Advanced Capital Budgeting

Calculation of NPV to decide whether to invest in the project or not

Formula to calculate NPV = Present Value of cash inflows – Present value of cash outflows

If investing in a project, we will calculate NPV from project point of view which means cash flows will be considered before making any payment to Debt holders, Equity and Preference shareholders.

Cash inflows and outflows is calculated as per below method but note that while calculating cash flows allocated overhead cost, sunk cost or historical costs are to be Ignored:

Cash Outflows from the project

Amount Initially invested in the project	xx
Amount Initially invested in working capital requirement	xx
TOTAL	**xx**

Cash Inflows during lifetime from the project

Sales	xx
(-) Expenses	(xx)
Earnings before Interest, Tax, Depreciation and Amortisation (EBITDA)	**Xx**
(-) Depreciation	(xx)
Earnings before Interest and Tax (EBIT)	**xx**
(-) Tax	(xx)
Profit after Tax	**xx**
(+) Depreciation	xx
(+/-) Change in working capital	xx
Cash Flows from the project	**xx**

Cash Inflows at end of life of project

Salvage value of project after adjusting any tax	xx
Amount received from release of working capital	xx
TOTAL	**xx**

Note:

Cash flows are discounted using discounting rate given in question or by calculating WACC

WACC = $(W_e \times K_e) + (W_p \times K_p) + (W_d \times K_d)$

Ke = Cost of Equity as per CAPM method **[Rf + b(Rm – Rf]**

Kp= Dividend rate of Preference

Kd= Debt Interest rate (1 – Tax rate)

There are 2 types of cash flows:

- Nominal Cash Flows (Cash flows after giving effect of inflation)
- Real Cash Flows (Cash flows without giving effect of inflation)

Formula to calculate nominal cash flow from real cash flows:

Nominal Cash Flows: $Real\ Cash\ Flows \times (1 + Inflation\ Rate)$

Note: While calculating nominal cash flows, effect of inflation is not given in depreciation amount because in income tax deduction of depreciation is allowed on actual cost of asset

There are 2 types of discounting rates:

- Nominal Discounting rate: Used when cash flows given are nominal cash flows
- Real Discounting rate: Used when cash flows given are real cash flows

Formula to calculate nominal discounting rate from real discounting rate:

Nominal discounting Rate: $(1 + Real\ Rate)(1 + Inflation\ Rate)$

Sometimes RADR is used to calculate NPV of project when there is high risk in project
In simpler terms, when risk in project is high, discounting rate will also be high

RADR = Risk Free Rate + Risk Premium
Risk Premium = Risk Index x (Minimum return required from project – Risk Free Rate)

Certainty Equivalent approach to calculate NPV:

Step 1: Under this, risky cash flows from the project are converted into certain cash flows using certainty equivalent co-efficient which is given in the question
Step 2: These certain cash flows are then discounted using **risk free rate of return**

Example from ICAI Module

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:

$$NPV = \frac{10,00,000 \times (0.90)}{(1.05)} + \frac{15,00,000 \times (0.85)}{(1.05)^2} + \frac{20,00,000 \times (0.82)}{(1.05)^3} + \frac{25,00,000 \times (0.78)}{(1.05)^4} - 45,00,000$$

=₹5,34,570

Profitability Index (PI) is simple way to measure how much profit you can expect to make for each rupee you invest in a project. It helps you figure out if a project is worth investing in or not.

Here's how it works:

- If PI is greater than 1, it means project is profitable and you should consider going ahead with it.
- If the PI is less than 1, it means the project is not profitable, and you should avoid it.

Profitability Index = $\frac{Present\ value\ of\ Future\ cash\ flows}{Initial\ Investment}$

Adjusted NPV method:
APV helps you figure out the value of a project in two parts:

1. Value of the project if you paid all cash (no borrowing).
2. Value added by using debt (because borrowing money can sometimes save on taxes)

Formula of Adjusted NPV: Base case NPV + PV of Tax Benefit on Interest

Note: Base case NPV is calculated by using cost of equity assuming company is all equity financed

Example from ICAI main exam

The Management of a multinational company TL Ltd. is engaged in construction of Infrastructure Project. A proposal to construct a Toll Road in Nepal is under consideration of the Management.

