A Study on Application of Sensitivity Analysis Techniques In Capital Budgeting Decisions

Mr. Suresh A.S

Assistant Professor, PES Institute of Technology, Bangalore

Abstract

Investment decision is concerned with allocation of funds. Since financial management deals with mobilization and deployment of funds, equal importance must be given to both the functions. Funds are mobilized through long term, medium term and short-term sources. The main aim of such investment is to get proper yield from the project, so that it can recover the cost associated with each source of funds and earn required amount of profit to compensate the risk involved in the business. Equity has the cost of dividend, debenture has the cost of interest, and preference share has the cost of dividend. All these costs must be recovered through the judicious allocation of available funds. This is a risky decision to be taken by managers, as they have to forecast the anticipated profit which is based on several uncertainties. Thus this is a decision based on risk and uncertainty. The firm has to evaluate the investment proposals in relation of their expected returns and risk to determine whether the investment is feasible or not. The process through which different projects are evaluated is known as capital budgeting.

Keywords: *Deployment of funds, Mobilization, Risk, Yield.*

Introduction

The concept, capital budgeting is a financial management tool through which capital expenditure proposals are evaluated. The expenditure, risk and uncertainties that are associated with each proposal will be examined. The profit, cost and inflow of cash of the projects are compared and best projects are selected for the purpose of investment. This tool is used in almost all the stages of business cycle. In the initial stages, a firm has to buy plant and machinery, at the growth stage, it requires funds for expansion and at the saturation stage, firm requires funds for diversification. Therefore, it is an ongoing process essentially needed in the process of financial management.

Capital project planning is the process by which companies allocate funds to various investment projects designed to ensure profitability and growth. Evaluation of such project involves estimating their future benefits to the company and comparing these with their costs. In a competitive economy, the economic viability and prosperity of a company depends upon the effectiveness and adequacy of a capital expenditure evaluation and control procedure. Decision in respect of acquisition of fixed assets is directly linked with the profitability. Capital Budgeting involves the search for new and more profitable investment proposals and the making of an economic analysis to determine the profit potential of each investment proposal. It is a process by which available cash and credit resources are allocated among competitive long-term investment opportunities so as to promote the greatest profitability of company over a period of time. It refers to the total process of Generating, Evaluating, Selecting and Follow up on capital expenditure alternatives.

Purpose of Investment Appraisal

The purpose of investment appraisal is to assess the economic prospects of a proposed investment project. It is a methodology for calculating the expected return based on cash-flow forecasts of many, often inter-related, project variables. The evaluation of project risk therefore depends on the one hand, on firm's ability to identify and understand the nature of uncertainty surrounding the key project variables and on the other, on having the tools and methodology to process its risk implications on the return of the project.

Project Uncertainty

The first task of project evaluation is to estimate the future values of the projected variables. Generally, we utilize information regarding a specific event of the past to predict a possible future outcome of the same or similar event. The approach usually employed in investment appraisal is to calculate a "best estimate" based on the available data and use it as an input in the evaluation model. These single-value estimates are usually the mode (the most likely outcome), the average, or a conservative estimate.

In selecting a single value however, a range of other probable outcomes for each project variable (data which are often of vital importance to the investment decision as they pertain to the risk aspects of the project) are not included in the analysis. By relying completely on single values as inputs it is implicitly assumed that the values used in the appraisal are certain. The outcome of the project is therefore also

presented as a certainty with no possible variance or margin of error associated with it, recognizing the fact that the values projected are not certain, an appraisal report is usually supplemented to include sensitivity and scenario analysis tests. Sensitivity analysis, in its simplest form, involves changing the value of a variable in order to test its impact on the final result. It is therefore used to identify the project's most important highly sensitive variables.

