2

Project Planning and Capital Budgeting

Question 1

Distinguish between Net Present-value and Internal Rate of Return.

Answer

NPV and IRR: NPV and IRR methods differ in the sense that the results regarding the choice of an asset under certain circumstances are mutually contradictory under two methods. IN case of mutually exclusive investment projects, in certain situations, they may give contradictory results such that if the NPV method finds one proposal acceptable, IRR favours another. The different rankings given by the NPV and IRR methods could be due to size disparity problem, time disparity problem and unequal expected lives.

The net present value is expressed in financial values whereas internal rate of return (IRR) is expressed in percentage terms.

In net present value cash flows are assumed to be re-invested at cost of capital rate. In IRR re-investment is assumed to be made at IRR rates.

Question 2

Write short note on Certainty Equivalent Approach.

Answer

Certainty Equivalent Approach (CE): This approach recognizes risk in capital budgeting analysis by adjusting estimated cash flows and employs risk free rate to discount the adjusted cash-flows. Under this method, the expected cash flows of the project are converted to equivalent riskless amounts. The greater the risk of an expected cash flow, the smaller the certainty equivalent values for receipts and longer the CE value for payment. This approach is superior to the risk adjusted discounted approach as it can measure risk more accurately.

This is yet another approach for dealing with risk in capital budgeting to reduce the forecasts of cash flows to some conservative levels. In certainty Equivalent approach we incorporate risk to adjust the cash flows of a proposal so as to reflect the risk element. The certainty Equivalent approach adjusts future cash flows rather than discount rates. This approach explicitly recognizes risk, but the procedure for reducing the forecasts of cash flows is implicit and likely to be inconsistent from one investment to another.

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Question 3

What is the sensitivity analysis in Capital Budgeting?

Answer

Sensitivity Analysis in Capital Budgeting: Sensitivity analysis is used in Capital budgeting for more precisely measuring the risk. It helps in assessing information as to how sensitive are the estimated parameters of the project such as cash flows, discount rate, and the project life to the estimation errors. Future being always uncertain and estimations are always subject to error, sensitivity analysis takes care of estimation errors by using a number of possible outcomes in evaluating a project. The methodology adopted in sensitivity analysis is to evaluate a project by using a number of estimated cash flows so as to provide to the decision maker an insight into the variability of outcome. Thus, it is a technique of risk analysis which studies the responsiveness of a criterion of merit like NPV or IRR to variation in underlying factors like selling price, quantity sold, returns from an investment etc.

Sensitivity analysis answers questions like,

(i) What happens to the present value (or some other criterion of merit) if flows are, say ₹ 50,000 than the expected ₹ 80,000?

(ii) What will happen to NPV if the economic life of the project is only 3 years rather than expected 5 years?

Therefore, wherever there is an uncertainty, of whatever type, the sensitivity analysis plays a crucial role. However, it should not be viewed as the method to remove the risk or uncertainty, it is only a tool to analyse and measure the risk and uncertainty. In terms of capital budgeting the possible cash flows are based on three assumptions:

(a) Cash flows may be worst (pessimistic)

(b) Cash flows may be most likely.

(c) Cash flows may be most optimistic.

Sensitivity analysis involves three steps

(1) Identification of all those variables having an influence on the project's NPV or IRR.

(2) Definition of the underlying quantitative relationship among the variables.

(3) Analysis of the impact of the changes in each of the variables on the NPV of the project.

The decision maker, in sensitivity analysis always asks himself the question – what if?

Question 4

Write short note on Social Cost Benefit analysis.

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Answer

Social Cost Benefit Analysis: It is increasingly realised that commercial evaluation of projects is not enough to justify commitment of funds to a project especially when the project belongs to public utility and irrespective of its financial viability it needs to be implemented in the interest of the society as a whole. Huge amount of funds are committed every year to various public projects of all types–industrial, commercial and those providing basic infrastructure facilities. Analysis of such projects has to be done with reference to the social costs and benefits since they cannot be expected to yield an adequate commercial rate of return on the funds employed at least during the short period. A social rate of return is more important. The actual costs or revenues do not necessarily reflect the monetary measurement of costs or benefits to the society. This is because the market price of goods and services are often grossly distorted due to various artificial restrictions and controls from authorities, hence a different yardstick has to be adopted for evaluating a particular project of social importance and its costs and benefits are valued at 'opportunity cost' or shadow prices to judge the real impact of their burden as costs to the society. Thus, social cost benefit analysis conducts a monetary assessment of the total cost and revenues or benefits of a project, paying particular attention to the social costs and benefits which do not normally feature in conventional costing.

United Nations Industrial Development Organisation (UNIDO) and Organisation of Economic Cooperation and Development (OECD) have done much work on Social Cost Benefit analysis. A great deal of importance is attached to the social desirability of projects like employment generation potential, value addition, foreign exchange benefit, living standard improvement etc. UNIDO and OECD approaches need a serious consideration in the calculation of benefits and costs to the society. This technique has got more relevance in the developing countries where public capital needs precedence over private capital.

Question 5

Comment briefly on the social cost benefit analysis in relation to evaluation of an Industrial project.

Answer

Social Cost-Benefit Analysis of Industrial Projects: This refers to the moral responsibility of both PSU and private sector enterprises to undertake socially desirable projects – that is, the social contribution aspect needs to be kept in view.

Industrial capital investment projects are normally subjected to rigorous feasibility analysis and cost benefit study from the point of view of the investors. Such projects, especially large ones often have a ripple effect on other sections of society, local environment, use of scarce national resources etc. Conventional cost-benefit analysis ignores or does not take into account or ignores the societal effect of such projects. Social Cost Benefit (SCB) is recommended and resorted to in such cases to bring under the scanner the social costs and benefits.

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SCB sometimes changes the very outlook of a project as it brings elements of study which are unconventional yet very relevant. In a study of a famous transportation project in the UK from a normal commercial angle, the project was to run an annual deficit of more than 2 million pounds. The evaluation was adjusted for a realistic fare structure which the users placed on the services provided which changed the picture completely and the project got justified. Large public sector/service projects especially in under-developed countries which would get rejected on simple commercial considerations will find justification if the social costs and benefits are considered.

SCB is also important for private corporations who have a moral responsibility to undertake socially desirable projects, use scarce natural resources in the best interests of society, generate employment and revenues to the national exchequer.

Indicators of the social contribution include

(a) Employment potential criterion;

(b) Capital output ratio – that is the output per unit of capital;

(c) Value added per unit of capital;

(d) Foreign exchange benefit ratio.

Question 6

Write a brief note on project appraisal under inflationary conditions.

Answer

Project Appraisal under Inflationary Conditions: Project Appraisal normally involves feasibility evaluation from technical, commercial, economic and financial aspects. It is generally an exercise in measurement and analysis of cash flows expected to occur over the life of the project. The project cash outflows usually occur initially and inflows come in the future.

During inflationary conditions, the project cost increases on all heads viz. labour, raw material, fixed assets such as equipments, plant and machinery, building material, remuneration of technicians and managerial personnel etc. Beside this, inflationary conditions erode purchasing power of consumers and affect the demand pattern. Thus, not only cost of production but also the projected statement of profitability and cash flows are affected by the change in demand pattern. Even financial institutions and banks may revise their lending rates resulting in escalation in financing cost during inflationary conditions. Under such circumstances, project appraisal has to be done generally keeping in view the following guidelines which are usually followed by government agencies, banks and financial institutions.

(i) It is always advisable to make provisions for cost escalation on all heads of cost, keeping in view the rate of inflation during likely period of delay in project implementation.

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(ii) The various sources of finance should be carefully scruitinised with reference to probable revision in the rate of interest by the lenders and the revision which could be effected in the interest bearing securities to be issued. All these factors will push up the cost of funds for the organization.

(iii) Adjustments should be made in profitability and cash flow projections to take care of the inflationary pressures affecting future projections.

(iv) It is also advisable to examine the financial viability of the project at the revised rates and assess the same with reference to economic justification of the project. The appropriate measure for this aspect is the economic rate of return for the project which will equate the present value of capital expenditures to net cash flows over the life of the projects. The rate of return should be acceptable which also accommodates the rate of inflation per annum.

(v) In an inflationary situation, projects having early payback periods should be preferred because projects with long payback period are more risky.

Under conditions of inflation, the project cost estimates that are relevant for a future date will suffer escalation. Inflationary conditions will tend to initiate the measurement of future cash flows. Either of the following two approaches may be used while appraising projects under such conditions:

(i) Adjust each year's cash flows to an inflation index, recognising selling price increases and cost increases annually; or

(ii) Adjust the 'Acceptance Rate' (cut-off) suitably retaining cash flow projections at current price levels.

An example of approach (ii) above can be as follows:

Normal Acceptance Rate	:	15.0%
Expected Annual Inflation	:	5.0%
Adjusted Discount Rate	:	15.0 × 1.05 or 15.75%

It must be noted that measurement of inflation has no standard approach nor is easy. This makes the job of appraisal a difficult one under such conditions.

Question 7

What is Capital rationing?

Answer

Capital Rationing: When there is a scarcity of funds, capital rationing is resorted to. Capital rationing means the utilization of existing funds in most profitable manner by selecting the acceptable projects in the descending order or ranking with limited available funds. The firm must be able to maximize the profits by combining the most profitable proposals. Capital rationing may arise due to (i) external factors such as high borrowing rate or non-availability of

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loan funds due to constraints of Debt-Equity Ratio; and (ii) Internal Constraints Imposed by management. Project should be accepted as a whole or rejected. It cannot be accepted and executed in piecemeal.

IRR or NPV are the best basis of evaluation even under Capital Rationing situations. The objective is to select those projects which have maximum and positive NPV. Preference should be given to interdependent projects. Projects are to be ranked in the order of NPV. Where there is multi-period Capital Rationing, Linear Programming Technique should be used to maximize NPV. In times of Capital Rationing, the investment policy of the company may not be the optimal one.

In nutshell Capital Rationing leads to:

(i) Allocation of limited resources among ranked acceptable investments.

(ii) This function enables management to select the most profitable investment first.

(iii) It helps a company use limited resources to the best advantage by investing only in the projects that offer the highest return.

(iv) Either the internal rate of return method or the net present value method may be used in ranking investments.

Question 8

Explain the concept 'Zero date of a Project' in project management.

Answer

Zero Date of a Project means a date is fixed from which implementation of the project begins. It is a starting point of incurring cost. The project completion period is counted from the zero date. Pre-project activities should be completed before zero date. The pre-project activities should be completed before zero date. The pre-project activities are:

a. Identification of project/product

b. Determination of plant capacity

c. Selection of technical help/collaboration

d. Selection of site.

e. Selection of survey of soil/plot etc.

f. Manpower planning and recruiting key personnel

g. Cost and finance scheduling.

Question 9

What are the steps for Simulation Analysis?

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Answer

Steps for simulation analysis.

1. Modelling the project- The model shows the relationship of N.P.V. with parameters and exogenous variables. (Parameters are input variables specified by decision maker and held constant over all simulation runs. Exogenous variables are input variables, which are stochastic in nature and outside the control of the decision maker).
2. Specify values of parameters and probability distributions of exogenous variables.
3. Select a value at random from probability distribution of each of the exogenous variables.
4. Determine N.P.V. corresponding to the randomly generated value of exogenous variables and pre-specified parameter variables.
5. Repeat steps (3) & (4) a large number of times to get a large number of simulated N.P.V.s.
6. Plot frequency distribution of N.P.V.

Question 10

What is simulation analysis and how it is beneficial?

Answer

Simulation is the exact replica of the actual situation. To simulate an actual situation, a model shall be prepared. The simulation Analysis is a technique, in which infinite calculations are made to obtain the possible outcomes and probabilities for any given action.

Monte Carlo simulation ties together sensitivities and probability distributions. The method came out of the work of first nuclear bomb and was so named because it was based on mathematics of Casino gambling. Fundamental appeal of this analysis is that it provides decision makers with a probability distribution of NPVs rather than a single point estimates of the expected NPV.

This analysis starts with carrying out a simulation exercise to model the investment project. It involves identifying the key factors affecting the project and their inter relationships. It involves modeling of cash flows to reveal the key factors influencing both cash receipt and payments and their inter relationship.

This analysis specifies a range for a probability distribution of potential outcomes for each of model's assumptions.

1. Modelling the project: The model shows the relationship of NPV with parameters and exogenous variables. (Parameters are input variables specified by decision maker and held constant over all simulation runs. Exogenous variables are input variables, which are stochastic in nature and outside the control of the decision maker).

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2. Specify values of parameters and probability distributions of exogenous variables.
3. Select a value at random from probability distribution of each of the exogenous variables.
4. Determine NPV corresponding to the randomly generated value of exogenous variables and pre-specified parameter variables.
5. Repeat steps (3) & (4) a large number of times to get a large number of simulated NPVs.
6. Plot probability distribution of NPVs and compute a mean and Standard Deviation of returns to gauge the project's level of risk.

Advantages of Simulation Analysis:

(1) We can predict all type of bad market situation beforehand.

(2) Handle problems characterized by

   (a) numerous exogenous variables following any kind of distribution.

   (b) Complex inter-relationships among parameters, exogenous variables and endogenous variables. Such problems defy capabilities of analytical methods.

   (c) Compels decision maker to explicitly consider the inter-dependencies and uncertainties featuring the project.

Question 11

Explain in brief the contents of a Project Report.

Answer

The following aspects need to be taken into account for a Project Report -

1. Promoters: Their experience, past records of performance form the key to their selection for the project under study.
2. Industry Analysis: The environment outside and within the country is vital for determining the type of project one should opt for.
3. Economic Analysis: The demand and supply position of a particular type of product under consideration, competitor's share of the market along with their marketing strategies, export potential of the product, consumer preferences are matters requiring proper attention in such type of analysis.
4. Cost of Project: Cost of land, site development, buildings, plant and machinery, utilities e.g. power, fuel, water, vehicles, technical know how together with working capital margins, preliminary/pre-operative expenses, provision for contingencies determine the total value of the project.
5. Inputs: Availability of raw materials within and outside the home country, reliability of suppliers cost escalations, transportation charges, manpower requirements together with effluent disposal mechanisms are points to be noted.

