ADVANCED CAPITAL BUDGETING DECISIONS

CA Final | AFM

Last Day Revision Notes / Summary Notes / Concept Notes

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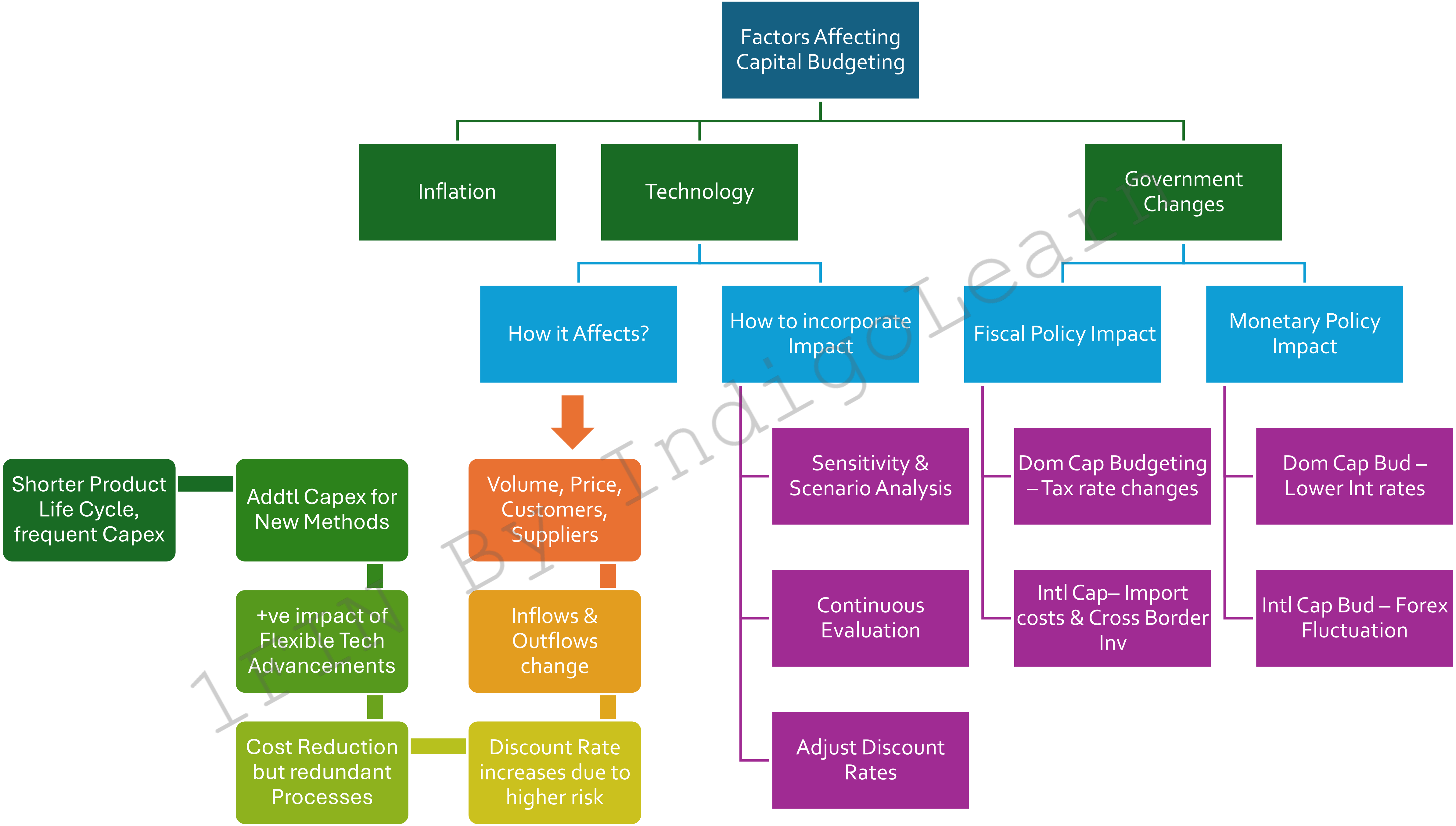
Factors Affecting Capital Budgeting
Inflation
Technology
Government Changes
How it Affects?
How to incorporate Impact
Fiscal Policy Impact
Monetary Policy Impact
Shorter Product Life Cycle, frequent Capex
Addtl Capex for New Methods
Volume, Price, Customers, Suppliers
Sensitivity & Scenario Analysis
Dom Cap Budgeting – Tax rate changes
Dom Cap Bud – Lower Int rates
+ve impact of Flexible Tech Advancements
Inflows & Outflows change
Continuous Evaluation
Intl Cap– Import costs & Cross Border Inv
Intl Cap Bud – Forex Fluctuation
Cost Reduction but redundant Processes
Discount Rate increases due to higher risk
Adjust Discount Rates

$$CFAT = (R - C - D)(1 - T) + D = (R - C)(1 - T) + DT$$

R – Project Revenue | C - Costs Excluding depreciation | D - Depreciation | T - Tax Rate

Nominal Return = Real Return + Inflation

$(1+N) = (1+R)(1+i)$

Nominal CF = Real CF x $(1+i)$

Dealing with Risk & Uncertainty in Investment Decisions

Certain CF

- No Need for Risk Assessment
- No Probability Involved

CF Involving Risk

- Use Probability Adjusted CF
- Req Evaluating potential outcomes & Likelihood

CF Uncertain

- No Probability can be assigned
- Challenging to assess potential outcomes

Why Risk is Adjusted in Cap Bud Decisions?

