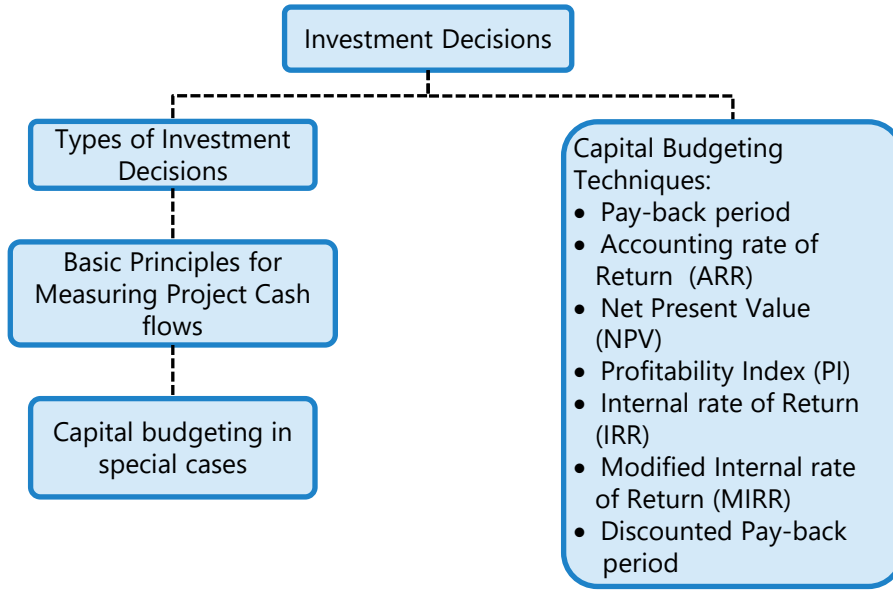
CHAPTER 7

INVESTMENT DECISIONS

LEARNING OUTCOMES

- State the objectives of capital investment decisions.
- Discuss the importance and purpose of Capital budgeting for a business entity.
- Calculate cash flows in capital budgeting decisions and try to explain the basic principles for measuring the same.
- Discuss the various investment evaluation techniques like Payback Period, Accounting Rate of Return (ARR), Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR), Discounted Payback Period, and Modified Internal Rate of Return (MIRR).
- Apply the concepts of the various investment evaluation techniques for capital investment in decision making.
- Discuss the advantages and disadvantages of the above-mentioned evaluation techniques.

CHAPTER OVERVIEW



1. INTRODUCTION

In the first chapter, we had discussed the three important functions of financial management which are Investment Decisions, Financing Decisions and Dividend Decisions. So far, we have studied Financing decisions in previous chapters. In this chapter, we will discuss the second important decision area of financial management which is Investment Decision. Investment decision is concerned with **optimum utilization of fund to maximize the wealth of the organization** and in turn the wealth of its shareholders. Investment decision is very crucial for an organization to fulfil its objectives; in fact, it generates revenue and ensures long term existence of the organization. Even the entities which exist not for profit are also required to make investment decision though not to earn profit but to fulfil its mission.

As we have seen in the Financing Decision chapter, each rupee of capital raised by an entity bears some cost, commonly known as cost of capital. It is necessary that each rupee raised is to be invested in a very prudent manner. It requires a proper planning for capital, and it is done through a proper budgeting. A proper budgeting

requires all the characteristics of budget. Due to this feature, investment decisions are very popularly known as Capital Budgeting, which means applying the principles of budgeting for capital investment.

In simple terms, Capital Budgeting involves:

- **Identification** of investment projects that are strategic to business' overall objectives;
- **Estimating and evaluating** post-tax incremental cash flows for each of the investment proposals; and
- **Selection** of an investment proposal that maximizes the return to the investors.

2. PURPOSE OF CAPITAL BUDGETING

The capital budgeting decisions are important, crucial and critical business decisions due to the following reasons:

(i) **Substantial Investment :** Investment decisions are related with fulfillment of long-term objectives and existence of an organization. To invest in a project(s), a substantial capital investment is required. Based on size of capital and timing of cash flows, sources of finance are selected. Due to huge capital investments and associated costs, it is therefore necessary for an entity to make such decisions after a thorough study and planning.

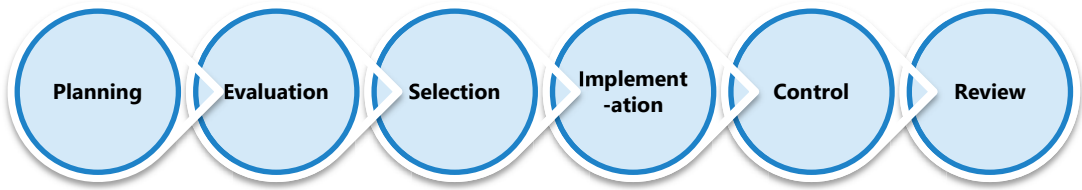
(ii) **Long time period:** The capital budgeting decision has its effect over a long period of time. These decisions not only affect the future benefits and costs of the firm but also influence the rate and direction of growth of the firm.

(iii) **Irreversibility:** Most of the investment decisions are irreversible. Once the decision is implemented, it is very difficult and reasonably and economically not possible to reverse the decision. The reason may be upfront payment of amount, contractual obligations, technological impossibilities etc.

(iv) **Complex decisions:** The capital investment decision involves an assessment of future events, which in fact is difficult to predict. Further, it is quite difficult to estimate in quantitative terms, all the benefits or the costs relating to a particular investment decision.

3. CAPITAL BUDGETING PROCESS

The extent to which the capital budgeting process needs to be formalised and systematic procedures to be established depends on the size of the organisation; number of projects to be considered; direct financial benefit of each project considered by itself; the composition of the firm's existing assets and management's desire to change that composition; timing of expenditures associated with the projects that are finally accepted.



(i) **Planning:** The capital budgeting process begins with the **identification of potential investment opportunities.** The opportunity then enters the planning phase when the potential effect on the firm's fortunes is assessed and the ability of the management of the firm to exploit the opportunity is determined. Opportunities having little merit are rejected and promising opportunities are advanced in the form of a proposal to enter the evaluation phase.

(ii) **Evaluation:** This phase involves the **determination of proposal** and its investments, inflows and outflows. Investment appraisal techniques, ranging from the simple payback method and accounting rate of return to the more sophisticated discounted cash flow techniques, are used to appraise the proposals. The technique selected should be the one that enables the manager to make the best decision in the light of prevailing circumstances.

(iii) **Selection:** Considering the returns and risks associated with the individual projects as well as the cost of capital to the organisation, the organisation will **choose among the projects** which maximises the shareholders' wealth.

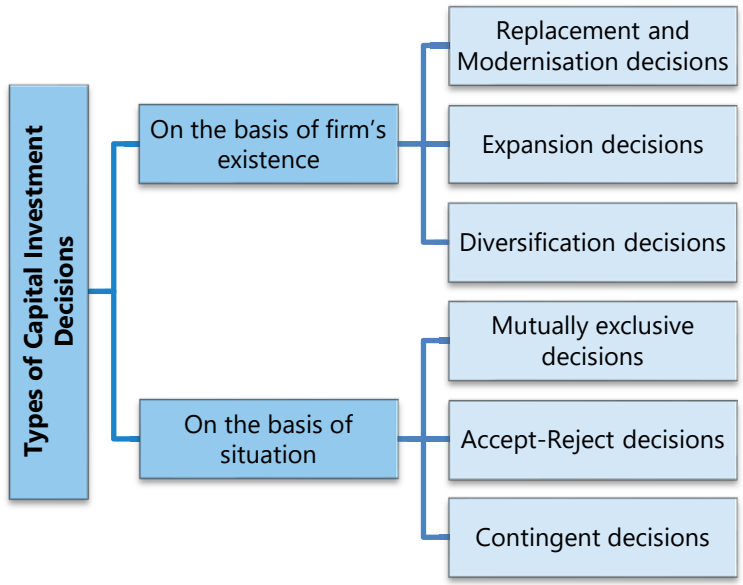
(iv) **Implementation:** When the final selection is made, the firm must acquire the necessary funds, purchase the assets, and begin the **implementation of the project.**

(v) **Control:** The **progress of the project is monitored** with the aid of feedback reports. These reports will include capital expenditure progress reports, performance reports comparing actual performance against plans set and post completion audits.

(vi) **Review:** When a project terminates, or even before, the organisation should **review the entire project** to explain its success or failure. This phase may have implication for firm's planning and evaluation procedures. Further, the review may produce ideas for new proposals to be undertaken in the future.

4. TYPES OF CAPITAL INVESTMENT DECISIONS

There are many ways to classify the capital budgeting decision. Generally capital investment decisions are classified in two ways. One way is to classify them on the basis of firm's existence. Another way is to classify them on the basis of decision situation.



4.1 On the basis of firm's existence

The capital budgeting decisions are taken by both newly incorporated firms as well as by existing firms. The new firms may require decision making in respect of selection of a plant to be installed. Whereas the existing firm may require taking

decisions to meet the requirement of new environment or to face the challenges of competition. These decisions may be classified as follows:

(i) **Replacement and Modernisation decisions:** The replacement and modernisation decisions aims to improve operating efficiency and reduce cost. Generally, all types of plant and machinery require replacement either because the economic life of the plant or machinery is over or because it has become technologically outdated. The former decision is known as replacement decision and latter is known as modernisation decision. Both replacement and modernisation decisions are called as cost reduction decisions.

(ii) **Expansion decisions:** Existing successful firms may experience growth in demand of their product line. If such firms experience shortage or delay in the delivery of their products due to inadequate production facilities, they may consider proposal to add capacity to existing product line.

(iii) **Diversification decisions:** These decisions require evaluation of proposals to diversify into new product lines, new markets etc. for reducing the risk of failure by dealing in different products or by operating in several markets.

Both expansion and diversification decisions are called revenue expansion decisions.

4.2 On the basis of situations

The capital budgeting decisions on the basis of situations are classified as follows:

(i) **Mutually exclusive decisions:** The decisions are said to be mutually exclusive if two or more alternative proposals are such that the **acceptance of one proposal** will exclude the acceptance of the other alternative proposals. For instance, a firm may be considering proposal to install a semi-automatic or highly automatic machine. If the firm installs a semi-automatic machine, it excludes the acceptance of proposal to install highly automatic machine.

(ii) **Accept-Reject decisions:** The accept-reject decisions occur when **proposals are independent** and do not compete with each other. The firm may accept or reject a proposal on the basis of a minimum return on the required investment. All those proposals which give a higher return than certain desired rate of return are accepted and the rest are rejected.

(iii) Contingent decisions: The contingent decisions are made when the proposals are **dependable** proposals. The investment in one proposal requires investment in one or more other proposals. For example, if a company accepts a proposal to set up a factory in remote area, it will have to invest in infrastructure, like building of roads, houses for employees etc. also.

4.3 Steps of Capital Budgeting Procedure

1. **Estimation** of Cash flows over the entire life for each of the projects under consideration.
2. **Evaluate** each of the alternative, using different decision criteria.
3. **Determining** the minimum required rate of return (i.e., WACC) to be used as discount rate.

Accordingly, this chapter is divided into two sections:

1. Estimation of Cash Flows
2. Capital Budgeting Techniques

SECTION 1

5. ESTIMATION OF PROJECT CASH FLOWS

Capital Budgeting analysis considers only **incremental cash flows** from an investment likely to result due to acceptance of any project. Therefore, one of the most important tasks in capital budgeting is estimating future cash flows for a project. Though one of the techniques i.e., Accounting Rate of Return (ARR) evaluates profitability of a project on the basis of accounting profit, but accounting profit has its own limitations. Timings of cash flow may not match with the period of profit. Further, non-cash items like depreciation have no immediate cash outflow.

The cash flows are estimated on the basis of inputs provided by various departments such as Production department, Finance department, Marketing department, etc.he project cash flow stream consists of cash outflows and cash inflows. The costs are denoted as "cash outflows" whereas the benefits are denoted as "cash inflows".

An investment decision implies the choice of an objective, an appraisal technique and the project's life. The objective and technique must be related to definite period of time. The life of the project may be determined by taking into consideration the following factors:

(i) Technological obsolescence;

(ii) Physical deterioration; and

(iii) Decline in demand for the product

No matter how good a company's maintenance policy, technological or demand forecasting abilities are, uncertainty will always be there.

Calculating Cash Flows: Before we analyze how cash flow is computed in capital budgeting decision, following items needs consideration:

(a) Depreciation: As mentioned earlier, depreciation is a **non-cash item** and itself does not affect the cash flow. However, we must consider tax shield or benefit from depreciation in our analysis. Since this benefit reduces cash outflow for taxes, it is considered as cash inflow. To understand how depreciation acts as tax shield, let us consider following example:

Example -1

X Ltd. manufactures electronic motors fitted in desert coolers. It has an annual turnover of ₹ 30 crore and cash expenses to generate this much of sale is ₹ 25 crore. Suppose applicable tax rate is 30% and depreciation is ₹ 1.50 crore p.a.

The table below is showing Tax shield due to depreciation under two scenarios i.e., with and without depreciation:

	No Depreciation is Charged (₹ Crore)	**Depreciation is Charged (₹ Crore)**
Total Sales	30.00	30.00
Less: Cost of Goods Sold	(25.00)	(25.00)
	5.00	5.00
Less: Depreciation	-	1.50
Profit before tax	5.00	3.50
Less: Tax @ 30%	1.50	1.05

Profit after Tax	3.50	2.45
Add: Depreciation*	-	1.50
Cash Flow	3.50	3.95

* Being non- cash expenditure depreciation has been added back while calculating the cash flow.

As we can see in the above table that due to depreciation under the second scenario, a tax saving of ₹ 0.45 crore (₹ 1.50 – ₹ 1.05) was made. This is called tax shield. The tax shield is considered while estimating cash flows.

(b) Opportunity Cost: Opportunity cost is **foregoing of a benefit** due to choosing an alternative investment option. For example, if a company owns a piece of land acquired 10 years ago for ₹ 1 crore can be sold for ₹ 10 crore in today's value. If the company uses this piece of land for a project, then its sale value i.e. ₹ 10 crore forms the part of initial outlay as by using the land the company has foregone ₹ 10 crore which could be earned by selling it. This opportunity cost can occur both at the time of initial outlay and during the tenure of the project.

Opportunity costs are considered for estimation of cash outflows.

(c) Sunk Cost: Sunk cost is an outlay of cash that has **already been incurred** in the past and cannot be reversed in present. Therefore, these costs do not have any impact on decision making, hence should be excluded from capital budgeting analysis. For example, if a company has paid a sum of ₹ 1,00,000 for consultancy fees to a firm to prepare a Project Report for analysing a particular project ie. Feasibility study or viability study. Then the consultancy fee paid is irrelevant and is not considered for estimating cash flows as it has already been paid and shall not affect our decision whether project should be undertaken or not.

(d) Working Capital: Every big project requires working capital because, for every business, investment in working capital is must. Therefore, while evaluating the projects, **initial working capital requirement** should be treated as **cash outflow and at the end of the project its release should be treated as cash inflow.** It is important to note that no depreciation is provided on working capital though it might be possible that at the time of its release its value might have been reduced. Further there may be also a possibility that additional working capital may be required during the life of the project. In such cases the additional working capital required is treated as cash outflow at that period of time. Similarly, any

reduction in working capital shall be treated as cash inflow. It may be noted that, if nothing has been specifically mentioned for the release of working capital it is assumed that full amount has been realized at the end of the project. However, adjustment on account of increase or decrease in working capital needs to be incorporated.

(e) Allocated Overheads: As discussed in the subject of Cost and Management Accounting, allocated overheads are charged on the basis of some **rational basis** such as machine hour, labour hour, direct material consumption etc. Since, expenditures already incurred are allocated to new proposal, they should not be considered as cash flows. However, if it is expected that overhead cost shall increase due to acceptance of any proposal then incremental overhead cost shall be treated as cash outflow.

(f) Additional Capital Investment: It is not necessary that capital investment shall be required in the beginning of the project. It can also be required during the continuance of the project. In such cases, it shall be treated as cash outflows at that period of time.

Categories of Cash Flows: It is helpful to place project cash flows into three categories:

(a) Initial Cash Outflow: The initial cash outflow for a project depends upon the type of capital investment decision as follows:

(i) If decision is related to investment in a **fresh proposal** or an expansion decision, then initial cash outflow shall be calculated as follows:

		Amount	Amount
	Cost of new Asset(s)		xxx
Add:	Installation/Set-Up Costs	xxx	
Add:	Investment in Working Capital	xxx	xxx
	Initial Cash Outflow		**xxx**

(ii) If decision is related to **replacement decision,** then initial cash outflow shall be calculated as follows:

		Amount	Amount
	Cost of new Asset(s)		xxx

Add:	Installation/Set-Up Costs	xxx	
Add/(less):	Increase (Decrease) in net Working Capital level	xxx	
Less:	Net Proceeds from sale of old assets	(xxx)	
Add/(less):	Tax expense (saving/ loss) due to sale of Old Asset	xxx	xxx
	Initial Cash Outflow		**xxx**

(b) Interim Cash Flows: After making the initial cash outflow that is necessary to begin implementing a project, the firm hopes to get benefit from the future cash inflows generated by the project. The initial cash outflow for a project depends upon the type of capital investment decision as follows:

(i) If analysis is related to a fresh or completely a **new project** then interim cash flow is calculated as follows:

		Amount	**Amount**
	Profit after Tax (PAT)		xxx
Add:	Non-Cash expenses (e.g. Depreciation)	xxx	
Add/(less):	Net decrease (increase) in Working Capital	xxx	xxx
	Interim net cash flow for the period		**xxx**

(ii) Similarly, interim cash flow in case of replacement decision shall be calculated as follows:

		Amount	**Amount**
	Net increase (decrease) in Operating Revenue		xxx
Add/(less):	Net decrease (increase) in operating expenses		xxx
	Net changes in income before taxes		xxx

Add/(less):	Net decrease (increase) in taxes		xxx
	Net change in income after taxes		xxx
Add/(less):	Net decrease (increase) in depreciation charges		xxx
	Incremental net cash flow for the period		**xxx**

(c) Terminal-Year Net Cash Flow: For calculating the net cash flow at the terminal year, we will first calculate the incremental net cash flow for the period as calculated in point (b) above and further, we will make adjustments to it as follows:

		Amount	Amount
	Final salvage value (disposal costs) of asset		xxx
Add:	Interim Cash Flow	xxx	
Add/(less):	Tax savings (tax expenses) due to sale or disposal of asset (Including depreciation)	xxx	
Add:	Release of Net Working Capital	xxx	xxx
	Terminal Year net cash flow		**xxx**

6. BASIC PRINCIPLES FOR MEASURING PROJECT CASH FLOWS

For developing the project cash flows, the following principles must be kept in mind.

