
2	2,000	1,653	– 2,529	Not recovered
3	2,000	1,503	– 1,026	Not recovered
4	2,000	1,366	340	Recovered
5	2,000	1,242	1,582	

Payback Period = $3 + \frac{1,026}{1,366} = 3.75$ Years.

Since, discounted payback period > 3 years. Therefore, reject the project **Ans.**

Example 3.6

From the following cash flow.

EOY	*0*	*1*	*2*	*3*	*4*	*5*
Cash Flow	*– 3,000*	*800*	*1,000*	*1,100*	*1,210*	*1,464*

Calculate both types of payback period. MARR= 10% **TU-2069**

Solution:

a. **Simple Payback Period Method**

Year	Cash Flow	Cumulative Cash Flow	Remarks
0	– 3,000	– 3,000	
1	800	– 2,200	Not recovered
2	1,000	– 1,200	Not recovered
3	1,100	– 100	Not recovered
4	1,210	1,110	Recovered
5	1,464	2,574	

Payback Period = $3 + \frac{100}{1,210}$ = 3.08 Years

Therefore, simple payback period = 3.08 year **Ans.**

Discounted Payback Period

Year	Cash Flow	Net Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	– 3,000	– 3,000	– 3,000	
1	800	727.3	– 2,272.7	Not recovered
2	1,000	826.44	– 1,446.26	Not recovered
3	1,100	826.44	– 619.82	Not recovered
4	1,210	826.44	206.62	Recovered
5	1,464	909.03	1,115.64	

Payback Period = $3 + \frac{619.82}{826.44}$

= 3.75 years

Therefore, discounted payback period= 3.75 years **Ans.**

Example 3.7

benefit cost Ratio

Find both types of BCR of a project having initial investment = Rs 5,000, Annual O and M = Rs 200, salvage value = 500 at the end of 10th year, Income at the end of 1st year is Rs 700 and is increasing by 100 per year, MARR=12%. **TU-2068**

Solution:

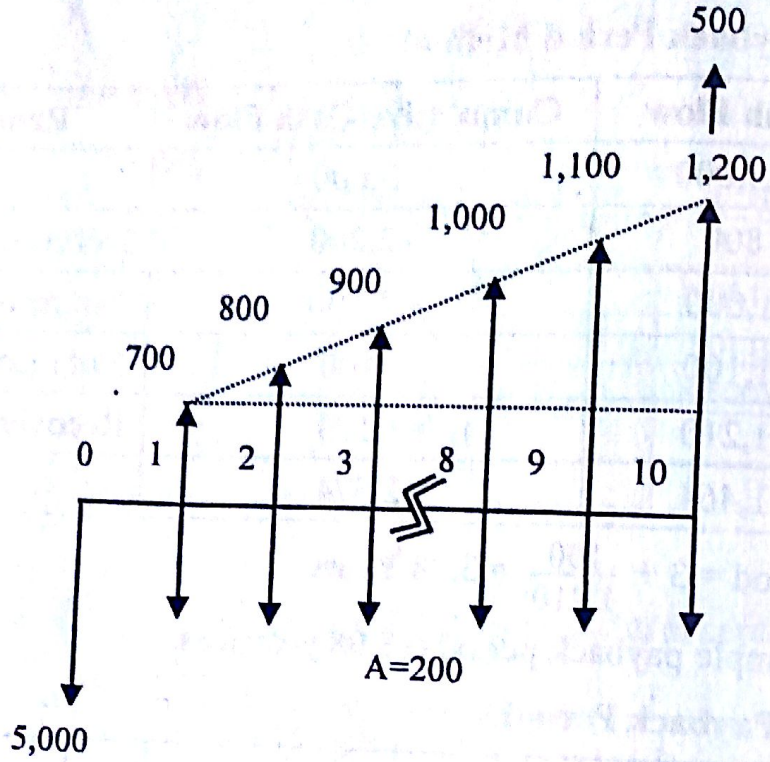


Fig. 3.6. *Cash Flow Diagram.*

Present Worth Method

$$\text{Conv. B/C ratio} = \frac{\text{PW of benefits}}{\text{I} - \text{PW (SV)} + \text{PW of O and M}}$$