- Opportunity Cost Considering foregone opportunities
- Risk Premium: IS Return commensurate with Risk

Risk ≠ Uncertainty

Risk : Probabilities can be assigned | Uncertainty : Probabilities cannot be assigned

Factors Affecting Cap Bud Decisions

Internal

- Project-Specific Risks – Location / Environment
- Company-Specific Risks Credit / Management

External

- Industry-Specific Risks: Regulatory / tax / subsidies
- Market-Specific Risks: Supply chain RM shortages
- Competition Risks: New competitors / Tech
- Economic Condition Risks: Inflation, / Interest rate / Forex
- International Risks: Geopolitical Risks / Trade sanctions

Risk Analysis

Statistical Techniques
- Probability
- Variance / SD
- Co-efficient of Variation

Conventional techniques
- RADR
- Certainty Equivalent

Other Techniques
- Sensitivity Analysis
- Scenario Analysis
- Simulation Analysis
- Decision Tree

Expected NCF for a period $= \sum Pi\ NCFi$

For Single Period ENPV $= \sum_{t=1}^{n} \frac{ENCF}{(1+k)^t}$

For Multi-Period ENPV $= \frac{ENCF}{(1+k)^1} + \frac{ENCF}{(1+k)^2} + \cdots \frac{ENCF}{(1+k)^t}$

Variance $\sigma^2 = \sum_{j=1}^{n} (NCF - ENCF)^2$

Multi-Period $\sigma^2 = \frac{\sum(x-\bar{x})^2}{n}$

With Probability $\sigma^2 = \sum Pi(x - \bar{x})^2$

Hiller's Method:

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

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

When Following Text is Used "SD of the PV distribution" or SD about Expected Value"

Co-efficient of Variation:

$= \frac{Standard\ Deviation}{Expected\ Cash\ Flow}$

= Risk Per unit of CF

Lower CV = Lower Risk

SD Vs. Variance
- Variance – Portrays range / spread of cash flow values, emphasizing how far each value deviates from the mean
- SD - quantifies variability or risk associated with the cash flow values

Certainty Equivalent Method

NPV $= \sum \frac{\alpha * NCF}{(1+Rf)^n}$ - *Initial Investment*

$\alpha = \frac{Certain\ CF}{Expected\ CF\ from\ Risky\ Projects}$

Advantages
- Simple & Easy
- Allows adjustments for higher risk in specific years& Easy computation for diff risk levels

Disadvantages
- No objective or mathematical technique for estimating CE.
- CEs subjectively estimated by Mgmt & Ignores Shareholders Risk Perception

Determine NPV of the project with the following information: 1

Initial Outlay of project	₹ 40,000
Annual CFAT - Real	₹ 15,000
Useful life	4 years
Salvage value	Nil
Cost of Capital (Including inflation premium of 10%)	12%

Solution:

Method 1: Discounting Nominal Cash Flows

Year	Real CF	Inflation	Nominal CF	Disc Rate @12%	PV
1	15,000	=(1+10%)^1= 1.1	16,500	0.892	14,718.000
2	15,000	=(1+10%)^2= 1.21	18,150	0.797	14,465.550
3	15,000	=(1+10%)^3= 1.331	19,965	0.712	14,210.693
4	15,000	=(1+10%)^4= 1.4641	21,961.5	0.636	13,967.514
			76,576.5		57,361.76

PVCIF = ₹ 57,362

Initial Investment = ₹ 40,000

NPV = **₹ 17,362**

Method 2: Discounting Real Cash Flows with Real Rate

1+ Nominal Rate = (1+ Real Rate) * (1+ Inflation Rate)

(1+ Real Rate) = *(1+Nominal Rate)/(1+Inflation Rate)*

Real Rate = *(1+Nominal Rate)/(1+Inflation Rate)* -1

= *(1+12%)/(1+10%)* -1

= 1.82%

Year	Real CF	PVF @ 1.82%
1	15,000	0.982
2	15,000	0.965
3	15,000	0.947
4	15,000	0.930
		3.824

PVCIF (real) = 15,000* 3.824

= ₹ 57,366

PVCOF (real) = ₹ 40,000

NPV = **₹ 17,366**

Calculate Coefficient of Variation of Project A and Project B based on the following information: 2

Possible Event	Project A		Project B	
	CF(₹)	Prob	CF(₹)	Prob
A	10000	0.10	26,000	0.10
B	12,000	0.20	22,000	0.15
C	14,000	0.40	18,000	0.50
D	16,000	0.20	14,000	0.15
E	18,000	0.10	10,000	0.10

Solution:

Expected Cash Flows of the project A

Pi	CF	Pi * CF	$\sigma^2 = \sum Pi\,(x-\bar{x})^2$
0.1	10,000	1,000	$0.1\,(10{,}000 - 14{,}000)^2$
0.2	12,000	2,400	$0.2\,(12{,}000 - 14{,}000)^2$
0.4	14,000	5,600	$0.4\,(14{,}000 - 14{,}000)^2$
0.2	16,000	3,200	$0.2\,(16{,}000 - 14{,}000)^2$
0.1	18,000	1,800	$0.1\,(18{,}000 - 14{,}000)^2$
Total		14,000	48,00,000

σ^2 = **48,00,000** | σ = **2,190.89** | **CV = 2190/14000 = 0.1565**

Expected Cash Flows of the project B

Pi	CF	Pi * CF	$\sigma^2 = \sum Pi\,(x-\bar{x})^2$
0.10	26,000	2,600	$0.1\,(26{,}000 - 18{,}000)^2$
0.15	22,000	3,300	$0.15\,(22{,}000 - 18{,}000)^2$
0.50	18,000	9,000	$0.5\,(18{,}000 - 18{,}000)^2$
0.15	14,000	2,100	$0.15\,(14{,}000 - 18{,}000)^2$
0.10	10,000	1,000	$0.1\,(10{,}000 - 18{,}000)^2$
Total		18,000	1,76,00,000

σ^2 = **1,76,00,000** | σ = **4,195.235** | **CV = 0.2331**

3 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?