<u>The following information is available:</u>
The initial investment will be in purchase of equipment costing USD 250 lakhs. The economic life of the equipment is 10 years. The depreciation on the equipment will be charged on straight line method.

EBIDTA to be collected from the Toll Road is projected to be USD 33 lakhs per annum for a period of 20 years. To encourage investment Nepalese government is offering a 15 year term loan of USD 150 lakhs at an interest rate of 6 per cent per annum. The interest is to be paid annually. The loan will be repaid at the end of 15 year in one tranche.

The required rate of return for the project under all equity financing is 12 per cent per annum.
Post tax cost of debt is 5.6 per cent per annum. Corporate Tax Rate is 30 per cent.

All cash Flows will be in USD. Ignore inflation. You are required to advise the management on the viability of the proposal by using Adjusted Net Present Value method.

Given
PVIFA (12%, 10) = 5.650, PVIFA (12%, 20) = 7.469, PVIFA (8%,15) = 8.559, PVIF (8%, 15) = 0.315.

Solution:
Net Present Value (All Equity Financed) – Base NPV

Particulars	**Period**	**USD Lakhs**	**PVF @ 12%**	**PV (USD Lakhs)**
Initial Investment	0	(250.00)	1.000	(250.000)
EBIDTA	1 to 20	33.00	7.469	246.477
Tax	1 to 20	(9.90)	7.469	(73.943)
Depreciation	1 to 10	(25.00)		
Tax Saving on Dep	1 to 10	7.50	5.650	42.375
NPV				(35.091)

Present Value of Impact of Financing by Debt

Particulars	Period	USD Lakhs	PVF @ 8%	PV (USD Lakhs)
Loan	0	150.00	1.000	150.000
Interest	1 to 15	(9.00)	8.559	(77.031)
Tax Saving on Interest	1 to 15	2.70	8.559	23.109
Repayment of Principal	15	(150.00)	0.315	(47.250)
NPV				48.828

Adjusted Present Value of the Project
= Base NPV + PV of Impact of Financing = - US$ 35.091 + US $ 48.828 lakh = US$ 13.737 lakh
Advise: Since APV is positive, TL Ltd. should accept the project.

Alternatively, if instead of PV of overall impact of Financing the PV of impact of tax shield on Interest is considered then APV shall be computed as follows:
= Base NPV + PV of Tax Shield on Interest = - US $ 35.091 + US $ 23.109 lakh = - US $ 11.982 lakh
Advise: Since APV is negative, TL Ltd. should not accept the project.

If in question various Projects are given, then how to decide which project is to be selected?

- On basis of NPV, Project having highest NPV will be selected
- On basis of standard Deviation of project, Project having lower standard Deviation will be selected
- On basis of Coefficient of variation (CV) of project, Project having lower CV will be selected

Variance of Project (σ^2) = $\sum P(x-\overline{x})^2$

Standard Deviation of Project (σ) = $\sqrt{\sum P(x-\overline{x})^2}$

Co efficient of variation (CV) = $\frac{\textbf{Standard Deviation of Project } (\sigma)}{\textbf{Mean } (\overline{x})}$

Example from ICAI Module

Calculate Variance and Standard Deviation of Project A and Project B on basis of following information:

Possible Event	Project A		Project B	
	NPV (Rs)	Probability	NPV (Rs)	Probability
A	8,000	0.10	24,000	0.10
B	10,000	0.20	20,000	0.15
C	12,000	0.40	16,000	0.50
D	14,000	0.20	12,000	0.15
E	16,000	0.10	8,000	0.10

Solution Calculation of Expected Value for Project A and Project B

Project A				Project B		
Possible Event	NPV	Probability	Expected Value	NPV	Probability	Expected Value
A	8,000	0.10	800	24,000	0.10	2,400
B	10,000	0.20	2,000	20,000	0.15	3,000
C	12,000	0.40	4,800	16,000	0.50	8,000
D	14,000	0.20	2,800	12,000	0.15	1,800
E	16,000	0.10	1,600	8,000	0.10	800
ENCF			12,000			16,000