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6. Technical Analysis: Technical know-how, plant layout, production process, installed and operating capacity of plant and machinery form the core of such analysis.
7. Financial Analysis: Estimates of production costs, revenue, tax liabilities profitability and sensitivity of profits to different elements of costs and revenue, financial position and cash flows, working capital requirements, return on investment, promoters contribution together with debt and equity financing are items which need to be looked into for financial viability.
8. Social Cost Benefit Analysis: Ecological matters, value additions, technology absorptions, level of import substitution form the basis of such analysis.
9. SWOT Analysis: Liquidity/Fund constraints in capital market, limit of resources available with promoters, business/financial risks, micro/macro economic considerations subject to government restrictions, role of Banks/Financial Institutions in project assistance, cost of equity and debt capital in the financial plan for the project are factors which require careful examinations while carrying out SWOT analysis.
10. Project Implementation Schedule: Date of commencement, duration of the project, trial runs, cushion for cost and time over runs and date of completion of the project through Network Analysis have all to be properly adhered to in order to make the project feasible.

Question 12

A manufacturing unit engaged in the production of automobile parts is considering a proposal of purchasing one of the two plants, details of which are given below:

Particulars	***Plant A***	***Plant B***
Cost	*₹ 20,00,000*	*₹ 38,00,000*
Installation charges	*₹ 4,00,000*	*₹ 2,00,000*
Life	*20 years*	*15 years*
Scrap value after full life	*₹ 4,00,000*	*₹ 4,00,000*
Output per minute (units)	*200*	*400*

The annual costs of the two plants are as follows:

Particulars	***Plant A***	***Plant B***
Running hours per annum	*2,500*	*2,500*
Costs:	***(In ₹)***	***(In ₹)***
Wages	*1,00,000*	*1,40,000*
Indirect materials	*4,80,000*	*6,00,000*
Repairs	*80,000*	*1,00,000*
Power	*2,40,000*	*2,80,000*
Fixed Costs	*60,000*	*80,000*

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Will it be advantageous to buy Plant A or Plant B? Substantiate your answer with the help of comparative unit cost of the plants. Assume interest on capital at 10 percent. Make other relevant assumptions:

Note: *10 percent interest tables*

	20 Years	*15 Years*
Present value of ₹ 1	*0.1486*	*0.2394*
Annuity of ₹ 1 (capital recovery factor with 10% interest)	*0.1175*	*0.1315*

Answer

Working Notes:

Calculation of Equivalent Annual Cost

	Machine A	Machine B
Cash Outlay	₹ 24,00,000	₹ 40,00,000
Less:PV of Salvage Value		
4,00,000 x 0.1486	₹ 59,440	
4,00,000 x 0.2394		₹ 95,760
Annuity Factor	0.1175	0.1315
	₹ 2,75,016	₹ 5,13,408

Computation of Cost Per Unit

	Machine A	Machine B
Annual Output (a)	2500 x 60 x 200	2500 x 60 x 400
	= 3,00,00,000	= 6,00,00,000
Annual Cost (b)	₹	₹
Wages	1,00,000	1,40,000
Indirect Material	4,80,000	6,00,000
Repairs	80,000	1,00,000
Powers	2,40,000	2,80,000
Fixed Cost	60,000	80,000
Equivalent Annual Cost	2,75,016	5,13,408
Total	12,35,016	17,13,408
Cost Per Unit (b)/(a)	0.041167	0.02860

Decision: As the unit cost is less in proposed Plant B, it may be recommended that it is advantageous to acquire Plant B.

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Question 13

XYZ Ltd., an infrastructure company is evaluating a proposal to build, operate and transfer a section of 35 kms. of road at a project cost of ₹ 200 crores to be financed as follows:

Equity Shares Capital ₹ 50 crores, loans at the rate of interest of 15% p.a. from financial institutions ₹ 150 crores. The Project after completion will be opened to traffic and a toll will be collected for a period of 15 years from the vehicles using the road. The company is also required to maintain the road during the above 15 years and after the completion of that period, it will be handed over to the Highway authorities at zero value. It is estimated that the toll revenue will be ₹ 50 crores per annum and the annual toll collection expenses including maintenance of the roads will amount to 5% of the project cost. The company considers to write off the total cost of the project in 15 years on a straight line basis. For Corporate Income-tax purposes the company is allowed to take depreciation @ 10% on WDV basis. The financial institutions are agreeable for the repayment of the loan in 15 equal annual instalments – consisting of principal and interest.

Calculate Project IRR and Equity IRR. Ignore Corporate taxation.

Explain the difference in Project IRR and Equity IRR.

Answer

Computation of Project IRR

Project IRR is computed by using the following equation:

Where,

CO_0 = Cash outflow at time zero

CF_i = Net cash inflow at different points of time

N = Life of the project and

R = Rate of discount (IRR)

Now,

CO_0 = ₹ 200 crores

CF_i = ₹ 40 crores p.a. for 15 years

(Refer to working note (i))

Therefore,

$$₹\ 200\ \text{crore} = \frac{₹\ 40\ \text{crores}}{(1 + r)^{15}}$$

The value of IRR of the project:

1. An approximation of IRR is made on the basis of cash flow data. A rough approximation may be made with reference to the payback period. The payback period in the given case

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is 5 years i.e. $\left(\frac{₹\ 200\ \text{crores}}{₹\ 40\ \text{crores}}\right)$. From the PVAF table the closest figures are given in rate 18% (5.092) and the rate 19% (4.876). This means the IRR of the project is expected to be between 18% and 19%.

2. The estimate of IRR cash inflow of the project for both these rates is as follows:

At 18% = ₹ 40 crores × PVAF (18%, 15 years)

= ₹ 40 crores × 5.092

= ₹ 203.68 crores

At 19% = ₹ 40 crores × PVAF (19%, 15 years)

= ₹ 40 crores × 4.876

= ₹ 195.04 crores

3. The exact IRR by interpolating between 18% and 19% is worked out as follows:

$$\text{IRR} = 18\% + \frac{₹\ 203.68\ \text{crores} - ₹200\ \text{crores}}{₹\ 203.68\ \text{crores} - ₹\ 195.04\ \text{crores}} \times 1\%$$

$$= 18\% + \frac{₹\ 3.68\ \text{crores}}{₹\ 8.64\ \text{crores}} \times 1\%$$

$$= 18\% + 0.426\%$$

$$= 18.43\%$$

Therefore, the IRR of the project is 18.43%.

Working Notes:

(i) Net cash inflow of the project

Cash inflow	₹
Toll revenue	50 crores p.a. for 15 years
Cash outflow	₹
Toll collection expenses including maintenance of the roads (5% of ₹ 200 crores)	10 crores p.a. for 15 years
Net cash inflow	40 crores p.a. for 15 years

Note: Since corporate taxes is not payable. The impact of depreciation need not be considered.

Computation of Equity IRR

Equity IRR is computed by using the following equation:

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Cash inflow at zero date from equity shareholders = $\frac{\text{Cash inflow available for equity shareholders}}{(1+r)^n}$

Where,

r = Equity IRR

n = Life of the project

Here, Cash inflow at zero date from equity shareholders = ₹ 50 crores

Cash inflow for equity shareholders = ₹ 14.35 crores p.a.

(*Refer to working note)*

Therefore:

$$₹\ 50 \text{ crores} = \frac{₹\ 14.35 \text{ crores}}{(1+r)^{15}}$$

The value of equity IRR of the project is calculated as follows:

1. An approximation of IRR is made on the basis of cash flow data. A rough approximation may be made with reference to the payable period. The payback period in the given case is $3.484\left(\frac{₹\ 50 \text{ crores}}{₹\ 14.35 \text{ crores}}\right)$. From the PVAF table the closest figure may be about 25% and 30%. This means the equity IRR of project must be between 25% and 30%.
2. The estimated NPV of the project at 25% = ₹ 14.35 crores X 3.859 = ₹ 55.3766 crores. The estimated NPV of the project at 30% = ₹ 14.35 crores X 3.268 = ₹ 46.896 crores
3. IRR by using Interpolation Formula will be

$$= 25\% + \frac{55.377-50}{55.3766-46.896} X 5\%$$

$$= 25\% + \frac{5.377}{8.4806} X 5\%$$

= 25%+ 3.17% =28.17%

(ii) Equated annual instalment (i.e. principal + interest) of loan from financial institution:

Amount of loan from financial institution	₹ 150 crores
Rate of interest	15% p.a.
No. of years	15
Cumulative discount factor for 1-15 years	5.847

Hence, equated yearly instalment will be ₹ 150 crores/5.847 i.e. ₹ 25.65 crores.

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(iii) Cash inflow available for equity shareholders

Net cash inflow of the project	₹ 40.00 crores
[Refer to working note (i)]	
Equated yearly instalment of the project	₹ 25.65 crores
[Refer to working note (ii)]	
Cash inflow available for equity shareholders	₹ 14.35 crores

Difference in Project IRR and Equity IRR:

The project IRR is 18.4% whereas Equity IRR is 28%. This is attributed to the fact that XYZ Ltd. is earning 18.4% on the loan from financial institution but paying only 15%. The difference between the return and cost of funds from financial institution has enhanced equity IRR. The 3.4% (18.4% - 15%) earnings on ₹ 150 crores goes to equity shareholders who have invested ₹ 50 crore i.e.

$$3.4\% \times \frac{₹\ 150\ \text{crores}}{₹\ 50\ \text{crores}} = 10.2\%$$ is added to the project IRR which gives equity IRR of 28%.

Question 14

ABC Chemicals is evaluating two alternative systems for waste disposal, System A and System B, which have lives of 6 years and 4 years respectively. The initial investment outlay and annual operating costs for the two systems are expected to be as follows:

	System A	***System B***
Initial Investment Outlay	*₹ 5 million*	*₹ 4 million*
Annual Operating Costs	*₹ 1.5 million*	*₹ 1.6 million*
Salvage value	*₹ 1 million*	*₹ 0.5 million*

If the hurdle rate is 15%, which system should ABC Chemicals choose?

The PVIF @ 15% for the six years are as below:

Year	*1*	*2*	*3*	*4*	*5*	*6*
PVIF	*0.8696*	*0.7561*	*0.6575*	*0.5718*	*0.4972*	*0.4323*

Answer

PV of Total Cash Outflow under System A

	₹
Initial Outlay	50,00,000
PV of Annual Operating Cost (1-6 years) 15,00,000 x 3.7845	56,76,750

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Less: PV of Salvage Value ₹ 10,00,000 x 0.4323	(4,32,300)
	1,02,44,450
PVAF (15%, 6)	3.7845
Equivalent Annual Cost (1,02,44,450/3.7845)	27,06,949

PV of Total Cash Outflow under System B

Initial Outlay	40,00,000
PV of Annual Operating Cost (1-4 years) 16,00,000 x 2.855	45,68,000
Less: PV of Salvage Value ₹ 5,00,000 x 0.5718	(2,85,900)
	82,82,100
PVAF (15%, 4)	2.855
Equivalent Annual Cost (82,82,100/2.855)	29,00,911

Since Equivalent Annual Cost (EAC) is least in case of system A hence same should be opted.

Question 15

Skylark Airways is planning to acquire a light commercial aircraft for flying class clients at an investment of ₹ 50,00,000. The expected cash flow after tax for the next three years is as follows: *(₹)*

Year 1		*Year 2*		*Year 3*	
CFAT	*Probability*	*CFAT*	*Probability*	*CFAT*	*Probability*
14,00,000	*0.1*	*15,00,000*	*0.1*	*18,00,000*	*0.2*
18,00,000	*0.2*	*20,00,000*	*0.3*	*25,00,000*	*0.5*
25,00,000	*0.4*	*32,00,000*	*0.4*	*35,00,000*	*0.2*
40,00,000	*0.3*	*45,00,000*	*0.2*	*48,00,000*	*0.1*

The Company wishes to take into consideration all possible risk factors relating to airline operations. The company wants to know:

(i) The expected NPV of this venture assuming independent probability distribution with 6 per cent risk free rate of interest.

(ii) The possible deviation in the expected value.

(iii) How would standard deviation of the present value distribution help in Capital Budgeting decisions?

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Answer

(i) Expected NPV

(₹ in lakhs)

Year I			*Year II*			*Year III*		
CFAT	P	CF×P	CFAT	P	CF×P	CFAT	P	CF×P
14	0.1	1.4	15	0.1	1.5	18	0.2	3.6
18	0.2	3.6	20	0.3	6.0	25	0.5	12.5
25	0.4	10.0	32	0.4	12.8	35	0.2	7.0
40	0.3	12.0	45	0.2	9	48	0.1	4.8
	$\bar{x}$ or $\overline{CF}$	27.0		$\bar{x}$ or $\overline{CF}$	29.3			$\bar{x}$ or $\overline{CF}$ 27.9

NPV	*PV factor @ 6%*	*Total PV*
27	0.943	25.461
29.3	0.890	26.077
27.9	0.840	23.436
	PV of cash inflow	74.974
	Less: Cash outflow	50.000
	NPV	24.974

(ii) Possible deviation in the expected value

Year I				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_1	$(X - \bar{X})^2 P^1$
14 – 27	-13	169	0.1	16.9
18 – 27	-9	81	0.2	16.2
25 – 27	-2	4	0.4	1.6
40 – 27	13	169	0.3	50.7
				85.4

$\sigma_1 = \sqrt{85.4} = 9.241$

Year II				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_2	$(X - \bar{X})^2 \times P_2$
15-29.3	-14.3	204.49	0.1	20.449
20-29.3	-9.3	86.49	0.3	25.947
32-29.3	2.7	7.29	0.4	2.916
45-29.3	15.7	246.49	0.2	49.298
				98.61

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$\sigma_2 = \sqrt{98.61} = 9.930$

Year III				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_3	$(X - \bar{X})^2 \times P_3$
18-27.9	-9.9	98.01	0.2	19.602
25-27.9	-2.9	8.41	0.5	4.205
35-27.9	7.1	50.41	0.2	10.082
48-27.9	20.1	404.01	0.1	40.401
				74.29

$\sigma\sigma_3 = \sqrt{74.29} = 8.619$

Standard deviation about the expected value:

$$= \sqrt{\frac{85.4}{(1.06)^2} + \frac{98.61}{(1.06)^4} + \frac{74.29}{(1.06)^6}} = 14.3696$$

(iii) Standard deviation is a statistical measure of dispersion; it measures the deviation from a central number i.e. the mean.

In the context of capital budgeting decisions especially where we take up two or more projects giving somewhat similar mean cash flows, by calculating standard deviation in such cases, we can measure in each case the extent of variation. It can then be used to identify which of the projects is least riskier in terms of variability of cash flows.