The use of risk analysis in investment appraisal carries sensitivity and scenario analysis to make logical conclusion. Monte Carlo simulation adds the dimension of dynamic analysis to project evaluation by making it possible build up random scenarios which are consistent with the analyst's key assumptions about risk. By being essentially a decision making tool, risk analysis has many applications and functions that extend its usefulness beyond pure investment appraisal decisions. It can also develop into a powerful decision making device in marketing, strategic management, economics, financial budgeting, production management and in many other fields in which relationships that are based on uncertain variables are modeled to facilitate and enhance the decision making process.

The most important function of the business is the investment. Income from the investment helps the company to recover costs and also the liabilities. Most of the companies do not consider the risk associated with their estimations of cash inflow, cost of capital because it is one of the most complex and slippery aspects of capital budgeting. But analyzing the risk factor helps to select best alternatives in an efficient way. Hence variations in risk need to be explicitly evaluated in capital budgeting process.

Assumptions for the study

i. Depreciation is assumed at 9% at straight line method. The tax rate is assumed at 42%. The company utilizes 8% of discount factor. The risk free rate assumed is 9%.
ii. Two machines are considered for the study, namely machine 1 and machine 2. These machines are complimentary to each other. Acceptance of one machine leads to rejection of another machine.
iii. The machines are completely utilized up to the capacity. Hence the total production is considered as total sales.

ιϖ. All machines incur some maintenance cost covers a minimum wastage of production, lubrication and tools utilized for the proper maintenance of the machines and this cost increases as the life of the machine increases.

ϖ. The machines are used based on the capacity of production by that machine. The machine is assumed to work approximately for 23 days a month.

Machine 1: M1

M1 is the machine which has the capacity of producing 10 million units per annum; the cost of the machine is Rs. 40 million. Life of the machine is 5 years. The salvage value of the machine is Rs. 2.2 million.

Machine 2: M2

M2 is the machine which has the capacity of producing 12 million units per annum. The cost of the machinery is Rs. 45 million. Life of the machine is 5 years. The salvage value of the machine is Rs. 2.47 million.

Application of Sensitivity Analysis Techniques For Machine 1: M1

Table 1.1: Computation of depreciation amount

(Amount in '000)

Years	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Amount	40000	36400	32800	29200	25600
Depreciation	3600	3600	3600	3600	3600
Balance	**36400**	**32800**	**29200**	**25600**	**22000**

Computations of cash flows under different case (Most likely, Optimistic and pessimistic case)

- **MOST LIKELY CASE**

Table 1.2: Computation of cash inflows from the operation under Most Likely

(Amount in '000)

YEARS	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**

REVENUE	1250000	1250000	1250000	1250000	1250000
(-) COST	1130000	1141300	1152713	1164240	1175882
CASH SAVINGS	120000	108700	97287	85760	74118
(-) DEP	3600	3600	3600	3600	3600
EADBT	116400	105100	93687	82160	70518
(-) TAX (42%)	48888	44142	39349	34507	29618
EADAT	67512	60958	54338	47653	40900
(+) DEP	3600	3600	3600	3600	3600
(+) SALVAGE	NIL	NIL	NIL	NIL	2200
CASH INFLOW	**71112**	**64558**	**57938**	**51253**	**46700**
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**65850**	**55326**	**46003**	**37671**	**31803**

Total present value of cash inflows: **236653**

NPV = Total present value - initial investment

= 236653 - 40000

= **196653**

- **OPTIMISTIC CASE**

Table 1.3: Computation of NPV when revenue is 1300000

(in '000)

YEARS	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
REVENUE	1300000	1300000	1300000	1300000	1300000
(-) COST	1130000	1141300	1152713	1164240	1175882
CASH SAVINGS	170000	158700	147287	135760	124118
(-) DEP	3600	3600	3600	3600	3600
EADBT	166400	155100	143687	132160	120518
(-) TAX (42%)	69888	65142	60349	55507	50618
EADAT	96512	89958	83338	76653	69900

(+) DEP	3600	3600	3600	3600	3600
(+) SALVAGE	NIL	NIL	NIL	NIL	2200
CASH INFLOW	100112	93558	86938	80253	75700
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**92704**	**80179**	**69029**	**58986**	**51552**