PW of benefits = 700 (P/A, 12%, 10) + 100 (P/G, 12%, 10)
= 700 (5.6502) + 100 (20.2541)
= 5,980.55

I = 5,000

PW (SV) = 500 (P/F, 12%, 10) = 161
PW of O and M = 200 (P/A, 12%, 10)
= 200 (5.6502)
= 1,130.04

Substituting these values in the above equation

$$\text{Conv. B/C ratio} = \frac{5980.55}{5000 - 161 + 1130.04} = 1.001 \textbf{ Ans.}$$

$$\text{Modified B/C ratio} = \frac{\text{PW of benefits} - \text{PW of O \& M}}{\text{I} - \text{PW (SV)}}$$

$$\text{Modified B/C ratio} = \frac{5980.55 - 1130.04}{5000 - 161} = 1.002 \textbf{ Ans.}$$

Example 3.8

Determine the PW. MARR= 10% per year. **TU-2068**

EOY	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Cash Flow (0000) Rs	*– 15*	*5*	*5*	*5*	*4*	*3*	*2*	*1*

Evaluate both types of payback period also. Take standard payback period = 4 years.

Solution:

a. PW Calculation

$$PW = \sum_{t=1}^{n} \frac{A_t}{(1+i)^t}$$

$$= \frac{A_0}{(1+i)^0} + \frac{A_1}{(1+i)^1} + \frac{A_2}{(1+i)^2} + ... + \frac{A_n}{(1+i)^n}$$

$$= -\frac{15}{(1+0.1)^0} + \frac{5}{(1+0.1)^1} + \frac{5}{(1+0.1)^2} + \frac{5}{(1+0.1)^3} + \frac{4}{(1+0.1)^4} + \frac{3}{(1+0.1)^5} + ... \frac{2}{(1+0.1)^6} + \frac{1}{(1+0.1)^7}$$

$= 3.671183 \times 10{,}000 =$ Rs 36,711.83 **Ans.**

b. Pay Back Period

Simple Payback Period Method

EOY	Cash Flow (000)	Cumulative Cash Flow	Remarks
0	– 15	–15	
1	5	–10	Not recovered
2	5	–5	Not recovered
3	5	0	Recovered
4	4	4	
5	3	7	
6	2	9	
7	1	10	

Since, Payback Period = 3 years < 4 years.
Therefore, project is accepted **Ans.**

Discounted Payback Period

EOY	Cash Flow (000)	Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	–15	–15	–15	
1	5	4.5	–10.5	Not recovered
2	5	4.13	– 6.37	Not recovered
3	5	3.75	– 2.62	Not recovered
4	4	2.73	0.11	Recovered
5	3	1.86	1.97	
6	2	1.13	3.10	
7	1	0.51	3.61	

$$\text{Payback Period} = 3 + \frac{2.62}{2.72}$$

$$= 3.96$$

Since discounted payback period = 3.96 Years < 4 years.
Therefore, project is accepted **Ans.**

Example 3.9

Cash flows of a project are as follows: Take MARR= 10%

EOY	Cash inflow	Cash outflow
0	0	+10,00,000
1	5,00,000	1,00,000
2	5,60,000	2,00,000
3	6,20,000	3,00,000
4	6,80,000	4,00,000
5	7,40,000	5,00,000

a. Calculate both types of payback period (Standard payback period=3years).

b. Evaluate IRR (PW formulation) prepare UIP

Solution:

i. Simple Payback Period Method

EOY	Cash inflow	Cash outflow	Net Cash Flow	Cumulative Cash Flow	Remarks
0	0	+10,00,000	−10,00,000	−10,00,000	
1	5,00,000	1,00,000	4,00,000	− 6,00,000	Not recovered
2	5,60,000	2,00,000	3,60,000	− 2,40,000	Not recovered
3	6,20,000	3,00,000	3,20,000	80,000	Recovered
4	6,80,000	4,00,000	2,80,000	3,60,000	
5	7,40,000	5,00,000	2,40,000	6,00,000	