A project, which has a lower coefficient of variation will be preferred if sizes are heterogeneous.

Besides this, if we assume that probability distribution is approximately normal we are able to calculate the probability of a capital budgeting project generating a net present value less than or more than a specified amount.

Question 16

(a) Cyber Company is considering two mutually exclusive projects. Investment outlay of both the projects is ₹ 5,00,000 and each is expected to have a life of 5 years. Under three possible situations their annual cash flows and probabilities are as under:

		Cash Flow (₹)	
Situation	Probabilities	Project A	ProjectB
Good	0.3	6,00,000	5,00,000
Normal	0.4	4,00,000	4,00,000
Worse	0.3	2,00,000	3,00,000

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The cost of capital is 7 per cent, which project should be accepted? Explain with workings.

(b) A company is considering Projects X and Y with following information:

Project	*Expected NPV (₹)*	*Standard deviation*
X	*1,22,000*	*90,000*
Y	*2,25,000*	*1,20,000*

(i) Which project will you recommend based on the above data?

(ii) Explain whether your opinion will change, if you use coefficient of variation as a measure of risk.

(iii) Which measure is more appropriate in this situation and why?

Answer

(a) Project A

Expected Net Cash flow (ENCF)

0.3 (6,00,000) + 0.4 (4,00,000) + 0.3 (2,00,000) = 4,00,000

σ^2=0.3 (6,00,000– 4,00,000)^2 + 0.4 (4,00,000 – 4,00,000)^2 + 0.3 (2,00,000 – 4,00,000)^2

$\sigma = \sqrt{24,00,00,00,000}$

σ = 1,54,919.33

Present Value of Expected Cash Inflows = 4,00,000 × 4.100 = 16,40,000

NPV = 16,40,000 – 5,00,000 = 11,40,000

Project B

ENCF = 0.3 (5,00,000) + 0.4 (4,00,000) + 0.3 (3,00,000) = 4,00,000

σ^2=0.3 (5,00,000 – 4,00,000)^2 + 0.4 (4,00,000 – 4,00,000)^2 + 0.3 (3,00,000 – 4,00,000)^2

$\sigma = \sqrt{6,00,00,00,000}$

σ = 77,459.66

Present Value of Expected Cash Inflows = 4,00,000 × 4.100 = 16,40,000

NPV = 16,40,000 – 5,00,000 = 11,40,000

Recommendation: NPV in both projects being the same, the project should be decided on the basis of standard deviation and hence project 'B' should be accepted having lower standard deviation, means less risky.

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(b) (i) On the basis of standard deviation project X be chosen because it is less risky than Project Y having higher standard deviation.

(ii) $CV_x = \frac{SD}{ENPV} = \frac{90,000}{1,22,000} = 0.738$

$CV_y = \frac{1,20,000}{2,25,000} = 0.533$

On the basis of Co-efficient of Variation (C.V.) Project X appears to be more risky and Y should be accepted.

(iii) However, the NPV method in such conflicting situation is best because the NPV method is in compatibility of the objective of wealth maximisation in terms of time value.

Question 17

KLM Ltd., is considering taking up one of the two projects-Project-K and Project-So Both the projects having same life require equal investment of ₹ 80 lakhs each. Both are estimated to have almost the same yield. As the company is new to this type of business, the cash flow arising from the projects cannot be estimated with certainty. An attempt was therefore, made to use probability to analyse the pattern of cash flow from other projects during the first year of operations. This pattern is likely to continue during the life of these projects. The results of the analysis are as follows:

Project K		***Project S***	
Cash Flow (in ₹)	***Probability***	***Cash Flow (in ₹)***	***Probability***
11	*0.10*	*09*	*0.10*
13	*0.20*	*13*	*0.25*
15	*0.40*	*17*	*0.30*
17	*0.20*	*21*	*0.25*
19	*0.10*	*25*	*0.10*

Required:

(i) Calculate variance, standard deviation and co-efficient of variance for both the projects.

(ii) Which of the two projects is more risky?

Answer

Calculation of Variance and Standard Deviation

Project K

Expected Net Cash Flow

= (0.1 x 11) + (0.20 x13) + (0.40 x 15) + (0.20 x 17) + (0.10 x 19)

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= 1.1 + 2.6 + 6 + 3.4 + 1.9 = 15

$\sigma^2 = 0.10(11 - 15)^2 + 0.20(13 - 15)^2 + 0.40(15 - 15)^2 + 0.20(17 - 15)^2 + 0.10(19 - 15)^2$

= 1.6 + 0.8 + 0 + 0.8 + 1.6 = 4.8

$\sigma = \sqrt{4.8} = 2.19$

Project S

Expected Net Cash Flow

= (0.10 X 9) + (0.25 X 13) + (0.30 X 17) + (0.25 X 21) + (0.10 X 25)

= 0.9 + 3.25 + 5.1 + 5.25 + 2.5 = 17

$\sigma^2 = 0.1(9-17)^2 + 0.25(13-17)^2 + 0.30(17-17)^2 + 0.25(21-17)^2 + 0.10(25-17)^2$

= 6.4 + 4 + 0 + 4 + 6.4 = 20.8

$\sigma = \sqrt{20.8} = 4.56$

Calculation of Coefficient of Variation

Coefficient of Variation = $\frac{\text{Standard Deviation}}{\text{Mean}}$

Project K = $\frac{2.19}{15} = 0.146$

Project S = $\frac{4.56}{17} = 0.268$

Project S is riskier as it has higher Coefficient of Variation.

Question 18

Project X and Project Y are under the evaluation of XY Co. The estimated cash flows and their probabilities are as below:

Project X : Investment (year 0) ₹ 70 lakhs

Probability weights	*0.30*	*0.40*	*0.30*
Years	*₹ lakhs*	*₹ lakhs*	*₹ lakhs*
1	*30*	*50*	*65*
2	*30*	*40*	*55*
3	*30*	*40*	*45*

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Project Y: Investment (year 0) ₹ 80 lakhs.

Probability weighted	*Annual cash flows through life*
	₹ lakhs
0.20	*40*
0.50	*45*
0.30	*50*

(a) Which project is better based on NPV, criterion with a discount rate of 10%?

(b) Compute the standard deviation of the present value distribution and analyse the inherent risk of the projects.

Answer

(a) Calculation of NPV of XY Co.:

Project X		*Cash flow*	*PVF*	*PV*
Year				
1	(30 × 0.3) + (50 × 0.4) + (65 × 0.3)	48.5	0.909	44.09
2	(30 × 0.3) + (40 × 0.4) + (55 × 0.3)	41.5	0.826	34.28
3	(30 × 0.3) + (40 × 0.4) + (45 × 0.3)	38.5	0.751	28.91
				107.28
	NPV: (107.28 – 70.00) =			(+) 37.28

Project Y (For 1-3 Years)

1-3	(40 × 0.2) + (45 × 0.5) + (50 × 0.3)	45.5	2.487	113.16
	NPV (113.16 – 80.00)			(+) 33.16

(b) Calculation of Standard deviation σ

As per Hiller's model

$$M = \sum_{i=0}^{n} (1+r)^{-1} Mi$$

$$\sigma^2 = \sum_{i=0}^{n} (1+r)^{-2i} \sigma_i^2$$

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Hence

Project X

Year

1 $\sqrt{(30-48.5)^2 0.30+(50-48.5)^2 0.40+(65-48.5)^2 0.30} = \sqrt{185.25}$ =13.61

2 $\sqrt{(30-41.5)^2 0.30+(40-41.5)^2 0.40+(55-41.5)^2 0.30} = \sqrt{95.25}$ = 9.76

3 $\sqrt{(30-38.5)^2 0.30+(40-38.5)^2 0.40+(45-38.5)^2 0.30} = \sqrt{35.25}$ = 5.94

Standard Deviation about the expected value

$$= \sqrt{\frac{185.25}{(1+0.10)^2}+\frac{95.25}{(1+0.10)^4}+\frac{35.25}{(1+0.10)^6}}$$

$$= \sqrt{\frac{185.25}{1.21}+\frac{95.25}{1.4641}+\frac{35.25}{1.7716}} = \sqrt{153.10+65.06+19.90}$$

$$= \sqrt{238.06} = 15.43$$

Project Y (For 1-3 Years)

$\sqrt{(40-45.5)^2 0.20+(45-45.5)^2 0.50+(50-45.5)^2 0.30} = \sqrt{12.25}$ = 3.50

Standard Deviation about the expected value

$$= \sqrt{\frac{12.25}{(1+0.10)^2}+\frac{12.25}{(1+0.10)^4}+\frac{12.25}{(1+0.10)^6}}$$

$$= \sqrt{\frac{12.25}{1.21}+\frac{12.25}{1.4641}+\frac{12.25}{1.7716}} = \sqrt{10.12+8.37+6.91}$$

$$= \sqrt{25.4} = 5.03$$

Analysis: Project Y is less risky as its Standard Deviation is less than Project X.

Question 19

Shivam Ltd. is considering two mutually exclusive projects A and B. Project A costs ₹ 36,000 and project B ₹ 30,000. You have been given below the net present value probability distribution for each project.

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Project A		*Project B*	
NPV estimates (₹)	*Probability*	*NPV estimates (₹)*	*Probability*
15,000	*0.2*	*15,000*	*0.1*
12,000	*0.3*	*12,000*	*0.4*
6,000	*0.3*	*6,000*	*0.4*
3,000	*0.2*	*3,000*	*0.1*

(i) Compute the expected net present values of projects A and B.

(ii) Compute the risk attached to each project i.e. standard deviation of each probability distribution.

(iii) Compute the profitability index of each project.

(iv) Which project do you recommend? State with reasons.

Answer

(i) Statement showing computation of expected net present value of Projects A and B:

Project A			*Project B*		
NPV Estimate (₹)	*Probability*	*Expected Value*	*NPV Estimate*	*Probability*	*Expected Value*
15,000	0.2	3,000	15,000	0.1	1,500
12,000	0.3	3,600	12,000	0.4	4,800
6,000	0.3	1,800	6,000	0.4	2,400
3,000	0.2	600	3,000	0.1	300
	1.0	EV = 9,000		1.0	EV = 9,000

(ii) Computation of Standard deviation of each project

Project A

P	X	(X – EV)	P (X-EV)²
0.2	15,000	6,000	72,00,000
0.3	12,000	3,000	27,00,000
0.3	6,000	- 3,000	27,00,000
0.2	3,000	- 6,000	72,00,000
			Variance = 1,98,00,000

Standard Deviation of Project A = $\sqrt{1,98,00,000}$ = ₹4,450

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Project B

P	X	(X – EV)	P (X-EV)²
0.1	15,000	6,000	36,00,000
0.4	12,000	3,000	36,00,000
0.4	6,000	- 3,000	36,00,000
0.1	3,000	- 6,000	36,00,000
			Variance = 1,44,00,000

Standard Deviation of Project A = $\sqrt{1,44,00,000}$ = ₹3,795

(iii) Computation of profitability of each project

Profitability index = Discount cash inflow / Initial outlay

In case of Project A : PI = $\frac{9,000+36,000}{36,000}=\frac{45,000}{36,000}=1.25$

In case of Project B : PI = $\frac{9,000+30,000}{30,000}=\frac{39,000}{30,000}=1.30$

(iv) Measurement of risk is made by the possible variation of outcomes around the expected value and the decision will be taken in view of the variation in the expected value where two projects have the same expected value, the decision will be the project which has smaller variation in expected value. In the selection of one of the two projects A and B, Project B is preferable because the possible profit which may occur is subject to less variation (or dispersion). Much higher risk is lying with project A.

Question 20

Aeroflot airlines is planning to procure a light commercial aircraft for flying class clients at an investment of ₹ 50 lakhs. The expected cash flow after tax for next three years is as follows:

(₹ in lakh)

Year 1		***Year 2***		***Year 3***	
CFAT	***Probability***	***CFAT***	***Probability***	***CFAT***	***Probability***
15	*.1*	*15*	*.1*	*18*	*.2*
18	*.2*	*20*	*.3*	*22*	*.5*
22	*.4*	*30*	*.4*	*35*	*.2*
35	*.3*	*45*	*.2*	*50*	*.1*

The company wishes to consider all possible risk factors relating to an airline.

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The company wants to know-

(i) the expected NPV of this proposal assuming independent probability distribution with 6 per cent risk free rate of interest, and

(ii) the possible deviation on expected values.

Answer

(i) Determination of expected CFAT

								₹ in lakh
Year-1			Year-2			Year - 3		
CFAT	P_1	Cash flow	CFAT	P_2	Cash flow	CFAT	P_3	Cash flow
15	0.1	1.5	15	0.1	1.5	18	0.2	3.6
18	0.2	3.6	20	0.3	6	22	0.5	11
22	0.4	8.8	30	0.4	12	35	0.2	7
35	0.3	10.5	45	0.2	9	50	0.1	5
		$\overline{CF_1}$ 24.4			$\overline{CF_2}$ 28.5			$\overline{CF_3}$ 26.6

CFAT (₹ in lakh)	PV factor @ 6%	Total PV (₹ in lakh)
24.4	0.943	23.009
28.5	0.890	25.365
26.6	0.840	22.344
		70.718
	Less Cash flow	50.000
	= NPV	20.718

(ii) Determination of Standard deviation for each year

Year 1

$(CF_1 - \overline{CF_1})^2$	$(CF_1 - \overline{CF_1})^2$	P_1	
$(15-24.4)^2$	88.36	0.1	8.836
$(18-24.4)^2$	40.96	0.2	8.192
$(22-24.4)^2$	5.76	0.4	2.304
$(35-24.4)^2$	112.36	0.3	33.708
			53.04

$$\sigma = \sqrt{53.04} = 7.282$$

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Year 2

$(CF_2-\overline{CF_2})^2$	$(CF_2-\overline{CF_2})^2$	P_2	
$(15-28.5)^2$	182.25	0.1	18.225
$(20-28.5)^2$	72.25	0.3	21.675
$(30-28.5)^2$	2.25	0.4	0.9
$(45-28.5)^2$	272.25	0.2	54.45
			95.25

$$\sigma = \sqrt{95.25} = 9.76$$

Year -3

$(CF_3-\overline{CF_3})^2$	$(CF_3-\overline{CF_3})^2$	P_3	
$(18-26.6)^2$	73.96	0.2	14.792
$(22-26.6)^2$	21.16	0.5	10.58
$(35-26.6)^2$	70.56	0.2	14.112
$(50-26.6)^2$	547.56	0.1	54.756
			94.24

$$\sigma = \sqrt{94.24} = 9.70$$

Standard deviation of the expected Values

$$\sqrt{\sum_{t=1}^{n} \frac{\sigma^2_t}{(1+i)^{2t}}}$$

$$\sigma = \sqrt{\frac{53.04}{(1+0.06)^2} + \frac{95.25}{(1+0.06)^4} + \frac{94.24}{(1+0.06)^6}}$$

$$\sigma = \sqrt{47.21+75.45+66.44} = \sqrt{189.10} = 13.75$$

Question 21

Following are the estimates of the net cash flows and probability of a new project of M/s X Ltd.:

	Year	*P=0.3*	*P=0.5*	*P=0.2*
Initial investment	*0*	*4,00,000*	*4,00,000*	*4,00,000*
Estimated net after tax cash inflows per year	*1 to 5*	*1,00,000*	*1,10,000*	*1,20,000*
Estimated salvage value (after tax)	*5*	*20,000*	*50,000*	*60,000*

Required rate of return from the project is 10%. Find:

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(i) The expected NPV of the project.