Solution:

Expected NPV @ 6%

Year	0	1	2	3
Cash Flow (WN1)	(50)	27	29.3	27.9
PVF @6%	1	0.943	0.890	0.840
	(50)			74.97
NPV				24.974

Variance and SD of Cash Flow

Year	1	2	3
σ^2	85.4	98.61	74.29
σ	9.2412	9.9302	8.619

Expected Value of the Deviation – Hiller's Method

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

$$= \sqrt{206.4855}$$

= **₹ 14.3696 lakhs**

Standard Deviation identifies risk in cash flows. Using this, coefficient of variation can be computed and per unit of cashflows, how much risk is taken can be measured and decision on capital budgeting can be taken.

Standard Deviation and Variance

$\sigma^2 \quad = \sum P_i(x - \bar{x})^2$

Year 1

0.1* $(14-27)^2$ = 16.9

0.2* $(18-27)^2$ = 16.2

0.4* $(25-27)^2$ = 1.6

0.3* $(40-27)^2$ = 50.7

σ^2 = 85.4

σ = 9.2412

Year 2

0.1* $(15-29.3)^2$ = 20.449

0.3* $(20-29.3)^2$ = 25.947

0.4* $(32-29.3)^2$ = 2.916

0.2* $(45-29.3)^2$ = 49.298

σ^2 = 98.61

σ = 9.9302

Year 3

0.2* $(18-27.9)^2$ = 19.602

0.5* $(25-27.9)^2$ = 4.205

0.2* $(35-27.9)^2$ = 10.082

0.1* $(48-27.9)^2$ = 40.401

σ^2 = 74.29

σ = 8.619

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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.

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. SD of each Prob distribution.
(iii) Compute the profitability index of each project.
(iv) Which project do you recommend? State with reasons

Solution:

A			B		
P_i	CF	P_i *CF	P_i	CF	P_i *CF
0.2	15,000	3,000	0.1	15,000	1,500
0.3	12,000	3,600	0.4	12,000	4,800
0.3	6,000	1,800	0.4	6,000	2,400
0.2	3,000	600	0.1	3,000	300
1.0		**9,000**			**9,000**

Expected NPV of Project A and B are ₹ 9,000 each.

σ_A^2 = 0.2(15,000-9,000)² + 0.3(12,000-9,000)² +0.3(6,000-9,000)² +0.2(3,000-9,000)² = 1,98,00,000

σ = **4,449.72**

σ_B^2 = 0.1(15,000-9,000)² + 0.4(12,000-9,000)² +0.4(6,000-9,000)² +0.1(3,000-9,000)² = 1,44,00,000

σ = **3,794.73**

Profitability Index of each project

	A	B
NPV	9,000	9,000
Add: Outflow	36,000	30,000
Inflow	45,000	39,000

Profitability Index $= \frac{Discounted\ Cash\ Inflow}{Intial\ Outflow}$

A $= \frac{45,000}{36,000} =$ **1.25**

B $= \frac{39,000}{30,000} =$ **1.30**

Project B has lower standard Deviation of Cash Flow at ₹ 3,794.73 for the same NPV of ₹ 9,000 and for a lower investment of ₹ 30,000 implying a higher Profitability Index of 1.3, hence **project B should be chosen**.

Conventional Techniques Imp Points

- Cannot adjust both CF & Discount rate - Only one
- Nature of uncertainty / risk associated with the project determines adjustment of CF / Disc Rate
- Contributes to Informed Decision Making

$$RADR, k_c = R_f + Risk\ Premium$$

$$\text{Profitability Index} = \frac{PV\ of\ CF}{Initial\ Investment}$$

RADR Adv	Dis Adv
Easy	Risk Premium Difficult to find out
Risk Premium in Disc Factor	NPV yes – SD No

Senstivity Analysis. Adv	Dis Adv
Identifies Critical Factors	Assumes Independence of Variables
Simple	Ignores Probability

Sensitivity Analysis Process

1. Identify Variables impacting project NPV / IRR
2. Establish relationship with NPV or IRR.
3. Adjust 1 variable at a time while keeping other variables constant to analyse its impact on NPV or IRR.
4. Identify which variables & (their sensitivity level) have the most significant impact on NPV or IRR.

- **Scenario analysis** evaluates multiple scenarios involving simultaneous changes in input variables.
- Best/ base/ worst-case Scenarios

Advantages:

- Considers multiple changes at once, providing a more comprehensive view
- Incorporates diverse scenarios, covering a range of potential business conditions

Disadvantages

- The range might still be limited and not cover all possible real-world situations
- Can be complex and challenging to manage due to a large number of variables and scenarios possible.