$$\text{Payback Period} = 2 + \frac{2,40,000}{3,20,000} = 2.75 \text{ Years.}$$

Result

Since Payback Period is less than 3 years so accept the project **Ans.**

ii. Discounted Payback Period

EOY	Cash inflow	Cash outflow	Net Cash Flow	Net Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	0	-10,00,000	-10,00,000	−10,00,000	−10,00,000	
1	5,00,000	1,00,000	4,00,000	3,63,636.36	− 6,36,363.6	Not recovered
2	5,60,000	2,00,000	3,60,000	2,97,520.66	− 3,38,842.9	Not recovered
3	6,20,000	3,00,000	3,20,000	2,40,420.73	− 98,422.25	Not recovered
4	6,80,000	4,00,000	2,80,000	1,91,243.76	92,821.54	Recovered
5	7,40,000	5,00,000	2,40,000	1,49,021.11	2,41,842.65	

$$\text{Payback Period} = 3 + \frac{98,422.25}{1,91,243.76} = 3.51 \text{ years.}$$

Result

Since Payback Period is greater than 3 years so reject the project **Ans.**

IRR Calculation Using PW Formulation

NPW = 0 at the rate of return

NPW = −10,00,000 + 4,00,000 (P/A, i%, 5) − 40,000 (P/G, i%, 5)

@ i = 15%

NPW= −10,00,000 + 4,00,000 (3.3522) − 40,000 (5.7751) = 1,09,876

@ i = 20%

NPW = −10,00,000 + 4,00,000 (2.9906) − 40,000 (4.9061)

NPW = − 4

By interpolating

i = 19.99% say 20%

Therefore, IRR = 20% **Ans.**

Table 3.1: Unrecovered Investment Balance Calculation.

N	Unpaid Balance	Return of Unpaid	Payment Received	Unpaid Balance at the end of Year
0	−10,00,000	0	0	−10,00,000
1	−10,00,000	− 2,00,000	4,00,000	− 8,00,000
2	− 8,00,000	− 1,60,000	3,60,000	− 6,00,000
3	− 6,00,000	− 1,20,000	3,20,000	− 4,00,000
4	− 4,00,000	− 80,000	2,80,000	− 2,00,000
5	− 2,00,000	− 40,000	2,40,000	0