(ii) The best case and the worst case NPVs.

(iii) The probability of occurrence of the worst case if the cash flows are perfectly dependent overtime and independent overtime.

(iv) Standard deviation and coefficient of variation assuming that there are only three streams of cash flow, which are represented by each column of the table with the given probabilities.

(v) Coefficient of variation of X Ltd. on its average project which is in the range of 0.95 to 1.0. If the coefficient of variation of the project is found to be less risky than average, 100 basis points are deducted from the Company's cost of Capital

Should the project be accepted by X Ltd?

Answer

(a) (i) Expected cash flows:-

Year			*Net cash flows*	*P.V.*	*PV. @ 10%*
0	(4,00,000 x 1)	=	(-)4,00,000	1.000	(-)4,00,000
1 to 4	(1,00,000x0.3+1,10,000x0.5 + 1,20,000 x 0.2)	=	1,09,000	3.170	3,45,530
5	[1,09,000 + (20,000 x 0.3 + 50,000 x 0.5 + 60,000 x 0.2)]	=	1,52,000	0.621	94,392
			NPV=		39,922

(ii) ENPV of the worst case

1,00,000 x 3.790 = ₹3,79,000 (Students may have 3.791 also the values will change accordingly)

20,000 x 0.621 = ₹12,420/-

ENPV = (-) 4,00,000 + 3,79,000 + 12,420 = (-) ₹8,580/-

ENPV of the best case

ENPV = (-) 4,00,000 + 1,20,000 x 3.790 + 60,000 x 0.621 = ₹92,060/-.

(iii) (a) Required probability = 0.3

(b) Required probability = $(0.3)^5$ = 0.00243

(iv) The base case NPV = (-) 4,00,000 + (1,10,000 x 3.79) + (50,000 x 0.621)

= ₹47,950/-

ENPV = 0.30 x (-) 8580 + 0.5 x 47950 + 92060 x 0.20 = ₹39,813/-

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Therefore,

$$\sigma_{ENPV} = \sqrt{0.3(-8580-39,813)^2 + 0.5(47950-39813)^2 + 0.2(92,060-39,813)^2} = ₹35,800/-$$

Therefore, CV = 35,800/39,813 = 0.90

(v) Risk adjusted out of cost of capital of X Ltd. = 10% - 1% = 9%.

NPV

Year	Expected net cash flow	PV @ 9%	
0	(-)4,00,000	1.000	(-)4,00,000
1 to 4	1,09,000	3.240	3,53,160
5	1,52,000	0.650	98,800
		ENPV =	51,960

Therefore, the project should be accepted.

Question 22

XYZ Ltd. is considering a project for which the following estimates are available:

	₹
Initial Cost of the project	*10,00,000*
Sales price/unit	*60*
Cost/unit	*40*
Sales volumes	
Year 1	*20000 units*
Year 2	*30000 units*
Year 3	*30000 units*

Discount rate is 10% p.a.

You are required to measure the sensitivity of the project in relation to each of the following parameters:

(a) Sales Price/unit

(b) Unit cost

(c) Sales volume

(d) Initial outlay and

(e) Project lifetime

Taxation may be ignored.

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Answer

Calculation of NPV

NPV $= - 10,00,000 + \frac{20,000 \times 20}{1.1} + \frac{30,000 \times 20}{1.21} + \frac{30,000 \times 20}{1.331}$

= - 10,00,000 + 3,63,636 + 4,95,868 + 4,50,789

= 13,10,293 – 10,00,000

= ₹3,10,293/-.

Measurement of sensitivity is as follows:

(a) Sales Price:-

Let the sale price/Unit be S so that the project would break even with 0 NPV.

$\therefore 10,00,000 = \frac{20,000 \times (S-40)}{1.1} + \frac{30,000 \times (S-40)}{1.21} + \frac{30,000(S-40)}{1.331}$

S – 40 = 10,00,000/65,514

S – 40 = ₹15.26

S = ₹55.26 which represents a fall of (60-55.26)/60

Or 0.079 or 7.9%

Alternative Method

$\frac{10,00,000 \times 20}{13,10,293}$ = ₹ 15.26

S= ₹40 + ₹15.26

= ₹55.26

Alternative Solution

If sale Price decreased by say 10%, then NPV (at Sale Price of ₹ 60 – ₹ 6 = ₹ 54)

NPV = $-10,00,000 + \frac{20000 \times 14}{(1.1)^1} + \frac{30000 \times 14}{(1.1)^2} + \frac{30000 \times 14}{(1.1)^3}$

= -10,00,000 +2,54,545 + 3,47,107 + 3,15,552

= -82,796

NPV decrease (%) = $\frac{3,10,293-(-82,796)}{3,10,293}$ X 100 = 126.68%

(b) Unit Cost:-

If sales price = ₹ 60 the cost price required to give a margin of ₹15.26 is

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(₹60 – ₹15.26) or ₹44.74 which would represent a rise of 11.85% i.e., $\left(\frac{44.74-40}{40}\times 100\right)$

Alternative Solution

If unit cost increased by say 10%. The new NPV will be as follows:

$$\text{NPV} = -10,00,000 + \frac{20000\times 16}{(1.1)^1}+\frac{30000\times 16}{(1.1)^2}+\frac{30000\times 16}{(1.1)^3}$$

= -10,00,000 +2,90,909 + 3,96,694 + 3,60,631

= 48,234

$$\text{NPV decrease (\%)} = \frac{3,10,293-(48,234)}{3,10,293} \text{ X } 100 = 84.46\%$$

(c) Sales volume:-

The requisite percentage fall is:-

3,10,293/13,10,293 $\times$ 100 = 23.68%

Alternative Solution

If sale volume decreased by say 10%. The new NPV will be as follows:

$$\text{NPV} = -10,00,000 + \frac{18000\times 20}{(1.1)^1}+\frac{27000\times 20}{(1.1)^2}+\frac{27000\times 20}{(1.1)^3}$$

= -10,00,000 + 3,27,272 + 4,46,281 + 4,05,710

= 1,79,263

$$\text{NPV decrease (\%)} = \frac{3,10,293-1,79,263}{3,10,293} \text{ X } 100 = 42.22\%$$

(d) Since PV of inflows remains at ₹13,10,293 the initial outlay must also be the same.

$\therefore$ Percentage rise = 3,10,293/10,00,000 $\times$ 100 = 31.03%.

Alternative Solution

If initial outlay increased by say 10%. The new NPV will be as follows:

$$\text{NPV} = -11,00,000 + \frac{20000\times 20}{(1.1)^1}+\frac{30000\times 20}{(1.1)^2}+\frac{30000\times 20}{(1.1)^3}$$

= -11,00,000 + 3,63,636 + 4,95,868 + 4,50,789 = 2,10,293

$$\text{NPV decrease (\%)} = \frac{3,10,293-2,10,293}{3,10,293} \text{ X } 100 = 32.22\%$$

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(e) Present value for 1st two years.

= - 10,00,000 + 4,00,000 x 0.909 + 6,00,000 x 0.826

= - 10,00,000 + 3,63,600 + 4,95,600

= - 10,00,000 + 8,59,200

= - 1,40,800

∴ The project needs to run for some part of the third year so that the present value of return is ₹1,40,800. It can be computed as follows:

(i) 30,000 units x ₹ 20 x 0.751 = ₹4,50,600

(ii) Per day Production in (₹) assuming a year of 360 days =

$$\frac{₹\,4,50,600}{360} = ₹\,1,252$$

(iii) Days needed to recover ₹1,40,800 = $\frac{₹\,1,40,800}{₹\,1,252} = 112$

Thus, if the project runs for 2 years and 112 days then break even would be achieved representing a fall of $\frac{(3-2.311)}{3} \times 100$ = 22.97%.

Question 23

From the following details relating to a project, analyse the sensitivity of the project to changes in initial project cost, annual cash inflow and cost of capital:

Initial Project Cost (₹)	*1,20,000*
Annual Cash Inflow (₹)	*45,000*
Project Life (Years)	*4*
Cost of Capital	*10%*

To which of the three factors, the project is most sensitive? (Use annuity factors: for 10% 3.169 and 11% 3.103).

Answer

CALCULATION OF NPV

	₹
PV of cash inflows (₹ 45,000 x 3.169)	1,42,605
Initial Project Cost	1,20,000
NPV	22,605

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If initial project cost is varied adversely by 10%*

NPV (Revised) (₹ 1,42,605 - ₹ 1,32,000)	₹ 10,605
Change in NPV (₹ 22,605 – ₹ 10,605)/ ₹ 22,605 i.e.	53.08 %

If annual cash inflow is varied adversely by 10%*

Revised annual inflow	₹ 40,500
NPV (Revised) (₹ 40,500 x 3.169) – (₹ 1,20,000)	(+) ₹ 8,345
Change in NPV (₹ 22,605 – ₹ 8,345) / ₹ 22,605	63.08 %

If cost of capital is varied adversely by 10%*

NPV (Revised) (₹ 45,000 x 3.103) – ₹ 1,20,000	(+) ₹ 19,635
Change in NPV (₹ 22,605 – ₹ 19,635) / ₹ 22,605	13.14 %

Conclusion: Project is most sensitive to 'annual cash inflow'.

*Note: Students may please note that they may assume any other percentage rate other than 10 % say 15%, 20 % 25 % etc.

Question 24

Red Ltd. is considering a project with the following Cash flows:

₹

Years	*Cost of Plant*	*Recurring Cost*	*Savings*
0	*10,000*		
1		*4,000*	*12,000*
2		*5,000*	*14,000*

The cost of capital is 9%. Measure the sensitivity of the project to changes in the levels of plant value, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factor at 9% are as under:

Year	***Factor***
0	*1*
1	*0.917*
2	*0.842*

Which factor is the most sensitive to affect the acceptability of the project?

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Answer

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	= (₹ 3,668)
	Savings	₹ 12,000 x 0.917	= ₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	= (₹ 4,210)
	Savings	₹ 14,000 x 0.842	= ₹ 11,788
			₹ 14,914
Year 0	*Less:* P.V. of Cash Outflow	₹ 10,000 x 1	₹ 10,000
		NPV	₹ 4,914

Sensitivity Analysis

(i) Increase of Plant Value by ₹ 4,914

$$\therefore \frac{4,914}{10,000} \text{ x } 100 = 49.14\%$$

(ii) Increase of Running Cost by ₹ 4,914

$$\frac{4,914}{3,668+4,210} = \frac{4,914}{7,878} \text{ x } 100 = 62.38\%$$

(iii) Fall in Saving by ₹ 4,914

$$\frac{4,914}{11,004+11,788} = \frac{4,914}{22,792} \text{ x } 100 = 21.56\%$$

Hence, savings factor is the most sensitive to affect the acceptability of the project as in comparison of other two factors a slight % change in this fact shall more affect the NPV than others.

Alternative Solution

P.V. of Cash Flows

Year 1	Running Cost	₹ 4,000 x 0.917	= (₹ 3,668)
	Savings	₹ 12,000 x 0.917	= ₹ 11,004
Year 2	Running Cost	₹ 5,000 x 0.842	= (₹ 4,210)
	Savings	₹ 14,000 x 0.842	= ₹ 11,788
			₹ 14,914
Year 0	Less: P.V. of Cash Outflow	₹ 10,000 x 1	₹ 10,000
		NPV	₹ 4,914

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Sensitivity Analysis

(i) If the initial project cost is varied adversely by say 10%*.

NPV (Revised) (₹ 4,914 – ₹ 1,000) = ₹ 3,914

Change in NPV $\frac{₹\ 4,914 - ₹\ 3,914}{₹\ 4,914}$ = 20.35%

(ii) If Annual Running Cost is varied by say 10%*.

NPV (Revised) (₹ 4,914 – ₹ 400 X 0.917 – ₹ 500 X 0.843)

= ₹ 4,914 – ₹ 367 – ₹ 421= ₹ 4,126

Change in NPV $\frac{₹\ 4,914 - ₹\ 4,126}{₹\ 4,914}$ = 16.04%

(iii) If Saving is varied by say 10%*.

NPV (Revised) (₹ 4,914 – ₹ 1,200 X 0.917 – ₹ 1,400 X 0.843)

= ₹ 4,914 – ₹ 1,100 – ₹ 1,180 = ₹ 2,634

Change in NPV $\frac{₹\ 4,914 - ₹\ 2,634}{₹\ 4,914}$ = 46.40%

Hence, savings factor is the most sensitive to affect the acceptability of the project.

* Any percentage of variation other than 10% can also be assumed.

Question 25

The Easygoing Company Limited is considering a new project with initial investment, for a product "Survival". It is estimated that IRR of the project is 16% having an estimated life of 5 years.

Financial Manager has studied that project with sensitivity analysis and informed that annual fixed cost sensitivity is 7.8416%, whereas cost of capital (discount rate) sensitivity is 60%.

Other information available are:

Profit Volume Ratio (P/V) is 70%,

Variable cost ₹ 60/- per unit

Annual Cash Flow ₹ 57,500/-

Ignore Depreciation on initial investment and impact of taxation.