6.1 Block of Assets and Depreciation

From above discussion, it is clear that tax shield/ benefit from depreciation is considered while calculating cash flows from the project. Taxable income is calculated as per the provisions of Income Tax or similar Act of a country. The treatment of deprecation is based on the concept of "Block of Assets", which means a group of assets falling within a particular class of assets. This class of assets can be building, machinery, furniture etc. in respect of which depreciation is charged at

same rate. The treatment of tax depends on the fact whether block of asset consist of one asset or several assets. To understand the concept of block of asset, let us discuss an example as follows:

Example- 2

Suppose A Ltd. acquired new machinery for ₹ 1,00,000, depreciable at 20% as per written down value (WDV) method. The machine has an expected life of 5 years with salvage value of ₹ 10,000. The treatment of depreciation/ short term capital loss in the 5th year in two cases shall be as follows:

Depreciation for initial 4 years shall be common and WDV at the beginning of the 5th year shall be computed as follows:

	₹
Purchase Price of Machinery	1,00,000
Less: Depreciation @ 20% for year 1	20,000
WDV at the end of year 1	80,000
Less: Depreciation @ 20% for year 2	16,000
WDV at the end of year 2	64,000
Less: Depreciation @ 20% for year 3	12,800
WDV at the end of year 3	51,200
Less: Depreciation @ 20% for year 4	10,240
WDV at the end of year 4	40,960

(i) **Case 1 - There is no other asset in the Block:** When there is only one asset in the block and block shall cease to exist at the end of 5th year, then no deprecation shall be charged in 5th year and tax benefit/loss on short term capital loss/ gain shall be calculated as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	10,000
Short Term Capital Loss (STCL)	30,960
Tax Benefit on STCL @ 30%	9,288

(ii) **Case 2 - More than one asset exists in the Block:** When more than one asset exists in the block, then deprecation shall be charged in the terminal year (5th year) in which asset is sold. The WDV on which depreciation be charged shall be calculated by deducting sale value from the WDV in the beginning of that year. Tax benefit on depreciation shall be calculated as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	10,000
WDV	30,960
Depreciation @ 20%	6,192
Tax Benefit on Depreciation @ 30%	1,858

Now suppose if in above two cases, sale value of machine is ₹ 50,000, then no depreciation shall be provided in Case 2 because the WDV at the beginning of 5th year is only ₹ 40,960 i.e., less than sale value of ₹ 50,000 and tax loss on STCG in Case 1 shall be computed as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	50,000
Short Term Capital Gain (STCG)	9,040
Tax outflow on STCG @ 30%	2,712

6.2 Exclusion of Financing Costs Principle

When cash flows relating to long-term funds are being defined, financing costs of long-term funds (interest on long-term debt and equity dividend) should be excluded from the analysis. The interest and dividend payments are reflected in the weighted average cost of capital. Hence, if interest on long-term debt and dividend on equity capital are deducted in defining the cash flows, the cost of long-term funds will be counted twice.

The **exclusion** of financing costs principle means that:

(i) **The interest on long-term debt** is ignored while computing profits and taxes.

(ii) **The expected dividends** are deemed irrelevant in cash flow analysis.

While dividends pose no difficulty as they come only from profit after taxes, interest needs to be handled properly. Since interest is usually deducted in the process of arriving at profit after tax, an amount equal to 'Interest (1 – Tax rate)' should be added back to the figure of Profit after Tax as shown below:

= Profit Before Interest and Tax × (1 – Tax rate)

= (Profit Before Tax + Interest) (1 – Tax rate)

= (Profit Before Tax) (1 – Tax rate) + (Interest) (1 – Tax rate)

= Profit After Tax + Interest (1 – Tax rate)

Thus, whether the tax rate is applied directly to the profit before interest and tax figure or whether the tax – adjusted interest, which is simply interest (1 – tax rate), is added to profit after tax, we get the same result only.

Example- 3

Suppose XYZ Ltd.'s expected profit for the forthcoming 4 years is as follows:

	Year 1	Year 2	Year 3	Year 4
Profit before Interest and Tax	₹ 10,000	₹ 20,000	₹ 40,000	₹ 50,000

If interest payable is ₹ 5,000 and tax rate is 30%, then the profit after tax excluding financing cost shall be as follows:

	Year 1 (₹)	Year 2 (₹)	Year 3 (₹)	Year 4 (₹)
Profit before Interest and Tax	10,000	20,000	40,000	50,000
Less: Interest	(5,000)	(5,000)	(5,000)	(5,000)
	5,000	15,000	35,000	45,000
Less: Tax @ 30%	(1,500)	(4,500)	(10,500)	(13,500)
Profit after Tax (PAT)	3,500	10,500	24,500	31,500
Add: Interest (1- t)	3,500	3,500	3,500	3,500
PAT excluding financing cost	7,000	14,000	28,000	35,000

Alternatively

	Year 1 (₹)	Year 2 (₹)	Year 3 (₹)	Year 4 (₹)
Profit before Interest and Tax	10,000	20,000	40,000	50,000
Less: Tax @ 30%	3,000	6,000	12,000	15,000
PAT excluding financing cost	7,000	14,000	28,000	35,000

6.3 Post-tax Principle

Tax payments like other payments must be properly deducted in deriving the cash flows. That is, cash flows must be defined in post-tax terms. It is always better to avoid using pre-tax cash flows and using pre-tax discounting rate. The discounting rate and the cash flows, both must be post-tax only.

Statement showing the calculation of Cash Inflow After Tax (CFAT)

Particulars	(₹)	(₹)
Sales value		xxx
Less: Variable Cost		xxx
Contribution		xxx
Less: Fixed Cost		
(a) Fixed Cash Cost (excluding Interest)	xxx	
(b) Depreciation	xxx	xxx
Earning Before Tax (EBT)		xxx
Less: Tax		xxx
Earning After Tax (EAT)		xxx
Add: Depreciation		xxx
Cash Inflow After Tax (CFAT)		xxx

ILLUSTRATION 1

ABC Ltd is evaluating the purchase of a new machinery with a depreciable base of ₹ 1,00,000; expected economic life of 4 years and change in earnings before taxes and depreciation of ₹ 45,000 in year 1, ₹ 30,000 in year 2, ₹ 25,000 in year 3 and ₹ 35,000 in year 4. Assume straight-line depreciation and a 20% tax rate. You are required to COMPUTE relevant cash flows.

SOLUTION

Depreciation = ₹ 1,00,000 ÷ 4 = ₹ 25,000

Amount in (₹)

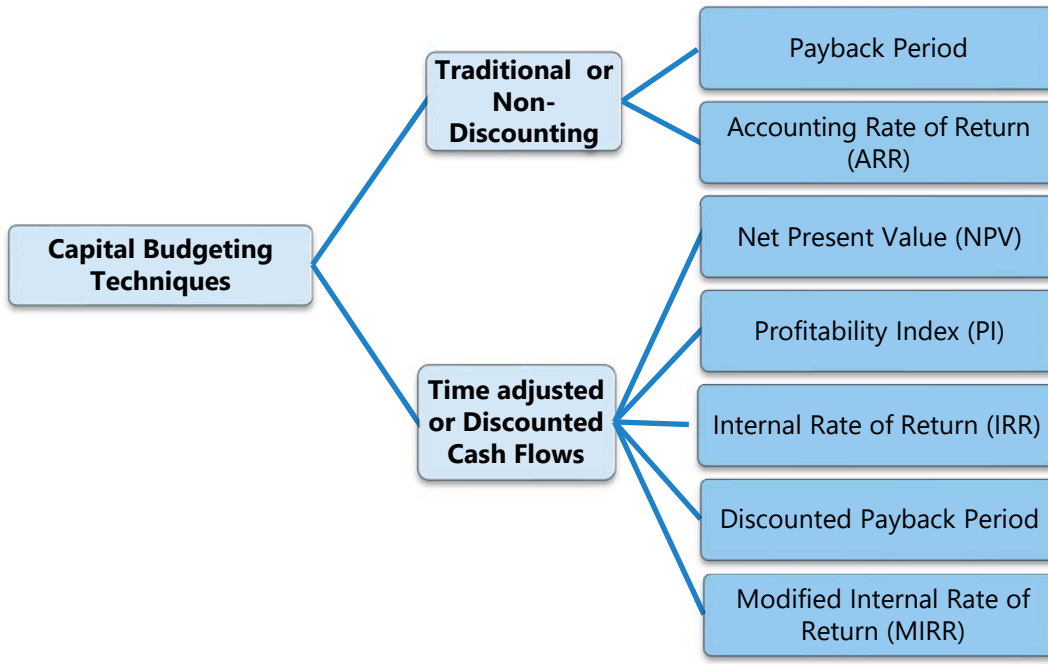
	Years			
	1	**2**	**3**	**4**
Earnings before tax and depreciation	45,000	30,000	25,000	35,000
Less: Depreciation	(25,000)	(25,000)	(25,000)	(25,000)
Earnings before tax	20,000	5,000	0	10,000
Less: Tax @20%	(4,000)	(1,000)	0	(2,000)
Earnings after tax	16,000	4,000	0	8,000
Add: Depreciation	25,000	25,000	25,000	25,000
Net Cash flow	41,000	29,000	25,000	33,000

SECTION 2

7. CAPITAL BUDGETING TECHNIQUES

In order to maximise the return to the shareholders of a company, it is important that the best or most profitable investment projects are selected. Results of making a bad long-term investment decision can be devastating in both financial and strategic terms. Proper care is required for investment project selection and evaluation.

There are number of techniques available for the appraisal of investment proposals and can be classified as presented below:



Organisations may use one or more of capital investment evaluation techniques from above. Some organisations use different methods for different types of projects while others may use multiple methods for evaluating each project. The techniques discussed below are Payback Period, Accounting Rate of Return (ARR), Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR), Discounted Payback Period and Modified Internal Rate of Return (MIRR).

8. TRADITIONAL OR NON-DISCOUNTING TECHNIQUES

These techniques of capital Budgeting does not discount the future cash flows. There are two such traditional techniques namely Payback Period and Accounting Rate of Return.

8.1 Payback Period

Time required to recover the initial cash-outflow is called pay-back period. The payback period of an investment is the length of time required for the cumulative total net cash flows from the investment to equal the total initial cash outlays. At

that point in time (payback period), the investor has recovered all the money invested in the project.

Steps in Payback period technique:

(a) The first step in calculating the payback period is determining the total initial capital investment (cash outflow).

(b) The second step is calculating/estimating the annual expected after-tax cash flows over the useful life of the project.

1. Uniform Cash Flows: When the cash inflows are uniform over the useful life of the project, the number of years in the payback period can be calculated using the following equation:

$$\text{Payback period} = \frac{\text{Total initial capital investment}}{\text{Annual expected after - tax net cash flow}}$$

Example- 4

Suppose a project costs ₹ 20,00,000 and yields annually a profit of ₹ 3,00,000 after depreciation @ 12½% (straight line method) but before tax at 50%.

The first step would be to calculate the cash inflow from this project. The cash inflow is calculated as follows:

Particulars	**(₹)**
Profit before tax	3,00,000
Less: Tax @ 50%	1,50,000
Profit after tax	1,50,000
Add: Depreciation written off	2,50,000
Total cash inflow	4,00,000

While calculating cash inflow, depreciation is added back to profit after tax since it does not result in cash outflow. The cash generated from a project therefore is equal to profit after tax plus depreciation. The payback period of the project shall be:

$$\text{Payback period} = \frac{₹\ 20,00,000}{4,00,000} = 5 \text{ Years}$$

Some Accountants calculate payback period after discounting the cash flows by a predetermined rate and the payback period so calculated is called as 'Discounted payback period' (discussed later on in the chapter).

2. **Non-Uniform Cash Flows:** When the annual cash inflows are not uniform, the cumulative cash inflow from operations must be calculated for each year. The payback period shall be corresponding period when total of cumulative cash inflows is equal to the initial capital investment. However, if exact sum does not match, then the period in which it lies should be identified. After that we need to compute the fraction of the year. This method can be understood with the help of an example:

Example- 5

Suppose XYZ Ltd. is analyzing a project requiring an initial cash outlay of ₹ 2,00,000 and is expected to generate cash inflows as follows:

Year	Annual Cash Inflows (₹)
1	80,000
2	60,000
3	60,000
4	20,000

It's payback period shall be computed by using cumulative cash flows as follows:

Year	Annual Cash Inflows (₹)	Cumulative Cash Inflows (₹)
1	80,000	80,000
2	60,000	1,40,000
3	60,000	2,00,000
4	20,000	2,20,000

In 3rd year, cumulative cash inflows equal to initial cash outlay i.e., ₹ 2,00,000. Hence, payback period is 3 years.

Suppose if in above example, the initial outlay is ₹ 2,05,000, then:

Payback period shall lie between 3 to 4 years. Since up to 3 years, a sum of ₹ 2,00,000 shall be recovered and balance of ₹ 5,000 shall be recovered in the part (fraction) of 4th year, computation is as follows:

$$\text{Part of } 4^{th} \text{ year} = = \frac{\text{Balance Cash outlay}}{\text{Commulative Cash Inflow at } 4^{th} \text{ year}} = \frac{₹\ 5,000}{₹\ 20,000} = \frac{1}{4} \text{ year}$$

Thus, total cash outlay of ₹ 2,05,000 shall be recovered in 3¼ years' time.

Advantages of Payback period

- It is **easy to compute.**
- It is easy to understand as it **provides a quick estimate of the time** needed for the organization to recoup the cash invested.
- The length of the payback period can also **serve as an estimate of a project's risk;** the longer the payback period, the riskier the project as long-term predictions are less reliable. In some industries with high obsolescence risk like software industry or in situations where an organization is short on cash, short payback periods often become the determining factor for investments.

Limitations of Payback period

- It **ignores the time value of money**. As long as the payback periods for two projects are the same, the payback period technique considers them equal as investments, even if one project generates most of its net cash inflows in the early years of the project while the other project generates most of its net cash inflows in the latter years of the payback period.
- A second limitation of this technique is its failure to consider an investment's total profitability; it only considers cash inflows up-to the period in which initial investment is fully recovered and **ignores cash flows after the payback period**.
- Payback technique places much emphasis on short payback periods thereby **ignoring long-term projects**.

8.1.1 Payback Reciprocal

As the name indicates, it is the reciprocal of payback period. A major drawback of the payback period method of capital budgeting is that it does not indicate any cut off period for the purpose of investment decision. It is, however, argued that the

reciprocal of the payback would be a close approximation of the Internal Rate of Return (later discussed in detail) if the life of the project is at least twice the payback period and the project generates equal amount of the annual cash inflows. In practice, the payback reciprocal is a helpful tool for quick estimation of rate of return of a project provided its life is at least twice the payback period.

The payback reciprocal can be calculated as follows:

$$\text{Payback Reciprocal} = \frac{\text{Average annual cash in flow}}{\text{Initial investment}}$$

Example- 6

Suppose a project requires an initial investment of ₹ 20,000 and it would give annual cash inflow of ₹ 4,000. The useful life of the project is estimated to be 10 years.

In this example, payback reciprocal $= \frac{₹\ 4,000 \times 100}{₹\ 20,000} = 20\%$

The above payback reciprocal provides a reasonable approximation of the internal rate of return, i.e. 20%.

8.2 Accounting (Book) Rate of Return (ARR) or Average Rate of Return (ARR)

The accounting rate of return of an investment measures the **average annual net income** of the project (incremental income) as a percentage of the investment.

$$\text{Accounting Rate of Return (ARR)} = \frac{\text{Average annual net income}}{\text{Investment}}$$

The numerator is the average annual net income generated by the project over its useful life. The denominator can be either the initial investment (including installation cost) or the average investment over the useful life of the project. Average investment means the average amount of fund remained blocked during the lifetime of the project under consideration. Further, ARR can be calculated in a number of ways as shown in the following example:

Example- 7

Suppose Times Ltd. is going to invest in a project a sum of ₹ 3,00,000 having a life span of 3 years. Salvage value of machine is ₹ 90,000. The profit before depreciation for each year is ₹ 1,50,000.

The Profit after Tax and value of Investment in the Beginning and at the End of each year shall be as follows:

Year	Profit Before Depreciation (₹)	Depreciation (₹)	Profit after Depreciation (₹)	Value of Investment in (₹)	
				Beginning	End
1	1,50,000	70,000	80,000	3,00,000	2,30,000
2	1,50,000	70,000	80,000	2,30,000	1,60,000
3	1,50,000	70,000	80,000	1,60,000	90,000

The ARR can be computed by following methods as follows:

(a) Version 1: Annual Basis

$$ARR = \frac{Profit\ after\ Depreciation}{Investment\ in\ the\ begining\ of\ the\ year} x100$$

Year	
1	$\frac{80,000}{3,00,000} = 26.67\%$
2	$\frac{80,000}{2,30,000} = 34.78\%$
3	$\frac{80,000}{1,60,000} = 50\%$

$$Average\ ARR = \frac{26.67\% + 34.78\% + 50.00\%}{3} = 37.15\%$$

(b) Version 2: Total Investment Basis

$$ARR = \frac{Average\ Annual\ Profit}{Investment\ in\ the\ begining} \times 100$$

$$= \frac{(80,000 + 80,000 + 80,000)/3}{3,00,000} \times 100 = 26.67\%$$

(c) Version 3: Average Investment Basis

$$ARR = \frac{Average\ Annual\ Profit}{Average\ Investment} \times 100$$

Average Investment = (₹ 3,00,000 + ₹ 90,000)/2 = ₹ 1,95,000

Or, Average Investment = ½ (Initial Investment – Salvage Value) + Salvage Value

= ½ (₹ 3,00,000 – ₹ 90,000) + ₹ 90,000 = ₹ 1,95,000

$$ARR = \frac{80,000}{1,95,000} \times 100 = 41.03\%$$

Further, it is important to note that project may also require additional working capital during its life in addition to initial working capital. In such situation, formula for the calculation of average investment shall be modified as follows:

½(Initial Investment – Salvage Value) + Salvage Value + Additional Working Capital

Continuing above example, suppose a sum of ₹ 45,000 is required as additional working capital during the project life, then average investment shall be:

= ½ (₹ 3,00,000 – ₹ 90,000) + ₹ 90,000 + ₹ 45,000 = ₹ 2,40,000 and

$$ARR = \frac{80,000}{2,40,000} \times 100 = 33.33\%$$

Some organizations prefer the initial investment because it is objectively determined and is not influenced by either the choice of the depreciation method or the estimation of the salvage value. Either of these amounts is used in practice but it is important that the same method be used for all investments under consideration.