Differences	Sensitivity Analysis	Scenario Analysis
Scope	1 Variable change	Simultaneous Multiple variable changes
Complexity	Simple	Complex
Outcomes	Simplistic Outcomes	Varied & Comprehensive outcomes
Approach	No Correlation	Possibility of Multiple Correlated Factors

5 If Investment proposal costs ₹ 45,00,000 and risk-free rate is 5%, calculate net present value under certainty equivalent technique:

Year	Expected cash flow (₹)	Certainty Equivalent coefficient
1	10,00,000	0.90
2	15,00,000	0.85
3	20,00,000	0.82
4	25,00,000	0.78

Solution:

Cash outflow for Year 0 is ₹ 45 Lakhs

Year	0	1	2	3	4
CF in ₹ Lakhs	(45)	10	15	20	25
PVF @5%	1	0.952	0.907	0.864	0.823
DCF		9.524	13.605	17.277	20.568
∝		0.90	0.85	0.82	0.78
DCF * ∝		8.5716	11.56425	14.16714	16.04304

PVCIF = 50.34603 Lakhs
Less: COF = 45 Lakhs
NPV = **₹ 5.34603 Lakhs**

6 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:

(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?

Solution:

Initial Investment = ₹ 4,00,000

Cash Flows (Year 1–5) (Expected) = 0.3* 1,00,000 + 0.5* 1,10,000 + 0.2* 1,20,000 = **₹ 1,09,000**

Salvage Value = 0.3* 20,000 + 0.5* 50,000 + 0.2* 60,000 = ₹ **43,000**

Present Value Factor @ 10% Cost of Capital

PVF_A (5,10%)	= 3.7908* 1,09,000	= ₹ 4,13,195.76
PVF (5,10%)	= 0.6209* 43,000	= ₹ 26,699.61
Total		= **₹ 4,39,895.37**

i) Net Present Value = PV of Cash Inflows – PV of Cash Outflows

= 4,39,895.37– 4,00,000

= **₹ 39,895.37**

NPV in best and worst cases

	Best Case	Worst Case
Per year Cash flow (a)	1,20,000	1,00,000
PVF_A (b)	3.7908	3.7908
A= (a)* (b)	4,54,896	3,79,080
Salvage Value (c)	60,000	20,000
PVF (Year 5) (d)	0.6209	0.6209
B= (c)* (d)	37,254	12,418
A+B	4,92,150	3,91,498
Less: Investment	4,00,000	4,00,000
NPV	92,150	(8,502)

Cash flows perfectly Dependent Overtime

First year cash flows determine cash flow of all subsequent years, of which probability is provided 0.3.

Cash flows are Independent Overtime. Probability of worst case in all 5 years,

= 0.3*0.3*0.3*0.3*0.3 = 0.00243

Most Likely NPV = -4,00,000+1,10,000*3.7908 + 50,000*0.620 = 48,033

σ^2 = 0.3(-8,502-39,895)² + 0.5(48,033-39,895)² + 0.2(92,150-39,895)²

= 1,28,19,11,409.4

σ = 35,803.79

Coefficient of Variation = $\frac{\sigma}{ENPV} = \frac{35803.79}{39895}$ = **0.897**

Because Coefficient of Variation is 0.897, which is less than 0.95, the cost of capital will be 100 bps lower than 10% i.e it will 9%. 9% is RADR. ENPV of project at 9% Cost of Capital:

Year	PVF@ 9%	
Year 0	1	4,00,000 Investment
Year 1-5	3.889	1,09,000 Inflow
Year 5	0.6499	43,000 Salvage
	NPV	₹ 51,919.03

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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.

Solution:

Project NPV for the given data

Year	0	1	2	3
Cash Flow (WN1)	– 10,00,000	4,00,000	6,00,000	6,00,000
PVF @10%	1	0.909	0.8264	0.7513
PVCIF	-10,00,000	3,63,636.36	4,95,867.76	4,50,788.8
NPV	-10,00,000			13,10,293
NPV	3,10,293			

Method 1: Sensitivity, when Selling Price reduces by 10%

Year	0	1	2	3
Cash Flow (WN1)	– 10,00,000	2,80,000	4,20,000	4,20,000
PVF @10%	1	0.909	0.8264	0.7513
PVCIF	-10,00,000	2,54,545.45	3,47,107.44	3,15,552.22
NPV	-10,00,000			9,17,205.11
NPV	-82,794.89			

From a 10% reduction in selling price, the NPV fell by ₹ 3,93,087.89 to ₹ –82,794 from 3,10,293 i.e., a reduction of **126.68%**

Method 2: At what Selling Price will NPV be zero.

Let S be the sale price,

$$\left\{\frac{(S-40)*20{,}000}{1.1}+\frac{(S-40)*30{,}000}{1.1^2}+\frac{(S-40)*30{,}000}{1.1^3}\right\}-10{,}00{,}000=0$$

-36,20,586 +65,514.65 S= 0 => **S = 55.26**

At price of ₹ 55.26, i.e., a reduction in Selling Price by ₹ 4.74, i.e., a **reduction of 7.89%** the NPV reduces by 100% to zero.

Change in Unit Cost: **Method 1:** Unit Cost Increases by 10% from 40 to 44

Year	0	1	2	3
Cash Flow (WN 3)	-10,00,000	3,20,000	4,80,000	4,80,000
PV @10%	-10,00,000			10,48,234.41
NPV				₹ 48,234.41

Reduction in NPV = 3,10,293 – 48,234

= ₹ 2,62,058 **= 84.45%**

For 10% increase in cost, the NPV reduces by 84.45%

Method 2: At what cost, NPV will be zero

Year	0	1	2	3
Cash Flow (WN 3)	-10,00,000	(60-c)*20,000	(60-c)*30,000	(60-c)*20,000
		1.1	1.21	1.31

29,30,879 – 65,514.6 C = 0

C = 44.736

If Cost increases by **11.84%** i.e., ₹ 4.736 from ₹ 40 to ₹ 44.736, the NPV will reduce by 100% to zero.