Calculate

(i) Initial Investment of the Project

(ii) Net Present Value of the Project

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(iii) Annual Fixed Cost

(iv) Estimated annual unit of sales

(v) Break Even Units

Cumulative Discounting Factor for 5 years

8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%
3.993	3.890	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127

Answer

(i) Initial Investment

IRR = 16% (Given)

At IRR, NPV shall be zero, therefore

Initial Cost of Investment = PVAF (16%,5) x Cash Flow (Annual)

= 3.274 x ₹ 57,500

= ₹ 1,88,255

(ii) Net Present Value (NPV)

Let Cost of Capital be X, then $\frac{16-X}{X}=60\%$ **X = 10%**

Thus NPV of the project

= Annual Cash Flow x PVAF (10%, 5) – Initial Investment

= ₹ 57,500 x 3.791 – ₹ 1,88,255

= ₹ 2,17,982.50 – ₹ 1,88,255 **=** ₹ 29,727.50

(iii) Annual Fixed Cost

Let change in the Fixed Cost which makes NPV zero is X. Then,

₹ 29,727.50 – 3.791X = 0

Thus X = ₹ 7,841.60

Let original Fixed Cost be Y then,

Y × 7.8416% = ₹ 7,841.60

Y = ₹ 1,00,000

Thus Fixed Cost is equal to ₹ 1,00,000

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(iv) Estimated Annual Units of Sales

$$\text{Selling Price per unit} = \frac{₹\ 60}{100\% - 70\%} = ₹\ 200$$

$$\frac{\text{Annual Cash Flow + Fixed Cost}}{\text{P/V Ratio}} = \text{Sales Value}$$

$$\frac{₹\ 57{,}500 + ₹\ 1{,}00{,}000}{0.70} = ₹\ 2{,}25{,}000$$

$$\text{Sales in Units} = \frac{₹\ 2{,}25{,}000}{₹\ 200} = 1{,}125 \text{ units}$$

(v) Break Even Units

$$\frac{\text{Fixed Cost}}{\text{Contribution Per Unit}} = \frac{1{,}00{,}000}{140} = 714.285 \text{ units}$$

Question 26

Unnat Ltd. is considering investing ₹ 50,00,000 in a new machine. The expected life of machine is five years and has no scrap value. It is expected that 2,00,000 units will be produced and sold each year at a selling price of ₹ 30.00 per unit. It is expected that the variable costs to be ₹ 16.50 per unit and fixed costs to be ₹ 10,00,000 per year. The cost of capital of Unnat Ltd. is 12% and acceptable level of risk is 20%.

You are required to measure the sensitivity of the project's net present value to a change in the following project variables:

(a) sale price;

(b) sales volume;

(c) variable cost;

(d) On further investigation it is found that there is a significant chance that the expected sales volume of 2,00,000 units per year will not be achieved. The sales manager of Unnat Ltd. suggests that sales volumes could depend on expected economic states which could be assigned the following probabilities:

State of Economy	*Annual Sales (in Units)*	*Prob.*
Poor	*1,75000*	*0·30*
Normal	*2,00,000*	*0·60*
Good	*2,25,000*	*0·10*

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Calculate expected net present value of the project and give your decision whether company should accept the project or not.

Answer

Calculation of NPV

= - ₹ 50,00,000 + [2,00,000 (₹ 30 – ₹ 16.50) – ₹ 10,00,000] PVIAF (12%,5)

= - ₹ 50,00,000 + [2,00,000 (₹ 13.50) – ₹ 10,00,000] 3.605

= - ₹ 50,00,000 + [₹ 27,00,000 – ₹ 10,00,000] 3.605

=- ₹ 50,00,000 + ₹ 61,28,500 = ₹ 11,28,500

Measurement of Sensitivity Analysis

(a) Sales Price:-

Let the sale price/Unit be S so that the project would break even with 0 NPV.

∴ ₹ 50,00,000 = [2,00,000 (S – ₹ 16.50) – ₹ 10,00,000] PVIAF (12%,5)

₹ 50,00,000 = [2,00,000S – ₹ 33,00,000 – ₹ 10,00,000] 3.605

₹ 50,00,000 = [2,00,000S – ₹ 43,00,000] 3.605

₹ 13,86,963 = 2,00,000S – ₹ 43,00,000

₹ 56,86,963 = 2,00,000S

S = ₹ 28.43 which represents a fall of (30 - 28.43)/30 or 0.0523 or 5.23%

(b) Sales volume:-

Let V be the sale volume so that the project would break even with 0 NPV.

∴ ₹ 50,00,000 = [V (₹ 30 – ₹ 16.50) – ₹ 10,00,000] PVIAF (12%,5)

₹ 50,00,000 = [V (₹ 13.50) – ₹ 10,00,000] PVIAF (12%,5)

₹ 50,00,000 = [₹ 13.50V – ₹ 10,00,000] 3.605

₹ 13,86,963 = ₹ 13.50V – ₹ 10,00,000

₹ 23,86,963 = ₹ 13.50V

V = 1,76,812 which represents a fall of (2,00,000 - 1,76,812)/2,00,000 or 0.1159 or 11.59%

(c) Variable Cost:-

Let the variable cost be V so that the project would break even with 0 NPV.

 ₹ 50,00,000 = [2,00,000(₹ 30 – V) – ₹ 10,00,000] PVIAF(12%,5)

₹ 50,00,000 = [₹ 60,00,000 – 2,00,000 V – ₹ 10,00,000] 3.605

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₹ 50,00,000 = [₹ 50,00,000 – 2,00,000 V] 3.605

₹ 13,86,963 = ₹ 50,00,000 – 2,00,000 V

₹ 36,13,037 = 2,00,000V

V = ₹ 18.07 which represents a fall of (18.07 – 16.50)/16.50 or 0.0951 or 9.51%

(d) Expected Net Present Value

(1,75,000 X 0.30) + (2,00,000 X 0.60) + (2,25,000 X 0.10) =1,95,000

NPV = [1,95,000 X ₹ 13.50 – ₹ 10,00,000] 3.605 – ₹ 50,00,000 = ₹ 8,85,163

Further NPV in worst and best cases will be as follows:

Worst Case:

[1,75,000 X ₹ 13.50 – ₹ 10,00,000] 3.605 – ₹ 50,00,000 = - ₹ 88,188

Best Case:

[2,25,000 X ₹ 13.50 – ₹ 10,00,000] 3.605 – ₹ 50,00,000 = ₹ 23,45,188

Thus there are 30% chances that the rise will be a negative NPV and 70% chances of positive NPV. Since acceptable level of risk of Unnat Ltd. is 20% and there are 30% chances of negative NPV hence project should not be accepted.

Question 27

XY Ltd. has under its consideration a project with an initial investment of ₹ 1,00,000. Three probable cash inflow scenarios with their probabilities of occurrence have been estimated as below:

Annual cash inflow (₹)	*20,000*	*30,000*	*40,000*
Probability	*0.1*	*0.7*	*0.2*

The project life is 5 years and the desired rate of return is 20%. The estimated terminal values for the project assets under the three probability alternatives, respectively, are ₹ 0, 20,000 and 30,000.

You are required to:

(i) Find the probable NPV;

(ii) Find the worst-case NPV and the best-case NPV; and

(iii) State the probability occurrence of the worst case, if the cash flows are perfectly positively correlated over time.

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Answer

The expected cash flows of the project are as follows:

Year	*Pr = 0.1*	*Pr = 0.7*	*Pr = 0.2*	*Total*
	₹	₹	₹	₹
0	-10,000	-70,000	-20,000	-1,00,000
1	2,000	21,000	8,000	31,000
2	2,000	21,000	8,000	31,000
3	2,000	21,000	8,000	31,000
4	2,000	21,000	8,000	31,000
5	2,000	21,000	8,000	31,000
5	0	14,000	6,000	20,000

(i) NPV based on expected cash flows would be as follows:

$$=-₹\ 1,00,000 + \frac{₹\ 31,000}{(1+0.20)^1} + \frac{₹\ 31,000}{(1+0.20)^2} + \frac{₹\ 31,000}{(1+0.20)^3} + \frac{₹\ 31,000}{(1+0.20)^4} + \frac{₹\ 31,000}{(1+0.20)^5} + \frac{₹\ 20,000}{(1+0.20)^5}$$

= - ₹ 1,00,000 + ₹ 25,833.33 + ₹ 21,527.78 + ₹ 17,939.81 + ₹ 14,949.85+ ₹ 12,458.20 + ₹ 8,037.55

NPV = ₹ 746.52

(ii) For the worst case, the cash flows from the cash flow column farthest on the left are used to calculate NPV

$$= -₹\ 100,000 + \frac{₹20,000}{(1+0.20)^1} + \frac{₹20,000}{(1+0.20)^2} + \frac{₹20,000}{(1+0.20)^3} + \frac{₹20,000}{(1+0.20)^4} + \frac{₹20,000}{(1+0.20)^5}$$

= - ₹ 100,000 + ₹ 16,666.67+ ₹ 13,888.89 + ₹ 11,574.07 + ₹ 9,645.06+ ₹ 8037.76

NPV = - ₹ 40,187.76

For the best case, the cash flows from the cash flow column farthest on the right are used to calculated NPV

$$= -₹\ 100,000 + \frac{₹\ 40,000}{(1+0.20)^1} + \frac{₹\ 40,000}{(1+0.20)^2} + \frac{₹\ 40,000}{(1+0.20)^3} + \frac{₹\ 40,000}{(1+0.20)^4} + \frac{₹\ 40,000}{(1+0.20)^5} + \frac{₹\ 30,000}{(1+0.20)^5}$$

= - ₹ 1,00,000 + ₹ 33,333.33+ ₹ 27,777.78 + ₹ 23,148.15+ ₹ 19,290.12 + ₹ 16,075.10 + ₹ 12,056.33

NPV = ₹ 31,680.81

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(iii) If the cash flows are perfectly dependent, then the low cash flow in the first year will mean a low cash flow in every year. Thus the possibility of the worst case occurring is the probability of getting ₹ 20,000 net cash flow in year 1 is 10%.

Question 28

The Textile Manufacturing Company Ltd., is considering one of two mutually exclusive proposals, Projects M and N, which require cash outlays of ₹ 8,50,000 and ₹ 8,25,000 respectively. The certainty-equivalent (C.E) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bonds is 6% and this is used as the risk free rate. The expected net cash flows and their certainty equivalents are as follows:

Project M			*Project N*	
Year-end	*Cash Flow ₹*	*C.E.*	*Cash Flow ₹*	*C.E.*
1	*4,50,000*	*0.8*	*4,50,000*	*0.9*
2	*5,00,000*	*0.7*	*4,50,000*	*0.8*
3	*5,00,000*	*0.5*	*5,00,000*	*0.7*

Present value factors of ₹ 1 discounted at 6% at the end of year 1, 2 and 3 are 0.943, 0.890 and 0.840 respectively.

Required:

(i) Which project should be accepted?

(ii) If risk adjusted discount rate method is used, which project would be appraised with a higher rate and why?

Answer

(i) Statement Showing the Net Present Value of Project M

Year end	*Cash Flow (₹) (a)*	*C.E. (b)*	*Adjusted Cash flow (₹) (c) = (a) × (b)*	*Present value factor at 6% (d)*	*Total Present value (₹) (e) = (c) × (d)*
1	4,50,000	0.8	3,60,000	0.943	3,39,480
2	5,00,000	0.7	3,50,000	0.890	3,11,500
3	5,00,000	0.5	2,50,000	0.840	2,10,000
					8,60,980
Less: Initial Investment					8,50,000
Net Present Value					10,980

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Statement Showing the Net Present Value of Project N

Year end	*Cash Flow (₹)* (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor (d)	Total Present value (₹) (e) = (c) × (d)
1	4,50,000	0.9	4,05,000	0.943	3,81,915
2	4,50,000	0.8	3,60,000	0.890	3,20,400
3	5,00,000	0.7	3,50,000	0.840	2,94,000
					9,96,315
Less: Initial Investment					8,25,000
Net Present Value					1,71,315

Decision: Since the net present value of Project N is higher, so the project N should be accepted.

(ii) Certainty - Equivalent (C.E.) Co-efficient of Project M (2.0) is lower than Project N (2.4). This means Project M is riskier than Project N as "higher the riskiness of a cash flow, the lower will be the CE factor". If risk adjusted discount rate (RADR) method is used, Project M would be analysed with a higher rate.

RADR is based on the premise that riskiness of a proposal may be taken care of, by adjusting the discount rate. The cash flows from a more risky proposal should be discounted at a relatively higher discount rate as compared to other proposals whose cash flows are less risky. Any investor is basically risk averse. However, he may be ready to take risk provided he is rewarded for undertaking risk by higher returns. So, more risky the investment is, the greater would be the expected return. The expected return is expressed in terms of discount rate which is also the minimum required rate of return generated by a proposal if it is to be accepted. Therefore, there is a positive correlation between risk of a proposal and the discount rate.

Question 29

Determine the risk adjusted net present value of the following projects:

	X	*Y*	*Z*
Net cash outlays (₹)	*2,10,000*	*1,20,000*	*1,00,000*
Project life	*5 years*	*5 years*	*5 years*
Annual Cash inflow (₹)	*70,000*	*42,000*	*30,000*
Coefficient of variation	*1.2*	*0.8*	*0.4*

The Company selects the risk-adjusted rate of discount on the basis of the coefficient of variation:

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Coefficient of Variation	*Risk-Adjusted Rate of Return*	*P.V. Factor 1 to 5 years At risk adjusted rate of discount*
0.0	*10%*	*3.791*
0.4	*12%*	*3.605*
0.8	*14%*	*3.433*
1.2	*16%*	*3.274*
1.6	*18%*	*3.127*
2.0	*22%*	*2.864*
More than 2.0	*25%*	*2.689*

Answer

Statement showing the determination of the risk adjusted net present value

Projects	*Net cash outlays*	*Coefficient of variation*	*Risk adjusted discount rate*	*Annual cash inflow*	*PV factor 1-5 years*	*Discounted cash inflow*	*Net present value*
	₹			₹		₹	₹
(i)	*(ii)*	*(iii)*	*(iv)*	*(v)*	*(vi)*	*(vii) = (v) × (vi)*	*(viii) = (vii) – (ii)*
X	2,10,000	1.20	16%	70,000	3.274	2,29,180	19,180
Y	1,20,000	0.80	14%	42,000	3.433	1,44,186	24,186
Z	1,00,000	0.40	12%	30,000	3.605	1,08,150	8,150

Question 30

New Projects Ltd. is evaluating 3 projects, P-I, P-II, P-III. Following information is available in respect of these projects:

	P-I	*P-II*	*P-III*
Cost	*₹15,00,000*	*₹11,00,000*	*₹19,00,000*
Inflows-Year 1	*6,00,000*	*6,00,000*	*4,00,000*
Year 2	*6,00,000*	*4,00,000*	*6,00,000*
Year 3	*6,00,000*	*5,00,000*	*8,00,000*
Year 4	*6,00,000*	*2,00,000*	*12,00,000*
Risk Index	*1.80*	*1.00*	*0.60*

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Minimum required rate of return of the firm is 15% and applicable tax rate is 40%. The risk free interest rate is 10%.