Advantages of ARR

- This technique **uses readily available data** that is routinely generated for financial reports and does not require any special procedures to generate data.
- This method may also mirror the method used to **evaluate performance** on the operating results of an investment and management performance. Using the same procedure in both decision-making and performance evaluation ensures consistency.

- Calculation of the accounting rate of return method **considers all net incomes over the entire life of the project** and provides a measure of the investment's profitability.

Limitations of ARR

- The accounting rate of return technique, like the payback period technique, **ignores the time value of money** and considers the value of all cash flows to be equal.
- The technique uses accounting numbers that are dependent on the organization's **choice of accounting procedures,** and different accounting procedures, e.g., depreciation methods, can lead to substantially different amounts for an investment's net income and book values.
- The method **ignores cash flows**; while net income is a useful measure of profitability, the net cash flow is a better measure of an investment's performance.
- Furthermore, inclusion of only the book value of the invested asset **ignores** the fact that a project can require **commitments of working capital** and other outlays that are not included in the book value of the project.

ILLUSTRATION 2

A project requiring an investment of ₹ 10,00,000 and it yields profit after tax and depreciation which is as follows:

Years	*Profit after tax and depreciation (₹)*
1	*50,000*
2	*75,000*
3	*1,25,000*
4	*1,30,000*
5	*80,000*
Total	*4,60,000*

Suppose further that at the end of the 5th year, the plant and machinery of the project can be sold for ₹ 80,000. DETERMINE Average Rate of Return.

SOLUTION

In this case the rate of return can be calculated as follows:

$$\frac{\text{Total Profit} \div \text{No. of years}}{\text{Average investment / Initial Investment}} \times 100$$

(a) If Initial Investment is considered then,

$$= \frac{₹\ 4,60,000 \div 5 \text{ years}}{₹\ 10,00,000} \times 100 = \frac{₹\ 92,000}{₹\ 10,00,000} \times 100 = 9.2\%$$

This rate is compared with the rate expected on other projects, had the same funds been invested alternatively in those projects. Sometimes, the management compares this rate with the minimum rate (called-cut off rate). For example, management may decide that they will not undertake any project which has an average annual yield after tax less than 20%. Any capital expenditure proposal which has an average annual yield of less than 20%, will be automatically rejected.

(b) If Average investment is considered, then,

$$= \frac{₹\ 92,000}{\text{Average Investment}} \times 100 = \frac{₹\ 92,000}{₹\ 5,40,000} \times 100 = 17.04\%$$

Where,

Average Investment = ½ (Initial investment – Salvage value) + Salvage value

= ½ (₹ 10,00,000 – ₹ 80,000) + ₹ 80,000

= ₹ 4,60,000 + ₹ 80,000 = ₹ 5,40,000

9. DISCOUNTING TECHNIQUES

Discounting techniques consider time value of money and discount the cash flows to their Present Value. These techniques are also known as Present Value techniques. These are namely Net Present Value (NPV), Internal Rate of Return (IRR) and Profitability Index (PI), Discounted Payback Period. First, let us discuss about Determination of Discount rate and it will be followed by the four techniques.

Determining Discount Rate

Theoretically, the discount rate or **desired / expected rate of return** on an investment is the rate of return the firm would have earned by investing the same

funds in the best available alternative investment that has the same risk. Determining the best alternative opportunity available is difficult in practical terms so rather than using the true opportunity cost, organizations often use an alternative measure for the desired rate of return. An organization may establish a minimum rate of return that all capital projects must meet; this minimum could be based on an industry average or the cost of other investment opportunities. Many organizations choose to use the overall cost of capital or Weighted Average Cost of Capital (WACC) that an organization has incurred in raising funds or expects to incur in raising the funds needed for an investment.

9.1 Net Present Value Technique (NPV)

The net present value technique is a discounted cash flow method that considers the time value of money in evaluating capital investments. An investment has cash flows throughout its life, and it is assumed that an amount of cash flow in the early years of an investment is worth more than an amount of cash flow in a later year.

The net present value method uses a specified discount rate to bring all subsequent cash inflows after the initial investment to their present values (the time of the initial investment is year 0).

The net present value of a project is the amount, in current value of amount, the investment earns after paying cost of capital in each period.

Net present value = Present value of net cash inflow - Total net initial investment

Since it might be possible that some additional investment may also be required during the life time of the project, then appropriate formula shall be:

Net present value = Present value of cash inflows - Present value of cash outflows

It can be expressed as below:

$$NPV = \left(\frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + \frac{C_3}{(1+k)^3} + ... + \frac{C_n}{(1+k)^n} \right) - I$$

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+k)^t} - I$$

Where,

C = Cash flow of various years

k = Discount rate

N = Life of the project

I = Investment

Steps for calculating Net Present Value (NPV):

The steps for calculating net present value are:

1. **Determine** the net cash inflow in each year of the investment.
2. **Select** the desired rate of return or discounting rate or Weighted Average Cost of Capital.
3. **Find** the discount factor for each year based on the desired rate of return selected.
4. **Determine** the present values of the net cash flows by multiplying the cash flows by respective discount factors of respective period called Present Value (PV) of Cash flows
5. Total the amounts of all **PVs of Cash Flows.**

Decision Rule:

If NPV ≥ 0	Accept the Proposal
If NPV ≤ 0	Reject the Proposal

The NPV method can be used to select between mutually exclusive projects; the one with the higher NPV should be selected.

ILLUSTRATION 3

COMPUTE the net present value for a project with a net investment of ₹ 1,00,000 and net cash flows for year one is ₹ 55,000; for year two is ₹ 80,000 and for year three is ₹ 15,000. Further, the company's cost of capital is 10%.

[PVIF @ 10% for three years are 0.909, 0.826 and 0.751]

SOLUTION

Year	Net Cash Flows (₹)	PVIF @ 10%	Discounted Cash Flows (₹)
0	(1,00,000)	1.000	(1,00,000)
1	55,000	0.909	49,995
2	80,000	0.826	66,080
3	15,000	0.751	11,265
Net Present Value			27,340

Recommendation: Since the net present value of the project is positive, the company should accept the project.

ILLUSTRATION 4

ABC Ltd. is a small company that is currently analyzing capital expenditure proposals for the purchase of equipment; the company uses the net present value technique to evaluate projects. The capital budget is limited to ₹500,000 which ABC Ltd. believes is the maximum capital it can raise. The initial investment and projected net cash flows for each project are shown below. The cost of capital of ABC Ltd is 12%. You are required to COMPUTE the NPV of the different projects.

	Project A (₹)	***Project B (₹)***	***Project C (₹)***	***Project D (₹)***
Initial Investment	*200,000*	*190,000*	*250,000*	*210,000*
Project Cash Inflows:				
Year 1	*50,000*	*40,000*	*75,000*	*75,000*
2	*50,000*	*50,000*	*75,000*	*75,000*
3	*50,000*	*70,000*	*60,000*	*60,000*
4	*50,000*	*75,000*	*80,000*	*40,000*
5	*50,000*	*75,000*	*100,000*	*20,000*

SOLUTION

Calculation of net present value:

Period	PV factor	Project A (₹)	Project B (₹)	Project C (₹)	Project D (₹)
0	1.000	(2,00,000)	(1,90,000)	(2,50,000)	(2,10,000)
1	0.893	44,650	35,720	66,975	66,975
2	0.797	39,850	39,850	59,775	59,775
3	0.712	35,600	49,840	42,720	42,720
4	0.636	31,800	47,700	50,880	25,440
5	0.567	28,350	42,525	56,700	11,340
Net Present Value		(19,750)	25,635	27,050	(3,750)

Advantages of NPV

- NPV method takes into account the **time value of money**.
- The whole stream of **cash flows is considered.**
- The net present value can be seen as the addition to the wealth of shareholders. The criterion of NPV is thus in conformity with basic financial objectives.
- The NPV uses the **discounted cash flows** i.e., expresses cash flows in terms of current rupees. The NPVs of different projects therefore can be compared. It implies that each project can be evaluated independent of others on its own merit.

Limitations of NPV

- It involves **difficult calculations**.
- The application of this method necessitates forecasting cash flows and the discount rate. Thus, **accuracy of NPV depends on accurate estimation** of these two factors which may be quite difficult in practice.
- The decision under NPV method is based on absolute measure. It **ignores the difference in initial outflows**, size of different proposals etc. while evaluating mutually exclusive projects.

9.2 Profitability Index/Desirability Factor/Present Value Index Method (PI)

The students may have seen how with the help of discounted cash flow technique, the two alternative proposals for capital expenditure can be compared. In certain cases, we have to compare a number of proposals, each involving different amounts of cash inflows.

One of the methods of comparing such proposals is to work out what is known as the 'Desirability factor', or 'Profitability Index' or 'Present Value Index Method'.

Mathematically:

The Profitability Index (PI) is calculated as below:

$$\text{Profitability Index (PI)} = \frac{\text{Sum of discounted cash in flows}}{\text{Initial cash outlay or Total discounted cash outflow (as the case may)}}$$

Decision Rule:

If PI ≥ 1	Accept the Proposal
If PI ≤ 1	Reject the Proposal

In case of mutually exclusive projects, project with higher PI should be selected.

ILLUSTRATION 5

Suppose we have three projects involving discounted cash outflow of ₹ 5,50,000, ₹ 75,000 and ₹ 1,00,20,000 respectively. Suppose further that the sum of discounted cash inflows for these projects are ₹ 6,50,000, ₹ 95,000 and ₹ 1,00,30,000 respectively. CALCULATE the desirability factors for the three projects.

SOLUTION

The desirability factors for the three projects would be as follows:

1. $= \frac{₹6,50,000}{₹5,50,000} = 1.18$

2. $= \frac{₹95,000}{₹75,000} = 1.27$

3. $= \frac{₹1,00,30,000}{₹1,00,20,000} = 1.001$

It can be seen that in absolute terms, project 3 gives the highest cash inflows yet its desirability factor is low. This is because the outflow is also very high. The **Desirability/ Profitability Index factor helps us in ranking various projects**.

Since PI is an extension of NPV, it has same advantages and limitation.

Advantages of PI

- The method also uses the **concept of time value of money**.
- In the PI method, since the present value of cash inflows is divided by the present value of cash outflow, it is a **relative measure** of a project's profitability.

Limitations of PI

- Profitability index **fails as a guide** in resolving capital rationing where **projects are indivisible.**
- Once a single large project with high NPV is selected, possibility of accepting several small projects which together may have higher NPV than the **single project is excluded**.
- Also, situations may arise where a project with a lower profitability index selected may generate cash flows in such a way that another project can be taken up one or two years later, the total NPV in such case being more than the one with a project with highest Profitability Index.

The Profitability Index approach thus **cannot be used indiscriminately** but all other type of alternatives of projects will have to be worked out.

9.3 Internal Rate of Return Method (IRR)

The internal rate of return method considers the time value of money, the initial cash investment, and all cash flows from the investment. But unlike the net present value method, the internal rate of return method does not use the desired rate of return but estimates the discount rate that makes the present value of subsequent cash inflows equal to the initial investment. This discount rate is called IRR.

IRR Definition: Internal rate of return for an investment proposal is **the discount rate that equates the present value of the expected cash inflows with the initial cash outflow.**

This IRR is then compared to a criterion rate of return that can be the organization's desired rate of return for **evaluating capital investments**.

Calculation of IRR: The procedures for computing the internal rate of return vary with the pattern of net cash flows over the useful life of an investment.

Scenario 1: For an investment with uniform cash flows over its life, the following equation is used:

Step 1: Total initial investment = Annual cash inflow × Annuity discount factor of the discount rate for the number of periods of the investment's useful life

If A is the annuity discount factor, then:

$$A = \frac{\text{Total initial cash disbursements and commitments for the investment}}{\text{Annual (equal) cash inflows from the investment}}$$

Step 2: Once A is calculated, the interest rate corresponding to project's life, the value of A is searched in Present Value Annuity Factor (PVAF) table. If exact value of 'A' is found the respective interest rate shall be IRR. However, it rarely happens therefore we follow the steps discussed below:

Step 1: Compute approximate payback period also called fake payback period.

Step 2: Locate this value in PVAF table corresponding to period of life of the project. The value may be falling between two discounting rates.

Step 3: Discount cash flows using these two discounting rates.

Step 4: Use following Interpolation Formula:

$$LR + \frac{\text{NPV at LR}}{\text{NPV at LR - NPV at HR}} \times (HR - LR)$$

Or

$$LR + \frac{\text{PV at LR - CI}}{\text{PV at LR - PV at HR}} \times (HR - LR)$$

Where,

LR = Lower Rate

HR = Higher Rate

CI = Capital Investment

ILLUSTRATION 6

A Ltd. is evaluating a project involving an outlay of ₹10,00,000 resulting in an annual cash inflow of ₹2,50,000 for 6 years. Assuming salvage value of the project is zero; DETERMINE the IRR of the project.

SOLUTION

First of all, we shall find an approximation of the payback period:

$$= \frac{10,00,000}{2,50,000} = 4$$

Now, we shall search this figure in the PVAF table corresponding to 6-year row.

The value 4 lies between values 4.111 and 3.998, correspondingly discounting rates are 12% and 13% respectively

NPV @ 12% and 13% is:

$NPV_{12\%}$ = (10,00,000) + 4.111 × 2,50,000 = +27,750

$NPV_{13\%}$ = (10,00,000) + 3.998 × 2,50,000 = -500

The internal rate of return is, thus, more than 12% but less than 13%. The exact rate can be obtained by interpolation:

$$IRR = 12\% + \frac{27,750}{27,750 - (-500)} \times (13\% - 12\%)$$

$$= 12\% + \frac{27,750}{28,250} = 12.978\%$$

IRR = 12.978%

Scenario 2: When the cash inflows are not uniform over the life of the investment, the determination of the discount rate can involve trial and error and interpolation between discounting rates as mentioned above. However, IRR can also be found out by using following procedure:

Step 1: Discount the cash flow at any random rate, say 10%, 15% or 20%.

Step 2: If resultant NPV is negative, then discount cash flows again by lower discounting rate to make NPV positive. Conversely, if resultant NPV is positive, then again discount cash flows by higher discounting rate to make NPV negative.

Step 3: Use following Interpolation Formula:

$$LR + \frac{\text{NPV at LR}}{\text{NPV at LR - NPV at HR}} \times (HR - LR)$$

Where

LR = Lower Rate

HR = Higher Rate

ILLUSTRATION 7

CALCULATE the internal rate of return of an investment of ₹ 1,36,000 which yields the following cash inflows:

Year	*Cash Inflows (₹)*
1	*30,000*
2	*40,000*
3	*60,000*
4	*30,000*
5	*20,000*

SOLUTION

Let us discount cash flows by 10%.

Year	Cash Inflows (₹)	Discounting factor at 10%	Present Value (₹)
1	30,000	0.909	27,270
2	40,000	0.826	33,040
3	60,000	0.751	45,060
4	30,000	0.683	20,490
5	20,000	0.621	12,420
		Total present value	1,38,280
		Less: Initial Investment	1,36,000
		NPV	+2,280

The NPV calculated @ 10% is positive. Therefore, a higher discount rate is suggested, say, 12%.

Year	Cash Inflows (₹)	Discounting factor at 12%	Present Value (₹)
1	30,000	0.893	26,790
2	40,000	0.797	31,880
3	60,000	0.712	42,720
4	30,000	0.636	19,080
5	20,000	0.567	11,340
		Total present value	1,31,810
		Less: Initial Investment	1,36,000
		NPV	- 4,190

The internal rate of return is, thus, more than 10% but less than 12%. The exact rate can be obtained by interpolation:

$$\text{IRR} = \text{LR} + \frac{\text{NPV at LR}}{\text{NPV at LR - NPV at HR}} \times (\text{HR - LR})$$

$$= 10 + \frac{₹2,280}{₹2,280 - (-4,190)} \times (12 - 10)$$

$$= 10 + \frac{₹2,280}{₹6,470} \times (12 - 10) = 10 + 0.704$$

IRR = 10.704%

ILLUSTRATION 8

A company proposes to install machine involving a capital cost of ₹3,60,000. The life of the machine is 5 years and its salvage value at the end of the life is nil. The machine will produce the net operating income after depreciation of ₹68,000 per annum. The company's tax rate is 45%.

The Net Present Value factors for 5 years are as under:

Discounting rate	*14*	*15*	*16*	*17*	*18*
Cumulative factor	*3.43*	*3.35*	*3.27*	*3.20*	*3.13*

You are required to COMPUTE the internal rate of return of the proposal.

SOLUTION

Computation of Cash inflow per annum ₹

Particulars	(₹)
Net operating income per annum	68,000
Less: Tax @ 45%	(30,600)
Profit after tax	37,400
Add: Depreciation (₹ 3,60,000 / 5 years)	72,000
Cash inflow	1,09,400

The IRR of the investment can be found as follows:

NPV = – ₹ 3,60,000 + ₹ 1,09,400 ($PVAF_5$, r) = 0

or $PVAF_5$,r (Cumulative factor) = $\frac{₹3,60,000}{₹1,09,400} = 3.29$

As 3.29 falls between Discounted rate 15 & 16, the computation is as below :

Computation of Internal Rate of Return

	Discounting Rate	
	15%	**16%**
Cumulative factor	3.35	3.27
PV of Inflows (₹)	3,66,490 (₹ 1,09,400×3.35)	3,57,738 (₹ 1,09,400×3.27)
Less: Initial outlay (₹)	3,60,000	3,60,000
NPV (₹)	6,490	(2,262)

$$IRR = 15 + \left[\frac{6,490}{6,490+2,262}\right] \times (16-15) = 15 + 0.74 = 15.74\%.$$

9.3.1 Acceptance Rule

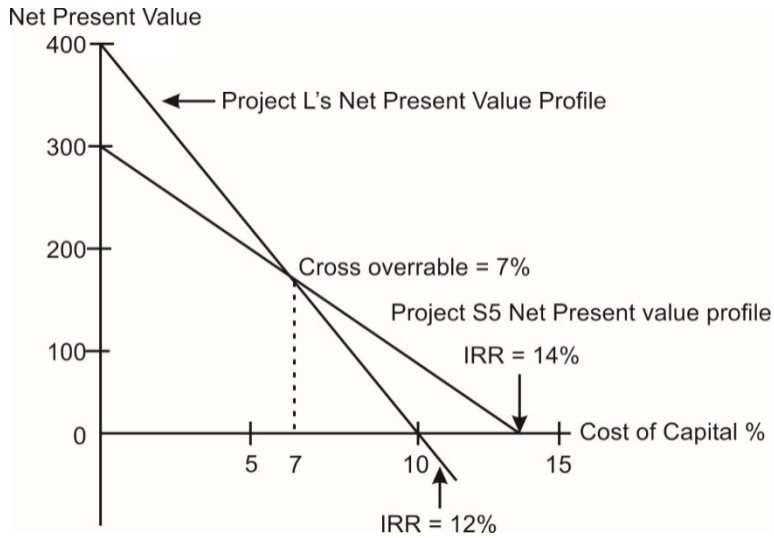
The use of IRR, as a criterion to accept capital investment decision involves a comparison of IRR with the required rate of return known as cut-off rate. The project should the accepted if IRR is greater than cut-off rate. If IRR is equal to cut-

off rate the firm is indifferent. If IRR less than cut off rate the project is rejected. Thus,

If IRR ≥ Cut-off Rate or WACC	Accept the Proposal
If IRR ≤ Cut-off Rate or WACC	Reject the Proposal

9.3.2 Internal Rate of Return (IRR) and Mutually Exclusive Projects

Projects are called mutually exclusive, when the selection of one precludes the selection of others e.g. in case a company owns a piece of land which can be put to use either for project S or L, such projects are mutually exclusive to each other i.e. the selection of one project necessarily means the rejection of the other. Refer to the figure below:



As long as the cost of capital is greater than the crossover rate of 7%, (1) NPV_S is larger than NPV_L and (2) IRR_S exceeds IRR_L. Hence, if the cut- off rate or the cost of capital is greater than 7%, both the methods shall lead to selection of project S. However, if the cost of capital is less than 7%, the NPV method ranks Project L higher, but the IRR method indicates that the Project S is better.