Total present value of cash inflows: **352450**

NPV = Total present value - initial investment

= 352450 - 40000

= **312450**

- **PESSIMISTIC CASE**

Table 1.4: Computation of NPV when revenue is 1200000

(in '000)

YEARS	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
REVENUE	1200000	1200000	1200000	1200000	1200000
(-) COST	1130000	1141300	1152713	1164240	1175882
CASH SAVINGS	70000	58700	47287	35760	24118
(-) DEP	3600	3600	3600	3600	3600
EADBT	66400	55100	43687	32160	20518
(-) TAX (42%)	27888	23142	18349	13507	8618
EADAT	38512	31958	25338	18655	11900
(+) DEP	3600	3600	3600	3600	3600
(+) SALVAGE	NIL	NIL	NIL	NIL	2200
CASH INFLOW	42112	35558	28938	22253	17700
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**38996**	**30473**	**22977**	**16356**	**12054**

Total present value of cash inflows: **121036**

NPV = Total present value - Initial investment

= 121036 - 40000

= **81036**

Risk Adjusted Discount Rate Method

Table 1.5: Computation of NPV when discount rate is 13%

Discount rate: Rate of return + Risk premium = 8 + 5 = 13%

(in '000)

YEARS	CASH INFLOW	PV@13%	PV CASH INFLOWS
2012-13	71112	0.885	62934
2013-14	64558	0.783	50549
2014-15	57938	0.693	40151
2015-16	51253	0.613	31418
2016-17	46700	0.543	25358
TOTAL PRESENT VALUE			**210410**

Total present value of cash inflows: 210410

NPV = Total present value - Initial investment

= 210410 - 40000

= 170410

Table 1.6: Computation of NPV when discount rate is 15%

(in '000)

YEARS	CASH INFLOW	PV@15%	PV CASH INFLOWS
2012-13	71112	0.869	61796
2013-14	64558	0.756	48806
2014-15	57938	0.657	38065

2015-16	51253	0.572	29317
2016-17	46700	0.497	23210
TOTAL PRESENT VALUE			**201194**

Total present value of cash inflows: 201194

NPV = Total present value - Initial investment

= 201194 - 40000

= 161194

Certainty Equivalent Method

Table 1.7: Computation of NPV by assuming probability for BEST CASE

CEC = Certainty equivalent coefficient, PVF = Present value factor

(in ‘000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	100112	0.95	95106	0.926	88068
2013-14	93558	0.9	84202	0.857	72161
2014-15	86938	0.9	78244	0.794	62126
2015-16	80253	0.9	72228	0.735	53088
2016-17	75700	0.9	68130	0.681	46397

Total present value of cash inflows: 321840

NPV = Total present value - Initial investment

= 321840 - 40000

= 281840

Table 1.8: Computation of NPV by assuming probability for NORMAL CASE

(in ‘000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	71112	0.95	67556	0.926	62557
2013-14	64558	0.9	58102	0.857	49793
2014-15	57938	0.9	52144	0.794	41402
2015-16	51253	0.9	46128	0.735	33904
2016-17	46700	0.9	42030	0.681	28622

Total present value of cash inflows: 216278

NPV = Total present value - Initial investment

= 216278 - 40000

= 176278

Table 1.9: Computation of NPV by assuming probability for WORST CASE

(in '000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	42112	0.95	40006	0.926	37046
2013-14	35558	0.9	32002	0.857	27426
2014-15	28938	0.9	26044	0.794	20679
2015-16	22253	0.9	20028	0.735	14721
2016-17	17700	0.9	15930	0.681	10848

Total present value of cash inflows: 110270

NPV = Total present value - Initial investment

= 110270 - 40000

= 70270

Standard Deviation

Table 1.10: Computation of Standard Deviation For Normal Case

(in '000)

Years	Cash inflows	Prob(f)	Prob* cash inflow (x)	Deviation	f*deviation 2
2012-13	71112	0.2	14222	(2560)	1309696
2013-14	64558	0.2	12912	(1249)	312000
2014-15	57938	0.2	11588	75	1125
2015-16	51253	0.2	10251	1412	398749
2016-17	46700	0.2	9340	2323	1079266

