Accounting for Financial and Managerial Decision and Control [AFMDC]

Unit 14

Investment Decision Under Condition of Risk and Uncertainty

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Contents

- Investment decision under risk and uncertainty by using:

(i) Adjusted discount rate, certainty equivalent co-efficient, sensitivity and scenario analysis

(ii) Standard deviation, co-efficient of variation, probability distribution approach

Learning Objectives

- Understand the concepts of risk and uncertainty
- Analyze the risk under condition of uncertainty using: Adjusted discount rate, certainty equivalent co-efficient, sensitivity and scenario analysis
- Measure the risk by using different approaches: Standard deviation, co-efficient of variation, probability distribution approach

Concept of Risk and Uncertainty

- Capital investment project should be less risky.
- To evaluate the capital investment project, there should be estimated future cash flows.
- The future is always uncertain.
- So, one of the basic requirements of capital investment decision making is to project all cash flows with a reasonable degree of accuracy.
- But cash flows cannot be always forecast with certainty, there is considerable risk involved in most investment decision.
- Where more of uncertainty, the greater the risk is involved in an investment decision.
- Therefore, during evaluating capital investment decision, the investor should take into account the accuracy of estimations and business risk involved.
- The investor or enterprise should prefer a less risky investment proposal as compared to a more risky investment proposal.

Concept of Risk and Uncertainty

- Risk is a term with reference to capital budgeting, which explains the difference between the expectation of return on investment and the actual realization.
- The variation of actual result and estimation is due to the several factors as price, sales volume, effectiveness of advertisement, competition, cost of materials, overheads cost etc.
- All these depend on the national economy, political stability and rate of inflation etc.
- The variation and irregularity in future cash inflows (or future return on investment) compared to estimation is called risk.

Concept of Risk and Uncertainty

i. Certainty

- Certainty refers to a situation where the actual return on investment will be equal to the estimated return

ii. Uncertainty

- The probability of a certain event occurred is unknown
- When the future outcome cannot be predicted with any degree of confidence from a knowledge of past or existing events, that is known as uncertainty

iii. Risk

- It occurs where it is known what the future outcome will be, but the various possible outcomes may be expected with some degree of confidence from the knowledge of past or existing events
- We shall use the terms risk and uncertainty interchangeably and it will be referring to the situation of uncertain decision-making

Measure of Risk

- The risk involved in capital budgeting can be measured

(i) Absolute terms – measure in terms of amount
  - sensitivity analysis and standard deviation

(ii) Relative terms – measure in terms of percentage
  - coefficient of variation

Measure of Risk – Sensitivity Analysis

- Widely accepted measure of risk and uncertainty as it expresses risk in more precise terms.
- Uses a number of possible outcomes in its evaluation of a project and in this way it takes care of estimation error.
- Analysis uses a number of estimated cash flows.
- It provides to the decision-maker an insight into the variability of the outcomes.

Measure of Risk – Scenario Analysis

- Scenario analysis is a process of examining and evaluating possible events that could take place in the future by considering various feasible results in outcome.
- Three scenarios:

a) Basic case scenario
b) Worst case scenario
c) Best case scenario

Measure of Risk – Scenario Analysis

- The risk of the project is measured on the basis of the differences or gaps between NPV of search scenario.

- The scenario analysis provides different cash flows estimates as possible outcomes associated with the project under the following three assumptions:

1. The Most Pessimistic (i.e. the Worst)
2. The Most Likely (i.e. the Expected), and
3. The Most Optimistic (i.e. the Best)

Question 1 (Scenario Analysis)

ABC Company Limited is attempting to evaluate two mutually exclusive projects A and B. Each project requires a net investment of Rs. 10,000 and annual cash flows from each of the project is estimated at Rs. 2,000 per annum in the next 15 years. The company's cost of capital may be taken at 10%. The management has made the following optimistic, most likely and pessimistic estimates of the annual cash inflows associated with each of these projects.

	Project A	Project B
Initial Investment	Rs. 10,000	Rs. 10,000
Cash Flow Estimates		
Pessimistic	1,500	0
Most Likely	2,000	2,000
Optimistic	2,500	4,000

You are required to give your considered opinion for helping the management in arriving at a decision to select the project.