Required:

(i) Find out the risk-adjusted discount rate (RADR) for these projects.

(ii) Which project is the best?

Answer

(i) The risk free rate of interest and risk factor for each of the projects are given. The risk adjusted discount rate (RADR) for different projects can be found on the basis of CAPM as follows:

Required Rate of Return = I_{Rf} + (k_o - I_{RF}) Risk Factor

For P-I : RADR = 0.10 + (0.15 – 0.10) 1.80 = 19%

For P-II : RADR = 0.10 + (0.15 – 0.10) 1.00 = 15 %

For P-III : RADR = 0.10 + (0.15 – 0.10) 0.60 = 13 %

(ii) The three projects can now be evaluated at 19%, 15% and 13% discount rate as follows:

Project P-I

Annual Inflows	₹ 6,00,000
PVAF (19 %, 4)	2.639
PV of Inflows (₹ 6,00,000 x 2.639)	₹ 15,83,400
Less: Cost of Investment	₹ 15,00,000
Net Present Value	**₹ 83,400**

Project P-II

Year	Cash Inflow (₹)	PVF (15%,n)	PV (₹)
1	6,00,000	0.870	5,22,000
2	4,00,000	0.756	3,02,400
3	5,00,000	0.658	3,29,000
4	2,00,000	0.572	1,14,400
Total Present Value			12,67,800
Less: Cost of Investment			11,00,000
Net Present Value			**1,67,800**

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Project P-III

Year	Cash Inflow (₹)	PVF (13%,n)	PV (₹)
1	4,00,000	0.885	3,54,000
2	6,00,000	0.783	4,69,800
3	8,00,000	0.693	5,54,400
4	12,00,000	0.613	7,35,600
Total Present Value			21,13,800
Less: Cost of Investment			19,00,000
Net Present Value			**2,13,800**

Project P-III has highest NPV. So, it should be accepted by the firm

Question 31

A firm has projected the following cash flows from a project under evaluation:

Year	*₹ lakhs*
0	*(70)*
1	*30*
2	*40*
3	*30*

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10%. The expected annual rate of inflation is 5%.

Show how the viability of the project is to be evaluated.

Answer

It is stated that the cash flows have been adjusted for inflation; hence they are "nominal". The cost of capital or discount rate is "real". In order to be compatible, the cash flows should be converted into "real flow". This is done as below:

Year	*Nominal cash flows*	*Adjusted Inflation* factor*	*Real cash flows*	*PVF @ 10%*	*PV of cash flows*
0	(70)	–	(70)	1.000	(70)
1	30	0.952	28.56	0.909	25.96
2	40	0.907	36.28	0.826	29.97
3	30	0.864	25.92	0.751	19.47
				Total	75.40
Less: Cash out flow					70.00
NPV (+)					5.40

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* 1/1.05; $1/(1.05)^2$; $1/(1.05)^3$;

Advise: With positive NPV, the project is financially viable.

Alternatively, instead of converting cash flows into real terms, the discount rate can be converted into nominal rate. Result will be the same.

An alternative solution is presented herewith

Alternative solution:

Year	*Nominal cash flows*	*PVF @ 15.50% adjusted by the inflation factor i.e. 5%**	*PV of cash flows*
1	30	0.866	25.98
2	40	0.749	29.96
3	30	0.649	19.47
		Cash inflow	75.41
		Less: Cash out flow	70.00
		Net present value	5.41

* $\frac{0.909}{1.05} = 0.866, \frac{0.826}{1.1025} = 0.749, \frac{0.751}{1.1576} = 0.649$

Advise: With positive NPV, the project is financially viable.

Question 32

Shashi Co. Ltd has projected the following cash flows from a project under evaluation:

Year	*0*	1	2	3
₹ (in lakhs)	*(72)*	*30*	40	30

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10%. The expected annual rate of inflation is 5%. Show how the viability of the project is to be evaluated. PVF at 10% for 1-3 years are 0.909, 0.826 and 0.751.

Answer

Here the given cash flows have to be adjusted for inflation. Alternatively, the discount rate can be converted into nominal rate, as follows:-

Year 1 = $\frac{0.909}{1.05}$ = 0.866; Year 2 = $\frac{0.826}{(1.05)^2}$ or $\frac{0.826}{1.1025}$ = 0.749

Year 3 = $\frac{0.751}{(1.05)^3} = \frac{0.751}{1.1576}$ = 0.649

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Year	Nominal Cash Flows (₹ in lakhs)	Adjusted PVF as above	PV of Cash Flows (₹ in lakhs)
1	30	0.866	25.98
2	40	0.749	29.96
3	30	0.649	19.47
	Cash Inflow		75.41
	Less: Cash Outflow		72.00
	Net Present Value		3.41

With positive NPV, the project is financially viable.

Alternative Solution

Assumption: The cost of capital given in the question is "Real'.

Nominal cost of capital = (1.10) (1.05) -1 = 0.155 =15.50%

DCF Analysis of the project

				(₹ Lakhs)
	Period	PVF @15.50%	CF	PV
Investment	0	1	-72	-72.00
Operation	1	0.866	30	+25.98
---do---	2	0.750	40	+30.00
---do---	3	0.649	30	+19.47
NPV				+3.45

The proposal may be accepted as the NPV is positive.

Question 33

KLM Ltd. requires ₹15,00,000 for a new project.

Useful life of project is 3 years.

Salvage value - NIL.

Depreciation is ₹5,00,000 p.a.

Given below are projected revenues and costs (excluding depreciation) ignoring inflation:

Year →	*1*	*2*	*3*
Revenues in ₹	*10,00,000*	*13,00,000*	*14,00,000*
Costs in ₹	*5,00,000*	*6,00,000*	*6,50,000*

Applicable tax rate is 35%. Assume cost of capital to be 14% (after tax). The inflation rates for revenues and costs are as under:

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Year	*Revenues %*	*Costs %*
1	*9*	*10*
2	*8*	*9*
3	*6*	*7*

PVF at 14%, for 3 years =0.877, 0.769 and 0.675
Show amount to the nearest rupee in calculations.

You are required to calculate net present value of the project.

Answer

(i) Inflation adjusted Revenues

Year	Revenues (₹)	Revenues (Inflation Adjusted) (₹)
1	10,00,000	10,00,000(1.09) = 10,90,000
2	13,00,000	13,00,000(1.09) (1.08) = 15,30,360
3	14,00,000	14,00,000(1.09) (1.08)(1.06) = 17,46,965

(ii) Inflation adjusted Costs

Year	Costs (₹)	Costs (Inflation Adjusted) (₹)
1	5,00,000	5,00,000(1.10) = 5,50,000
2	6,00,000	6,00,000(1.10)(1.09) = 7,19,400
3	6,50,000	6,50,000(1.10)(1.09)(1.07) = 8,33,905

(iii) Tax Benefit on Depreciation = ₹ 5,00,000 x 0.35 = ₹ 1,75,000

(iv) Net Profit after Tax

Year	Revenues (Inflation Adjusted) (₹) (1)	Costs (Inflation Adjusted) (₹) (2)	Net Profit (₹) (3) =(1) -(2)	Tax (₹) (4) = 35% of (3)	Profit after Tax (₹) (3) - (4)
1	10,90,000	5,50,000	5,40,000	1,89,000	3,51,000
2	15,30,360	7,19,400	8,10,960	2,83,836	5,27,124
3	17,46,965	8,33,905	9,13,060	3,19,571	5,93,489

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(iv) Present Value of Cash Inflows

Year	Net Profit after tax (₹)	Tax Benefit on Depreciation (₹)	Cash Inflow (₹)	PVF@ 14%	PV (₹)
1	3,51,000	1,75,000	5,26,000	0.877	4,61,302
2	5,27,124	1,75,000	7,02,124	0.769	5,39,933
3	5,93,489	1,75,000	7,68,489	0.675	5,18,730
					15,19,965

NPV = ₹ 15,19,965 – ₹ 15,00,000 = ₹ 19,965

Question 34

A firm has an investment proposal, requiring an outlay of ₹ 80,000. The investment proposal is expected to have two years economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹ 50,000 and 0.6 probability that cash inflow after tax will be ₹ 60,000. The probability assigned to cash inflow after tax for the year 2 is as follows:

The cash inflow year 1	*₹ 50,000*	*₹ 60,000*
The cash inflow year 2	*Probability*	*Probability*
	₹ 24,000 0.2	*₹ 40,000 0.4*
	₹ 32,000 0.3	*₹ 50,000 0.5*
	₹ 44,000 0.5	*₹ 60,000 0.1*

The firm uses a 10% discount rate for this type of investment.

Required:

(i) Construct a decision tree for the proposed investment project and calculate the expected net present value (NPV).

(ii) What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?

(iii) What will be the best outcome and the probability of that occurrence?

(iv) Will the project be accepted?

(Note: 10% discount factor 1 year 0.909; 2 year 0.826)

Answer

(i) The decision tree diagram is presented in the chart, identifying various paths and outcomes, and the computation of various paths/outcomes and NPV of each path are presented in the following tables:

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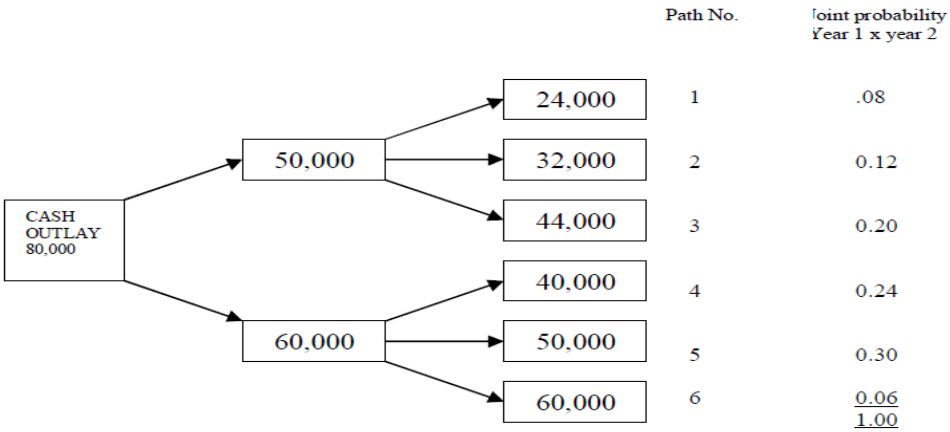

The Net Present Value (NPV) of each path at 10% discount rate is given below:

Path	*Year 1 Cash Flows (₹)*	*Year 2 Cash Flows (₹)*	*Total Cash Inflows (PV) (₹)*	*Cash Inflows NPV (₹)*	*(₹)*
1	50,000×.909 = 45,450	24,000×.826 = 19,824	65,274	80,000	(–) 14,726
2	45,450	32,000×.826 = 26,432	71,882	80,000	(–) 8,118
3	45,450	44,000×.826 = 36,344	81,794	80,000	1,794
4	60,000×.909 = 54,540	40,000×.826 = 33,040	87,580	80,000	7,580
5	54,540	50,000×.826 = 41,300	95,840	80,000	15,840
6	54,540	60,000×.826 = 49,560	1,04,100	80,000	24,100

Statement showing Expected Net Present Value

₹

z	*NPV (₹)*	*Joint Probability*	Expected NPV
1	–14,726	0.08	–1,178.08
2	–8,118	0.12	–974.16
3	1,794	0.20	358.80
4	7,580	0.24	1,819.20
5	15,840	0.30	4,752.00

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6	24,100	0.06	1,446.00
			6,223.76

(ii) If the worst outcome is realized the project will yield NPV of – ₹ 14,726. The probability of occurrence of this NPV is 8% and a loss of ₹ 1,178 (path 1).

(iii) The best outcome will be path 6 when the NPV is at ₹ 24,100. The probability of occurrence of this NPV is 6% and a expected profit of ₹ 1,446.

(iv) The project should be accepted because the expected NPV is positive at ₹ 6,223.76 based on joint probability.

Question 35

Jumble Consultancy Group has determined relative utilities of cash flows of two forthcoming projects of its client company as follows:

Cash Flow in ₹	*-15000*	*-10000*	*-4000*	*0*	*15000*	*10000*	*5000*	*1000*
Utilities	*-100*	*-60*	*-3*	*0*	*40*	*30*	*20*	*10*

The distribution of cash flows of project A and Project B are as follows:

Project A

Cash Flow (₹)	*-15000*	*- 10000*	*15000*	*10000*	*5000*
Probability	*0.10*	*0.20*	*0.40*	*0.20*	*0.10*

Project B

Cash Flow (₹)	*- 10000*	*-4000*	*15000*	*5000*	*10000*
Probability	*0.10*	*0.15*	*0.40*	*0.25*	*0.10*

Which project should be selected and why ?

Answer

Evaluation of project utilizes of Project A and Project B

	Project A		
Cash flow (in ₹)	**Probability**	**Utility**	**Utility value**
-15,000	0.10	-100	-10
-10,000	0.20	-60	-12
15,000	0.40	40	16
10,000	0.20	30	6
5,000	0.10	20	2
			2

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Cash flow (in ₹)	Project B		
	Probability	Utility	Utility value
-10,000	0.10	-60	-6
-4,000	0.15	-3	-0.45
15,000	0.40	40	16
5,000	0.25	20	5
10,000	0.10	30	3
			17.55

Project B should be selected as its expected utility is more

Question 36

You own an unused Gold mine that will cost ₹ 10,00,000 to reopen. If you open the mine, you expect to be able to extract 1,000 ounces of Gold a year for each of three years. After that the deposit will be exhausted. The Gold price is currently ₹ 5,000 an ounce, and each year the price is equally likely to rise or fall by ₹ 500 from its level at the start of year. The extraction cost is ₹4,600 an ounce and the discount rate is 10 per cent.