Project A:

Variance (σ2) = (8,000 – 12,000)2 × (0.1) + (10,000 – 12,000)2 × (0.2) + (12,000 – 12000)2 × (0.4) + (14,000 – 12,000)2 × (0.2) + (16000 – 12,000)2 × (0.1)

= 16,00,000 + 8,00,000 + 0 + 8,00,000 + 16,00,000 = 48,00,000

Standard Deviation (σ) = $\sqrt{\text{Variance}(\sigma^2)} = \sqrt{48,00,000} = 2,190.90$

Project B:

Variance(σ2) = (24,000 – 16,000)2 × (0.1) + (20,000 – 16,000)2 × (0.15) + (16,000 – 16,000)2 × (0.5) + (12,000 – 16,000)2 × (0.15) + (8,000 – 16,000)2 × (0.1)

= 64,00,000 + 24,00,000 + 0 + 24,00,000 + 64,00,000 = 1,76,00,000

Standard Deviation (σ) = $\sqrt{\text{Variance}(\sigma^2)} = \sqrt{1,76,00,000} = 4,195.23$

Note: If expected cash flows of different years (say 3 years) are given along with probability and standard deviation of the project is to be calculated. Then standard deviation of each year will be calculated first and then from variance of whole project standard deviation of the whole project is calculated as follows:

Variance of whole project: $\left(\frac{SD\ Year\ 1}{(1+\frac{R}{100})^1}\right)^2 + \left(\frac{SD\ Year\ 2}{(1+\frac{R}{100})^2}\right)^2 + \left(\frac{SD\ Year\ 3}{(1+\frac{R}{100})^3}\right)^2$

Standard Deviation of whole project = $\sqrt{Variance\ of\ Project\ calculated\ above}$

Example from ICAI Module

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.

Solution:

(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
	x or CF	27.0		x or CF	29.3			x or 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

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

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

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

Standard deviation about the expected value:

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

Sensitivity analysis

Sensitivity analysis is a technique used in advanced capital budgeting to assess how sensitive the NPV (Net Present Value) of a project is to changes in key variables like sales, costs etc.

In simpler terms, sensitivity analysis asks, "If I change one assumption (like sales, cost of materials, or interest rates), how much will it affect NPV?"

Here we calculate Most sensitive factor, which means factor which has largest effect on NPV.

1. Calculate Base NPV as per the information given in question
2. Then we need to calculate new NPV after considering change in this factor.
3. Then we will calculate % change in NPV by using following formula = $\frac{Base\ NPV - New\ NPV}{Base\ NPV} \times 100$
4. Most sensitive factor will be the one due to which % change in NPV is highest

Example from ICAI Module

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 (Rs)	1,20,000
Annual Cash Inflow (Rs)	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).

Solution:

CALCULATION OF NPV

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

If initial project cost is varied adversely by 10%*

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

If annual cash inflow is varied adversely by 10%*

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

If cost of capital is varied adversely by 10%*

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

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

Calculation of sensitivity such that NPV becomes zero:

1. Calculate the base NPV as per the information given in question
2. Now we have to change the value of factor so that NPV becomes zero. For this purpose we will assumed the value of revised factor as X and calculate this revised value
3. Next step is to calculate percentage change in this value of factor:
$$\frac{New\ Value\ of Factor - Old\ Value\ of\ Factor}{Old\ Value\ of\ Factor} \times 100$$
4. Most sensitive factor will be the one whose percentage change is smallest, since a small change in this factor's value led NPV to zero