Solution 1 (Scenario Analysis)

We get the expected cash flows by multiplying each possible cash flow by PVIFA factor. The outcomes are as follows:

Projects	Years	Outcomes	CFAT (Rs.)	PV Factor @ 10%	PV	NCO	NPV
		Pessimistic	1,500	7.606	11,409	10,000	1,409
A	1 - 15	Most Likely	2,000	7.606	15,212	10,000	5,212
		Optimistic	2,500	7.606	19,015	10,000	9,015
		Pessimistic	0	7.606	0	10,000	(10,000)
B	1 - 15	Most Likely	2,000	7.606	15,212	10,000	5,212
		Optimistic	4,000	7.606	30,424	10,000	20,424

From the above calculation, it can be seen that the sensitivity analysis provides very useful information about both the projects. Though both the projects appear equally desirable on the basis of most likely cash flow estimates. Project A is less risky than project B. However, the decision regarding the selection of project will depend upon the attitude of the decision-maker towards risk. A conservative decision-maker will select project A as there is no risk of suffering a loss. On the other hand, if decision-maker is a risk taker, he will choose project B as it is expected to yield high returns as compared to project A.

Measure of Risk – Standard Deviation

- Under this method, the difference between the possible cash flows that can occur and their expected value is obtained.
- The degree of risk present in a project is indicated by dispersion of cash flow.

$$\sigma = \sqrt{\Sigma\ dx^2 \cdot p_j}$$

Where, σ = Standard Deviation

dx = Deviation of Cash Flow $(x-\bar{x})$; x Represent Cash Flow and $\bar{x}$ Represent mean of Cash Flow

P_j = Probability Occurrence of Cash Flow

dx^2 = Square of Deviation of Cash Flow $(x - \bar{x})^2$

Question 2 (Standard Deviation)

As continuation from previous illustration, the probability distributions of the project's NPV are given below:

Project M		Project N	
NPV	**Probability**	**NPV**	**Probability**
Rs. 11,272	0.20	Rs. (80,000)	0.20
41,696	0.60	41,696	0.60
72,120	0.20	1,63,392	0.20

Calculate the expected value and standard deviation for project selection.

Solution 2 (Standard Deviation)

Calculation of Expected Values

Possible NPV	Probability	NPV × Probability
Project M		
Rs. 11,272	0.20	Rs. 2,254
41,696	0.60	25,018
72,120	0.20	14,424
		Expected NPV Rs. 41,696
Project N		
Rs. (80,000)	0.20	Rs (16,000)
41,696	0.60	25,018
1,63,392	0.20	32,678
		Expected NPV Rs. 41,696

Solution 2 (Standard Deviation)

Calculation of Standard Deviation

Cash Flow (Rs.) x	Mean Cash Flow $\bar{x}$	Deviation of Cash Flow $dx = (x - \bar{x}) \div 1{,}000$	Deviations Squared $dx^2 = (x - \bar{x})^2$	Probability p_j	Product of Probabilities and Squared Deviation $dx^2\ p_j$
Project M					
11,272	41,696	- 30.424	925.619	0.20	185.124
41,696	41,696	0	0	0.60	0
72,120	41,696	30.424	925.619	0.20	185.124
					$\Sigma dx^2\ p_j = 370.248$
Project N					
- 80,000	41,696	- 121.696	14,809.916	0.20	2,961.983
41,696	41,696	0	0	0.60	0
1,63,392	41,696	121.696	14,809.916	0.20	2,961.983
					$\Sigma dx^2\ p_j = 5{,}923.966$

Solution 2 (Standard Deviation)

$$\sigma \text{ (Project M)} = \sqrt{\Sigma\, dx^2 \,.\, p_j} \times 1{,}000 = \sqrt{370.248} \times 1{,}000 = 19{,}242 \text{ (Approx.)}$$

$$\sigma \text{ (Project N)} = \sqrt{\Sigma\, dx^2 \,.\, p_j} \times 1{,}000 = \sqrt{5{,}923.966} \times 1{,}000 = 76{,}967 \text{ (Approx.)}$$

The standard deviation of project M is smaller than that of project N. Therefore, it can be concluded that project M is less risky than project N.