Required:

(a) Should you open the mine now or delay one year in the hope of a rise in the Gold price?

(b) What difference would it make to your decision if you could costlessly (but irreversibly) shut down the mine at any stage? Show the value of abandonment option.

Answer

(a) (i) Assume we open the mine now at t = 0. Taking into account the distribution of possible future price of gold over the next three years, we have

$$NPV = -\text{Rs.}10,00,000 + \frac{1,000 \times [(0.5 \times 5,500 + 0.5 \times 4,500) - 4,600]}{1.10}$$

$$+ \frac{1,000 \times [(0.5)^2 (6,000 + 5,000 + 5,000 + 4,000) - 4,600]}{(1.10)^2}$$

$$+ \frac{1,000 \times [(0.5)^3 (6,500 + 5,500 + 5,500 + 4,500 + 4,500 + 5,500 + 4,500 + 3,500) - 4,600]}{(1.10)^3}$$

= – ₹ 5,260

Because the NPV is negative, we should not open the mine at t = 0. It does not make sense to open the mine at any price less than or equal to ₹ 5,000 per ounce.

(ii) Assume that we delay one year until t = 1, and open the mine if the price is ₹ 5,500.

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At that point:

$$NPV = (-)\ ₹\ 10,00,000 + \frac{₹\ 1000\left[\left(0.5 \times ₹\ 6000 + 0.5 \times ₹\ 5000\right) - ₹\ 4600\right]}{1.10} +$$

$$\frac{1000\left[\left((0.5)^2 \times (₹\ 6500 + ₹\ 5500 + ₹\ 5500 + ₹\ 4500)\right) - ₹\ 4600\right]}{(1.10)^2} +$$

$$\frac{1000\left[\left((0.5)^3 (₹\ 7000 + ₹\ 6000 + ₹\ 6000 + ₹\ 5000 + ₹\ 5000 + ₹\ 6000 + ₹\ 5000 + ₹\ 4000)\right) - ₹\ 4600\right]}{(1.10)^3}$$

= ₹ 12,38,167

If the price at t_1 reaches ₹ 5,500, then expected price for all future periods is ₹ 5,500.

NPV at t_0 = ₹ 12,38,167/1.10 = ₹ 11,25,606

If the price rises to ₹ 5,500 at t = 1, we should open the mine at that time.

The expected NPV of this strategy is:

(0.50 × ₹ 11,25,606) + (0.50 × 0) = ₹ 5,62,803

As already stated mine should not be opened if the price is less than or equal to ₹ 5,000 per ounce.

If the price at t_1 reaches ₹ 4,500, then expected price for all future periods is ₹ 4,500. In that situation we should not open the mine.

(b) Suppose we open the mine at t = 0, when the price is ₹ 5,000. At t = 2, there is a 0.25 probability that the price will be ₹ 4,000. Then since the price at t = 3 cannot rise above the extraction cost, the mine should be closed. If we open the mine at t = 0, when the price was ₹5,000 with the closing option the NPV will be:

$$NPV = -\ Rs.10,00,000 + \sum_{t=1}^{2} \frac{(5,000 - 4,600) \times 1,000}{(1.10)^t}$$

$$+ \frac{0.125 \times [1,900 + 900 + 900 + 900 - 100 - 100) \times 1,000]}{(1.10)^3}$$

= ₹ 1,07,438

Therefore, the NPV with the abandonment option (i.e. savings) is ₹ 1,07,438.

The value of the abandonment option is:

$0.125 \times 1,000 \times (100+1100) / (1.10)^3$ = ₹ 1,12,697

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The NPV of strategy (2), that to open the mine at t = 1, when price rises to ₹ 5,500 per ounce, even without abandonment option, is higher than option 1. Therefore, the strategy (2) is preferable.

Under strategy 2, the mine should be closed if the price reaches ₹ 4,500 at t = 3, because the expected profit is (₹ 4,500 – 4,600) × 1,000 = – ₹ 1,00,000.

The value of the abandonment option is:

$0.125 \times (1,00,000) / (1.10)^4$ = ₹ 8,538

Note: Students may also assume that the price of the gold remains at ₹ 5,000 to solve the question.

Question 37

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?

(Notes: 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).

Answer

A & Co.

Equivalent cost of (EAC) of new machine

		₹
(i)	Cost of new machine now	90,000

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	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	25,000	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)

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	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.

Alternatively, optimal replacement period can also be computed using the following table:

Scenario	Year	Cashflow	PV at 15%	PV
Replace immediately	0	(40,000)	1	(40,000)
	1 to 4	28,600	2.855	81,652
				41,652
Replace after 1 year	1	10,000	0.870	8,696
	1	(25,000)	0.870	(21,739)
	2 to 4	28,600	1.985	56,783
				43,739
Replace after 2 years	1	10,000	0.870	8,696
	2	20,000	0.756	15,123
	2	(15,000)	0.756	(11,342)
	3 and 4	28,600	1.229	35,157
				47,633
Replace after 3 years	1	10,000	0.870	8,696
	2	20,000	0.756	15,123
	3	30,000	0.658	19,725
	3	(10,000)	0.658	(6,575)
	4	28,600	0.572	16,352
				53,321
Replace after 4 years	1	10,000	0.870	8,696

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	2	20,000	0.756	15,123
	3	30,000	0.658	19,725
	4	40,000	0.572	22,870
				66,414

Question 38

A company has an old machine having book value zero – which can be sold for ₹ 50,000. The company is thinking to choose one from following two alternatives:

(i) To incur additional cost of ₹ 10,00,000 to upgrade the old existing machine.

(ii) To replace old machine with a new machine costing ₹ 20,00,000 plus installation cost ₹ 50,000.

Both above proposals envisage useful life to be five years with salvage value to be nil.

The expected after tax profits for the above three alternatives are as under :

Year	*Old existing Machine (₹)*	*Upgraded Machine (₹)*	*New Machine (₹)*
1	*5,00,000*	*5,50,000*	*6,00,000*
2	*5,40,000*	*5,90,000*	*6,40,000*
3	*5,80,000*	*6,10,000*	*6,90,000*
4	*6,20,000*	*6,50,000*	*7,40,000*
5	*6,60,000*	*7,00,000*	*8,00,000*

The tax rate is 40 per cent.

The company follows straight line method of depreciation. Assume cost of capital to be 15 per cent.

P.V.F. of 15%, 5 = 0.870, 0.756, 0.658, 0.572 and 0.497. You are required to advise the company as to which alternative is to be adopted.

Answer

(A)	**Cash Outflow**		₹
	(i)	In case machine is upgraded:	
		Upgradation Cost	10,00,000
	(ii)	In case new machine installed:	
		Cost	20,00,000
		Add: Installation cost	50,000

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		Total Cost	20,50,000
		Less: Disposal of old machine	
		₹ 50,000 – 40% tax	30,000
		Total Cash Outflow	20,20,000

Working Note:

(i) Depreciation – in case machine is upgraded

₹ 10,00,000 ÷ 5 = ₹ 2,00,000

(ii) Depreciation – in case new machine is installed

₹ 20,50,000 ÷ 5 = ₹ 4,10,000

(iii) Old existing machine – Book Value is zero. So no depreciation.

(B) Cash Inflows after Taxes (CFAT)

Year	Old Existing Machine	Upgraded Machine			
	(i) EAT/CFAT ₹	(ii) EAT ₹	(iii) DEP ₹	(iv) CFAT ₹	= (iv)-(i) Incremental CFAT ₹
1	5,00,000	5,50,000	2,00,000	7,50,000	2,50,000
2	5,40,000	5,90,000	2,00,000	7,90,000	2,50,000
3	5,80,000	6,10,000	2,00,000	8,10,000	2,30,000
4	6,20,000	6,50,000	2,00,000	8,50,000	2,30,000
5	6,60,000	7,00,000	2,00,000	9,00,000	2,40,000

Cash Inflow after Taxes (CFAT)

Year		New Machine		
	(vi) EAT ₹	(vii) DEP ₹	(viii) CFAT ₹	(ix) = (viii) – (i) Incremental CFAT (₹)
1	6,00,000	4,10,000	10,10,000	5,10,000
2	6,40,000	4,10,000	10,50,000	5,10,000
3	6,90,000	4,10,000	11,00,000	5,20,000
4	7,40,000	4,10,000	11,50,000	5,30,000
5	8,00,000	4,10,000	12,10,000	5,50,000

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P.V. AT 15% - 5 Years – on Incremental CFAT

Year	Upgraded Machine			New Machine		
	Incremental CFAT ₹	PVF	Total P.V. ₹	Incremental CFAT	PVF	Total PV ₹
1	2,50,000	0.870	2,17,500	5,10,000	0.870	4,43,700
2	2,50,000	0.756	1,89,000	5,10,000	0.756	3,85,560
3	2,30,000	0.658	1,51,340	5,20,000	0.658	3,42,160
4	2,30,000	0.572	1,31,560	5,30,000	0.572	3,03,160
5.	2,40,000	0.497	1,19,280	5,50,000	0.497	2,73,350
Total P.V. of CFAT			8,08,680			17,47,930
Less: Cash Outflows			10,00,000			20,20,000*
N.P.V. =			-1,91,320			- 2,72,070

*Acquisition Cost (including installation cost)	₹ 20,50,000
Less: Salvage Value of existing machine net of Tax	₹ 30,000
	₹ 20,20,000

As the NPV in both the new (alternative) proposals is negative, the company should continue with the existing old Machine.

Question 39

(a) *Company X is forced to choose between two machines A and B. The two machines are designed differently but have identical capacity and do exactly the same job. Machine A costs ₹ 1,50,000 and will last for 3 years. It costs ₹ 40,000 per year to run. Machine B is an 'economy' model costing only ₹ 1,00,000, but will last only for 2 years, and costs ₹ 60,000 per year to run. These are real cash flows. The costs are forecasted in rupees of constant purchasing power. Ignore tax. Opportunity cost of capital is 10 per cent. Which machine company X should buy?*

(b) *Company Y is operating an elderly machine that is expected to produce a net cash inflow of ₹ 40,000 in the coming year and ₹ 40,000 next year. Current salvage value is ₹ 80,000 and next year's value is ₹ 70,000. The machine can be replaced now with a new machine, which costs ₹ 1,50,000, but is much more efficient and will provide a cash inflow of ₹ 80,000 a year for 3 years. Company Y wants to know whether it should replace the equipment now or wait a year with the clear understanding that the new machine is the best of the available alternatives and that it in turn be replaced at the optimal point. Ignore tax. Take opportunity cost of capital as 10 per cent. Advise with reasons.*

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Answer

(a) Statement showing the evaluation of two machines

Machines	A	B
Purchase cost (₹): (i)	1,50,000	1,00,000
Life of machines (years)	3	2
Running cost of machine per year (₹): (ii)	40,000	60,000
Cumulative present value factor for 1-3 years @ 10% (iii)	2.486	–
Cumulative present value factor for 1-2 years @ 10% (iv)	–	1.735
Present value of running cost of machines (₹): (v)	99,440	1,04,100
	[(ii) × (iii)]	[(ii) × (iv)]
Cash outflow of machines (₹): (vi) = (i) + (v)	2,49,440	2,04,100
Equivalent present value of annual cash outflow	1,00,338	1,17,637
	[(vi) ÷ (iii)]	[(vi) ÷ (iv)]

Decision: Company X should buy machine A since its equivalent cash outflow is less than machine B.

(b) Statement showing present value of cash inflow of new machine when it replaces elderly machine now

NPV of New Machine

PV of Cash Inflow (80000 x 2.486)	1,98,880
Less: Purchase Cost of New Machine	1,50,000
	48,880

Since NPV of New Machine is positive, it should be purchased.

Timing Decision

Replace Now

Current Realizable Value	80,000
NPV of New Machine	48,880
Total NPV	1,28,880

Replace after 1 Year

Cash Inflow for Year 1	40000

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Realisable Value of Old Machine	70000
NPV of New Machine	48,880
Total NPV after 1 Year	1,58,880
PV of Total NPV (158880/1.1)	1,44,436

Advise: Since Total NPV is higher in case of Replacement after one year Machine should be replaced after 1 year.

Question 40

A machine used on a production line must be replaced at least every four years. Costs incurred to run the machine according to its age are:

Age of the Machine (years)					
	0	*1*	*2*	*3*	*4*
Purchase price (in ₹)	*60,000*				
Maintenance (in ₹)		*16,000*	*18,000*	*20,000*	*20,000*
Repair (in ₹)		*0*	*4,000*	*8,000*	*16,000*
Scrap Value (in ₹)		*32,000*	*24,000*	*16,000*	*8,000*

Future replacement will be with identical machine with same cost. Revenue is unaffected by the age of the machine. Ignoring inflation and tax, determine the optimum replacement cycle. PV factors of the cost of capital of 15% for the respective four years are 0.8696, 0.7561, 0.6575 and 0.5718.

Answer

Working Notes

First of all we shall calculate cash flows for each replacement cycle as follows:

One Year Replacement Cycle ₹

Year	Replacement Cost	Maintenance & Repair	Residual Value	Net cash Flow
0	(60,000)	-	-	(60,000)
1	-	(16,000)	32,000	16,000

Two Years Replacement Cycle ₹

Year	Replacement Cost	Maintenance & Repair	Residual Value	Net cash Flow
0	(60,000)	-	-	(60,000)
1	-	(16,000)	-	(16,000)
2	-	(22,000)	24,000	2,000

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Three Years Replacement Cycle ₹

Year	Replacement Cost	Maintenance & Repair	Residual Value	Net cash Flow
0	(60,000)	-	-	(60,000)
1	-	(16,000)	-	(16,000)
2	-	(22,000)	-	(22,000)
3	-	(28,000)	16,000	(12,000)

Four Years Replacement Cycle ₹

Year	Replacement Cost	Maintenance & Repair	Residual Value	Net cash Flow
0	(60,000)	-	-	(60,000)
1	-	(16,000)	-	(16,000)
2	-	(22,000)	-	(22,000)
3	-	(28,000)	-	(28,000)
4	-	(36,000)	8,000	(28,000)

Now we shall calculate NPV for each replacement cycles

		1 Year		2 Years		3 Years		4 Years	
Year	PVF@ 15%	Cash Flows	PV	Cash Flows	PV	Cash Flows	PV	Cash Flows	PV
0	1	-60,000	-60,000	-60,000	-60,000	-60,000	-60,000	-60,000	-60,000
1	0.8696	16,000	13,914	-16,000	-13,914	-16,000	-13,914	-16,000	-13,914
2	0.7561	-	-	2,000	1,512	-22,000	-16,634	-22,000	-16,634
3	0.6575	-	-	-	0	-12,000	-7,890	-28,000	-18,410
4	0.5718	-	-	-	0		0	-28,000	-16,010
			-46,086		-72,402		-98,438		-1,24,968

Replacement Cycles		EAC (₹)
1 Year	$\frac{46,086}{0.8696}$	52,997
2 Years	$\frac{72,402}{1.6257}$	44,536
3 Years	$\frac{98,438}{2.2832}$	43,114

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4 Years	$\frac{1,24,968}{2.855}$	43,772

Since EAC is least in case of replacement cycle of 3 years hence machine should be replaced after every three years.