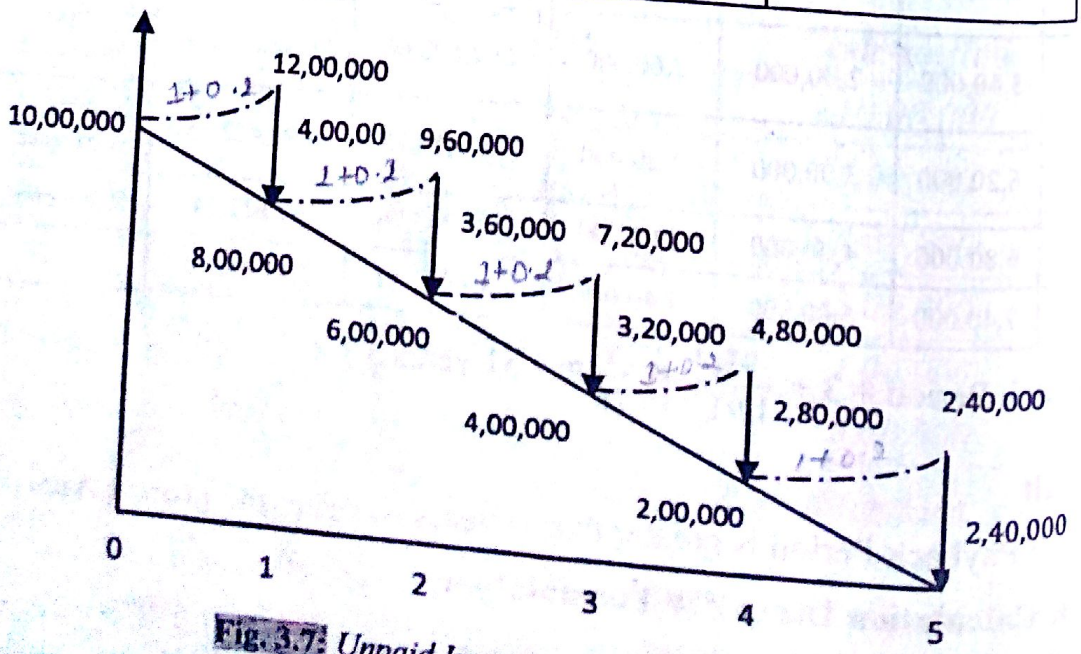


Fig. 3.7: *Unpaid Investment Balance Diagram.*

Example 3.10

Initial investment = Rs 1,00,000 **TU-2070**
Salvage Value = 0
Annual O and M cost = Rs 20,000
Useful Life = 5 years
Annual Benefit = 60,000 at the end of first year thereafter decreases by 4000 each year for the remaining years. MARR =12%

a. *Draw UIB diagram.*
b. *Evaluate conventional BCR using PW formulation. Take salvage value = 10,000*
c. *Evaluate discounted payback period. Take standard (cutoff) payback period = 3 years.*

Solution:

End of Year	Net Cash Out flow	Net Cash Inflow
0	–1,00,000	0
1	20,000	60,000
2	20,000	56,000
3	20,000	52,000
4	20,000	48,000
5	20,000	44,000

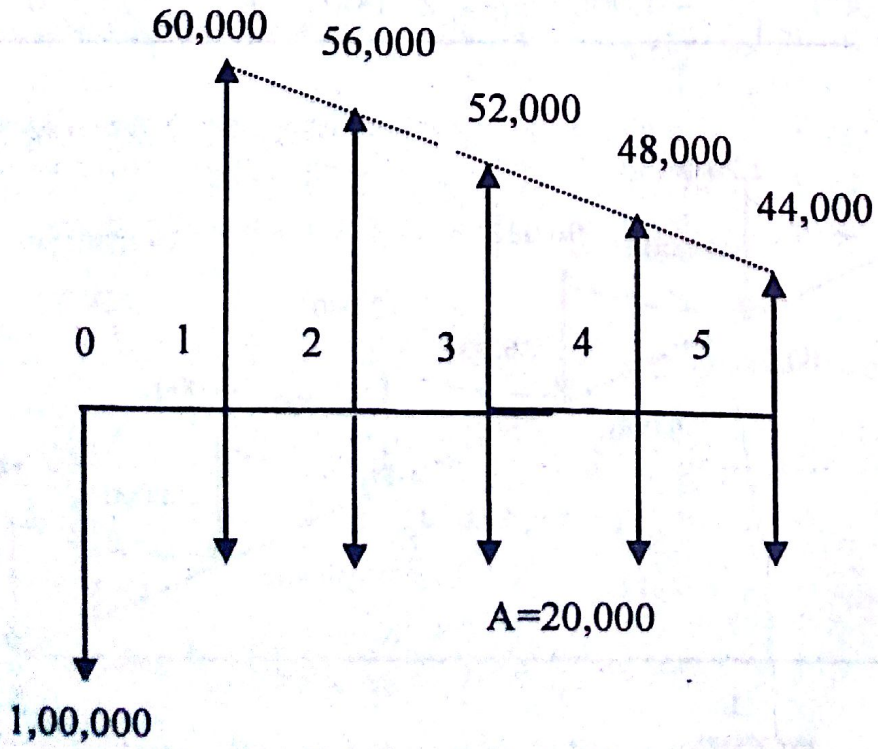


Fig. 3.8. *Cash Flow Diagram.*

NPW = 0 at the rate of return

NPW = −1,00,000 + 40,000(P/A, i%, 5) − 4,000(P/G, i%, 5)

@ i = 18%

NPW= −1,00,000 + 40,000 (3.1272) − 4,000 (5.2312) = 4,163.2

@ i = 20%

NPW = −1,00,000 + 40,000 (2.9906) − 4,000 (4.9061) = − 0.4

By interpolating

IRR = 19.99% say 20% **Ans.**

Table 3.3: Unrecovered Investment Balance Calculation.