The conclusion regarding the superiority of project M over project N would hold because both projects have an equal size of initial cash outlay. However, if the size of the project's outlay differs, the decision-maker should use the coefficient of variation to judge the riskiness of the project.

Measure of Risk – Coefficient of Variation

$$\text{Coefficient of Variation (C.V.)} = \frac{\text{Standard Deviation}}{\text{Expected Value}} \times 100$$

$$= \frac{\sigma}{\bar{X}} \times 100$$

The higher the coefficient of variation, the project is the riskier.

Coefficient of Variation

$$\text{Coefficient of Variation (C.V.)} = \frac{\text{Standard Deviation}}{\text{Expected Value}} \times 100$$

$$= \frac{\sigma}{\bar{X}} \times 100$$

As per Previous Question 2,

$$\text{Coefficient of Variation (Project M)} = \frac{19{,}242}{41{,}696} \times 100 = 46.15\%$$

$$\text{Coefficient of Variation (Project N)} = \frac{76{,}967}{41{,}696} \times 100 = 184.59\%$$

The higher the coefficient of variation, the project is the riskier.

Therefore, the project N is riskier than that of project M.

Risk Evaluation Approach

- Risk Adjusted Discount Rate Approach
- Certainty-equivalent Approach
- Probability Distribution Approach

Risk Adjusted Discount Rate Approach

RAD rate = Normal Rate or Risk Free Rate + Risk Premium Rate

Normal Rate or Risk Free Rate

This is the rate which will be computed by assuming "no risk" situation. At this rate future cash inflows will be discounted.

Risk Surplus or Risk Premium Rate

This is the rate which shows the additional return derived by taking risk over and above the normal rate. The volume of risk premium will depend upon the volume of risk and uncertainty. The greater the uncertainties in the future cash inflow, the greater the risk and hence the greater the premium is required.

Question 3 (Risk Adjusted Discount Rate Approach)

An enterprise is considering a new investment proposal requiring initial cash outlay of Rs. 3,00,000. The expected cash flow after tax from the project has been estimated as under:

Years	1	2	3	4
CFAT	Rs. 50,000	Rs. 1,00,000	Rs. 1,50,000	Rs. 1,50,000

The enterprise has normal cost of capital is 9% and management wish to have risk premium rate at 4%. Should the proposal be accepted?

Solution 3 (Risk Adjusted Discount Rate Approach)

Risk-adjusted Discounted (RAD) Rate = Risk Free Rate + Risk Premium Rate

RAD Rate = 9% + 4% = 13%

Statement Showing Net Present Values using Risk-adjusted Discount Rate

Years	Cash Inflows	Discount Factor @ 13%	P.V. of Cash Inflow
1	50,000	0.885	44,250
2	1,00,000	0.783	78,300
3	1,50,000	0.693	1,03,950
4	1,50,000	0.613	91,950
Total PV of Cash Inflows			3,18,450
Less: Initial Cash Outflows			3,00,000
Net Present Value			+ 18,450

Decision: Since net present value is positive, project should be accepted.

Certainty-Equivalent Approach

- Risk-adjusted factor is expressed in terms of a certainty-equivalent coefficient.
- It represents the relationship between the riskless cash flows and risky cash flows as below:

$$\text{Certainty-equivalent Coefficient} = \frac{\text{Riskless Cash Flow}}{\text{Risky Cash Flow}}$$

The risk free rate is assumed to be constant for all periods. The certainty-equivalent coefficient varies inversely with risk and it assumes a value between 0 and 1. When greater risk is perceived, a lower certainty equivalent coefficient is used and accordingly when lower risk is anticipated, a higher certainty equivalent coefficient is used

Question 4 (Certainty-Equivalent Approach)

The initial capital outlay of a project is Rs. 10,000. The project is expected to 4 years of life. During the life of the project the estimated cash flow after tax and certainty-equivalent coefficient factors are:

Years	1	2	3	4
CFAT	Rs. 6,000	Rs. 4,000	Rs. 4,000	Rs. 6,000
Certainty-equivalent	0.90	0.70	0.50	0.30

The Risk-free Discount Rate is 10%.

Required: Net Present Value of the Project.