Method 1: Reduction in Sales Volume by 10%

Year	0	1	2	3
C.F (WN 4)	= (10,00,000)	= 20* 18,000 = 3,60,000	=20* 27,000 = 5,40,000	=20*27,000 = 5,40,000

PV @ 10% = ₹ 1,79,263

Reduction from original NPV ₹ 3,10,293 = ₹ 1,31,029 **= 42.22%**

10% reduction in volume, reduces NPV by 42.22%

Method 2: At what volume will NPV be zero.

Since volume reduction is common across all 3 yrs, the reduced NPV equation for NPV @ 0

- Outflow+ current Inflow (1-x) = D
- 10,00,000+ 13,10,293(1-x) = 3,10,293- 3,10,293

3,10,293 = 13,10,293 x

$$x = \frac{310293}{1310293}$$

x = **23.68%**

Method 1: 10% increase in Outlay (₹ 1,00,000)

₹ 1,00,000 increase in outlay, reduces NPV by ₹ 1,00,000 i.e., 10% for ₹ 3,10,293 to ₹ 2,10,293 i.e., a reduction of **32.2276%**

Method 2: Increase in Outflow to be zero

Current Outflow = ₹ 10,00,000

Current Inflow = ₹ 13,10,293

Increase in outflow for NPV to be zero, is increase of ₹ 3,10,293 i.e., **31.03%** for NPV to reduce by 100%.

Method 1: If project life time reduces by 10%, i.e., from 3years to 2.7 years, last year reduction from 1 year to 0.7 years

Year	0	1	2	3
CF	(10,00,000)	4,00,000	6,00,000	6,00,000
Period	1	1	1	0.7
PV @ 10%	(10,00,000)	11,75,056		
NPV	1,75,056			

Reduction for 3,10,293 to 1,75,056 = **43.58%**

Method 2: At what period will NPV be zero.

Amount received in years 1 and 2

= 4,00,000/1.1 + 6,00,000/1.21 = ₹ 8,59,504

Balance to be recovered in PV terms = 10,00,000 – 8,59,504 = 1,40,496

Amount to be recovered in FV terms = 1,40,496 X 1.331 = 1,87,000

Total units manf per day = 30000 / 365 = 82.19 units

Profit per unit = ₹20

Per day profit = 82.19 x 20 = ₹1643.84

No of days of profit required = ₹1,87,000 / ₹1643.84 = 113.76 days.

Unit has to operate for 114 days in Year 3. i.e a reduction of 251 days in Yr 3.

So total period reduction = 251/1095 x 100 = 22.92 %

	Impact on NPV of a 10% Reduction	Change required for NPV= 0
Selling Price	126.68	7.89
Cost	84.45	11.84
Volume	42.22	23.68
Outlay	32.23	31.03
Time	43.58	22.92

Involves depicting decision-making processes via a branching tree-like structure, where choices and potential outcomes are evaluated sequentially.

Decision trees assist in assessing multiple scenarios, weighing outcomes, and making rational investment decisions.

Probabilities associated with chance nodes indicate the likelihood of specific outcomes, providing a nuanced understanding of potential scenarios.

The evaluation starts from the right (decision nodes) and progresses leftwards, assessing alternatives logically based on monetary implications.

Key Nodes and Components:

- Decision nodes: Points where choices are made regarding various alternatives.
- Events/ Chance nodes: Represent outcomes or events with associated probabilities.
- Outcomes: Depicted as circles, representing potential results of decisions and events.

Structure of a Decision Tree:

- Outcomes, such as good, bad, best case, worst case, or proceed / don't proceed, reflect potential scenarios branching from decision points.
- Tree structure denotes a hierarchy where outcomes are evaluated systematically, leading from right to left.
- The analysis begins by computing NPV at end nodes, moving backward to determine the most rational path.
- Rational decisions are made by choosing paths that maximize profits or minimize costs, not driven by personal preferences.

Steps in Decision Tree Analysis

Define the investment problem. → Identify alternatives for evaluation. → Draw a decision tree. → Evaluate alternatives using the decision tree structure. → Make a rational decision based on maximizing profits or minimizing costs.

Working Notes

Selling Price = ₹ 60/ Unit |Cost = ₹ 40/ unit =>Contribution = ₹ 20/ unit

Year 1 = 20,000 units, Cash flow = ₹ 4,00,000
Year 2 = 30,000 units, Cash flow = ₹ 6,00,000
Year 3 = 30,000 units, Cash flow = ₹ 6,00,000
Selling Price reduces by 10%

Selling Price = ₹ 54/ unit | Cost = ₹ 40/ unit=> Contribution = ₹ 14/ unit
Year 1 = 20,000 units, Cash flow = ₹ 2,80,000
Year 2 = 30,000 units, Cash flow = ₹ 4,20,000
Year 3 = 30,000 units, Cash flow = ₹ 4,20,000

Unit Cost increase by 10%
Selling Price = ₹ 60 / unit |Cost = ₹ 40+ 10% = ₹ 44=> Profit = ₹ 16
Year 1 = 20,000 units*16 Cash flow = ₹ 3,20,000
Year 2 = 30,000 units*16 Cash flow = ₹ 4,80,000
Year 3 = 30,000 units*16 Cash flow = ₹ 4,80,000

Reduction in Sales Volume

Year	Volume	%	Revised Volume
Year 1	20,000 units	10%	18,000
Year 2	30,000 units	10%	27,000
Year 3	30,000 units	10%	27,000

8 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).