N	Unpaid Balance	Return of Unpaid	Payment Received	Unpaid Balance at the end of Year
0	−1,00,000	0	0	−1,00,000
1	−1,00,000	− 20,000	40,000	− 80,000
2	− 80,000	−16,000	36,000	− 60,000
3	− 60,000	−12,000	32,000	− 40,000
4	− 40,000	− 8,000	28,000	− 20,000
5	− 20,000	− 4,000	24,000	0

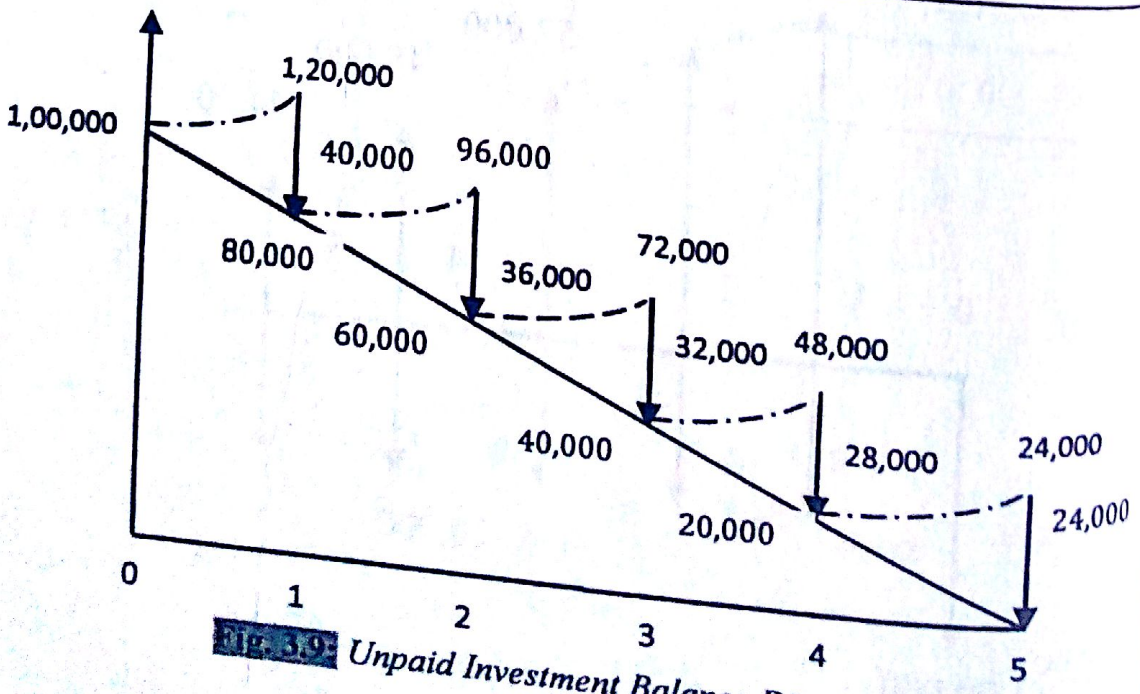
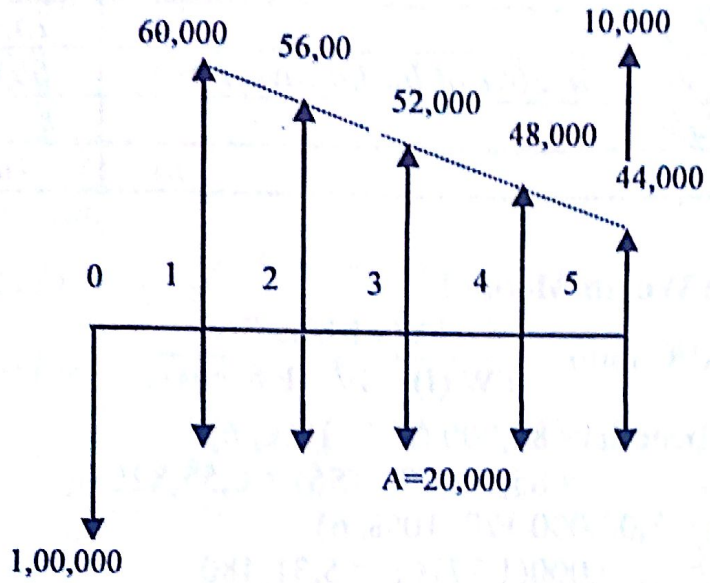