Solution 4 (Certainty-Equivalent Approach)

Statement Showing Net Present Values using Certainty Equivalent Coefficient

Years	Cash Inflows	Certainty Equivalent Coefficient	Certainty Equivalent Cash Inflows	Discount Factor @ 10%	P.V of Cash Inflow
0	(10,000)	1.0	(10,000)	1.000	(10,000)
1	6,000	0.9	5,400	0.909	4,908.60
2	4,000	0.7	2,800	0.826	2,312.80
3	4,000	0.5	2,000	0.751	1,502.00
4	6,000	0.3	1,800	0.683	1,229.40
Net present value					47.20

Probability Distribution Approach

- The uncertainty of happening of an event is termed as “probability”.
- The event may or may not occur.
- The probability estimate indicates one which can be ascertained that the event is going to occur definitely.
- If the probability estimate is zero, it should be presumed that the event does not occur.
- Under, probability distribution approach, the use of probability theory in analyzing the risk of long-term investment decisions under two situations:

1. Independent Cash Flows Over Time (Uncorrelated Cash Flow) and
2. Dependent Cash Flows Over Time (Perfectly Correlated Cash Flow)

Probability Distribution Approach

Independent Cash Flows Over Time (Uncorrelated Cash Flow)

- Independent cash flow over time (uncorrelated cash flow) refers that the future cash flows are not affected by the cash flows in the preceding or following years.

$$\sigma_{NPV} = \sqrt{\frac{\sigma_1^2}{(1+i)^{2n}} + \frac{\sigma_2^2}{(1+i)^{2n}} + \frac{\sigma_3^2}{(1+i)^{2n}} + \dots\dots\dots\dots + \frac{\sigma_n^2}{(1+i)^{2n}}}$$

Where,

i = Risk Free Rate of Return

n = Number of Years

σ = Standard Deviation for each Year

Probability Distribution Approach

Dependent Cash Flows Over Time (Uncorrelated Cash Flow)

- When cash flows in one period depends upon the cash flows in previous period, they are referred to as dependent cash flows

$$\sigma_{NPV} = \frac{\sigma_1}{(1+i)^1} + \frac{\sigma_2}{(1+i)^2} + \frac{\sigma_3}{(1+i)^3} + \ldots\ldots\ldots\ldots\ldots + \frac{\sigma_n}{(1=i)^n}$$

Special note:

If the question is silenced regarding the independent or dependent cash flows over time then the cash flow of a given project is to be considered as independent.

Probability Distribution Approach

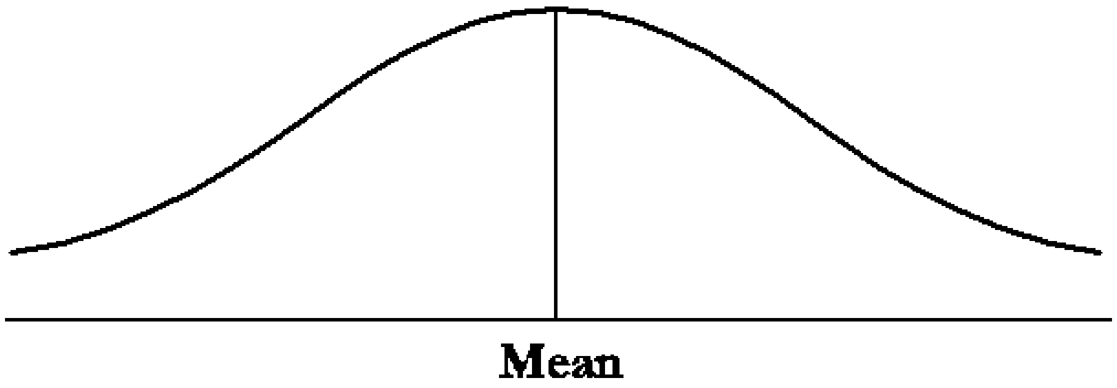
Analysis through Normal Probability Distribution

$$Z = \frac{X_{NPV} - \bar{X}_{NPV}}{\sigma_{NPV}}$$

$\bar{X}_{NPV}$ = expected value of NPV or mean

σ_{NPV} = standard deviation of NPV,

The standardized may be referred as Z



Using normal probability distribution, the decision-maker can have an idea of the probabilities of different expected values of NPV

Question 5 (Probability Distribution Approach)

A company is considering bringing a new machine to increase its capacity. The machine has an initial cost of Rs.1,400. The finance department has developed the following discrete probability distribution for cash flows generated by the additional capacity during its service life of three years.