As can be seen above, mutually exclusive projects can create problem with the IRR technique as IRR is expressed in percentage and does not take into account the scale of investment or the quantum of money earned.

Let us consider another example of two mutually exclusive projects A and B with the following details:

Example - 8

Cash flows

	Year 0	Year 1	IRR	NPV at 10%
Project A	(₹ 1,00,000)	₹ 1,50,000	50%	₹ 36,360
Project B	(₹ 5,00,000)	₹ 6,25,000	25%	₹ 68,180

Project A earns a return of 50% which is more than what Project B earns; however, the NPV of Project B is more than of Project A. Acceptance of Project A means rejection of Project B since the two Projects are mutually exclusive. Acceptance of Project A also implies that the total investment will be ₹ 4,00,000 less had the Project B been accepted, ₹ 4,00,000 being the difference between the initial investment of the two projects. Assuming that the funds are freely available at 10%, the total capital expenditure of the company should ideally be equal to sum total of all outflows provided they earn more than 10% return along with the chosen mutually exclusive project. Selection of Project A implies rejection of an opportunity to earn an additional amount of ₹ 31,820 (₹ 68,180 - ₹ 36,360) for the shareholders, thus reduction in the shareholders' wealth.

In the above example, the larger project had lower IRR, but maximises the shareholders' wealth. It is not safe to assume that a choice can be made between mutually exclusive projects using IRR in cases where the larger project also happens to have the higher IRR. Consider the following two Projects A and B with their relevant cash flows:

Example- 9

Year	Project A	Project B
	(₹)	(₹)
0	(9,00,000)	(8,00,000)
1	7,00,000	62,500
2	6,00,000	6,00,000
3	4,00,000	6,00,000
4	50,000	6,00,000

In this case, Project A has the larger investment and also has a higher IRR as shown below,

Year	(₹)	r = 46%	PV (₹)	(₹)	r = 35%	PV (₹)
0	(9,00,000)	1.0000	(9,00,000)	(8,00,000)	1.0000	(8,00,000)
1	7,00,000	0.6849	4,79,430	62,500	0.7407	46,294
2	6,00,000	0.4691	2,81,460	6,00,000	0.5487	3,29,220
3	4,00,000	0.3213	1,28,520	6,00,000	0.4064	2,43,840
4	50,000	0.2201	11,005	6,00,000	0.3011	1,80,660
			415			14
IRR of Project A = 46%						
IRR of Project B = 35%						

However, in case the relevant discounting factor is taken as 5%, the NPV of the two projects provides a different picture as follows:

Year	Project A (₹)			Project B (₹)		
	(₹)	r= 5%	PV (₹)	(₹)	r= 5%	PV (₹)
0	(9,00,000)	1.0	(9,00,000)	(8,00,000)	1.0	(8,00,000)
1	7,00,000	0.9524	6,66,680	62,500	0.9524	59,525
2	6,00,000	0.9070	5,44,200	6,00,000	0.9070	5,44,200
3	4,00,000	0.8638	3,45,520	6,00,000	0.8638	5,18,280
4	50,000	0.8227	41,135	6,00,000	0.8227	4,93,620
NPV			6,97,535			8,15,625

It can be seen from the above, Project B should be the one to be selected even though its IRR is lower than that of Project A. This decision shall need to be taken in spite of the fact that Project A has a larger investment coupled with a higher IRR as compared with Project B. **This type of anomalous situation arises due to reinvestment assumptions implicit in the two evaluation methods of NPV and IRR.**

9.3.3 The Reinvestment Assumption

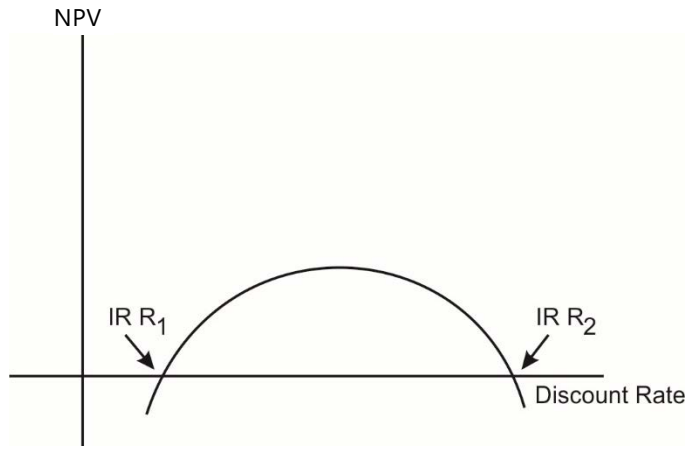
The Net Present Value technique assumes that all **cash flows can be reinvested** at the discount rate used for calculating the NPV. This is a logical assumption since

the use of the NPV technique implies that all projects which provide a higher return than the discounting factor are accepted.

In contrast, IRR technique assumes that all cash flows are reinvested at project's IRR. This assumption means that projects with heavy cash flows in the early years will be favoured by the IRR method vis-à-vis projects which have larger cash flows in the later years. This implicit reinvestment assumption means that Projects like A, with cash flows concentrated in the earlier years of life will be preferred by the method relative to Projects such as B.

9.3.4 Multiple Internal Rate of Return

In cases, where project cash flows change signs or reverse during the life of a project e.g. an initial cash outflow is followed by cash inflows and subsequently followed by a major cash outflow, there may be more than one IRR. The following graph of discount rate versus NPV may be used as an illustration:



In such situations. if the cost of capital is less than the two IRR's, a decision can be made easily, however otherwise the IRR decision rule may turn out to be misleading as the project should only be invested if the cost of capital is between IRR_1 and IRR_2.To understand the concept of multiple IRR, it is necessary to understand the implicit re-investment assumption in both NPV and IRR techniques.

Advantages of IRR

- This method makes use of the concept of **time value of money**.
- **All the cash flows** in the project **are considered**.

- **IRR is easier to use** as instantaneous understanding of desirability can be determined by comparing it with the cost of capital
- IRR technique **helps in achieving the objective** of maximisation of shareholder's wealth.

Limitations of IRR

- The calculation **process is tedious** if there is more than one cash outflow interspersed between the cash inflows; there can be multiple IRR, the interpretation of which is difficult.
- The IRR approach **creates a peculiar situation** if we compare two projects with different inflow/outflow patterns.
- It is assumed that under this method all the future cash inflows of a proposal are reinvested at a rate equal to the IRR. **It ignores a firm's ability to re-invest** in portfolio of different rates.
- If mutually exclusive projects are considered as investment options which have considerably different cash outlays. A project with a larger fund commitment but lower IRR contributes more in terms of absolute NPV and increases the shareholders' wealth. In such situation **decisions based only on IRR criterion may not be correct**.

9.4 Discounted Payback Period Method

This is similar to Payback period as discussed in 7.8.1 under the non-discounting method except that the cash flows here are discounted at predetermined rate and the payback period so calculated is called **Discounted payback period**. One of the most popular economic criteria for evaluating capital projects is the payback period. Payback period is the time required for cumulative cash inflows to recover the cash outflows of the project.

This technique is considered superior to simple payback period method because it takes into account time value of money.

Example- 10

For example, a ₹ 30,000 cash outlay for a project with annual cash inflows of ₹ 6,000 would have a payback period of 5 years (₹ 30,000 / ₹ 6,000).

The problem with the Payback Period is that it ignores the time value of money. In order to correct this, we can use discounted cash flows in calculating the payback period. Referring back to our example, if we discount the cash inflows at 15% required rate of return, we have:

Year	Cash Flow (₹)	PVF@15%	PV (₹)	Cumulative PV (₹)
1	6,000	0.870	5,220	5,220
2	6,000	0.756	4,536	9,756
3	6,000	0.658	3,948	13,704
4	6,000	0.572	3,432	17,136
5	6,000	0.497	2,982	20,118
6	6,000	0.432	2,592	22,710
7	6,000	0.376	2,256	24,966
8	6,000	0.327	1,962	26,928
9	6,000	0.284	1,704	28,632
10	6,000	0.247	1,482	30,114

The cumulative total of discounted cash flows after ten years is ₹ 30,114. Therefore, our discounted payback is approximately 10 years as opposed to 5 years under simple payback. It should be noted that **as the required rate of return increases, the distortion between simple payback and discounted payback grows**.

9.5 Modified Internal Rate of Return (MIRR)

As mentioned earlier, there are several limitations attached with the concept of the conventional Internal Rate of Return (IRR). The MIRR addresses some of these deficiencies e.g., it eliminates multiple IRR rates; it addresses **the reinvestment rate issue** and produces results which are consistent with the Net Present Value method. **This method is also called Terminal Value method**.

Under this method, all cash flows, apart from the initial investment, are brought to the terminal value using an appropriate discount rate (usually the Cost of Capital). This results in a single stream of cash inflow in the terminal year. **The MIRR is obtained by assuming a single outflow in the zeroth year and the terminal cash inflow** as mentioned above. **The discount rate which equates the present value of the terminal cash inflow to the zero year outflow is called the MIRR**.

The decision criterion of MIRR is same as IRR i.e. you accept an investment if MIRR is larger than required rate of return and reject if it is lower than the required rate of return.

ILLUSTRATION 9

An investment of ₹ 1,36,000 yields the following cash inflows (profits before depreciation but after tax). DETERMINE MIRR considering 8% as cost of capital.

Year	*(₹)*
1	*30,000*
2	*40,000*
3	*60,000*
4	*30,000*
5	*20,000*
	1,80,000

SOLUTION

Year 0 – Cash outflow = ₹ 1,36,000

The MIRR is calculated on the basis of investing the inflows at the cost of capital. The table below shows the value of the inflows, if they are immediately reinvested at 8%.

Year	Cash flow	@ 8% reinvestment rate factor	(₹)
1	30,000	1.3605*	40,815
2	40,000	1.2597	50,388
3	60,000	1.1664	69,984
4	30,000	1.0800	32,400
5	20,000	1.0000	20,000
			2,13,587

* Investment of ₹ 1 at the end of the year 1 is reinvested for 4 years (at the end of 5 years) shall become $1(1.08)^4$ = 1.3605. Similarly, reinvestment rate factor for remaining years shall be calculated. Please note that the investment at the end of 5^{th} year shall be reinvested for zero year, hence, reinvestment rate factor shall be 1.

The total cash outflow in year 0 (₹ 1,36,000) is compared with the possible inflow at year 5 and the resulting figure = $\frac{1,36,000}{2,13,587}$ = 0.6367 is the discount factor in year 5. By looking at the year 5 row in the present value tables, you will see that this gives a return of 9%. This means that the ₹ 2,13,587 received in year 5 is equivalent to ₹ 1,36,000 in year 0 if the discount rate is 9%. Alternatively, we can compute MIRR as follows:

Total return = $\frac{2,13,587}{1,36,000}$ = 1.5705

MIRR = $\sqrt[1/5]{1.5705}$ - 1 = 9%.

9.6 Comparison of Net Present Value and Internal Rate of Return Methods

Similarity

- Both the net present value (NPV) and the internal rate of return (IRR) methods are discounted cash flow methods which consider the time value of money.
- Both the techniques consider all cash flows over the expected useful life of the investment.

9.7 Different conclusion in the following scenarios

There are circumstances/scenarios under which the net present value method and the internal rate of return methods will reach different conclusions. Let us discuss these scenarios:

Scenario 1 – Scale or Size Disparity

Being **IRR a relative measure** and **NPV an absolute measure** in case of disparity in scale or size both may give contradicting ranking. This can be understood with the help of following illustration:

ILLUSTRATION 10

Suppose there are two Project A and Project B are under consideration. The cash flows associated with these projects are as follows:

Year	*Project A (₹)*	*Project B (₹)*
0	*(1,00,000)*	*(3,00,000)*
1	*50,000*	*1,40,000*
2	*60,000*	*1,90,000*
3	*40,000*	*1,00,000*

Assuming Cost of Capital equal to 10%, IDENTIFY which project should be accepted as per NPV Method and IRR Method.

SOLUTION

Net Present Value (NPV) of Projects

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 10%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.909	45,450	1,27,260
2	60,000	1,90,000	0.826	49,560	1,56,940
3	40,000	1,00,000	0.751	30,040	75,100
NPV				25,050	59,300

Internal Rate of Returns (IRR) of projects

Since by discounting cash flows at 10%, we are getting values very far from zero. Therefore, let us discount cash flows using 20% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 20%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.833	41,650	1,16,620
2	60,000	1,90,000	0.694	41,640	1,31,860
3	40,000	1,00,000	0.579	23,160	57,900
NPV				6,450	6,380

Even by discounting cash flows at 20%, we are getting values far from zero. Therefore, let us discount cash flows using 25% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 25%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.800	40,000	1,12,000
2	60,000	1,90,000	0.640	38,400	1,21,600
3	40,000	1,00,000	0.512	20,480	51,200
NPV				(1,120)	(15,200)

The internal rate of return is, thus, more than 20% but less than 25%. The exact rate can be obtained by interpolation:

$$IRR_A = 20\% + \frac{6,450}{6,450 - (1,120)} \times (25\% - 20\%) = 20\% + \left(\frac{6,450}{7,570} \times 5\%\right) = 24.26\%$$

$$IRR_B = 20\% + \frac{6,380}{6,380 - (15,200)} \times (25\% - 20\%) = 20\% + \left(\frac{6,380}{21,580} \times 5\%\right) = 21.48\%$$

Overall Position

	Project A	Project B
NPV @ 10%	₹ 25,050	₹ 59,300
IRR	24.26%	21.48%

Thus, there is contradiction in ranking by two methods.

Scenario 2 – Time Disparity in Cash Flows

It might be possible that overall cash flows may be more or less same in the projects but there may be disparity in their flows i.e. larger part of cash inflows may be occurred in the beginning or end of the project. In such situation there may be difference in the ranking of projects as per two methods. This can be understood with the help of following illustration:

ILLUSTRATION 11

Suppose ABC Ltd. is considering two Project X and Project Y for investment. The cash flows associated with these projects are as follows:

Year	*Project X (₹)*	*Project Y (₹)*
0	*(2,50,000)*	*(3,00,000)*
1	*2,00,000*	*50,000*
2	*1,00,000*	*1,00,000*
3	*50,000*	*3,00,000*

Assuming Cost of Capital be 10%, IDENTIFY which project should be accepted as per NPV Method and IRR Method.

SOLUTION

Net Present Value of Projects

Year	Cash Inflows of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 10%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
1	2,00,000	50,000	0.909	1,81,800	45,450
2	1,00,000	1,00,000	0.826	82,600	82,600
3	50,000	3,00,000	0.751	37,550	2,25,300
NPV				51,950	53,350

Internal Rate of Returns of projects

Since, by discounting cash flows at 10%, we are getting values far from zero. Therefore, let us discount cash flows using 20% discounting rate.

Year	Cash Inflows of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 20%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
1	2,00,000	50,000	0.833	1,66,600	41,650
2	1,00,000	1,00,000	0.694	69,400	69,400
3	50,000	3,00,000	0.579	28,950	1,73,700
NPV				14,950	(15,250)

Since, by discounting cash flows at 20% we are getting that value of Project X is positive and value of Project Y is negative. Therefore, let us discount cash flows of Project X using 25% discounting rate and Project Y using discount rate of 15%.

Year	Cash Inflows of Project X (₹)	Present Value Factor @ 25%	PV of Project X (₹)	Cash Inflows of Project Y (₹)	Present Value Factor @ 15%	PV of Project Y (₹)
0	(2,50,000)	1.000	(2,50,000)	(3,00,000)	1.000	(3,00,000)
1	2,00,000	0.800	1,60,000	50,000	0.870	43,500
2	1,00,000	0.640	64,000	1,00,000	0.756	75,600
3	50,000	0.512	25,600	3,00,000	0.658	1,97,400
NPV			(400)			16,500

The internal rate can be obtained by interpolation:

$$IRR_X = 20\% + \frac{14,950}{14,950 - (400)} \times (25\% - 20\%)$$

$$= 20\% + \left(\frac{14,950}{15,350} \times 5\%\right) = 24.87\%$$

$$IRR_B = 15\% + \frac{16,500}{16,500 - (15,250)} \times (20\% - 15\%)$$

$$= 15\% + \left(\frac{16,500}{31,750} \times 5\%\right) = 17.60\%$$

Overall Position

	Project A	Project B
NPV @ 10%	₹ 51,950	₹ 53,350
IRR	24.87%	17.60%

Thus, there is contradiction in ranking by two methods.

Scenario 3 – Disparity in life of Proposals (Unequal Lives)

Conflict in ranking may also arise if we are comparing two projects (especially mutually exclusive) having unequal lives. This can be understood with the help of following illustration:

ILLUSTRATION 12

Suppose MVA Ltd. is considering two Project A and Project B for investment. The cash flows associated with these projects are as follows:

Year	*Project A (₹)*	*Project B (₹)*
0	*(5,00,000)*	*(5,00,000)*
1	*7,50,000*	*2,00,000*
2	*0*	*2,00,000*
3	*0*	*7,00,000*

Assuming Cost of Capital equal to 12%, ANALYSE which project should be accepted as per NPV Method and IRR Method?