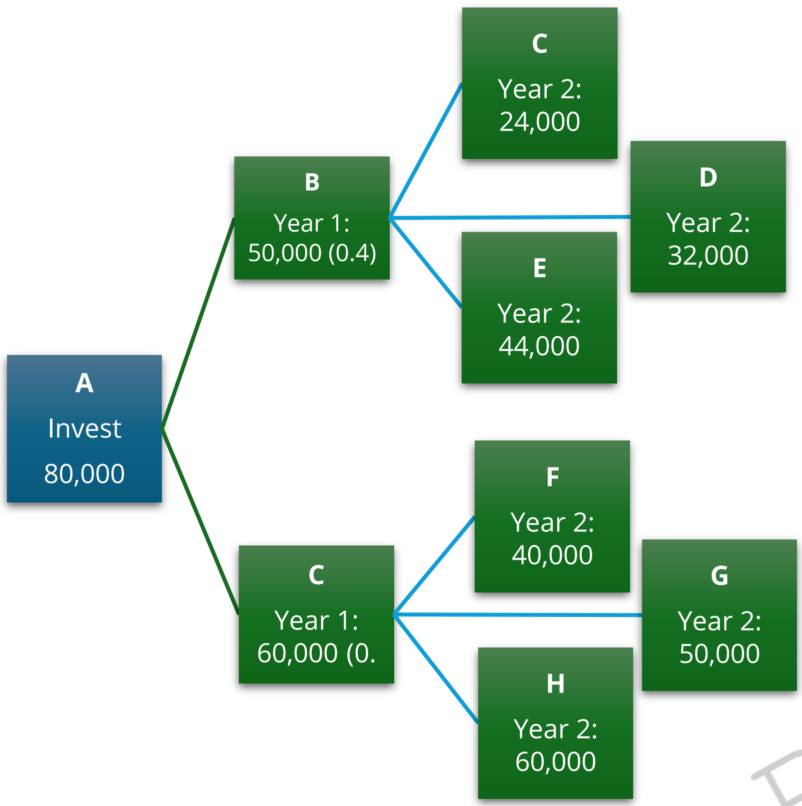
(ii) What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?

(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)

Solution:



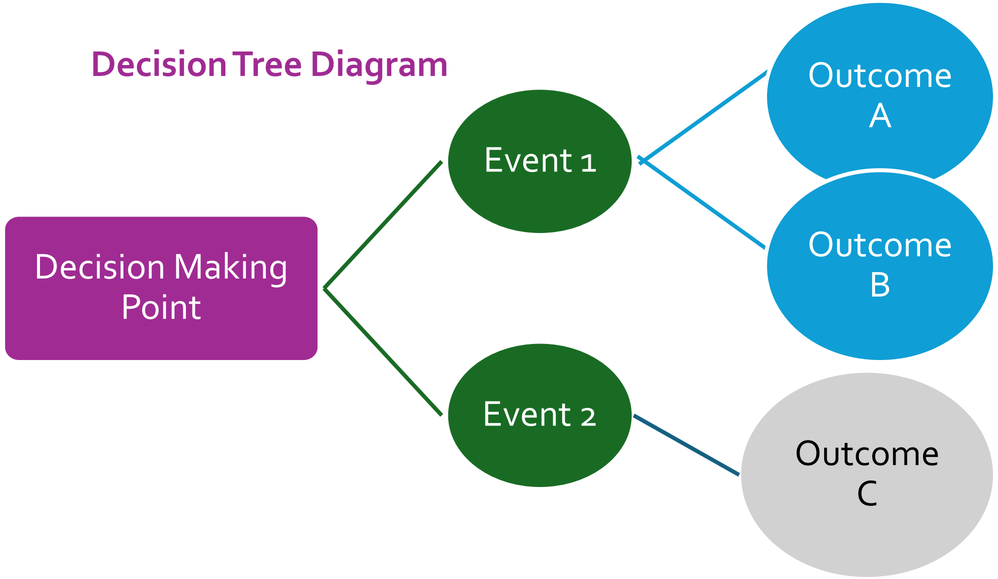
Expected Value

Part	Year 1 Cf* PV	Year 2 Cf*PV	– Invest	NPV (1)	Joint Probability (2)	(1)* (2)
1	= 50,000*0.909 = 45,450	= 24,000*0.826 = 19,824	– 80,000	–14,726	= 0.4*0.2 = 0.08	–1,178.08
2	45,450	= 32,000*0.826 = 26,432	– 80,000	–8,118	= 0.4*0.3 = 0.12	–974.16
3	45,450	= 44,000*0.826 = 36,344	– 80,000	1,794	= 0.4*0.5 = 0.2	358.8
4	= 60,000*0.909 = 54,540	= 40,000*0.826 = 33,040	– 80,000	7,580	= 0.6*0.4 =0.24	1,819.2
5	54,540	= 50,000*0.826 = 41,300	– 80,000	15,840	= 0.6*0.5 = 0.3	4,752
6	54,540	= 60,000*0.826 = 49,560	– 80,000	24,100	= 0.6*0.1 = 0.06	1,446
						6,223.76

Expected Value = **₹ 6,223.76**

- If worst outcome is realised, the NPV will be **–₹ 14,726** and probability will be 0.08
- If best outcome is realised, the NPV will be **–₹ 24,100** and probability will be 0.06
- Yes, the project is accepted as the expected value of NPV is positive at **₹ 6,223.76.**

Decision Tree Diagram



Monte Carlo Simulation involves choosing random paths using a random number generator and analysing multiple outcomes to create a distribution curve, showcasing a range of potential results.