Mean: $\sum\frac{x}{n}$ = 58313 / 5 = 11663

Standard deviation = √∑fd2 / n = √3100836 / 5 = 787.507

Coefficient of variance method:

$$\text{Variance} = \frac{\text{SD}}{\text{MEAN}}$$

= 787.507 / 11663

= 6.75%

Interpretation:

Sensitivity method = Optimistic case = 312450

Pessimistic case = 81036

Risk adjusted discount rate method = PV factor (13) = 170410

PV factor (15) = 161194

Certainty equivalent method = Best case = 281840

Normal case = 176278

Worst case = 70270

Standard deviation method = 787.507

Coefficient of variance method = 6.75%

Machinery-A2

Table 2.1: Computation of depreciation amount

(in '000)

	2012-13	2013-14	2014-15	2015-16	2016-17
AMOUNT	45000	40950	36900	32850	28800
DEPRECIATION	4050	4050	4050	4050	4050
BALANCE	**40950**	**36900**	**32850**	**28800**	**24750**

Computations of cash flows under different case (Most likely, Optimistic and pessimistic case)

Most Likey Case

Table 2.2: Computation of Cash Inflows from the Operation

(in '000)

YEARS	2012-13	2013-14	2014-15	2015-16	2016-17
REVENUE	1500000	1500000	1500000	1500000	1500000
(-) COST	1368000	1381680	1395497	1409452	1423546
CASH SAVINGS	132000	118320	104503	90548	76454
(-) DEP	4050	4050	4050	4050	4050
EADBT	127950	114270	100453	86498	72404
(-) TAX (42%)	53739	47993	42190	36329	30410

EADAT	74211	66277	58263	50169	41994
(+) DEP	4050	4050	4050	4050	4050
(+) SALVAGE	NIL	NIL	NIL	NIL	2475
CASH INFLOW	**78261**	**70327**	**60313**	**54219**	**48519**
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**72470**	**60270**	**49477**	**39851**	**33041**

Total present value of cash inflows: **255109**

NPV = Total present value - initial investment

= 255109 - 45000

= **210109**

Optimistic Case

TABLE 2.3: Computation of NPV when revenue is 1560000

(in '000)

YEARS	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
REVENUE	1560000	1560000	1560000	1560000	1560000
(-) COST	1368000	1381680	1395497	1409452	1423546
CASH SAVINGS	192000	178320	164503	150548	136454
(-) DEP	4050	4050	4050	4050	4050
EADBT	187950	174270	160453	146498	132404
(-) TAX (42%)	78939	73193	67390	61529	55610
EADAT	109011	101077	93063	84969	76794
(+) DEP	4050	4050	4050	4050	4050
(+) SALVAGE	NIL	NIL	NIL	NIL	2475
CASH INFLOW	113061	105127	97113	89019	83319
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**104694**	**90094**	**77108**	**65429**	**56740**

Total present value of cash inflows: **394065**

NPV = Total present value - initial investment

= 394065 - 45000

= **349065**

Pessimistic Case

Table 2.4: Computation of NPV when revenue is 1440000

(in '000)

YEARS	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
REVENUE	1440000	1440000	1440000	1440000	1440000
(-) COST	1368000	1381680	1395497	1409452	1423546
CASH SAVINGS	72000	58320	44503	30548	16454
(-) DEP	4050	4050	4050	4050	4050
EADBT	67950	54270	40453	26498	12404
(-) TAX (42%)	28539	22793	16990	11129	5210
EADAT	39411	31477	23463	15369	7194
(+) DEP	4050	4050	4050	4050	4050
(+) SALVAGE	NIL	NIL	NIL	NIL	2475
CASH INFLOW	43461	35527	27513	19419	13719
PV @ 8%	0.926	0.857	0.794	0.735	0.681
PV CASH INFLOW	**40245**	**30447**	**21845**	**14273**	**9343**