Fig. 3.9: *Unpaid Investment Balance Diagram.*

c. Calculation of BC Ratio by Present Worth Formulation



I = 1,00,000

PW (O& M) = 20,000 (P/A, 12%, 5) = 20,000 (3.6048) = 72,096

PW (B) = 60,000 (P/A, 12%, 5) – 4,000(P/G, 12%, 5)

= 60,000(3.6048) – 4,000(6.3970 = 1,90,700

PW (SV) = 10,000(P/F, 12%, 5) = 10,000(0.5674) = 5,674

$$\text{Conv. B/C ratio} = \frac{\text{PW (B)}}{\text{I} - \text{PW (SV)} + \text{PW (O \& M)}}$$

$$\text{Conv. B/C ratio} = \frac{190700}{100000 - 5674 + 72096} = 1.14 \textbf{ Ans.}$$

d. Discounted Payback Period

Year	Net Cash Flow	Net Present Worth of Discounted Cash Flow	Cumulative Cash Flow	Remarks
0	–1,00,000	–1,00,000	–1,00,000	
1	40,000	35,714.28	– 64,285.71	Not recovered
2	36,000	28,698.97	– 35,586.73	Not recovered
3	32,000	22,776.96	– 12,809.76	Not recovered
4	28,000	17,794.50	4,984.71	Recovered

$$\text{Payback Period} = 3 + \frac{12809.76}{17794.50} = 3.72 \text{ Years } \textbf{Ans.}$$

Example 3.11

Determine both types of B/C ratio from the following cash flow,

TU-2070

Initial Investment	*3,00,000*
Annual Revenue	*85,000*
Annual Costs	*15,000*
Salvage Value @ 20% of Initial Investment	*60,000*
Useful Life	*6 years*
MARR	*10%*

Solution:

e. Future Worth Method

$$\text{Conv. B/C ratio} = \frac{\text{FW of benefits}}{\text{FW (I)} - \text{SV} + \text{FW costs}}$$

FW of benefits = 85,000 (F/A, 10%, 6)
= 85,000 (7.7156) = 6,55,826

FW (I) = 3,00,000(F/P, 10%, 6)
= 3,00,000(1.7716) = 5,31,480

SV = 60,000

FW of Costs = 15,000 (F/A, 10%, 6)
= 15,000 (7.7156) = 1,15,734

Substituting these values in the above equation

$$\text{Conv. B/C ratio} = \frac{655826}{531480 - 60000 + 115734} = \mathbf{1.11\ Ans.}$$

$$\text{Modified B/C ratio} = \frac{\text{FW of benefits} - \text{FW costs}}{\text{FW (I)} - \text{SV}}$$

$$\text{Modified B/C ratio} = \frac{655826 - 115734}{531480 - 60000} = \mathbf{1.14\ Ans.}$$

Example 3.12

Equipment costs 2,50,000 and has salvage value of 50,000 at the end of its expected life 5 years. Annual expenses will be 40,000. It will produce revenue of 1,20,000 per year, MARR = 20%. = ϵ **TU-2069**

i. Evaluate IRR using AW formulation
ii. Evaluate both types of B/C ratio with FW formulation.
iii. Find ERR.

Solution:

i. IRR Calculation

AW Formulation

AW = 0 at the rate of return

AW = −2,50,000 (A/P, i% 5) − 40,000 + 1,20,000 + 50,000 (A/F, i%, 5)

$$\text{Or, } -2,50,000\left\{\frac{i(1+i)^5}{(1+i)^5-1}\right\}+80,000+50,000\left\{\frac{i}{(1+i)^5-1}\right\}=0$$

By trial and error
IRR= 21.57% **Ans.**

ii. B/C Ratio Calculation

FW Formulation

$$\text{Conv. B/C ratio} = \frac{\text{FW of benefits}}{\text{FW (I)} - \text{SV} + \text{FW costs}}$$