Parameters
- Input variables controlled by the investor in a simulation model, representing factors within their control, such as investment costs or interest rates.

Exogenous Variables
- Uncontrollable inputs with stochastic nature, such as market prices, which exhibit probability distributions without precise predictability.

Stochastic Variables:
- These variables cannot be precisely determined but possess probability distributions, contributing to the uncertainty within the simulation model.

Steps in Monte Carlo Simulation

Model Creation
- Identify Exogenous (Stochastic / random) Variables
- Determine Input Parameters
- Develop a Model Eg: NPV

Parameter Specification
- Assign Parameter Values
- Define Probability Distribution

Random Value Selection
- Generate Random Numbers
- Map to Probability Distribution

Iterative Process
- Choose Exogenous Variables
- Repeat Iteratively:

NPV Computation
- Calculate NPV

Analysis and Visualization
- Plot NPV Probability Distribution
- Compute Mean and Standard Deviation

With i = 10%, I = ₹ 1,30,000, CF t & n stochastic exogenous variables with the following distribution will be as under:

Annual Cash Flow		Project Life	
₹	**Probability**	**Year**	**Probability**
10,000	0.02	3	0.05
15,000	0.03	4	0.10
20,000	0.15	5	0.30
25,000	0.15	6	0.25
30,000	0.30	7	0.15
35,000	0.20	8	0.10
40,000	0.15	9	0.03
Total	**1.00**	**10**	**0.02**

Random Numbers

53479	81115	98036	12217	59526
97344	70328	58116	91964	26240
66023	38277	74523	71118	84892
99776	75723	03172	43112	83086
30176	48979	92153	38416	42436
81874	83339	14988	99937	13213
19839	90630	71863	95053	55532
09337	33435	53869	52769	18801
31151	58295	40823	41330	21093
67619	52515	03037	81699	17106

Correspondence between Values of Exogenous Variables and Two Digit Random Numbers:

Annual Cash Flow				Project Life			
Value (₹)	**Prob**	**Cumu. Pro**	**2 Digit Random No.**	**Year**	**Prob**	**Cumu. Pro**	**2 Digit Random No.**
10,000	0.02	0.02	00 – 01	3	0.05	0.05	00 – 04
15,000	0.03	0.05	02 – 04	4	0.10	0.15	05 – 14
20,000	0.15	0.20	05 – 19	5	0.30	0.45	15 – 44
25,000	0.15	0.35	20 – 34	6	0.25	0.70	45 – 69
30,000	0.30	0.65	35 – 64	7	0.15	0.85	70 – 84
35,000	0.20	0.85	65 – 84	8	0.10	0.95	85 – 94
40,000	0.15	1.00	85 – 99	9	0.03	0.98	95 – 97
				10	0.02	1.00	98 – 99

Run	Random No. (Annual Cash Flow)	Corresponding Value of Annual Cash Flow (1)	Random No. (Project Life)	Corresponding Value of Project Life	PVAF @ 10% (2)	NPV (1) × (2) – 1,30,000
1	53	30,000	97	9	5.759	42,770
2	66	35,000	99	10	6.145	85,075
3	19	25,000	81	7	4.868	(8,300)
4	31	20,000	09	4	3.170	(66,600)
5	31	25,000	67	6	4.355	(21,125)
6	81	35,000	70	7	4.868	40,380
7	48	30,000	75	7	4.868	16,040
8	30	40,000	33	5	3.791	21,640
9	90	40,000	33	5	3.791	21,640
10	58	30,000	52	6	4.355	650

Monte Carlo Simulation Adv & Dis Adv

Advantages

- Provides a range of potential bad outcomes beforehand
- Capable of managing and incorporating exogenous variables
- Considers complex interdependencies between variables
- Compels Decision Makers to consider interdependencies & uncertainties

Disadvantages

- Difficulty to model & Specify Probability Distribution
- Lack of Precision
- Complex Modelling by Experts
- Risk Assessment and NPV Impact

Steps in Replacement Decision

Step 1: Net Cash flow = Cost of new Machine – (Tax saving + market value of old machine) **[NCOF is *negative value]***

Tax Savings of Old Machine = (BV - MV)*Tax Rate

Step 2: Cash Flow per Year = (Change in Sales +/- Change in Operating Cost – Change in Depreciation) × (1- Tax) + Change in Depreciation

Or

(Change in Sales +/- Change in Operating Cost) ×(1- Tax) + (Change in Depreciation × Tax)

Step 3: Present Value of Cashflows = Present Value of Yearly Cash Flows (Step 2) + Present Value of Salvage value of New Machine

Step 4: NPV = Step 1 [cash outflow i.e -ve value] + Step 3 [cash inflow i.e +ve value]