SOLUTION

Net Present Value of Projects

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 12%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000	0.893	6,69,750	1,78,600
2	0	2,00,000	0.797	0	1,59,400
3	0	7,00,000	0.712	0	4,98,400
NPV				1,69,750	3,36,400

Internal Rate of Returns of projects

Let us discount cash flows using 50% discounting rate.

Year	Cash Inflows of Project A (₹)	Cash Inflows of Project B (₹)	Present Value Factor @ 50%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)

1	7,50,000	2,00,000	0.667	5,00,250	1,33,400
2	0	2,00,000	0.444	0	88,800
3	0	7,00,000	0.296	0	2,07,200
NPV				250	(70,600)

Since, IRR of project A shall be 50% as NPV is very small. Further, by discounting cash flows at 50%, we are getting NPV of Project B negative. Therefore, let us discount cash flows of Project B using 15% discounting rate.

Year	Cash Inflows of Project B (₹)	Present Value Factor @ 15%	PV of Project B (₹)
0	(5,00,000)	1.000	(5,00,000)
1	2,00,000	0.870	1,74,000
2	2,00,000	0.756	1,51,200
3	7,00,000	0.658	4,60,600
NPV			2,85,800

The internal rate can be obtained by interpolation:

$$IRR_B = 15\% + \frac{2,85,800}{2,85,800 - (70,600)} \times (50\% - 15\%)$$

$$= 15\% + \left(\frac{2,85,800}{3,56,400} \times 35\%\right) = 43.07\%$$

Overall Position

	Project A	Project B
NPV @ 12%	₹ 1,69,750	₹ 3,36,400
IRR	50.00%	43.07%

Thus, there is contradiction in ranking by two methods.

10. SUMMARY OF DECISION CRITERIA OF CAPITAL BUDGETING TECHNIQUES

Techniques		For Independent Project	For Mutually Exclusive Projects
Non-Discounted	**Pay Back**	(i) When Payback period ≤ Maximum Acceptable Payback period: **Accepted** (ii) When Payback period ≥ Maximum Acceptable Payback period: **Rejected**	Project with least Payback period should be selected
	Accounting Rate of Return (ARR)	(i) When ARR≥ Minimum Acceptable Rate of Return: **Accepted** (ii) When ARR ≤ Minimum Acceptable Rate of Return: **Rejected**	Project with the maximum ARR should be selected.
Discounted	**Net Present Value (NPV)**	(i) When NPV> 0: **Accepted** (ii) When NPV< 0: **Rejected**	Project with the highest positive NPV should be selected
	Profitability Index (PI)	(i) When PI > 1: **Accepted** (ii) When PI < 1: **Rejected**	When Net Present Value is same project with Highest PI should be selected
	Internal Rate of Return (IRR)	(i) When IRR >*K*: **Accepted** (ii) When IRR <*K*: **Rejected**	Project with the maximum IRR should be selected

11. SPECIAL CASES

11.1 Capital Budgeting under Capital Rationing

As discussed earlier, if project has positive NPV, it should be accepted with an objective of maximisation of wealth of shareholders. However, there may be a situation due to resource (capital) constraints (rationing) a firm may have to select some projects among various projects, all having positive NPVs. Broadly two scenarios may influence the method of evaluation to be adopted.

(i) **Projects are independent of each other and are divisible in nature:** In such situation, NPV rule should be modified and accordingly projects should be ranked on the basis of 'NPV per rupee of Capital 'method.

(ii) **Projects are not divisible:** In such situation, projects shall be ranked on the basis of absolute NPV and should be mixed up to the point available resources are exhausted.

ILLUSTRATION 13

Shiva Limited is planning its capital investment programme for next year. It has five projects all of which give a positive NPV at the company cut-off rate of 15 percent, the investment outflows and present values being as follows:

Project	*Investment (₹)*	*NPV @ 15% (₹)*
A	*(50,000)*	*15,400*
B	*(40,000)*	*18,700*
C	*(25,000)*	*10,100*
D	*(30,000)*	*11,200*
E	*(35,000)*	*19,300*

The company is limited to a capital spending of ₹ 1,20,000.

You are required to ILLUSTRATE the returns from a package of projects within the capital spending limit. The projects are independent of each other and are divisible (i.e., part-project is possible).

SOLUTION

Computation of NPVs per ₹ 1 of Investment and Ranking of the Projects

Project	Investment	NPV @ 15%	NPV per ₹ 1 invested	Ranking
	₹ '000	₹ '000		
A	(50)	15.4	0.31	5
B	(40)	18.7	0.47	2
C	(25)	10.1	0.40	3
D	(30)	11.2	0.37	4
E	(35)	19.3	0.55	1

Building up of a Programme of Projects based on their Rankings

Project	Investment	NPV @ 15%	
	₹ 000	₹ 000	
E	(35)	19.3	
B	(40)	18.7	
C	(25)	10.1	
D	(20)	7.5	(2/3 of project total)
	120	55.6	

Thus, Project A should be rejected and only two-third of Project D be undertaken. If the projects are not divisible then other combinations can be examined as:

	Investment	NPV @ 15%
	₹ 000	₹ 000
E + B + C	100	48.1
E + B + D	105	49.2

In this case E + B + D would be preferable as it provides a higher NPV despite D ranking lower than C.

11.2 Projects with unequal lives

Sometimes firm may be faced with any of the following problems:

(i) **Retaining** an old asset **or replace** it with new one.

(ii) Choosing one proposal among two proposals (**Mutually Exclusive**).

Although, while evaluating the proposals in the above scenarios, do not pose any special problem if they have same life period. But problem arises in case projects have unequal lives. In such situations we can deal with the problem by following any of the following method:

(i) Replacement Chain Method

(ii) Equivalent Annualized Criterion

These two methods can be understood with the help of following illustration:

ILLUSTRATION 14

R Pvt. Ltd. is considering modernizing its production facilities and it has two proposals under consideration. The expected cash flows associated with these projects and their NPV as per discounting rate of 12% and IRR is as follows:

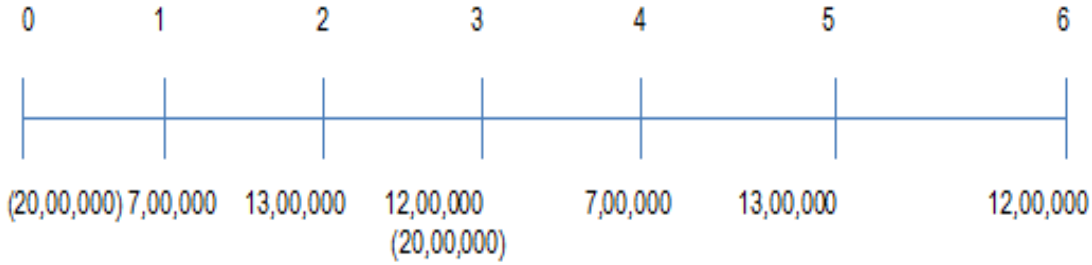
Year	Cash Flow	
	Project A (₹)	Project B (₹)
0	(40,00,000)	(20,00,000)
1	8,00,000	7,00,000
2	14,00,000	13,00,000
3	13,00,000	12,00,000
4	12,00,000	0
5	11,00,000	0
6	10,00,000	0
NPV @12%	6,49,094	5,15,488
IRR	17.47%	25.20%

IDENTIFY which project should R Pvt. Ltd. accept?

SOLUTION

Although from NPV point of view, Project A appears to be better but from IRR point of view, Project B appears to be better. Since, both projects have unequal lives, selection on the basis of these two methods shall not be proper. In such situation, we shall use any of the following method:

(i) Replacement Chain (Common Life) Method: Since the life of the Project A is 6 years and Project B is 3 years, to equalize lives, we can have second opportunity of investing in project B after one time investing. The position of cash flows in such situation shall be as follows:



NPV of extended life of 6 years of Project B shall be ₹ 8,82,403 and IRR of 25.20%. Accordingly, with extended life NPV of Project B it appears to be more attractive.

(ii) Equivalent Annualized Criterion: The method discussed above has one drawback when we have to compare two projects with one has a life of 3 years and other has 5 years. In such case, the above method shall require analysis of a period of 15 years i.e. common multiple of these two values. The simple solution to this problem is use of Equivalent Annualised Criterion involving following steps:

(a) Compute NPV using the WACC or discounting rate.

(b) Compute Present Value Annuity Factor (PVAF) of discounting factor used above for the period of each project.

(c) Divide NPV computed under step (a) by PVAF as computed under step (b) and compare the values.

Accordingly, for proposal under consideration:

	Project A	Project B
NPV @ 12%	₹ 6,49,094	₹ 5,15,488
PVAF @12%	4.112	2.402
Equivalent Annualized Criterion	₹ 1,57,854	₹ 2,14,608

Thus, Project B should be selected.

ILLUSTRATION 15

Alpha Company is considering the following investment projects:

	Cash Flows (₹)			
Projects	C_0	C_1	C_2	C_3
A	-10,000	+10,000		
B	-10,000	+7,500	+7,500	
C	-10,000	+2,000	+4,000	+12,000
D	-10,000	+10,000	+3,000	+3,000

(a) ANALYSE and rank the projects according to each of the following methods: (i) Payback, (ii) ARR, (iii) IRR and (iv) NPV, assuming discount rates of 10 and 30 per cent.

(b) Assuming the projects are independent, which one should be accepted? If the projects are mutually exclusive, IDENTIFY which project is the best?

SOLUTION

(a) (i) Payback Period

Project A: ₹ 10,000/₹ 10,000 = 1 year

Project B: ₹ 10,000/₹ 7,500 = $1\frac{1}{3}$ years

Project C: $2 \text{ years} + \frac{₹\ 10,000 - ₹\ 6,000}{₹\ 12,000} = 2\frac{1}{3}$ years

Project D: 1 year

(ii) ARR (Figures in ₹)

Project A: $\frac{(10,000 - 10,000)1/2}{(10,000)1/2} = 0$

Project B: $\frac{(15,000 - 10,000)1/2}{(10,000)1/2} = \frac{2,500}{5,000} = 50\%$

Project C: $\frac{(18,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,667}{5,000} = 53\%$

Project D: $\frac{(16,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,000}{5,000} = 40\%$

Note: This net cash proceed includes recovery of investment also. Therefore, net cash earnings are found by deducting initial investment.

(iii) IRR

Project A:	The net cash proceeds in year 1 are just equal to investment. Therefore, r = 0%.
Project B:	This project produces an annuity of ₹ 7,500 for two years. Therefore, the required PVAF is: ₹ 10,000/₹ 7,500 = 1.33. This factor is found under 32% column. Therefore, r = 32%
Project C:	Since cash flows are uneven, the trial and error method will be followed. Using 20% rate of discount, the NPV is + ₹ 1,389. At 30% rate of discount, the NPV is - ₹ 633. The true rate of return should be less than 30%. At 27% rate of discount, it is found that the NPV is - ₹ 86 and + ₹ 105 at 26%. Through interpolation, we find r = 26.5%
Project D:	In this case also by using the trial and error method, it is found that at 37.6% rate of discount, NPV becomes almost zero. Therefore, r = 37.6%.

(iv) NPV

Project A:

at 10% -10,000+10,000×0.909 = -910

at 30% -10,000+10,000×0.769 = -2,310

Project B:

at 10% -10,000+7,500(0.909+0.826) = +3,013

at 30% -10,000+7,500(0.769+0.592) = +208

Project C:

at 10% -10,000+2,000×0.909+4,000×0.826+12,000×0.751= +4,134

at 30% -10,000+2,000×0.769+4,000×0.592+12,000×0.455 =-633

Project D:

at 10% -10,000+10,000×0.909+3,000×(0.826+0.751) =+ 3,821

at 30% -10,000+10,000×0.769+3,000×(0.592+0.455) =+ 831

The projects are ranked as follows according to the various methods:

Projects	PBP	ARR	IRR	NPV (10%)	NPV (30%)
A	1	4	4	4	4
B	2	2	2	3	2
C	3	1	3	1	3
D	1	3	1	2	1

(b) Payback and ARR are theoretically unsound method for choosing between the investment projects. Between the two time-adjusted (DCF) investment criteria, NPV and IRR, NPV gives consistent results. If the projects are independent (and there is no capital rationing), either IRR or NPV can be used since the same set of projects will be accepted by any of the methods. In the present case, except Project A all the three projects should be accepted if the discount rate is 10%. Only Projects B and D should be undertaken if the discount rate is 30%.

If it is assumed that the projects are mutually exclusive, then under the assumption of 30% discount rate, the choice is between B and D (A and C are unprofitable). Both criteria IRR and NPV give the same results – D is the best. Under the assumption of 10% discount rate, ranking according to IRR and NPV conflict (except for Project A). If the IRR rule is followed, Project D should be accepted. But the NPV rule tells that Project C is the best. The NPV rule generally gives consistent results in conformity with the wealth maximization principle. Therefore, Project C should be accepted following the NPV rule.

ILLUSTRATION 16

The expected cash flows of three projects are given below. The cost of capital is 10 per cent.

(a) CALCULATE the payback period, net present value, internal rate of return and accounting rate of return of each project.

(b) IDENTIFY the rankings of the projects by each of the four methods.

(₹ in '000)

Period	*Project A (₹)*	*Project B (₹)*	*Project C (₹)*
0	*(5,000)*	*(5,000)*	*(5,000)*
1	*900*	*700*	*2,000*
2	*900*	*800*	*2,000*
3	*900*	*900*	*2,000*
4	*900*	*1,000*	*1,000*
5	*900*	*1,100*	
6	*900*	*1,200*	
7	*900*	*1,300*	
8	*900*	*1,400*	
9	*900*	*1,500*	
10	*900*	*1,600*	

SOLUTION

(a) Payback Period Method:

A = 5 + (500/900) = 5.56 years

B = 5 + (500/1,200) = 5.42 years

C = 2 + (1,000/2,000) = 2.5 years

Net Present Value Method:

NPV_A = (– 5,000) + (900 × 6.145) = (5,000) + 5,530.5 = ₹ 530.5

NPV_B is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	700	0.909	636
2	800	0.826	661
3	900	0.751	676
4	1000	0.683	683

5	1100	0.621	683
6	1200	0.564	677
7	1300	0.513	667
8	1400	0.467	654
9	1500	0.424	636
10	1600	0.386	618
			1591

NPV_C is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	2000	0.909	1,818
2	2000	0.826	1,652
3	2000	0.751	1,502
4	1000	0.683	683
			655

Internal Rate of Return

Project A

NPV at 12% = (5,000) + 900 × 5.650

= (5,000) + 5085 = 85

NPV at 13% = (5,000) + 900 × 5.426

= (5,000) + 4,883.40 = -116.60

$$IRR_A = 12 + \left[\frac{85}{85+116.60}\right] \times (13-12) = 12 + 0.42$$

= 12.42%.

Project B

IRR_B

Year	Cash flow (₹)	10% discount factor	Present value (₹)	16% discount factor	Present value (₹)
0	(5,000)	1.000	(5,000)	1.000	(5,000)
1	700	0.909	636	0.862	603
2	800	0.826	661	0.743	595
3	900	0.751	676	0.641	577
4	1,000	0.683	683	0.552	552
5	1,100	0.621	683	0.476	524
6	1,200	0.564	677	0.410	493
7	1,300	0.513	667	0.354	460
8	1,400	0.467	654	0.305	427
9	1,500	0.424	636	0.263	394
10	1,600	0.386	618	0.227	363
			1,591		(12)

Interpolating: $IRR_B = 10\% + \frac{1,591}{(1,591 + 12)} \times (16\% - 10\%) = 10\% + 5.94\% = 15.94\%$

Project C

IRR_C

Year	Cash flow (₹)	15% discount factor	Present value (₹)	18% discount factor	Present value (₹)
0	(5,000)	1.000	(5,000)	1.000	(5,000)
1	2,000	0.870	1,740	0.847	1,694
2	2,000	0.756	1,512	0.718	1,436
3	2,000	0.658	1,316	0.609	1,218
4	1,000	0.572	572	0.516	516
			140		(136)

Interpolating: $IRR_C = 15\% + \frac{140}{(140 + 136)} \times (18\% - 15\%) = 15\% + 1.52\% = 16.52\%$

Accounting Rate of Return:

ARR_A: Average capital employed = $\frac{5,000}{2} = ₹\ 2,500$

Average accounting profit = $\frac{(9,000 - 5,000)}{10} = ₹\ 400$

$ARR_A = \frac{(400 \times 100)}{2,500} = 16$ per cent

ARR_B: Average accounting profit = $\frac{(11,500 - 5,000)}{10} = ₹\ 650$

$ARR_B = \frac{(650 \times 100)}{2,500} = 26$ per cent

ARR_C: Average accounting profit = $\frac{(7,000 - 5,000)}{4} = ₹\ 500$

$ARR_C = \frac{(500 \times 100)}{2,500} = 20$ per cent

(b) Summary of Results

	A	B	C
Payback (years)	5.5	5.4	2.5
NPV (₹)	530.50	1,591	655
IRR (%)	12.42	15.94	16.52
ARR (%)	16	26	20

Comparison of Rankings

Method	Payback	NPV	IRR	ARR
1	C	B	C	B
2	B	C	B	C
3	A	A	A	A

ILLUSTRATION 17

X Limited is considering purchasing of new plant worth ₹80,00,000. The expected net cash flows after taxes and before depreciation are as follows:

Year	Net Cash Flows (₹)
1	14,00,000
2	14,00,000
3	14,00,000
4	14,00,000
5	14,00,000
6	16,00,000
7	20,00,000
8	30,00,000
9	20,00,000
10	8,00,000

The rate of cost of capital is 10%.