Year 1		Year 2		Year 3	
Cash Flow	Probability	Cash Flow	Probability	Cash Flow	Probability
200	0.10	300	0.15	100	0.20
400	0.20	600	0.20	300	0.30
600	0.50	900	0.40	600	0.40
800	0.20	1,000	0.25	900	0.10

Assuming the probability distributions of cash flows for future periods are independent (uncorrelated cash flow). The company's cost of capital is 12% and the company can invest in 6% treasury bills.

Required: (a) The expected monetary value (EMV) for each year.

(b) The expected net present value and decision regarding the proposal.

(c) The standard deviation of the cash flow for each year.

(d) The standard deviation of the net present value to measure the risk.

Question 5 (Probability Distribution Approach)

(e) If the total distribution is approximately normal and continuous,

i. What is the probability of NPV being zero or less?
ii. What is the probability of NPV being greater than zero?
iii. What is the probability of NPV is being less than Rs. 100?
iv. What is the probability of NPV is being more than Rs. 100?
v. What is the probability of NPV is being less than Rs. 300?
vi. What is the probability of NPV is being more than Rs. 300?
vii. What is the probability of NPV is being lies between Rs. 100 to Rs. 300?
viii. What is the probability of profitability index is being 1.5 or less?
ix. What is the probability of profitability index is being 1.5 or more?
x. What is the probability of NPV is being at least equal to mean?
xi. What is the probability of NPV is being 10% below mean?
xii. What is the probability of NPV is being 10% above mean?

Solution 5 (Probability Distribution Approach)

(a) Calculation of the Expected Monetary Value (EMV) for each Year

Year 1			Year 2			Year 3		
Cash Flow	Probability	Expected Value	Cash Flow	Probability	Expected Value	Cash Flow	Probability	Expected Value
x	p_j	$x \times p_j$	x	p_j	$x \times p_j$	x	p_j	$x \times p_j$
200	0.10	20	300	0.15	45	100	0.20	20
400	0.20	80	600	0.20	120	300	0.30	90
600	0.50	300	900	0.40	360	600	0.40	240
800	0.20	160	1,000	0.25	250	900	0.10	90
Expected Value ($\bar{x}_1$)		= 560	Expected Value ($\bar{x}_2$)		= 775	Expected Value ($\bar{x}_3$)		= 440

Solution 5 (Probability Distribution Approach)

(b) Calculation of the Expected Net Present Value

Years	Expected Monetary Value (EMV)	Discount Factor @ 6%	Present Value
1	560	0.943	528.08
2	775	0.890	689.75
3	440	0.840	369.60
Total Present Value			1,587.43
Less: Initial Net Cash Outlay (NCO)			1,400.00
Expected Net Present Value ($\bar{X}_{NPV}$)			187.43

Since, the expected net present value is become positive amounting Rs. 187.43, the proposal should be accepted.

Solution 5 (Probability Distribution Approach)

(c) Calculation of the Standard Deviation of the Cash Flow for each Year

Year 1

Cash Flow (Rs.) x	Probability p_j	Expected Value $\bar{x}$	Deviation of Cash Flow $dx = (x - \bar{x})$	Deviations Squared $dx^2 = (x - \bar{x})^2$	Product of Probabilities and Squared Deviation $dx^2 \times p_j$
200	0.10	560	- 360	1,29,600	12,960
400	0.20	560	- 160	25,600	5,120
600	0.50	560	40	1,600	800
800	0.20	560	240	57,600	11,520
					$\Sigma dx^2\ p_j$ = 30,400

$$\sigma_1 = \sqrt{\Sigma\ dx^2 \cdot p_j}$$

$$= \sqrt{30{,}400} = 174.36 \text{ (Approx.)}$$

Solution 5 (Probability Distribution Approach)