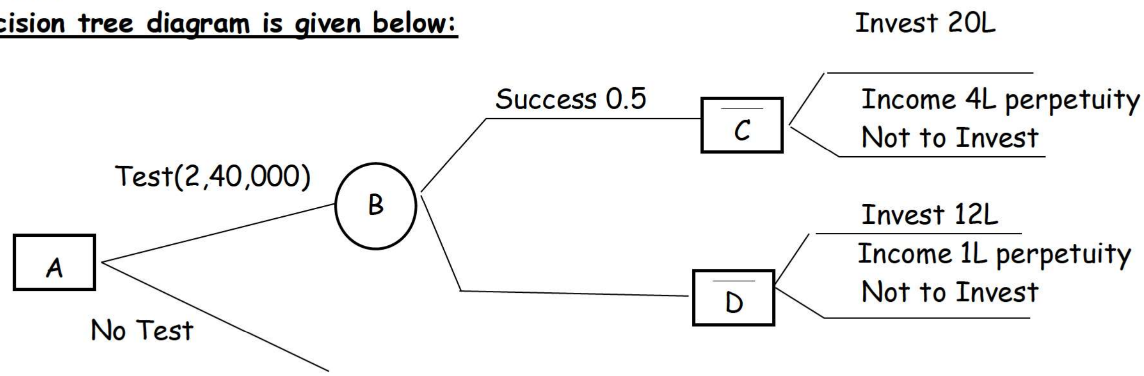
Decision Tree Concept

Example from ICAI Module

L & R Limited wishes to develop new virus-cleaner software. The cost of the pilot project would be ₹ 2,40,000. Presently, the chances of the product being successfully launched on a commercial scale are rated at 50%. In case it does succeed. L&R can invest a sum of ₹ 20 lacs to market the product. Such an effort can generate perpetually, an annual net after tax cash income of ₹ 4 lacs. Even if the commercial launch fails, they can make an investment of a smaller amount of ₹ 12 lacs with the hope of gaining perpetually a sum of ₹ 1 lac. Evaluate the proposal, adopting decision tree approach. The discount rate is 10%.

Solution

Decision tree diagram is given below:



Evaluation

At Decision Point C: The choice is between investing ₹ 20 lacs for a perpetual benefit of ₹ 4 lacs and not to invest. The preferred choice is to invest, since the capitalized value of benefit of ₹ 4 lacs (at 10%) adjusted for the investment of ₹ 20 lacs, yields a net benefit of ₹ 20 lacs.

At Decision Point D: The choice is between investing ₹ 12 lacs, for a similar perpetual benefit of ₹ 1 lac. and not to invest. Here the invested amount is greater than capitalized value of benefit at ₹ 10 lacs. There is a negative benefit of ₹ 2 lacs. Therefore, it would not be prudent to invest.

At Outcome Point B: Evaluation of EMV is as under (₹ in lacs).

Outcome	Amount (₹)	Probability	Result (₹)
Success	20.00	0.50	10.00
Failure	0.00	0.50	00.00
Net result			10.00

L&R Limited must make sequential decisions:

- First Decision (Test Phase): Invest ₹ 2,40,000 in a pilot project to assess feasibility.
- Second Decision (If Successful): Invest ₹ 20 lacs for large-scale marketing, yielding ₹ 4 lacs annually in perpetuity.
- Second Decision (If Failed): Invest ₹ 12 lacs for a smaller-scale effort, yielding ₹ 1 lac annually in perpetuity.

Using a discount rate of 10%, the present value of a perpetual cash flow is calculated as:

- If successful: ₹ 4 lacs / 10% = ₹ 40 lacs.
- If failed: ₹ 1 lac / 10% = ₹ 10 lacs.

Evaluating Decision Points

- Decision Point C (If Success = Invest ₹ 20L or Not)
  Net Benefit = ₹ 40 lacs - ₹ 20 lacs = ₹ 20 lacs (positive, so invest).
- Decision Point D (If Failure - Invest ₹ 12L or Not)
  Net Benefit = ₹ 10 lacs = ₹ 12 lacs = ₹ -2 lacs (negative, so do not invest).

Expected Monetary Value (EMV) Calculation= (₹20 lacs × 0.5) + (₹0 × 0.5) = ₹ 10lacs.

Replacement of Existing machine Decision (Format taken from ICAI material)

Step I. Net cash outflow at beginning (assumed at current time) [Present values of cost]:

Cost of New system – Sale value of old system	
(+/-) Tax payable on sale of old system or Tax savings on sale	

Tax Payable or Tax savings = (Book value of old system – Sale value of old system) x Tax Rate

Step II. Estimated change in cash flows per year if replacement decision is implemented.