You are required to CALCULATE:

(i) Pay-back period

(ii) Net present value at 10 discount factor

(iii) Profitability index at 10 discount factor

(iv) Internal rate of return with the help of 10% and 15% discount factor

The following present value table is given for you:

Year	Present value of ₹1 at 10% discount rate	Present value of ₹1 at 15% discount rate
1	0.909	0.87
2	0.826	0.756
3	0.751	0.658
4	0.683	0.572
5	0.621	0.497

6	0.564	0.432
7	0.513	0.376
8	0.467	0.327
9	0.424	0.284
10	0.386	0.247

SOLUTION

(i) Calculation of Pay-back Period

Cash Outlay of the Project = ₹ 80,00,000

Total Cash Inflow for the first five years = ₹ 70,00,000

Balance of cash outlay left to be paid back in the 6th year = ₹ 10,00,000

Cash inflow for 6th year = ₹ 16,00,000

So, the payback period is between 5th and 6th years, i.e.,

$$5 \text{ years} + \frac{₹10,00,000}{₹16,00,000} = 5.625 \text{ years or } 5 \text{ years } 7.5 \text{ months}$$

(ii) Calculation of Net Present Value (NPV) @10% discount rate:

Year	Net Cash Inflow (₹)	Present Value at Discount Rate of 10%	Present Value (₹)
	(a)	(b)	(c) = (a)× (b)
1	14,00,000	0.909	12,72,600
2	14,00,000	0.826	11,56,400
3	14,00,000	0.751	10,51,400
4	14,00,000	0.683	9,56,200
5	14,00,000	0.621	8,69,400
6	16,00,000	0.564	9,02,400
7	20,00,000	0.513	10,26,000
8	30,00,000	0.467	14,01,000
9	20,00,000	0.424	8,48,000
10	8,00,000	0.386	3,08,800
			97,92,200

Net Present Value (NPV) = Cash Outflow – Present Value of Cash Inflows

= ₹ 80,00,000 – ₹ 97,92,200 = 17,92,200

(iii) Calculation of Profitability Index @ 10% discount rate:

$$\text{Profitability Index} = \frac{\text{Present Value of Cash inflows}}{\text{Cost of the investment}}$$

$$= \frac{₹97,92,200}{₹\ 80,00,000} = 1.224$$

(iv) Calculation of Internal Rate of Return:

Net present value @ 10% interest rate factor has already been calculated in (ii) above, we will calculate Net present value @15% rate factor.

Year	Net Cash Inflow (₹)	Present Value at Discount Rate of 15%	Present Value (₹)
	(a)	(b)	(c) = (a)× (b)
1	14,00,000	0.870	12,18,000
2	14,00,000	0.756	10,58,400
3	14,00,000	0.658	9,21,200
4	14,00,000	0.572	8,00,800
5	14,00,000	0.497	6,95,800
6	16,00,000	0.432	6,91,200
7	20,00,000	0.376	7,52,000
8	30,00,000	0.327	9,81,000
9	20,00,000	0.284	5,68,000
10	8,00,000	0.247	1,97,600
			78,84,000

Net Present Value at 15% = ₹ 78,84,000 – ₹ 80,00,000 = ₹ -1,16,000

As the net present value @ 15% discount rate is negative, hence internal rate of return falls in between 10% and 15%. The correct internal rate of return can be calculated as follows:

$$\text{IRR} = L + \frac{NPV_L}{NPV_L - NPV_H}(H - L)$$

$$= 10\% + \frac{₹17,92,200}{₹17,92,200 - (-₹\ 1,16,000)}(15\% - 10\%)$$

$$= 10\% + \frac{₹\ 17,92,200}{₹19,08,200} \times 5\% \ = 14.7\%$$

ILLUSTRATION 18

HMR Ltd. is considering replacing a manually operated old machine with a fully automatic new machine. The old machine had been fully depreciated for tax purpose but has a book value of ₹2,40,000 on 31st March . The machine has begun causing problems with breakdowns and it cannot fetch more than ₹30,000 if sold in the market at present. It will have no realizable value after 10 years. The company has been offered ₹1,00,000 for the old machine as a trade in on the new machine which has a price (before allowance for trade in) of ₹4,50,000. The expected life of new machine is 10 years with salvage value of ₹35,000.

Further, the company follows straight line depreciation method but for tax purpose, written down value method depreciation @ 7.5% is considering that this is the only machine in the block of assets.

Given below are the expected sales and costs from both old and new machine:

	Old machine (₹)	**New machine (₹)**
Sales	*8,10,000*	*8,10,000*
Material cost	*1,80,000*	*1,26,250*
Labour cost	*1,35,000*	*1,10,000*
Variable overhead	*56,250*	*47,500*
Fixed overhead	*90,000*	*97,500*
Depreciation	*24,000*	*41,500*
PBT	*3,24,750*	*3,87,250*
Tax @ 30%	*97,425*	*1,16,175*
PAT	*2,27,325*	*2,71,075*

From the above information, ANALYSE whether the old machine should be replaced or not if required rate of return is 10%? Ignore capital gain tax.

PV factors @ 10%:

Year	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
PVF	*0.909*	*0.826*	*0.751*	*0.683*	*0.621*	*0.564*	*0.513*	*0.467*	*0.424*	*0.386*

SOLUTION

Workings:

1. Calculation of Base for depreciation or Cost of New Machine

Particulars	**(₹)**
Purchase price of new machine	4,50,000
Less: Sale price of old machine	1,00,000
	3,50,000

2. Calculation of Profit before tax as per books

Particulars	**Old machine (₹)**	**New machine (₹)**	**Difference (₹)**
PBT as per books	3,24,750	3,87,250	62,500
Add: Depreciation as per books	24,000	41,500	17,500
Profit before tax and depreciation (PBTD)	3,48,750	4,28,750	80,000

Calculation of Incremental NPV

Year	**PVF @ 10%**	**PBTD (₹)**	**Dep. @ 7.5% (₹)**	**PBT (₹)**	**Tax @ 30% (₹)**	**Cash Inflows (₹)**	**PV of Cash Inflows (₹)**
	(1)	**(2)**	**(3)**	**(4)**	**(5) = (4) x 0.30**	**(6) = (4) – (5) + (3)**	**(7) = (6) x (1)**
1	0.909	80,000.00	26,250.00	53,750.00	16,125.00	63,875.00	58,062.38
2	0.826	80,000.00	24,281.25	55,718.75	16,715.63	63,284.38	52,272.89
3	0.751	80,000.00	22,460.16	57,539.84	17,261.95	62,738.05	47,116.27
4	0.683	80,000.00	20,775.64	59,224.36	17,767.31	62,232.69	42,504.93
5	0.621	80,000.00	19,217.47	60,782.53	18,234.76	61,765.24	38,356.21
6	0.564	80,000.00	17,776.16	62,223.84	18,667.15	61,332.85	34,591.73
7	0.513	80,000.00	16,442.95	63,557.05	19,067.12	60,932.88	31,258.57

8	0.467	80,000.00	15,209.73	64,790.27	19,437.08	60,562.92	28,282.88
9	0.424	80,000.00	14,069.00	65,931.00	19,779.30	60,220.70	25,533.58
10	0.386	80,000.00	13,013.82	66,986.18	20,095.85	59,904.15	23,123.00
							3,81,102.44
Add: PV of Salvage value of new machine (₹ 35,000 × 0.386)							13,510.00
Total PV of incremental cash inflows							3,94,612.44
Less: Cost of new machine							3,50,000.00
Incremental Net Present Value							44,612.44

Analysis: Since the Incremental NPV is positive, the old machine should be replaced.

ILLUSTRATION 19

XYZ Ltd. is presently all equity financed. The directors of the company have been evaluating investment in a project which will require ₹270 lakhs capital expenditure on new machinery. They expect the capital investment to provide annual cash flows of ₹42 lakhs indefinitely which is net of all tax adjustments. The discount rate which it applies to such investment decisions is 14% net.

The directors of the company believe that the current capital structure fails to take advantage of tax benefits of debt and propose to finance the new project with undated perpetual debt secured on the company's assets. The company intends to issue sufficient debt to cover the cost of capital expenditure and the after tax cost of issue.

The current annual gross rate of interest required by the market on corporate undated debt of similar risk is 10%. The after tax costs of issue are expected to be ₹10 lakhs. Company's tax rate is 30%.

You are REQUIRED to:

(i) Calculate the adjusted present value of the investment,

(ii) Calculate the adjusted discount rate and

(iii) Explain the circumstances under which this adjusted discount rate may be used to evaluate future investments.

SOLUTION

(i) Calculation of Adjusted Present Value of Investment (APV)

Adjusted PV = Base Case PV + PV of financing decisions associated with the project

Base Case NPV for the project:

(-) ₹ 270 lakhs + (₹ 42 lakhs / 0.14)	= (-) ₹ 270 lakhs + ₹ 300 lakhs
	= ₹ 30
Issue costs	= ₹ 10 lakhs
Thus, the amount to be raised	= ₹ 270 lakhs + ₹ 10 lakhs
	= ₹ 280 lakhs
Annual tax relief on interest payment	= ₹ 280 X 0.1 X 0.3
	= ₹ 8.4 lakhs in perpetuity
The value of tax relief in perpetuity	= ₹ 8.4 lakhs / 0.1
	= ₹ 84 lakhs

Therefore, APV = Base case PV – Issue Costs + PV of Tax Relief on debt interest

= ₹ 30 lakhs – ₹ 10 lakhs + 84 lakhs = ₹ 104 lakhs

(ii) Calculation of Adjusted Discount Rate (ADR)

Annual Income / Savings required to allow an NPV to zero

Let the annual income be x.

(-) ₹280 lakhs X (Annual Income / 0.14) = (-) ₹104 lakhs

Annual Income / 0.14	= (-) ₹ 104 + ₹ 280 lakhs
Therefore, Annual income	= ₹ 176 X 0.14 = ₹ 24.64 lakhs
Adjusted discount rate	= (₹ 24.64 lakhs / ₹280 lakhs) X 100
	= 8.8%

(iii) Useable circumstances

This ADR may be used to evaluate future investments only if the business risk of the new venture is identical to the one being evaluated here and the project is to be financed by the same method on the same terms. The effect on the company's cost of capital of introducing debt into the capital structure cannot be ignored.

SUMMARY

- **Capital budgeting** is the process of evaluating and selecting long-term investments that are in line with the goal of investor's wealth maximization.
- The capital budgeting decisions are important, crucial and critical business decisions due to substantial expenditure involved; long period for the recovery of benefits; irreversibility of decisions and the complexity involved in capital investment decisions.
- One of the most important tasks in capital budgeting is estimating future cash flows for a project. The final decision we make at the end of the capital budgeting process is no better than the accuracy of our cash-flow estimates.
- Tax payments like other payments must be properly deducted in deriving the cash flows. That is, cash flows must be defined in post-tax terms.
- There are a number of capital budgeting techniques available for appraisal of investment proposals and can be classified as traditional (non-discounted) and time-adjusted (discounted).
- The most common traditional capital budgeting techniques are Payback Period and Accounting (Book) Rate of Return.
- **Payback Period** $= \frac{\text{Total initial capital investment}}{\text{Annual expected after - tax net cash flow}}$

  Payback Reciprocal $= \frac{\text{Average Annual cash in flow}}{\text{Initial investment}}$
- **Accounting rate of return (ARR)** $= \frac{\text{Average annual net income}}{\text{Investment}}$
- **Net Present Value Technique (NPV):**

  Net present value = Present value of cash inflows - Present value of cash outflows

  Or, $NPV = \left(\frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + \frac{C_3}{(1+k)^3} + ... + \frac{C_n}{(1+k)^n} \right) - I$

- **Profitability Index /Desirability Factor/Present Value Index Method (PI):**

$$\text{Profitability Index (PI)} = \frac{\text{Sum of discounted cash in flows}}{\text{Initial cash outlay or Total discounted cash outflow (as the case may)}}$$

- **Internal Rate of Return Method (IRR):**

$$LR + \frac{\text{NPV at LR}}{\text{NPV at LR - NPV at HR}} \times (HR - LR)$$

- **Modified Internal Rate of Return (MIRR):** All cash flows, apart from the initial investment, are brought to the terminal value using an appropriate discount rate (usually the Cost of Capital).

TEST YOUR KNOWLEDGE

Multiple Choice Questions (MCQs)

1. *A capital budgeting technique which does not require the computation of cost of capital for decision making purposes is:*

   (a) Net Present Value method

   (b) Internal Rate of Return method

   (c) Modified Internal Rate of Return method

   (d) Payback Period method

2. *If two alternative proposals are such that the acceptance of one shall exclude the possibility of the acceptance of another then such decision making will lead to:*

   (a) Mutually exclusive decisions

   (b) Accept reject decisions

   (c) Contingent decisions

   (d) None of the above

3. *In case a company considers a discounting factor higher than the cost of capital for arriving at present values, the present values of cash inflows will be:*

   (a) Less than those computed on the basis of cost of capital

(b) *More than those computed on the basis of cost of capital*

(c) *Equal to those computed on the basis of the cost of capital*

(d) *None of the above*

4. *If the cut off rate of a project is greater than IRR, we may:*

(a) *Accept the proposal*

(b) *Reject the proposal*

(c) *Be neutral about it*

(d) *Wait for the IRR to increase and match the cut off rate*

5. *While evaluating capital investment proposals, time value of money is used in which of the following techniques:*

(a) *Payback Period method*

(b) *Accounting rate of return*

(c) *Net present value*

(d) *None of the above*

6. *IRR would favour project proposals which have:*

(a) *Heavy cash inflows in the early stages of the project.*

(b) *Evenly distributed cash inflows throughout the project.*

(c) *Heavy cash inflows at the later stages of the project.*

(d) *None of the above.*

7. *The re-investment assumption in the case of the IRR technique assumes that:*

(a) *Cash flows can be re-invested at the projects IRR.*

(b) *Cash flows can be re-invested at the weighted cost of capital.*

(c) *Cash flows can be re-invested at the marginal cost of capital.*

(d) *None of the above*

8. *Multiple IRRs are obtained when:*

(a) *Cash flows in the early stages of the project exceed cash flows during the later stages.*

(b) *Cash flows reverse their signs during the project.*

(c) *Cash flows are uneven.*

(d) *None of the above.*

9. *Depreciation is included as a cost in which of the following techniques:*

(a) *Accounting rate of return*

(b) *Net present value*

(c) *Internal rate of return*

(d) *None of the above*

10. *Management is considering a ₹1,00,000 investment in a project with a 5 year life and no residual value. If the total income from the project is expected to be ₹60,000 and recognition is given to the effect of straight line depreciation on the investment, the average rate of return is:*

(a) *12%*

(b) *24%*

(c) *60%*

(d) *75%*

11. *Assume cash outflow equals ₹1,20,000 followed by cash inflows of ₹25,000 per year for 8 years and a cost of capital of 11%. What is the Net present value?*

(a) *(₹38,214)*

(b) *₹9,653*

(c) *₹8,653*

(d) *₹38,214*

12. *What is the Internal rate of return for a project having cash flows of ₹40,000 per year for 10 years and a cost of ₹2,26,009?*

(a) *8%*

(b) *9%*

(c) *10%*

(d) *12%*

13. *While evaluating investments, the release of working capital at the end of the project's life should be considered as:*

    (a) Cash inflow

    (b) Cash outflow

    (c) Having no effect upon the capital budgeting decision

    (d) None of the above

14. *Capital rationing refers to a situation where:*

    (a) Funds are restricted and the management has to choose from amongst available alternative investments.

    (b) Funds are unlimited and the management has to decide how to allocate them to suitable projects.

    (c) Very few feasible investment proposals are available with the management.

    (d) None of the above.

15. *Capital budgeting is done for:*

    (a) Evaluating short term investment decisions.

    (b) Evaluating medium term investment decisions.

    (c) Evaluating long term investment decisions.

    (d) None of the above.

Theoretical Questions

1. *DISCUSS the various techniques of capital budgeting.*
2. *DISCUSS NPV. How is it calculated?*
3. *DISCUSS in detail the 'Capital Budgeting Process'.*
4. *CLASSIFY various types of Capital Investment decisions known to you.*
5. *DESCRIBE the advantages and disadvantages of profitability of index.*
6. *DESCRIBE MIRR.*

Practical Problems

1. *Following data has been available for a capital project:*

Annual cash inflows	*₹ 1,00,000*
Useful life	*4 years*
Salvage value	*0*
Internal rate of return	*12%*
Profitability index	*1.064*

You are required to CALCULATE the following for this project:

(i) Cost of project

(ii) Cost of capital

(iii) Net present value

(iv) Payback period

PV factors at different rates are given below:

Discount factor	12%	11%	10%	9%
1 year	0.893	0.901	0.909	0.917
2 year	0.797	0.812	0.826	0.842
3 year	0.712	0.731	0.751	0.772
4 year	0.636	0.659	0.683	0.708

2. *Lockwood Limited wants to replace its old machine with a new automatic machine. Two models A and B are available at the same cost of ₹5 lakhs each. Salvage value of the old machine is ₹ 1 lakh. The utilities of the existing machine can be used if the company purchases model A. Additional cost of utilities to be purchased in this case will be ₹ 1 lakh. If the company purchases B, then all the existing utilities will have to be replaced with new utilities costing ₹2 lakhs. The salvage value of the old utilities will be ₹0.20 lakhs. The cash flows are expected to be:*

Year	Cash inflows of A (₹)	Cash inflows of B (₹)	P.V. Factor @ 15%
1	1,00,000	2,00,000	0.870
2	1,50,000	2,10,000	0.756
3	1,80,000	1,80,000	0.658

4	*2,00,000*	*1,70,000*	*0.572*
5	*1,70,000*	*40,000*	*0.497*
Salvage Value at the end of Year 5	*50,000*	*60,000*	

The targeted return on capital is 15%. You are required to (i) COMPUTE, for the two machines separately, net present value, discounted payback period and desirability factor and (ii) STATE which of the machines is to be selected?

3. *Hindlever Company is considering a new product line to supplement its range of products. It is anticipated that the new product line will involve cash investments of ₹ 7,00,000 at time 0 and ₹ 10,00,000 in year 1. After-tax cash inflows of ₹ 2,50,000 are expected in year 2, ₹ 3,00,000 in year 3, ₹ 3,50,000 in year 4 and ₹ 4,00,000 each year thereafter through year 10. Although the product line might be viable even after year 10, the company prefers to be conservative and end all calculations at that time.*

   (a) If the required rate of return is 15 per cent, COMPUTE net present value of the project. Is it acceptable?

   (b) ANALYSE what would be the case if the required rate of return were 10 per cent.

   (c) CALCULATE its internal rate of return.

   (d) COMPUTE the project's payback period.

4. *Elite Cooker Company is evaluating three investment situations: (1) Produce a new line of aluminium skillets, (2) Expand its existing cooker line to include several new sizes, and (3) Develop a new, higher-quality line of cookers. If only the project in question is undertaken, the expected present values and the amounts of investment required are:*

Project	***Investment required***	***Present value of Future Cash-Flows***
	₹	***₹***
1	*2,00,000*	*2,90,000*
2	*1,15,000*	*1,85,000*
3	*2,70,000*	*4,00,000*

If projects 1 and 2 are jointly undertaken, there will be no economies; the investments required and present values will simply be the sum of the parts. With projects 1 and 3, economies are possible in investment because one of the machines acquired can be used in both production processes. The total investment required for projects 1 and 3 combined is ₹ 4,40,000. If projects 2 and 3 are undertaken, there are economies to be achieved in marketing and producing the products but not in investment. The expected present value of future cash flows for projects 2 and 3 is ₹ 6,20,000. If all three projects are undertaken simultaneously, the economies noted will still hold. However, a ₹ 1,25,000 extension on the plant will be necessary, as space is not available for all three projects. CALCULATE NPV of the projects and STATE which project or projects should be chosen?