FW of benefits = 1,20,000 (F/A, 20%, 5)
= 1,20,000 (7.4416) = 8,92,992

FW (I) = 2,50,000(F/P, 20%, 5)
= 2,50,000 (2.4883) = 6,22,075

SV = 50,000

FW of Costs = 40,000 (F/A, 20%, 5)
= 40,000 (7.4416) = 2,97,664

Substituting these values in the above equation

$$\text{Conv. B/C ratio} = \frac{8,92,992}{6,22,075-50,000+2,97,664}$$

= 1.026 >1 justified **Ans.**

$$\text{Modified B/C ratio} = \frac{\text{FW of benefits} - \text{FW costs}}{\text{FW (I)} - \text{SV}}$$

$$\text{Modified B/C ratio} = \frac{8,92,992-2,97,664}{6,22,075-50,000} = 1.04 > 1 \text{ justified } \textbf{Ans.}$$

iii. ERR Calculation

Step 1: Discounting all the cash outflows to the present at c = 20%
= 2,50,000 + 40,000 (P/A, 20%, 5)
= 2,50,000 + 40,000 (2.991)
= Rs 3,69,640

Step 2: Compounding all the cash inflows to the future at c = 20%
= 1,20,000 (F/A, 20%, 5) + 50,000
= 1,20,000 (7.4416) + 50,000 = Rs 9,42,992

Step 3: Establishing equivalence between two equations
3,69,640 (F/P, i'%, 5) = 9,42,992
$(1 + i')^5 = 2.551$

Therefore, external rate of return ERR= 20.60 % **Ans.**

Example 3.13 TU-2068

Evaluate ERR. MARR=10%, ϵ= 8%

EOY	0	1	2	3	4	5
Cash Inflow (000)	–	40	1,50	120	800	200
Cash Outflow (000)	– 4,80	– 80	– 50	– 500	– 200	– 400

Solution:

Step 1: Discounting all the cash outflows to the present at ϵ=8%

= 4,80,000 + 80,000 (P/F, 8%, 1) + 50,000 (P/F, 8%, 2) + 5,00,000 (P/F, 8%, 3) + 2,00,000 (P/F, 8%, 4) + 4,00,000 (P/F, 8%, 5)

= 4,80,000 + 80,000 (0.9259) + 50,000 (0.8573) + 5,00,000 (0.7938) + 2,00,000 (0.7350) + 4,00,000 (0.6906)

= Rs 14,17,077

Step 2: Compounding all the cash inflows to the future at ϵ = 8%

= 40,000 (F/P, 8%, 4) + 1,50,000 (F/P, 15%, 3) + 1,20,000(F/P, 8%, 2) + 8,00,000(F/P, 8%, 1) + 2,00,000

= 40,000 (1.3605) + 1,50,000 (1.2597) + 1,20,000 (1.1604) + 8,00,000 (1.0800) + 2,00,000 = Rs 14,46,623

Step 3: Establishing equivalence between two equations

1417077 (F/P, i'%, 5) =14,46,623

$(1 + i')^5 = 1.0201 = 0.41\%$

Since ERR<MARR. Therefore reject the project **Ans.**

Example 3.14

A city plans a pipeline to transport water from a distant watershed area to the city. The pipeline will cost Rs 80,00,000 and have an expected life of seventy years. The city anticipates it will need to keep the water line in service indefinitely. Compute the capitalized cost assuming 7% interest.

Solution: We have given,

Initial investment (P) = Rs 80,00,000

Expected life (n) = 70years

Interest rate (i) = 7%

Capitalized cost (CC) =?

We can find A first based on initial investment.

A = P (A/P, 7%, 70) = 80,00,000 (0.0706) = Rs 5,64,800

Now, the infinite series payment formula could be applied for n = ∞:

We have the capitalized cost equation (CC) = $\frac{A}{i}$

Capitalized cost (CC) = $\frac{A}{i} = \frac{5,64,800}{0.07}$

= Rs 80,68,571.43

Therefore, capitalized cost (CC) = Rs 80,68,571.43 **Ans.**

Questions

1. Calculate IRR form the following cash flow and draw investment balance diagram.

Year	0	1	2	3	4	5
Cash Flow	– 800	250	300	400	–150	600

2. Evaluate IRR of the following project, identify whether the project is feasible or not? Also draw investment balance diagram.