Total present value of cash inflows: **116153**

NPV = Total present value - Initial investment

= 116153 - 45000

= **71153**

Risk Adjusted Discount Rate Method

Table 2.5: Computation of NPV when discount rate is 13%

Discount rate: Rate of return + Risk premium = 8 + 5 = 13%

(in '000)

YEARS	CASHINFLOW	PV @ 13%	PV CASH INFLOWS
2012-13	78261	0.885	69261
2013-14	70327	0.783	55066
2014-15	60313	0.693	41797
2015-16	54219	0.613	33236
2016-17	48519	0.543	26346
TOTAL PRESENT VALUE			**225706**

NPV = Total present value - Initial investment

= 225706 - 45000

= 180706

Table 2.6: Computation of NPV when discount rate is 15%

(in '000)

YEARS	CASHINFLOW	PV @ 15%	PV CASH INFLOWS
2012-13	78261	0.869	68009
2013-14	70327	0.756	53167
2014-15	60313	0.657	39626
2015-16	54219	0.572	31013
2016-17	48519	0.497	24114
TOTAL PRESENT VALUE			**215929**

NPV = Total present value - Initial investment

= 215929 - 45000

= 170929

Certainty Equivalent Method

Table 2.7: Computation of NPV by assuming probability for BEST CASE

CEC = Certainty equivalent coefficient, PVF = Present value factor

(in '000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	113061	0.95	107408	0.926	99460
2013-14	105127	0.9	94614	0.857	81084
2014-15	97113	0.9	87402	0.794	69397
2015-16	89019	0.9	80117	0.735	58886
2016-17	83319	0.9	74987	0.681	51066

Total present value of cash inflows: 359893

NPV = Total present value - Initial investment

= 359893 - 45000

= 314893

Table 2.8: Computation of NPV by assuming probability for NORMAL CASE

(in '000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	78261	0.95	74348	0.926	68846
2013-14	70327	0.9	63294	0.857	54243
2014-15	60313	0.9	54282	0.794	43100
2015-16	54219	0.9	48797	0.735	35866
2016-17	48519	0.9	43667	0.681	29737

Total present value of cash inflows: 231792

NPV = Total present value - Initial investment

= 231792 - 45000

= 186792

Table 2.9: Computation of NPV by assuming probability for WORST CASE

(in '000)

YEARS	CASH I/F	CEC	CEC*CASH I/F	PVF@8%	PV*CEC*CASH I/F
2012-13	43461	0.95	41288	0.926	38233
2013-14	35527	0.9	31974	0.857	27402
2014-15	27513	0.9	24762	0.794	19661
2015-16	19419	0.9	17477	0.735	12846
2016-17	13719	0.9	12347	0.681	8408

Total present value of cash inflows: 106550

NPV = Total present value - Initial investment

= 10550 - 45000

= 61550

Standard Deviation

Table 2.10: Computation of standard deviation for normal case

(in '000)

Years	Cash i/f	Prob(f)	Prob* cash i/f (x)	Deviation	f*deviation 2
2012-13	78261	0.2	15652	(3187)	2030374
2013-14	70327	0.2	14066	(1600)	511616
2014-15	60313	0.2	12063	403	32546
2015-16	54219	0.2	10844	1622	526307

2016-17	48519	0.2	9704	2762	1525950

Mean: $\sum \frac{x}{n}$ = 62330 / 5 = 12466

Standard deviation= √∑fd2 / n = √4626793 / 5 = 961.96

Coefficient of Variance Method:

Variance = SD / MEAN

= 961.96 / 12466

= 7.72%

Interpretation:

Sensitivity method = Optimistic case = 349065

Pessimistic case = 71153

Risk adjusted discount rate method = PV factor (13) = 180706

PV factor (15) = 170929

Certainty equivalent method = Best case = 314893

Normal case = 186792

Worst case = 61550

Standard deviation method = 961.96

Coefficient of variance method = 7.72 %

Compilation of the Risk Analysis Techniques Used:

Table 3.1: Sensitivity method

Key variables	Machine A1	Machine A2
Optimistic	312450	349065
Most likely	196653	210109
Pessimistic	81036	71153

Table 3.2: Risk adjusted discount rate method

Key variables	Machine A1	Machine A2
PV factor (13%)	170410	180706
PV factor (15%)	161194	170929

Table 3.3: Certainty equivalent method

Key variables	Machine A1	Machine A2
Best case	281840	314893
Normal case	176278	186792
Worst case	70270	61550

Table 3.4: Standard Deviation Method

Key variables	Machine A1	Machine A2
Standard deviation	787.507	961.96

Table 3.5: Coefficient of Variance Method

Key variables	Machine A1	Machine A2
Variance	6.75%	7.72%

Ranking of the Project on the Basis of Risk Analysis Techniques

Assign the rank for the machine from 1 and 2. Rank the best machine as 1. Rank both machines in each criterion. The machine which has least score will be overall ranked as 1st.

Table: 3.6: Ranking of the project

Key variables	Machine A1	Machine A2
Sensitivity method	01	02
Risk adjusted method	01	02
Certainty equivalent method	01	02
Standard deviation method	01	02
Coefficient of variance method	01	02

Table 3.7: Overall ranking of the machines

Machines	Machine A1	Machine A2
Total score	05	10
Overall ranking	1st	2nd

Hence according to discounted cash flow techniques machine A1 is selected.

Suggestions and Recommendations:

1. The analysis should not depend only on the discounted cash flow techniques to evaluate the best alternative from the available.

2. Risk factor involved in the project should be analyzed, which reduces the opportunity cost of the decision. It also yields high profits to the company.
3. Every decision is involved with some level of certainty and uncertainty. The level of uncertainty will be reduced by thorough analyze of the risk factors involved in that decision.
4. Risk analysis also helps us to resist the future risks faced by the company

Conclusion:

A risk analysis application utilizes a wealth of information, be it in the form of objective data or expert opinion, to quantitatively describe the uncertainty surrounding the key project variables as probability distributions and to calculate in a consistent manner its possible impact on the expected return of the project. The output of a risk analysis is not a single-value but a probability distribution of all possible expected returns. The prospective investor is therefore provided with a complete risk/return profile of the project showing all the possible outcomes that could result from the decision to stake his money on a particular investment project. Risk analysis is not a substitute tool for normal investment appraisal methodology but rather a tool that enhances its results. A good appraisal model is a necessary base on which the firm can set up a meaningful simulation. Risk analysis supports the investment decision by giving the investor a measure of the variance associated with a project appraisal return estimate.

References:

1. Aggarwal, Raj, 1980, "Corporate Uses of Sophisticated Capital Budgeting Techniques: A Strategic Perspective and a Critique of Survey Results," Interfaces 10 (No. 2, April) 31- 34.

2. Brealey, Richard A. and Stewart A. Myers., 1997, Principles of Corporate Finance, 5th edition, McGraw-Hill Companies, New York.

3. Brigham, Eugene F., 1975, "Hurdle Rates for Screening Capital Expenditure Proposals," Financial Management 4 (No. 3, Autumn), 17-26.

4. Evans, Dorla A. and Shawn M. Forbes, 1993, "Decision Making and Display Methods: The Case of Prescription and Practice in Capital Budgeting," The Engineering Economist 39 (No. 1, Fall), 87-92.

5. Financial Management Panel Discussion on Corporate Investment, (1989), Samuel C Weaver, moderator, Financial Management 18 (No. 1, Spring), 10-17.

6. Patricia A. Ryan and Glenn P. Ryan: Capital Budgeting Practices of the Fortune 1000: How Have Things Changed? – The Journal of Business and Management, Volume 8, Number 4, Winter 2002

7. Prasanna Chandra: Projects Planning, Analysis, Selection, Financing, Implementation and Review, 6th edition, Tata McGraw-Hill Publishing Company limited.