Change in sales	
+/- Change in operating costs	
- Change in Depreciation	
Total	
- Tax Rate (30%)	
Total	
+ Change in Depreciation	
Change in cash flows if replacement decision is taken	

Step III. Calculate NPV

Present value of yearly cash flows	**xx**
+ Present value of estimated salvage of new system	**xx**
- Present value of costs	**(xx)**
NPV	**xx**

Step IV. Decision:

- If NPV is positive we should accept the proposal to replace the machine
- If NPV is negative we should reject the proposal to replace the machine

Example from ICAI module

A Company named Roby's cube decided to replace the existing Computer system of their organisation. Original cost of 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 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 ₹ 10,00,000. Company follows straight line method of depreciation. Cost of capital of the company is 10% whereas tax rate is 30%.

Solution:

Step I. Net cash outflow at beginning (assumed at current time) [Present values of cost]:

Cost of New system – Sale value of old system (50,000 – 5,000)	45000
(+/-) Tax payable on sale of old system or Tax savings on sale	(2250)
	42,750

Tax Payable or Tax savings = (Book value of old system – Sale value of old system) x Tax Rate

Step II. Estimated change in cash flows per year if replacement decision is implemented.

Change in sales (10,00,000 x 10%)	10,000
+/- Change in operating costs	5,000
- Change in Depreciation (₹ 49,000/5 – ₹ 25,000/10)	(7,300)
Total	97,700
- Tax Rate (30%)	29,310
Total	68,390
+ Change in Depreciation	7,300
Change in cash flows if replacement decision is taken	12,690

Step III. Calculate NPV

Present value of yearly cash flows	xx
+ Present value of estimated salvage of new system	xx
- Present value of costs	(xx)

Present value of benefits = Present value of yearly cash flows + Present value of estimated salvage of new system

= ₹ 12,690 × PVIFA (10%, 5) + ₹ 1,000 × PVIF (10%, 5) = ₹ 48,723

Net present value = Present value of benefits - Present value of costs

= ₹ 48,723 – ₹ 42,750 = ₹ 5,973

Step IV. Decision rule: Since NPV is positive we should accept the proposal to replace the machine.

When to replace decision (Replacement Cycle Decision)

Step 1: Calculate NPV of Different replacement years

Step 2: Calculate Equivalent Annual cost (EAC) = $\frac{NPV}{Cumulative\ Present\ value\ Factor}$

Step 3: Replacement cycle which has lowest EAC which will chosen

Example from ICAI module

X Ltd. is a taxi operator. Each taxi cost to company ₹ 4,00,000 and has a useful life of 3 years. The taxi's operating cost for each of 3 years and salvage value at the end of year is as follows:

	Year 1	**Year 2**	**Year 3**
Operating Cost	₹ 1,80,000	₹ 2,10,000	₹ 2,38,000
Resale Value	₹ 2,80,000	₹ 2,30,000	₹ 1,68,000

You are required to determine the optimal replacement period of taxi if cost of capital of X Ltd. is 10%.

Solution:

NPV if taxi is kept for 1 Year

= - ₹ 4,00,000 - ₹ 1,80,000 (0.909) + ₹ 2,80,000 (0.909) = - ₹ 3,09,100

NPV if taxi is kept for 2 Year

= - ₹ 4,00,000 – ₹ 1,80,000 x 0.909 + ₹ 20,000 x 0.826 = - ₹ 5,47,100

NPV if taxi is kept for 3 Year

= - ₹ 4,00,000 – ₹ 1,80,000 x 0.909 – ₹ 2,10,000 x 0.826 – ₹ 70,000 x 0.751 = – ₹ 7,89,650

Since above NPV figures relate to different periods, there are not comparable. to make them comparable we shall use concept of EAC as follows:

EAC of 1 year: 3,09,100 /0.909 = ₹3,40,044

EAC of 2 year: 5,47,100 /1.735 = ₹3,15,331

EAC of 3 year: 7,89,650 /2.486 = ₹3,17,639

Since lowest EAC is for 2 year; Hence the optimum replacement cycle to replace taxi in 2 years.