Year 2

Cash Flow (Rs.) x	Probability p_j	Expected Value $\bar{x}$	Deviation of Cash Flow $dx = (x - \bar{x})$	Deviations Squared $dx^2 = (x - \bar{x})^2$	Product of Probabilities and Squared Deviation $dx^2 \times p_j$
300	0.15	775	- 475	2,25,625	33,843.75
600	0.20	775	- 175	30,625	6,125.00
900	0.40	775	125	15,625	6,250.00
1,000	0.25	775	225	50,625	12,656.25
					$\Sigma dx^2\ p_j$ = 58,875.00

$$\sigma_2 = \sqrt{\Sigma\ dx^2\ .\ p_j}$$
$$= \sqrt{58{,}875} = 242.64 \text{ (Approx.)}$$

Year 3

Cash Flow (Rs.) x	Probability p_j	Expected Value $\bar{x}$	Deviation of Cash Flow $dx = (x - \bar{x})$	Deviations Squared $dx^2 = (x - \bar{x})^2$	Product of Probabilities and Squared Deviation $dx^2 \times p_j$
100	0.20	440	- 340	1,15,600	23,120
300	0.30	440	- 140	19,600	5,880
600	0.40	440	160	25,600	10,240
900	0.10	440	460	2,11,600	21,160
					$\Sigma dx^2\ p_j$ = 60,400

$$\sigma_3 = \sqrt{\Sigma\ dx^2\ .\ p_j}$$
$$= \sqrt{60{,}400} = 245.76 \text{ (Approx.)}$$

Solution 5 (Probability Distribution Approach)

(d) Calculation of the Standard Deviation of the Net Present Value under Assumption of Independent (Uncorrelated Cash Flow) Cash Flows Over Time

$$\sigma_{NPV} = \sqrt{\frac{\sigma_1^2}{(1+i)^{2n}} + \frac{\sigma_2^2}{(1+i)^{2n}} + \frac{\sigma_3^2}{(1+i)^{2n}} + \dots\dots\dots\dots + \frac{\sigma_n^2}{(1+i)^{2n}}}$$

$$= \sqrt{\frac{(174.36)^2}{(1+0.06)^{2\times1}} + \frac{(242.64)^2}{(1+0.06)^{2\times2}} + \frac{(245.76)^2}{(1+0.06)^{2\times3}}}$$

$$= \sqrt{\frac{(174.36)^2}{(1.06)^2} + \frac{(242.64)^2}{(1.06)^4} + \frac{(245.76)^2}{(1.06)^6}}$$

$$= \sqrt{27{,}057.14 + 46{,}633.86 + 42{,}578.19}$$

$$\sigma_{NPV} = \text{Rs. } 340.98$$

Solution 5 (Probability Distribution Approach)

(e) Calculation of Probabilities:

Now, $\overline{X}_{NPV}$ = Rs. 187.43

σ_{NPV} = Rs. 340.98

$$Z = \frac{X_{NPV} - \overline{X}_{NPV}}{\sigma_{NPV}}$$

i. Probability of NPV being Zero or Less

$$Z = \frac{0 - 187.43}{340.98} = -0.55$$

Probability of NPV is being lies in between Rs. 0 to Rs. 187.43

($\Rightarrow$ Z = -0.55 to Z = 0) = 0.2088

Probability of NPV is being zero or less = 0.50 – 0.2088 = 0.2912 = 29.12%.

ii. Probability of NPV being Greater than Zero

Probability of NPV is being greater than zero = 0.50 + 0.2088 = 0.7088 = 70.88%

Solution 5 (Probability Distribution Approach)

(e) Calculation of Probabilities:

Now, $\overline{X}_{NPV}$ = Rs. 187.43

σ_{NPV} = Rs. 340.98

$$Z = \frac{X_{NPV} - \overline{X}_{NPV}}{\sigma_{NPV}}$$

iii. Probability of NPV is being Less than Rs. 100

$$Z = \frac{100 - 187.43}{340.98} = -0.26$$

Probability of NPV is being lies in between Rs. 100 to Rs. 187.43

($\Rightarrow$ Z = -0.26 to Z = 0) = 0.1026

Probability of NPV is being less than Rs. 100 = 0.50 – 0.1026 = 0.3974 = 39.74%

iv. Probability of NPV is being more than Rs. 100

Probability of NPV is being more than Rs. 100 = 0.50 + 0.1026 = 0.6026 = 60.26%

Solution 5 (Probability Distribution Approach)