Note: Alternatively Answer can also be computed by excluding initial outflow as there will be no change in final decision.

Question 41

Trouble Free Solutions (TFS) is an authorized service center of a reputed domestic air conditioner manufacturing company. All complaints/ service related matters of Air conditioner are attended by this service center. The service center employs a large number of mechanics, each of whom is provided with a motor bike to attend the complaints. Each mechanic travels approximately 40000 kms per annuam. TFS decides to continue its present policy of always buying a new bike for its mechanics but wonders whether the present policy of replacing the bike every three year is optimal or not. It is of believe that as new models are entering into market on yearly basis, it wishes to consider whether a replacement of either one year or two years would be better option than present three year period. The fleet of bike is due for replacement shortly in near future.

The purchase price of latest model bike is ₹ 55,000. Resale value of used bike at current prices in market is as follows:

Period	₹
1 Year old	35,000
2 Year old	21,000
3 Year old	9,000

Running and Maintenance expenses (excluding depreciation) are as follows:

Year	Road Taxes Insurance etc. (₹)	Petrol Repair Maintenance etc. (₹)
1	3,000	30,000
2	3,000	35,000
3	3,000	43,000

Using opportunity cost of capital as 10% you are required to determine optimal replacement period of bike.

Answer

In this question the effect of increasing running cost and decreasing resale value have to be

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weighted upto against the purchase cost of bike. For this purpose we shall compute Equivalent Annual Cost (EAC) of replacement in different years shall be computed and compared.

Year	Road Taxes (₹)	Petrol etc. (₹)	Total (₹)	PVF @10%	PV (₹)	Cumulative PV (₹)	PV of Resale Price (₹)	Net Outflow (₹)
1	3,000	30,000	33,000	0.909	29,997	29,997	31,815	(1,818)
2	3,000	35,000	38,000	0.826	31,388	61,385	17,346	44,039
3	3,000	43,000	46,000	0.751	34,546	95,931	6,759	89,172

Computation of EACs

Year*	Purchase Price of Bike (₹)	Net Outflow (₹)	Total Outflow (₹)	PVAF @ 10%	EAC♣ (₹)
1	55,000	(1,818)	53,182	0.909	58,506
2	55,000	44,039	99,039	1.735	57,083
3	55,000	89,172	1,44,172	2.486	57,993

Thus, from above table it is clear that EAC is least in case of 2 years, hence bike should be replaced every two years.

Question 42

DEF Ltd has been regularly paying a dividend of ₹ 19,20,000 per annum for several years and it is expected that same dividend would continue at this level in near future. There are 12,00,000 equity shares of ₹ 10 each and the share is traded at par.

The company has an opportunity to invest ₹ 8,00,000 in one year's time as well as further ₹ 8,00,000 in two year's time in a project as it is estimated that the project will generate cash inflow of ₹ 3,60,000 per annum in three year's time which will continue for ever. This investment is possible if dividend is reduced for next two years.

Whether the company should accept the project? Also analyze the effect on the market price of the share, if the company decides to accept the project.

Answer

First we calculate cost of Equity (K_e)/PE Ratio

* Assume these periods are the periods from which bike shall be kept in use.

♣ EAC is used to bring Cash Flows occurring for different periods at one point of Time.

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$D_1 = \frac{19,20,000}{12,00,000} = 1.6$

$P_0 = 10$

$K_e = \frac{D}{P} = \frac{₹\ 1.6}{10} = 16\%$

$P/E = \frac{10}{1.6} = 6.25$

Now we shall compute NPV of the project

$$NPV = \frac{-800000}{(1+0.16)} + \frac{-800000}{(1+0.16)^2} + \left[\frac{360000}{0.16} \times \frac{1}{(1+0.16)^2}\right]$$

= -6,89,655 – 5,94,530 + 16,72,117

= 3,87,932

As NPV of the project is positive, the value of the firm will increase by ₹ 3,87,932 and spread over the number of shares e.g. 12,00,000, the market price per share will increase by 32 paisa.

Question 43

Ramesh owns a plot of land on which he intends to construct apartment units for sale. No. of apartment units to be constructed may be either 10 or 15. Total construction costs for these alternatives are estimated to be ₹ 600 lakhs or ₹ 1025 lakhs respectively. Current market price for each apartment unit is ₹ 80 lakhs. The market price after a year for apartment units will depend upon the conditions of market. If the market is buoyant, each apartment unit will be sold for ₹ 91 lakhs, if it is sluggish, the sale price for the same will be ₹ 75 lakhs. Determine the value of vacant plot of land. Assuming that the construction cost will remain same in year 1 should Ramesh start construction now or keep the land vacant? The yearly rental per apartment unit is ₹ 7 lakhs and the risk free interest rate is 10% p.a.

Assume that the construction cost will remain unchanged.

Answer

Presently 10 units apartments shall yield a profit of ₹ 200 lakh (₹ 800 lakhs – ₹ 600 lakhs) and 15 unit apartment will yield a profit of ₹ 175 lakh (₹ 1200 lakhs – ₹ 1025 lakhs). Thus 10 units apartment is the best alternative if Ramesh has to construct now.

However, Ramesh waits for 1 year his pay-off will be as follows:

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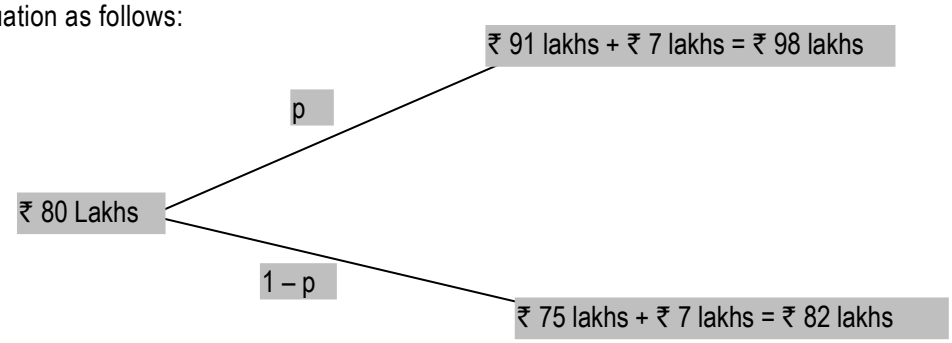
	Market Conditions	
	Buoyant Market	*Sluggish Market*
10 units apartments	₹ 91 lakhs X 10 – ₹ 600 lakhs = ₹ 310 lakhs	₹ 75 lakhs X 10 – ₹ 600 lakhs = ₹ 150 lakhs
15 units apartments	₹ 91 lakhs X 15 – ₹ 1025 lakhs = ₹ 340 lakhs	₹ 75 lakhs X 15 – ₹ 1025 lakhs = ₹ 100 lakhs

Thus if market conditions turnout to be buoyant the best alternative is 15 units apartments and net pay-off will be ₹ 340 lakhs and if market turnout to be sluggish the best alternative is the 10 units apartments and net pay-off shall be ₹ 150 lakhs.

To determine the value of vacant plot we shall use Binomial Model (Risk Neutral Method) of option valuation as follows:



Alternatively student can calculate these values as follows (Sale Value + Rent):

If market is buoyant then possible outcome = ₹ 91 lakh + ₹ 7 lakh = ₹ 98 lakhs

If market is sluggish then possible outcome = ₹ 75 lakh + ₹ 7 lakh = ₹ 82 lakhs

Let p be the probability of buoyant condition then with the given risk-free rate of interest of 10% the following condition should be satisfied:

$$₹\ 80\ \text{lakhs} = \frac{[(p \times ₹\ 98\text{lakhs}) + (1\text{-}p) \times ₹\ 82\text{lakhs}]}{1.10}$$

$$p = \frac{3}{8} \text{ i.e. } 0.375$$

Thus 1-p = 0.625

Expected cash flow next year

0.375 × ₹ 340 lakhs + 0.625 X ₹ 150 lakhs = ₹ 221.25 lakhs

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Present Value of expected cash flow:

₹ 221.25 lakhs (0.909) = ₹ 201.12 lakhs

Thus, the value of vacant plot is ₹ 201.12 lakhs

Since the current value of vacant land is more than profit from 10 units apartments now (₹ 200 lakh) the land should be kept vacant.

Question 44

Ram Chemical is in production Line of Chemicals and considering a proposal of building new plant to produce pesticides. The Present Value (PV) of new proposal is ₹ 150 crores (After considering scrap value at the end of life of project). Since this is a new product market, survey indicates following variation in Present Value (PV):

Condition Favourable in first year	*PV will increase 30% from original estimate*
Condition sluggish in first year	*PV will decrease by 40% from original Figures.*

In addition Rama Chemical has a option to abandon the project at the end of Year and dispose it at ₹ 100 crores. If risk free rate of interest is 8%, what will be present value of put option?

Answer

Decision Tree showing pay off

Year 0	Year 1	Pay off
	195	0
150		
	90	100-90 = 10

First of all we shall calculate probability of high demand (P) using risk neutral method as follows:

8% = p x 30% + (1-p) x (-40%)

0.08 = 0.30 p - 0.40 + 0.40p

$p = \frac{0.48}{0.70} = 0.6857$ say 0.686

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The value of abandonment option will be as follows:

Expected Payoff at Year 1

= p x 0 + [(1-p) x 10] = 0.686 x 0 + [0.314 x 10] = ₹ 3.14 crore

Since expected pay off at year 1 is 3.14 crore, present value of expected pay off will be:

$$\frac{3.14}{1.08} = 2.907 \text{ crore.}$$

This is the value of abandonment option (Put Option).

Question 45

The municipal corporation of a city with mass population is planning to construct a flyover that will replace the intersection of two busy highways X and Y. Average traffic per day is 10,000 vehicles on highway X and 8,000 vehicles on highway Y. 70% of the vehicles are private and rest are commercial vehicles. The flow of traffic across and between aforesaid highways is controlled by traffic lights. Due to heavy flow, 50% of traffic on each of the highways is delayed. Average loss of time due to delay is 1.3 minute in highway X and 1.2 minute in highway Y. The cost of time delayed is estimated to be ₹ 80 per hour for commercial vehicle and ₹ 30 for private vehicle.

The cost of stop and start is estimated to be ₹ 1.20 for commercial vehicle and ₹ 0.80 for private vehicle. The cost of operating the traffic lights is ₹ 80,000 a year. One policeman is required to be posted for 3 hours a day at the crossing which costs ₹ 150 per hour.

Due to failure to obey traffic signals, eight fatal accidents and sixty non-fatal accidents occurred in last 4 years. On an average, insurance settlements per fatal and non-fatal accidents are ₹ 5,00,000 and ₹ 15,000 respectively.

To eliminate the delay of traffic and the accidents caused due to traffic light violations, the flyover has been designed. It will add a quarter of kilometer to the distance of 20% of total traffic. No posting of policeman will be required at the flyover. The flyover will require investment of ₹ 3 Cr. Extra maintenance cost would be ₹ 70,000 a year.

The incremental operating cost for commercial vehicle will be ₹ 5 per km and ₹ 2 for non-commercial vehicle. Expected economic life of the flyover is 30 years having no salvage value. The cost of capital for the project is 8%. (corresponding capital recovery rate is 0.0888).

You are required to calculate:

(i) total net benefits to users,

(ii) annual cost to the state; and

(iii) benefit cost ratio

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Answer

Benefit to the Users (when 365 days taken in a year)

(i)	Annual Savings in Cost of Delays:	
	Highway X (10000 × 365 × 0.50 × $\frac{1.3}{60}$) (0.70 × 30 + 0.30 × 80)	₹ 17,79,375
	Highway Y (8000 × 365 × 0.50 × $\frac{1.2}{60}$) (0.70 × 30 + 0.30 × 80)	₹ 13,14,000
	(a)	₹ 30,93,375
(ii)	Annual Savings in Cost of Stops and Starts	
	Highway X (10000 × 365 × 0.50) (0.70 × 0.80 + 0.30 × 1.20)	₹ 16,79,000
	Highway Y (8000 × 365 × 0.50) (0.70 × 0.80 + 0.30 × 1.20)	₹ 13,43,200
	(b)	₹ 30,22,200
(iii)	Annual Saving in Accidents Claims (c)	
	$\frac{8}{4}$ × 500000 + $\frac{60}{4}$ × 15000 (c)	₹ 12,25,000
	Total Benefits (d) = (a) + (b) + (c)	**₹ 73,40,575**
	Less: Incremental Expenditures due to added distance	
	Highway X (10000 × 365 × 0.20 × 0.25) (0.70 × 2 + 0.30 × 5)	₹ 5,29,250
	Highway Y (8000 × 365 × 0.20 × 0.25) (0.70 × 2 + 0.30 × 5)	₹ 4,23,400
	(e)	**₹ 9,52,650**
	Total Net Benefits (d) – (e)	₹ 63,87,925

Annual Cost to State

Investment Cost (₹ 3,00,00,000 × 0.0888)	₹ 26,64,000
Extra Annual Maintenance	₹ 70,000
	₹ 27,34,000
Less: Saving in Cost of operating traffic lights (₹ 80,000 + 3 × 365 × ₹ 150)	₹ 2,44,250
	₹ 24,89,750

$$\text{Cost Benefit Ratio} = \frac{\text{PV of Benefits}}{\text{PV of Costs}} = \frac{₹\,63,87,925\,\text{PVAF}\left(\frac{1}{0.0888}\right)}{₹\,24,89,750\,\text{PVAF}\left(\frac{1}{0.0888}\right)} = \frac{₹\,7,19,36,092}{₹\,2,80,37,725} = 2.57$$

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