9

A Company named Roby's cube decided to replace the existing Computer system of their organization. The original cost of the old system was ₹ 25,000 and it was installed 5 years ago. Current market value of old system is ₹ 5,000. Depreciation of the old system was charged with life of 10 years with Estimated Salvage value as Nil. Depreciation of the new system will be charged with life over 5 years. Present cost of the new system is ₹ 50,000. Estimated Salvage value of the new system is ₹ 1,000. Estimated cost savings with the new system is ₹ 5,000 per year. Increase in sales with new system is assumed at 10% per year based on original total sales of ₹ 1,00,000. Company follows straight line method of depreciation. The cost of capital of the company is 10% whereas tax rate is 30%. Evaluate the replacement decision

Solution:

	Old System	New System
Original Cost	25,000	50,000
Original Life	10 years	5 years
Life Expected	5 years	0
Market Value (Today)	5,000	
Salvage Value (10 yrs)	0	1,000
Savings		5,000
Sales	1,00,000	
Increase In Sales		10,000 p.a
Depreciation	SLM	SLM
Kc	10%	10%
Tax	30%	30%

STEP 1:

Cash Outflow of New System + Cash Inflow of Old System

= –50,000 + 7,250 = **–42,750**

Calculation:

Book Value of Old System

Depreciation = $\frac{25{,}000-0}{10}$ = ₹ 2,500

Life Exhausted = 5 years

Depreciation for 5 years = 5* 2500 = 12,500

Current Book Value = 25,000– 12,500 = ₹ 12,500

Cash Inflow from Old System

i) Market Value = ₹ 5,000

ii) Tax Benefit on Loss = (Book Value – Market Value) * Tax Rate

= (12,500–5,000)*30% = ₹ 2,250

Cash Inflow = 5,000+ 2,250 = 7,250

Cash Outflow from New System = – 50,000

STEP 2: Changes in Annual Cash Flows

= (Change in Sales+ Change in Savings) (1–t) + (Change in Depreciation)*t

= (15,000) *(1-30%) + 7,300*30%

= 10,500+ 2,190 = **₹ 12,690**

Calculation:

i) Increase in Sales = ₹ 1,00,000* 10% = ₹ 10,000

ii) Savings = ₹ 5,000

iii) Change in Depreciation

= New depreciation – Old Depreciation

= 9,800 – 2,500 = 7,300

New depreciation = (Original cost – Salvage Value)/Life

= 50000-1000/5 = 9,800

STEP 3: PV of Annual Cash Flow @10% for 5 Years

= (12,690* 3.790786) + (1000*0.62092)

= 48,105.08 + 620.92 = **₹ 48,726**

STEP 4: PV of Cash Inflow+ PV of Cash Outflow

= 48,726– 42,750 = **₹ 5,976**

STEP 5: Since NPV>0, the replacement **decision is correct**.

Optimum Replacement Cycle

$$\text{Equivalent Annual Cost (EAC)} = \frac{\text{Present Value of Cash Outflow (PVCF)}}{\text{Present Value Annuity Factor(PVAF)}}$$

Lower EAC values indicate lower annual costs associated with replacements over the project's life.

Adjusted Present Value

Base Case NPV (on unlevered cost of capital) + PV of tax benefits on interest

10

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:

Machine Age (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.

Solution:

Replacement Cycle:

Repl. Cycle Years		1		2	
Year	**PVF 15%**	**CF**	**PVCF**	**CF**	**PVCF**
0	1	-60,000	-60,000	-60,000	-60,000
1	0.896	16,000	13,913.6	-16,000	-13,913.6
2	0.7561			2,000	1,512.2
3	0.6575				
4	0.5718				
		-46,086.4		-72,401	

Repl. Cycle Years		3		4	
Year	PVF 15%	CF	PVCF	CF	PVCF
0	1	-60,000	-60,000	-60,000	-60,000
1	0.896	-16,000	-13,913.6	-16,000	-13,913.6
2	0.7561	-22,000	-16,634.2	-22,000	-16,634.2
3	0.6575	-12,000	-7,890	-28,000	-18,410
4	0.5718			-28,000	-16,010.4
		-98,437.8		**-1,24,968.2**	

Optimum Replacement Cycle:

EAC = $\frac{CumCF}{PVAF}$

Replacement Period	Cum. PV of CF (1)	PVAF (2)	(1)/ (2)
1	-46,086.4	0.896	52,997
2	-72,401	1.6257	44,535
3	-98,437.8	2.2832	43,113.96
4	-1,24,968.2	2.855	43,771.7

The optimum replacement cycle is **after 3 years.** When EAC is lowest at ₹ 43,113.96.

Working Notes: Replacement at the end of Year 1:

Year	0	1
Cash Flows:		
Purchase	-60,000	
Maintenance		-16,000
Repairs		0
Scrap		32,000
	-60,000	**16,000**

Replacement at the end of Year 2:

Year	0	1	2
Cash Flows:			
Purchase	-60,000		
Maintenance		-16,000	-18,000
Repairs			-4,000
Scrap			24,000
	-60,000	**-16,000**	**2,000**

Replacement at the end of Year 3:

Year	0	1	2	3
Cash Flows:				
Purchase	-60,000			
Maintenance		-16,000	-18,000	-20,000
Repairs			-4,000	-8,000
Scrap				16,000
	-60,000	**16,000**	**-22,000**	**-12,000**

Replacement at the end of Year 4:

Year	0	1	2	3	4
Cash Flows:					
Purchase	-60,000				
Maintenance		-16,000	-18,000	-20,000	-20,000
Repairs			-4,000	-8,000	-16,000
Scrap					8,000
	-60,000	**16,000**	**-22,000**	**-28,000**	**-28,000**

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