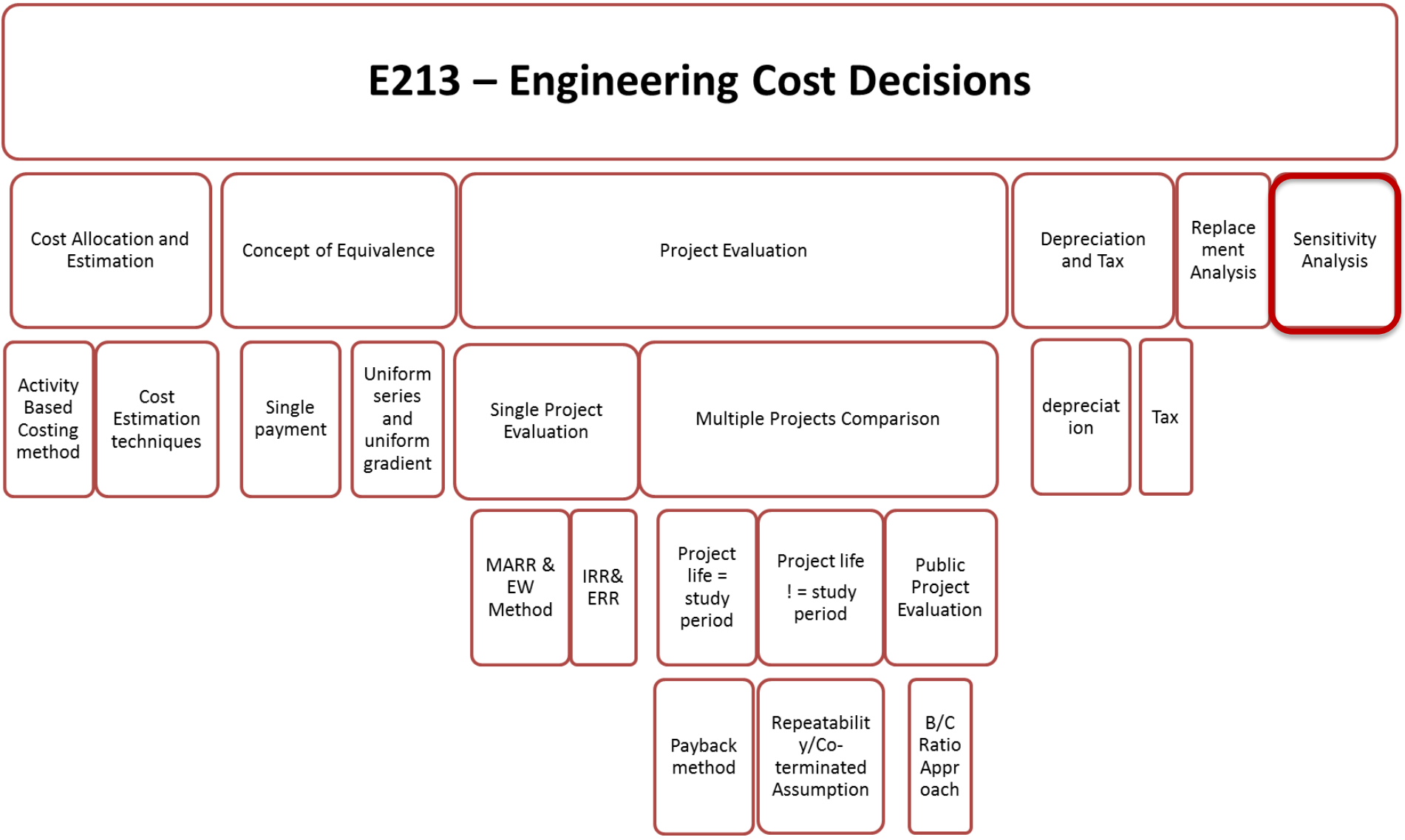
Problem 13

Does Change Matter?

E213 – Engineering Cost Decisions

SCHOOL OF ENGINEERING

Module Coverage: Topic Tree



Recap…

- Minimum Attractive Rate of Return (MARR)
  - An interest rate set by the company used to convert cash flows into equivalent worth at some point in time
  - Taking into consideration the type of business and risks involved
- Net Present Worth (PW)
  - The difference between the present value of cash inflows and the present value of cash outflows
- Internal rate of return (IRR)
  - The interest rate that equates the equivalent value of cash inflows to the equivalent value of cash outflows
- Payback Period
  - The period of time required for the return on an investment to "repay" the original investment.