5. *Cello Limited is considering buying a new machine which would have a useful economic life of five years, a cost of ₹ 1,25,000 and a scrap value of ₹ 30,000, with 80 per cent of the cost being payable at the start of the project and 20 per cent at the end of the first year. The machine would produce 50,000 units per annum of a new product with an estimated selling price of ₹ 3 per unit. Direct costs would be ₹ 1.75 per unit and annual fixed costs, including depreciation calculated on a straight- line basis, would be ₹ 40,000 per annum.*

   In the first year and the second year, special sales promotion expenditure, not included in the above costs, would be incurred, amounting to ₹ 10,000 and ₹ 15,000 respectively.

   CALCULATE NPV of the project for investment appraisal, assuming that the company's cost of capital is 10 percent.

6. *Ae Bee Cee Ltd. is planning to invest in machinery, for which it has to make a choice between the two identical machines, in terms of Capacity, 'X' and 'Y'. Despite being designed differently, both machines do the same job. Further, details regarding both the machines are given below:*

Particulars	***Machine 'X'***	***Machine 'Y'***
Purchase Cost of the Machine (₹)	*15,00,000*	*10,00,000*
Life (years)	*3*	*2*
Running cost per year (₹)	*4,00,000*	*6,00,000*

   The opportunity cost of capital is 9%.

   You are required to IDENTIFY the machine which the company should buy?

The present value (PV) factors at 9% are:

Year	t_1	t_2	t_3
$PVIF_{0.09,t}$	*0.917*	*0.842*	*0.772*

7. *Alley Pvt. Ltd. is planning to invest in a machinery that would cost ₹ 1,00,000 at the beginning of year 1. Net cash inflows from operations have been estimated at ₹ 36,000 per annum for 3 years. The company has two options for smooth functioning of the machinery - one is service, and another is replacement of parts. If the company opts to service a part of the machinery at the end of year 1 at ₹ 20,000, in such a case, the scrap value at the end of year 3 will be ₹ 25,000. However, if the company decides not to service the part, then it will have to be replaced at the end of year 2 at ₹ 30,800, and in this case, the machinery will work for the 4th year also and get operational cash inflow of ₹ 36,000 for the 4th year. It will have to be scrapped at the end of year 4 at ₹ 18,000.*

Assuming cost of capital at 10% and ignoring taxes, DETERMINE the purchase of this machinery based on the net present value of its cash flows.

If the supplier gives a discount of ₹ 10,000 for purchase, what would be your decision?

Note: The PV factors at 10% are:

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*
PV Factor	*1*	*0.9091*	*0.8264*	*0.7513*	*0.6830*	*0.6209*	*0.5645*

8. *NavJeevani hospital is considering to purchase a machine for medical projectional radiography which is priced at ₹ 2,00,000. The projected life of the machine is 8 years and has an expected salvage value of ₹ 18,000 at the end of 8^{th} year. The annual operating cost of the machine is ₹ 22,500. It is expected to generate revenues of ₹ 1,20,000 per year for eight years. Presently, the hospital is outsourcing the radiography work to its neighbour Test Center and is earning commission income of ₹ 36,000 per annum, net of taxes.*

Required:

ANALYSE whether it would be profitable for the hospital to purchase the machine. Give your recommendation under:

(i) Net Present Value method

(ii) Profitability Index method

Consider tax @30%. PV factors at 10% are given below:

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467

9. *XYZ Ltd. is planning to introduce a new product with a project life of 8 years. Initial equipment cost will be ₹ 3.5 crores. Additional equipment costing ₹ 25,00,000 will be purchased at the end of the third year from the cash inflow of this year. At the end of 8 years, the original equipment will have no resale value, but additional equipment can be sold for ₹ 2,50,000. A working capital of ₹ 40,00,000 will be needed and it will be released at the end of eighth year. The project will be financed with sufficient amount of equity capital.*

The sales volumes over eight years have been estimated as follows:

Year	1	2	3	4 – 5	6 – 8
Units per year	72,000	1,08,000	2,60,000	2,70,000	1,80,000

A sales price of ₹ 240 per unit is expected and variable expenses will amount to 60% of sales revenue. Fixed cash operating costs will amount ₹ 36,00,000 per year. The loss of any year will be set off from the profits of subsequent two years. The company is subject to 30 per cent tax rate and considers 12 per cent to be an appropriate after-tax cost of capital for this project. The company follows straight line method of depreciation.

CALCULATE the net present value of the project and advise the management to take appropriate decision.

The PV factors at 12% are

Year	1	2	3	4	5	6	7	8
PV Factor	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404

10. *A large profit making company is considering the installation of a machine to process the waste produced by one of its existing manufacturing process to be converted into a marketable product. At present, the waste is removed by a contractor for disposal on payment by the company of ₹ 150 lakh per annum for the next four years. The contract can be terminated upon installation of the aforesaid machine on payment of a compensation of ₹ 90 lakh before the*

processing operation starts. This compensation is not allowed as deduction for tax purposes.

The machine required for carrying out the processing will cost ₹ 600 lakh. At the end of the 4th year, the machine can be sold for ₹ 60 lakh and the cost of dismantling and removal will be ₹ 45 lakh.

Sales and direct costs of the product emerging from waste processing for 4 years are estimated as under:

(₹ In lakh)

Year	**1**	**2**	**3**	**4**
Sales	966	966	1,254	1,254
Material consumption	90	120	255	255
Wages	225	225	255	300
Other expenses	120	135	162	210
Factory overheads	165	180	330	435
Depreciation (as per income tax rules)	150	114	84	63

Initial stock of materials required before commencement of the processing operations is ₹ 60 lakh at the start of year 1. The stock levels of materials to be maintained at the end of year 1, 2 and 3 will be ₹ 165 lakh and the stocks at the end of year 4 will be nil. The storage of materials will utilise space which would otherwise have been rented out for ₹ 30 lakh per annum. Labour costs include wages of 40 workers, whose transfer to this process will reduce idle time payments of ₹ 45 lakh in the year- 1 and ₹ 30 lakh in the year- 2. Factory overheads include apportionment of general factory overheads except to the extent of insurance charges of ₹ 90 lakh per annum payable on this venture. The company's tax rate is 30%.

Consider cost of capital @ 14%, the present value factors of which is given below for four years:

Year	1	2	3	4
PV factors @14%	0.877	0.769	0.674	0.592

ADVISE the management on the desirability of installing the machine for processing the waste. All calculations should form part of the answer.

11. *Xavly Ltd. has a machine which has been in operation for 3 years. The machine has a remaining estimated useful life of 5 years with no salvage value in the end. Its current market value is ₹2,00,000. The company is considering a proposal to purchase a new model of machine to replace the existing machine. The relevant information is as follows:*

	Existing Machine	***New Machine***
Cost of machine	*₹3,30,000*	*₹10,00,000*
Estimated life	*8 years*	*5 years*
Salvage value	*Nil*	*₹40,000*
Annual output	*30,000 units*	*75,000 units*
Selling price per unit	*₹15*	*₹15*
Annual operating hours	*3,000*	*3,000*
Material cost per unit	*₹4*	*₹4*
Labour cost per hour	*₹40*	*₹70*
Indirect cash cost per annum	*₹50,000*	*₹65,000*

The company uses written down value of depreciation @ 20% and it has several other machines in the block of assets. The Income tax rate is 30 per cent and Xavly Ltd. does not make any investment, if it yields less than 12 per cent.

ADVISE Xavly Ltd. whether the existing machine should be replaced or not.

PV factors @12%:

Year	*1*	*2*	*3*	*4*	*5*
PVF	*0.893*	*0.797*	*0.712*	*0.636*	*0.567*

12. *A & Co. is contemplating whether to replace an existing machine or to spend money on overhauling it. A & Co. currently pays no taxes. The replacement machine costs ₹90,000 now and requires maintenance of ₹10,000 at the end of every year for eight years. At the end of eight years it would have a salvage value of ₹20,000 and would be sold. The existing machine requires increasing amounts of maintenance each year and its salvage value falls each year as follows:*

Year	Maintenance (₹)	Salvage (₹)
Present	0	40,000
1	10,000	25,000
2	20,000	15,000
3	30,000	10,000
4	40,000	0

The opportunity cost of capital for A & Co. is 15%.

REQUIRED:

When should the company replace the machine?

(Note: Present value of an annuity of Re. 1 per period for 8 years at interest rate of 15% : 4.4873; present value of Re. 1 to be received after 8 years at interest rate of 15% : 0.3269).

13. *A chemical company is presently paying an outside firm ₹ 1 per gallon to dispose off the waste resulting from its manufacturing operations. At normal operating capacity, the waste is about 50,000 gallons per year.*

After spending ₹ 60,000 on research, the company discovered that the waste could be sold for ₹ 10 per gallon if it was processed further. Additional processing would, however, require an investment of ₹ 6,00,000 in new equipment, which would have an estimated life of 10 years with no salvage value. Depreciation would be calculated by straight line method.

Except for the costs incurred in advertising ₹ 20,000 per year, no change in the present selling and administrative expenses is expected, if the new product is sold. The details of additional processing costs are as follows:

Variable : ₹ 5 per gallon of waste put into process.

Fixed : (Excluding Depreciation) ₹ 30,000 per year.

There will be no losses in processing, and it is assumed that the total waste processed in a given year will be sold in the same year. Estimates indicate that 50,000 gallons of the product could be sold each year.

The management when confronted with the choice of disposing off the waste or processing it further and selling it, seeks your ADVICE. Which alternative

would you recommend? Assume that the firm's cost of capital is 15% and it pays on an average 50% Tax on its income.

You should consider Present value of Annuity of ₹ 1 per year @ 15% p.a. for 10 years as 5.019.

14. *Manoranjan Ltd is a News broadcasting channel having its broadcasting Centre in Mumbai. There are total 200 employees in the organisation including top management. As a part of employee benefit expenses, the company serves tea or coffee to its employees, which is outsourced from a third-party. The company offers tea or coffee three times a day to each of its employees. 120 employees prefer tea all three times, 40 employees prefer coffee all three times and remaining prefer tea only once in a day. The third-party charges ₹ 10 for each cup of tea and ₹ 15 for each cup of coffee. The company works for 200 days in a year.*

Looking at the substantial amount of expenditure on tea and coffee, the finance department has proposed to the management an installation of a master tea and coffee vending machine which will cost ₹ 10,00,000 with a useful life of five years. Upon purchasing the machine, the company will have to enter into an annual maintenance contract with the vendor, which will require a payment of ₹ 75,000 every year. The machine would require electricity consumption of 500 units p.m. and current incremental cost of electricity for the company is ₹ 12 per unit. Apart from these running costs, the company will have to incur the following consumables expenditure also:

(1) Packets of Coffee beans at a cost of ₹ 90 per packet.

(2) Packet of tea powder at a cost of ₹ 70 per packet.

(3) Sugar at a cost of ₹ 50 per Kg.

(4) Milk at a cost of ₹ 50 per litre.

(5) Paper cup at a cost of 20 paise per cup.

Each packet of coffee beans would produce 200 cups of coffee and same goes for tea powder packet. Each cup of tea or coffee would consist of 10g of sugar on an average and 100 ml of milk.

The company anticipate that due to ready availability of tea and coffee through vending machines its employees would end up consuming more tea and coffee.

It estimates that the consumption will increase by on an average 20% for all class of employees. Also, the paper cups consumption will be 10% more than the actual cups served due to leakages in them.

The company is in the 25% tax bracket and has a current cost of capital at 12% per annum. Straight line method of depreciation is allowed for the purpose of taxation. You as a financial consultant is required to ADVISE on the feasibility of acquiring the vending machine.

PV factors @ 12%:

Year	*1*	*2*	*3*	*4*	*5*
PVF	*0.8929*	*0.7972*	*0.7118*	*0.6355*	*0.5674*

ANSWERS/SOLUTIONS

Answers to the MCQs based Questions

1.	(d)	**2.**	(a)	**3.**	(a)	**4.**	(b)	**5.**	(c)	**6.**	(a)
7.	(a)	**8.**	(b)	**9.**	(a)	**10.**	(b)	**11.**	(c)	**12.**	(d)
13.	(a)	**14.**	(a)	**15.**	(c)						

Answers to Theoretical Questions

1. Please refer paragraph 7

2. Please refer paragraph 9.1

3. Please refer paragraph 3

4. Please refer paragraph 4

5. Please refer paragraph 9.2

6. Please refer paragraph 9.5

Answers to Practical Problems

1. (i) Cost of the Project

At 12% internal rate of return (IRR), the sum of total cash inflows = cost of the project i.e initial cash outlay

Annual cash inflows = ₹ 1,00,000

Useful life = 4 years

Considering the discount factor table @ 12%, cumulative present value of cash inflows for 4 years is 3.038 (0.893 + 0.797 + 0.712 + 0.636).

Hence, Total Cash inflows for 4 years for the Project is:

₹ 1,00,000 × 3.038 = ₹ 3,03,800

Hence, Cost of the Project = ₹ 3,03,800

(ii) Cost of Capital

$$\text{Profitability index} = \frac{\text{Sum of Discounted Cash inflows}}{\text{Cost of the project}}$$

$$1.064 = \frac{\text{Sum of Discounted Cash inflows}}{₹\,3,03,800}$$

∴ Sum of Discounted Cash inflows = ₹ 3,23,243.20

Since, Annual Cash Inflows = ₹ 1,00,000

Hence, cumulative discount factor for 4 years $= \frac{₹\,3,23,243.20}{₹\,1,00,000} = 3.232$

From the discount factor table, at discount rate of 9%, the cumulative discount factor for 4 years is 3.239 (0.917 + 0.842 + 0.772 + 0.708).

Hence, Cost of Capital = 9% (approx.)

(iii) Net Present Value (NPV)

NPV = Sum of Present Values of Cash inflows – Cost of the Project

= ₹ 3,23,243.20 – ₹ 3,03,800 = ₹ 19,443.20₹

(iv) Payback Period

$$\text{Payback period} = \frac{\text{Cost of the Project}}{\text{Annual Cash Inflows}} = \frac{₹\,3,03,800}{₹\,1,00,000} = 3.038 \text{ years}$$

2. Working:

Calculation of Cash -outflow at year zero

Particulars	A (₹)	B (₹)
Cost of Machine	5,00,000	5,00,000
Cost of Utilities	1,00,000	2,00,000
Salvage value of Old Machine	(1,00,000)	(1,00,000)
Salvage of value Old Utilities	–	(20,000)
Total Expenditure (Net)	5,00,000	5,80,000

(i) (a) Calculation of NPV

Year	PV Factor @ 15%	Machine A		Machine B	
		Cash Inflows (₹)	Discounted value of inflows (₹)	Cash Inflows (₹)	Discounted value of inflows (₹)
0	1.000	(5,00,000)	(5,00,000)	(5,80,000)	(5,80,000)
1	0.870	1,00,000	87,000	2,00,000	1,74,000
2	0.756	1,50,000	1,13,400	2,10,000	1,58,760
3	0.658	1,80,000	1,18,440	1,80,000	1,18,440
4	0.572	2,00,000	1,14,400	1,70,000	97,240
5	0.497	1,70,000	84,490	40,000	19,880
Salvage	0.497	50,000	24,850	60,000	29,820
Net Present Value			42,580		18,140

Since the Net present Value of both the machines is positive both are acceptable.

(b) Discounted Pay-back Period **(Amount in ₹)**

Year	Machine A		Machine B	
	Discounted cash inflows	Cumulative Discounted cash inflows	Discounted cash inflows	Cumulative Discounted cash inflows
1	87,000	87,000	1,74,000	1,74,000
2	1,13,400	2,00,400	1,58,760	3,32,760

3	1,18,440	3,18,840	1,18,440	4,51,200
4	1,14,400	4,33,240	97,240	5,48,440
5	1,09,340*	5,42,580	49,700*	5,98,140

* Includes salvage value.

Discounted Payback Period (For A and B):

$$\text{Machine A} = 4 \text{ years} + \left(\frac{5,00,000 - 4,33,240}{1,09,340}\right) = 4.61 \text{ years}$$

$$\text{Machine B} = 4 \text{ years} + \left(\frac{5,80,000 - 5,48,440}{49,700}\right) = 4.63 \text{ years}$$

(c) Desirability Factor or Profitability Index:

$$\text{Profitability Index (PI)} = \frac{\text{Sum of present value of net cash inflow}}{\text{Initial cash outflow}}$$

$$\text{Machine A} = \frac{₹\,5,42,580}{₹\,5,00,000} = 1.08; \quad \text{Machine B} = \frac{₹\,5,98,140}{₹\,5,80,000} = 1.03$$

(ii) Since the absolute surplus in the case of A is more than B and also the desirability factor, it is better to choose A.

The discounted payback period in both the cases is almost same, also the net present value is positive in both the cases, but the desirability factor (profitability index) is higher in the case of Machine A, it is therefore better to choose Machine A.

3. (a) Computation of NPV at 15% discount rate

Year	Cash flow	Discount Factor (15%)	Present value
	(₹)		(₹)
0	(7,00,000)	1.000	(7,00,000)
1	(10,00,000)	0.870	(8,70,000)
2	2,50,000	0.756	1,89,000
3	3,00,000	0.658	1,97,400
4	3,50,000	0.572	2,00,200
5 – 10	4,00,000	2.163	8,65,200
Net Present Value			(1,18,200)

As the net present value is negative, the project is unacceptable.

(b) Computation of NPV if discount rate would be 10% discount rate

Year	Cash flow	Discount Factor (10%)	Present value
	(₹)		(₹)
0	(7,00,000)	1.000	(7,00,000)
1	(10,00,000)	0.909	(9,09,000)
2	2,50,000	0.826	2,06,500
3	3,00,000	0.751	2,25,300
4	3,50,000	0.683	2,39,050
5 –10	4,00,000	2.974	11,89,600
Net Present Value			2,51,450

Since NPV = ₹ 2,51,450 is positive, hence the project would be acceptable.