(e) Calculation of Probabilities:

Now, $\bar{X}_{NPV}$ = Rs. 187.43

σ_{NPV} = Rs. 340.98

$$Z = \frac{X_{NPV} - \bar{X}_{NPV}}{\sigma_{NPV}}$$

v. Probability of NPV is being less than Rs. 300

$$Z = \frac{300 - 187.43}{340.98} = +\ 33$$

Probability of NPV is being lies in between Rs. 187.43 to Rs. 300

($\Rightarrow$ Z = 0 to Z = +0 33) = 0.1293

Probability of NPV is being less than Rs. 300 = 0.50 + 0.1293 = 0.6293 = 62.93%

vi. Probability of NPV is being more than Rs. 300

Probability of NPV is being more than Rs. 300 = 0.50 - 0.1293 = 0.3707 = 37.07%

Solution 5 (Probability Distribution Approach)

(e) Calculation of Probabilities:

Now, $\bar{X}_{NPV}$ = Rs. 187.43

σ_{NPV} = Rs. 340.98

$$Z = \frac{X_{NPV} - \bar{X}_{NPV}}{\sigma_{NPV}}$$

vii. Probability of NPV is being lies between Rs. 100 to Rs. 300

$$Z = \frac{100 - 187.43}{340.98} = -0.26$$

$$Z = \frac{300 - 187.43}{340.98} = +33$$

Probability of NPV is being lies in between Rs. 100 to Rs. 187.43

($\Rightarrow$ Z = -0.26 to Z = 0) = 0.1026

Probability of NPV is being lies in between Rs. 187.43 to Rs. 300

($\Rightarrow$ Z = 0 to Z = +0 33) = 0.1293

Probability of NPV is being lies between Rs.100 to Rs. 300 = 0.1026 + 0.1293

= 0.2319

= 23.19%

Solution 5 (Probability Distribution Approach)

viii. Probability of Profitability Index being 1.5 or less

$$\text{Profitability Index} = \frac{\text{Present Value of Future Cash Inflow after Tax}}{\text{Present Value of Initial Cash Outflow}}$$

$$\text{Profitability Index} = \frac{\text{NPV + NCO}}{\text{NCO}}$$

$$1.5 = \frac{\text{NPV + Rs. 1,400}}{\text{Rs. 1,400}}$$

$$\text{NPV} = \text{Rs. } 700$$

Now, $$Z = \frac{700 - 187.43}{340.98} = +1.50$$

Probability of NPV is being lies in between Rs. 187.43 to Rs. 700

($\Rightarrow$Z = 0 to Z = + 1.50) = 0.4332

Probability of profitability index is being 1.5 or less = 0.50 + 0.4332 = 0.9332 = 93.32%

ix. Probability of Profitability Index is being 1.5 or more

Probability of profitability index is being 1.5 or more = 0.50 - 0.4332 = 0.0668 = 6.68%

Solution 5 (Probability Distribution Approach)

x. Probability of NPV is being at Least equal to Mean

$$Z = \frac{187.43 - 187.43}{340.98} = 0.00$$

Probability of NPV is being lies in between Rs.187.43 to Rs.187.43

($\Rightarrow$Z = 0.00 to Z =0.00) = 0.50

Probability of NPV is being at least equal to mean = 0.50 = 50%

xi. Probability of NPV is being 10% below Mean

$$Z = \frac{168.69 - 187.43}{340.98} = -0.05$$

Probability of NPV is being lies in between Rs.168.69 to Rs.187.43

($\Rightarrow$Z =-0.05 to Z=0.00)=0.0199

Probability of NPV is being 10% below mean = 0.0199 = 1.99%

xii. Probability of NPV is being 10% above Mean

$$Z = \frac{206.17 - 187.43}{340.98} = +0.05$$

Probability of NPV is being lies in between Rs.187.43 to Rs.206.17

($\Rightarrow$Z=0.00to Z=+0.05)=0.0199

Probability of NPV is being 10% above mean = 0.0199 = 1.99%

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Thank You