Dealing with Uncertainties

Methods of Describing Project Risk

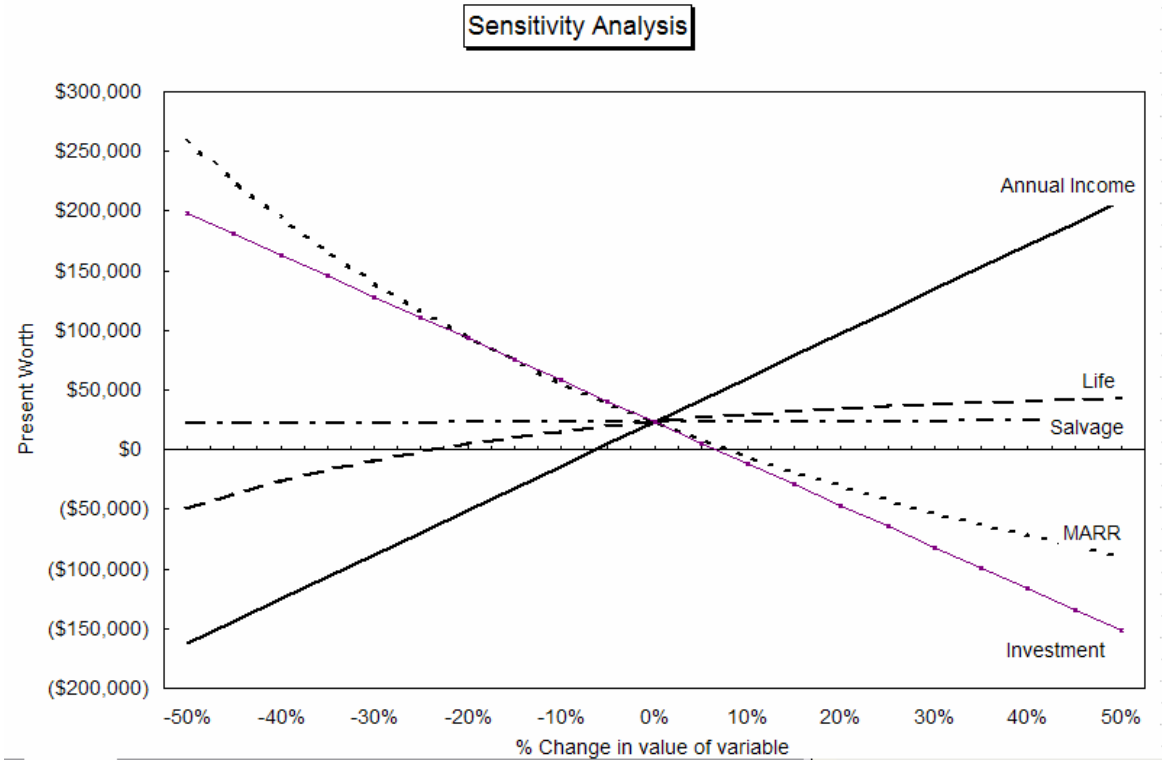
- Break-even analysis
  - (E.g. use “Goal Seek” function to obtain factor value at zero PW)
- Sensitivity analysis  **Today’s focus**
  - Sensitivity graph (Spider Plot)
- Scenario analysis (Combination of factors)
  - Worst-case scenario
  - Most-likely-case scenario
  - Best-case scenario

Dealing with Uncertainties

Sensitivity Analysis

- Cash flows in an investment are estimates and usually uncertain.
- Point estimates are never sufficient.
- Need to study the effect on Net Present Worth (PW) of variation in input variables. (e.g. revenue, operating cost, study period)
- Pay special attention to those variables that may ‘make or break’ an investment.