(c) Calculation of IRR:

$$\text{IRR} = \text{LR} + \frac{\text{NPV at LR}}{\text{NPV at LR} - \text{NPV at HR}} \times (\text{HR} - \text{LR})$$

$$= 10\% + \frac{₹\,2,51,450}{₹\,2,51,450 - (-)1,18,200} \times (15\% - 10\%)$$

$$= 10\% + 3.4012 \text{ or } 13.40\%$$

(d) Computation of Pay-back period of the project:

Payback Period = 6 years:

– ₹ 7,00,000– ₹ 10,00,000 + ₹ 2,50,000 + ₹ 3,00,000 + ₹ 3,50,000 + ₹ 4,00,000 + ₹ 4,00,000 = 0

4. Calculation of NPV

Project	Investment Required	Present value of Future Cash Flows	Net Present value
	₹	₹	₹
1	2,00,000	2,90,000	90,000
2	1,15,000	1,85,000	70,000
3	2,70,000	4,00,000	1,30,000
1 and 2	3,15,000	4,75,000	1,60,000

1 and 3	4,40,000	6,90,000	2,50,000
2 and 3	3,85,000	6,20,000	2,35,000
1, 2 and 3 (Refer Working note)	6,80,000*	9,10,000	2,30,000

Working Note:

(i) Total Investment required if all the three projects are undertaken simultaneously:

	(₹)
Project 1 & 3	4,40,000
Project 2	1,15,000
Plant extension cost	1,25,000
Total	6,80,000

(ii) Total of Present value of Cash flows if all the three projects are undertaken simultaneously:

	(₹)
Project 2 & 3	6,20,000
Project 1	2,90,000
Total	9,10,000

Projects 1 and 3 should be chosen, as they provide the highest net present value.

5. Calculation of Net Cash flow

Contribution = (3.00 – 1.75) × 50,000 = ₹ 62,500

Fixed costs = 40,000 – [(1,25,000 – 30,000)/5] = ₹ 21,000

Year	Capital (₹)	Contribution (₹)	Fixed costs (₹)	Adverts (₹)	Net cash flow (₹)
0	(1,00,000)	-	-	-	(1,00,000)
1	(25,000)	62,500	(21,000)	(10,000)	6,500
2	-	62,500	(21,000)	(15,000)	26,500

3	-	62,500	(21,000)	-	41,500
4	-	62,500	(21,000)	-	41,500
5	30,000	62,500	(21,000)	-	71,500

Calculation of Net Present Value

Year	Net cash flow (₹)	10% discount factor	Present value (₹)
0	(1,00,000)	1.000	(1,00,000)
1	6,500	0.909	5,909
2	26,500	0.826	21,889
3	41,500	0.751	31,167
4	41,500	0.683	28,345
5	71,500	0.621	44,402
		NPV	31,712

The net present value of the project is ₹ 31,712.

6. Statement Showing the Evaluation of Two Machines

	Particulars	Machine 'X'	Machine 'Y'
(i)	Purchase Cost	₹ 15,00,000	₹ 10,00,000
(ii)	Life of Machine	3 years	2 years
(iii)	Running Cost of Machine per year	₹ 4,00,000	₹ 6,00,000
(iv)	PVIFA (0.09, 3)	2.531	
	PVIFA (0.09, 2)		1.759
(v)	PV of Running Cost of Machine {(iii) × (iv)}	₹ 10,12,400	₹ 10,55,400
(vi)	Cash outflows of Machine {(i) + (v)}	₹ 25,12,400	₹ 20,55,400
(vii)	Equivalent PV of Annual Cash outflow {(vi)/(iv)}	₹ 9,92,651	₹ 11,68,505

Recommendation: Ae Bee Cee Ltd. should buy Machine 'X' since equivalent annual cash outflow is less than that of Machine 'Y'.

7. Option I: Purchase Machinery and Service Part at the end of Year 1.

Net Present value of cash flow @ 10% per annum discount rate.

$$\text{NPV (in ₹)} = -1,00,000 + \frac{36,000}{(1.1)} + \frac{36,000}{(1.1)^2} + \frac{36,000}{(1.1)^3} - \frac{20,000}{(1.1)} + \frac{25,000}{(1.1)^3}$$

$$= -1,00,000 + 36,000\ (0.9091 + 0.8264 + 0.7513) - (20,000 \times 0.9091) + (25,000 \times 0.7513)$$

$$= -1,00,000 + (36,000 \times 2.4868) - 18,182 + 18,782.5$$

$$= -1,00,000 + 89,524.8 - 18,182 + 18,782.5$$

$$\text{NPV} = -9,874.7$$

Since, Net Present Value is negative; therefore, this option is not to be considered.

If Supplier gives a discount of ₹ 10,000, then:

NPV (in ₹) = + 10,000 – 9,874.7 = + 125.3

In this case, Net Present Value is positive but very small; therefore, this option may not be advisable.

Option II: Purchase Machinery and Replace Part at the end of Year 2.

$$\text{NPV (in ₹)} = -1,00,000 + \frac{36,000}{(1.1)} + \frac{36,000}{(1.1)^2} + \frac{36,000}{(1.1)^3} - \frac{30,800}{(1.1)^2} + \frac{54,000}{(1.1)^4}$$

$$= -1,00,000 + 36,000\ (0.9091 + 0.8264 + 0.7513) - (30,800 \times 0.8264) + (54,000 \times 0.6830)$$

$$= -1,00,000 + 36,000\ (2.4868) - 25,453.12 + 36,882$$

$$= -1,00,000 + 89,524.8 - 25,453.12 + 36,882$$

$$\text{NPV} = + 953.68$$

Net Present Value is positive, but very low as compared to the investment.

If the Supplier gives a discount of ₹ 10,000, then:

NPV (in ₹) = 10,000 + 953.68 = 10,953.68

Decision: Option II is worth investing as the net present value is positive and higher as compared to Option I.

8. Determination of Cash inflows

Particulars	**(₹)**
Sales Revenue	1,20,000
Less: Operating Cost	22,500
	97,500
Less: Depreciation (₹ 2,00,000 – ₹ 18,000)/8	22,750
Net Income	74,750
Less: Tax @ 30%	22,425
Earnings after Tax (EAT)	52,325
Add: Depreciation	22,750
Cash inflow after tax per annum	75,075
Less: Loss of Commission Income	36,000
Net Cash inflow after tax per annum	39,075
In 8th Year :	
New Cash inflow after tax	39,075
Add: Salvage Value of Machine	18,000
Net Cash inflow in year 8	57,075

(i) Calculation of Net Present Value (NPV)

Year	**CFAT (₹)**	**PV Factor @10%**	**Present Value of Cash inflows (₹)**
1 to 7	39,075	4.867	1,90,178.03
8	57,075	0.467	26,654.03
			2,16,832.06
		Less: Cash Outflows	2,00,000.00
		NPV	16,832.06

(ii) Calculation of Profitability Index

$$\text{Profitability Index} = \frac{\text{Sum of discounted cash in flows}}{\text{Present value of cash out flows}} = \frac{2,16,832.06}{2,00,000} = 1.084$$

Advise: Since the net present value (NPV) is positive and profitability index is also greater than 1, the hospital may purchase the machine.

9. Workings:

(a) Calculation of annual cash flows **(₹ in lakh)**

Year	Sales	VC	FC	Dep.	Profit	Tax	PAT	Dep.	Cash inflow
1	172.80	103.68	36	43.75	(10.63)	–	–	43.75	33.12
2	259.20	155.52	36	43.75	23.93	3.99*	19.94	43.75	63.69
3	624.00	374.40	36	43.75	169.85	50.955	118.895	43.75	162.645
4–5	648.00	388.80	36	48.25	174.95	52.485	122.465	48.25	170.715
6–8	432.00	259.20	36	48.25	88.55	26.565	61.985	48.25	110.235

(b) Calculation of Depreciation:

- On Initial equipment $= \frac{₹\,350\ \text{lakh}}{8\ \text{years}} = 43.75\ \text{lakh}$

- On additional equipment $= \frac{(₹\,25 - ₹\,2.5)\ \text{lakh}}{5\ \text{years}} = 4.5\ \text{lakh}$

(c) *Calculation of tax in 2nd Year:

	₹ in lakh
Profit for the year	23.93
Less: Set off of unabsorbed depreciation in 1st year	(10.63)
Taxable profit	13.30
Tax @30%	3.99

(d) Calculation of Initial cash outflow

	₹ in lakh
Cost of New Equipment	350
Add: Working Capital	40
Outflow	390

Calculation of NPV **(₹ in lakh)**

Year	Cash flows	PV factor @12%	PV of cash-flows	Remark
0	(390)	1.000	(390.00)	Initial equipment cost

1	33.12	0.893	29.57	
2	63.69	0.797	50.76	
3	162.645	0.712	115.80	
3	(25.00)	0.712	(17.80)	Additional equipment cost
4	170.715	0.636	108.57	
5	170.715	0.567	96.79	
6	110.235	0.507	55.89	
7	110.235	0.452	49.83	
8	110.235	0.404	44.53	
8	40.00	0.404	16.16	Release of working capital
8	2.50	0.404	1.01	Additional equipment salvage value
Net Present Value			161.11	

Advise: Since the project has a positive NPV, therefore, it should be accepted.

10. Statement of Operating Profit from processing of waste

(₹ in lakh)

Year	**1**	**2**	**3**	**4**
Sales (A)	966	966	1,254	1,254
Material consumption	90	120	255	255
Wages	180	195	255	300
Other expenses	120	135	162	210
Factory overheads (insurance only)	90	90	90	90
Loss of rent on storage space (opportunity cost)	30	30	30	30
Depreciation (as per income tax rules)	150	114	84	63
Total cost (B)	660	684	876	948
Profit {(C)=(A) - (B)}	306	282	378	306
Less: Tax (30%)	91.8	84.6	113.4	91.8
Profit after Tax (PAT)	214.2	197.4	264.6	214.2

Statement of Incremental Cash Flows

(₹ in lakh)

Year	0	1	2	3	4
Cost of Machine	(600)				
Material stock	(60)	(105)	-	-	165
Compensation for contract	(90)	-	-	-	-
Contract payment saved	-	150	150	150	150
Tax on contract payment	-	(45)	(45)	(45)	(45)
Incremental profit	-	306	282	378	306
Depreciation added back	-	150	114	84	63
Tax on profits	-	(91.8)	(84.6)	(113.4)	(91.8)
Profit on sale of machinery (net)	-	-	-	-	15
Total incremental cash flows	(750)	364.2	416.4	453.6	562.2
Present value factor	1.00	0.877	0.769	0.674	0.592
Present value of cash flows	(750)	319.40	320.21	305.73	332.82
Net present value	528.16				

Advice: Since the net present value of cash flows is ₹ 528.16 lakh which is positive the management should install the machine for processing the waste.

Notes:

1. Material stock increases are taken in cash flows.
2. Idle time wages have also been considered.
3. Apportioned factory overheads are not relevant only insurance charges of this project are relevant.
4. Sale of machinery - Net income after deducting removal expenses taken. Tax on Capital gains is ignored.
5. Saving in contract payment and income tax thereon is considered in the cash flows.

11. (i) Calculation of Net Initial Cash Outflows:

	₹
Cost of new machine	10,00,000
Less: Sale proceeds of existing machine	2,00,000
Net initial cash outflows	8,00,000

(ii) Calculation of Base for depreciation

Particulars		₹
WDV of Existing Machine		
Cost of existing machine		3,30,000
Less: Depreciation for year 1	66,000	
Depreciation for Year 2	52,800	
Depreciation for Year 3	42,240	1,61,040
WDV of Existing Machine (i)		**1,68,960**
Depreciation base of New Machine		
Cost of new machine		10,00,000
Add: WDV of existing machine		1,68,960
Less: Sales value of existing machine		2,00,000
Depreciation base of New Machine (ii)		9,68,960
Base for incremental depreciation [(ii) – (i)]		8,00,000

(iii) Calculation of annual Profit Before Tax and depreciation

Particulars		**Existing machine**	**New Machine**	**Differential**
(1)		**(2)**	**(3)**	**(4)=(3)–(2)**
Annual output		30,000 units	75,000 units	45,000 units
		₹	₹	₹
(A)	Sales revenue @ ₹ 15 per unit	4,50,000	11,25,000	6,75,000
(B)	Less: Cost of Operation			
	Material @ ₹ 4 per unit	1,20,000	3,00,000	1,80,000

Labour			
Old = 3,000 × ₹ 40	1,20,000		90,000
New = 3,000 × ₹ 70		2,10,000	
Indirect cash cost	50,000	65,000	15,000
Total Cost (B)	2,90,000	5,75,000	2,85,000
Profit Before Tax and depreciation (PBTD) (A – B)	1,60,000	5,50,000	3,90,000

(iv) Calculation of Incremental Net Present Value:

Year	PBTD	Dep. @ 20%	PBT	Tax @ 30%	Net cash flow	PVF @ 12%	PV
(1)	(2)	(3)	(4=2-3)	(5)	(6=4-5+3)	(7)	(8=6 x 7)
1	3,90,000	1,60,000	2,30,000	69,000.00	3,21,000.00	0.893	2,86,653.00
2	3,90,000	1,28,000	2,62,000	78,600.00	3,11,400.00	0.797	2,48,185.80
3	3,90,000	1,02,400	2,87,600	86,280.00	3,03,720.00	0.712	2,16,248.64
4	3,90,000	81,920	3,08,080	92,424.00	2,97,576.00	0.636	1,89,258.34
5	3,90,000	65,536	3,24,464	97,339.20	2,92,660.80	0.567	1,65,938.67
							11,06,284.45
Add: PV of Salvage Value of new machine (₹ 40,000 x 0.567)							22,680.00
Less: Initial Cash Outflow							8,00,000.00
NPV							3,28,964.45

Advice: Since the incremental NPV is positive, existing machine should be replaced.

12. A & Co.

Equivalent cost of (EAC) of new machine

		₹
(i)	Cost of new machine now	90,000
	Add: PV of annual repairs @ ₹ 10,000 per annum for 8 years (₹ 10,000 × 4.4873)	44,873
		1,34,873
	Less: PV of salvage value at the end of 8 years (₹20,000×0.3269)	6,538
		1,28,335
	Equivalent annual cost (EAC) (₹ 1,28,335/4.4873)	28,600

PV of cost of replacing the old machine in each of 4 years with new machine

Scenario	Year	Cash Flow	PV @ 15%	PV
		(₹)		(₹)
Replace Immediately	0	(28,600)	1.00	(28,600)
		40,000	1.00	40,000
				11,400
Replace in one year	1	(28,600)	0.870	(24,882)
	1	(10,000)	0.870	(8,700)
	1	25,0000	0.870	21,750
				(11,832)
Replace in two years	1	(10,000)	0.870	(8,700)
	2	(28,600)	0.756	(21,622)
	2	(20,000)	0.756	(15,120)
	2	15,000	0.756	11,340
				(34,102)
Replace in three years	1	(10,000)	0.870	(8,700)
	2	(20,000)	0.756	(15,120)
	3	(28,600)	0.658	(18,819)
	3	(30,000)	0.658	(19,740)
	3	10,000	0.658	6,580
				(55,799)
Replace in four years	1	(10,000)	0.870	(8,700)
	2	(20,000)	0.756	(15,120)
	3	(30,000)	0.658	(19,740)
	4	(28,600)	0.572	(16,359)
	4	(40,000)	0.572	(22,880)
				(82,799)

Advice: The company should replace the old machine immediately because the PV of cost of replacing the old machine with new machine is least.

13. Evaluation of Alternatives:

Savings in disposing off the waste

Particulars	**(₹)**
Outflow (50,000 × ₹ 1)	50,000
Less: tax savings @ 50%	25,000
Net Outflow per year	**25,000**

Calculation of Annual Cash inflows in Processing of waste Material

Particulars	**Amount (₹)**	**Amount (₹)**
Sale value of waste (₹ 10 × 50,000 gallon)		5,00,000
Less: Variable processing cost (₹ 5 × 50,000 gallon)	2,50,000	
Less: Fixed processing cost	30,000	
Less: Advertisement cost	20,000	
Less: Depreciation	60,000	(3,60,000)
Earnings before tax (EBT)		**1,40,000**
Less: Tax @ 50%		(70,000)
Earnings after tax (EAT)		70,000
Add: Depreciation		60,000
Annual Cash inflows		**1,30,000**

Total Annual Benefits = Annual Cash inflows + Net savings (adjusting tax) in disposal cost

= ₹ 1,30,000 + ₹ 25,000 = ₹ 1,55,000

Calculation of Net Present Value

Year	**Particulars**	**Amount (₹)**
0	Investment in new equipment	(6,00,000)
1 to 10	Total Annual benefits × PVAF (10 years, 15%)	

	₹ 1,55,000 × 5.019	7,77,945
	Net Present Value	1,77,945

Recommendation: Processing of waste is a better option as it gives a positive Net Present Value.

Note- Research cost of ₹ 60,000 is not relevant for decision making as it is sunk cost.

14. A. Computation of CFAT (Year 1 to 5)

Particulars		**Amount (₹)**
(a) Savings in existing Tea & Coffee charges	(120 × 10 ×3) + (40 ×15 × 3) + (40 ×10 × 1) x 200 days	11,60,000
(b) AMC of machine		(75,000)
(c) Electricity charges	500 ×12 ×12	(72,000)
(d) Coffee Beans	(W.N.) 144 × 90	(12,960)
(e) Tea Powder	(W.N.) 480 × 70	(33,600)
(f) Sugar	(W.N.) 1248 × 50	(62,400)
(g) Milk	(W.N.) 12480 × 50	(6,24,000)
(h) Paper Cup	(W.N.) 1,37,280 × 0.2	(27,456)
(i) Depreciation	10,00,000/5	(2,00,000)
Profit before Tax		**52,584**
(-) Tax @ 25%		(13,146)
Profit after Tax		**39,438**
Depreciation		2,00,000
CFAT		**2,39,438**

B. Computation of NPV

Year	**Particulars**	**CF**	**PVF @ 12%**	**PV**
0	Cost of machine	(10,00,00)	1	(10,00,000)
1-5	CFAT	2,39,438	3.6048	8,63,126
Net Present Value				**(1,36,874)**

Since NPV of the machine is negative, it should not be purchased.

Working Note:

Computation of Qty of consumable

No. of Tea Cups = [(120 × 3 × 200 days) + (40 × 1 × 200 days) × 1.2 = 96,000

No. of Coffee cups = 40 × 3 × 200 days × 1.2 = 28,800

No. of coffee beans packet $= \frac{28,800}{200}$ = 144

No. of Tea Powder Packets $= \frac{96,000}{200}$ = 480

Qty of Sugar $= \frac{(96,000 + 28,800)6,000}{1,000\ g}$ = 1248 kgs

Qty of Milk $= \frac{(96,000 + 28,800)6,000}{1,000\ ml}$ = 12,480 litres

No. of paper cups = (96,000 + 28,800) × 1.1 = 1,37,280

NOTES