End of Year	Cash Flow
1	– 40,000
2	– 50,000
3	– 60,000
4	–70,000
5	– 80,000
6	– 10,000

3. Determine conventional and modified B/C ratio for the given project if interest rate is 11%.

Investment	10,000
Life of Project (Years)	8
Annual Benefits	4,600
Annual Costs	3,000
Salvage Value	2,500

4. Find the net present value (NPV) of the cash receipts shown below when effective interest rate is 10% compounded annually.

Cash Flow Details	
0	– 500
1	– 100
2	0
3	600
4	100
5	400
6	150

5. Evaluate IRR of the following project, identify whether the project is feasible or not? Also draw investment balance diagram.

Investment	5,00,000
Annual Benefits	1,20,000
Annual Costs	30,000
Useful Life (Years)	10
MARR	10%

6. Find both types of B/C ratio using present worth and annual worth method.

Investment	4,00,000
Annual Benefits	1,75,000
Annual Costs	25,000
MARR	10%
Salvage Value	40,000

7. Calculate both types of BCR of a project with following details MARR=12%

Initial Investment	Annual Income	Annual Cost	Useful Life	Salvage Value
Rs 1,00,000	Rs 20,000 at the end of first year and increase by 5% per year.	Rs 3,000 at the end of first year and increase by Rs 500 per year.	12 Years	25,000

8. Determine conventional and modified B/C ratio for the given project. The cash flow diagram are as follows:

Investment	50,000
Useful Life (Years)	5
Salvage Value	5,000
Annual Benefits	12,000
Annual Costs O & M	6,000
Interest Rate	8%

Check whether the investment is worthwhile or not?

9. Consider an investment project with the following cash flows:

Cash Flow Details	
0	– 22,000
1	– 1,000
2	0
3	4,000
4	3,000
5	15,000

Compute the IRR for this investment and determine its accessibility at MARR=10% and draw also an investment balance diagram.

10. Using IRR method, determine whether the project is acceptable or not?

Investment	50,000
Annual Benefits	14,000
Annual Costs	20,000
Useful Life (Years)	6
Salvage Value	5,000
MARR	12%

11. Evaluate IRR of the following project, identify whether the project is feasible or not? Also draw investment balance diagram.

Initial Investment	5,00,000
Annual Revenues	1,20,000
Annual Costs	30,000
Useful Life (Years)	10
MARR	10%

12. Define cost benefit ratio. Find out the both types of B/C ratio using present worth and annual worth method.

Initial Investment	4,00,000
Annual Revenues	1,75,000
Annual Costs	25,000
Salvage Value	40,000
Useful Life (Years)	6
MARR	12%

13. Evaluate IRR of the following project and identify whether the projects are feasible or not. Also draw the investment balance diagram.

Initial Investment	6,00,000
Annual Revenues	1,50,000
Annual Costs	40,000
Salvage Value	40,000
Useful Life (Years)	10
MARR	10%

14. Calculate the equivalent future worth of the project having the following information of cash flow. Use arithmetic gradient.

EOY	Payments
1	8,000
2	7,000
3	6,000
4	5,000

15. Find the both types payback period of the project with the following cash flow status.

EOY	Payments
0	– 1,500
1	200
2	400
3	450
4	450
5	600
6	900
7	1,100

16. For the cash flow given below and a 10% interest, compute the value of C for net amount equal to be zero at the end of eight years.

EOY	Payments
1	0
2	–100
3	– 200
4	– 300
5	0
6	C
7	C
8	C

17. Evaluate IRR of the following project and identify whether the project is feasible or not.

Initial Investment	5,00,000
Annual Revenues	80,000
Annual O & M Costs	15,000
Useful Life	20 Years
MARR	10%

18. Find IRR and ERR of the following cash flow. Draw investment balance diagram based on IRR value. MARR = ϵ = 12%.

EOY	0	1	2	3	4
Net Cash Flow in Rs	– 5,50,000	– 50,000	+ 1,25,000	+ 3,50,000	+ 6,25,000

19. What do you mean by payback period? Differentiate between simple and discounted payback period method.
20. State the advantages and disadvantages of IRR.
21. What is benefit cost analysis? Explain the different form of benefit cost analysis.
22. Differentiate between financial and economic analysis.
23. Write short notes
    (a) Public sector project. (b) Present worth. (c) Future worth.
    (d) Annual worth. (e) Life cycle costing.