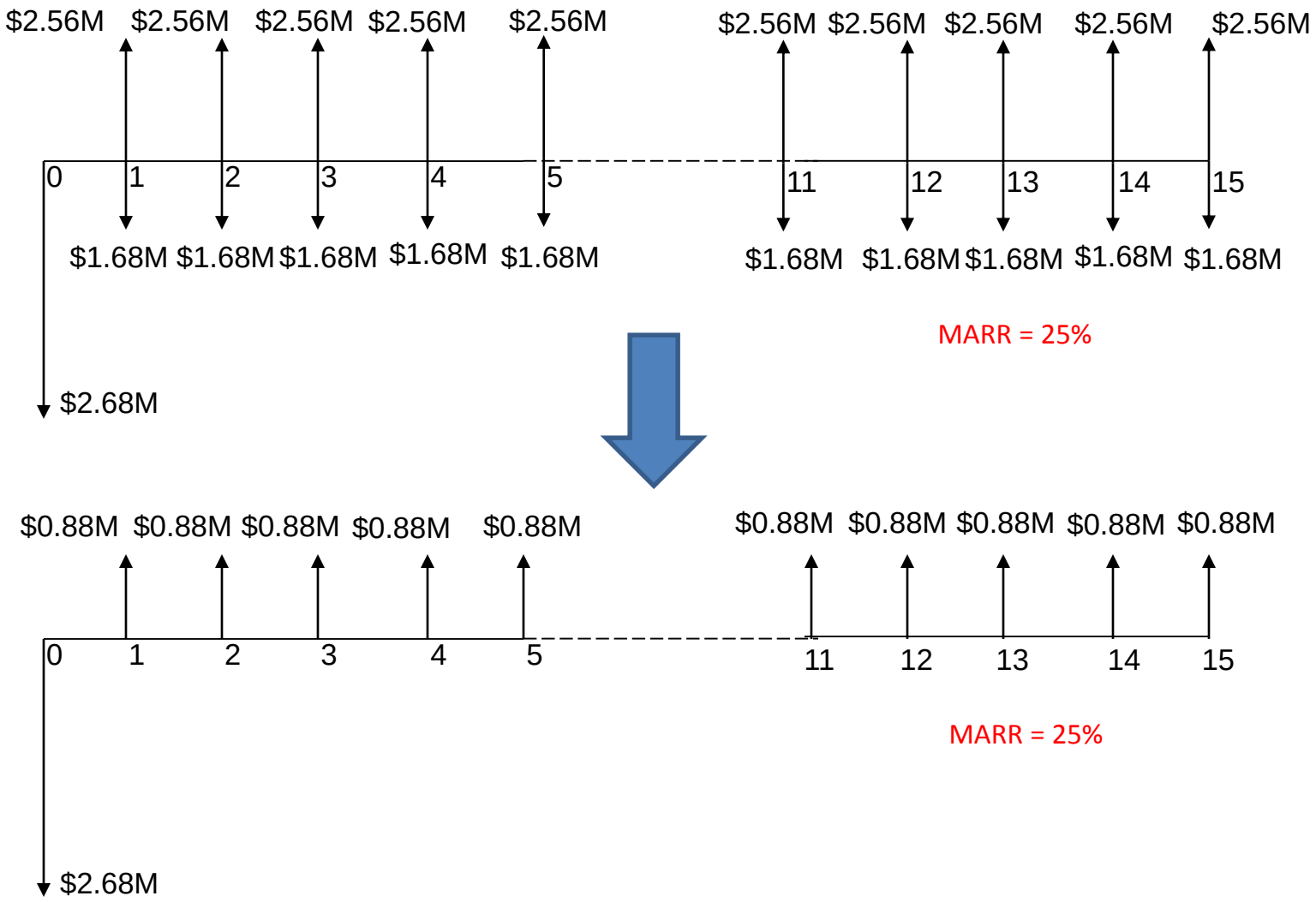
Sensitivity Graph (Spider Plot)



- The Spider Plot plots the resultant PW to changes in each factor's best estimates. The other factors are assumed to remain at their most likely values.
- It shows the sensitivity of the PW to percent changes in each factor's best estimates. The relative ***degree of sensitivity*** of the PW to each factor is indicated by the ***slope of the curves*** (the steeper the slope, the more sensitive the PW is to the factor).

P13 Suggested Solution

Draw Cash Flow Diagram



Calculation of Net Present Worth (PW)

Net Present Worth

= Initial Investment + PW (Annual Cash Flow) + PW (Salvage Value)

= -$2,680,000 + ($2,560,000- $1,680,000) (P/A, 25%, 15) + 0

= -$2,680,000 + $880,000 (3.2682)

= $716,151

- With each factor having the best estimated value, net PW indicates the economic worth of the investment, taking into account the MARR of the investing company
- Since Net PW(25%) > 0, investment is economically feasible

Sensitivity Analysis

% Change	MARR	Life	Revenue	Expenses	Investment
-30%	0.175	11	$1,792,000	$1,176,000	$1,876,000
-20%	0.2	12	$2,048,000	$1,344,000	$2,144,000
-10%	0.225	14	$2,304,000	$1,512,000	$2,412,000
0	0.25	15	$2,560,000	$1,680,000	$2,680,000
10%	0.275	17	$2,816,000	$1,848,000	$2,948,000
20%	0.3	18	$3,072,000	$2,016,000	$3,216,000
30%	0.325	20	$3,328,000	$2,184,000	$3,484,000

Each factor is allowed to change within -30% to 30% of its original value

When Initial Investment is increased by 30%:

Initial Investment

= $2,680,000 (**1+30%**)

= $**3,484,000**

Sensitivity Analysis

% Change	MARR	Life	Revenue	Expenses	Investment
-30%	$1,900,985	$501,945	($2,247,763)	$2,661,219	$1,520,151
-20%	$1,434,416	$598,107	($1,259,791)	$2,012,863	$1,252,151
-10%	$1,044,791	$666,916	($271,820)	$1,364,507	$984,151
0	$716,151	$716,151	$716,151	$716,151	$716,151
10%	$436,344	$751,381	$1,704,122	$67,795	$448,151
20%	$196,026	$776,589	$2,692,093	($580,561)	$180,151
30%	($12,060)	$794,627	$3,680,065	($1,228,917)	($87,849)

E.g. Net Present Worth if investment is 30% higher

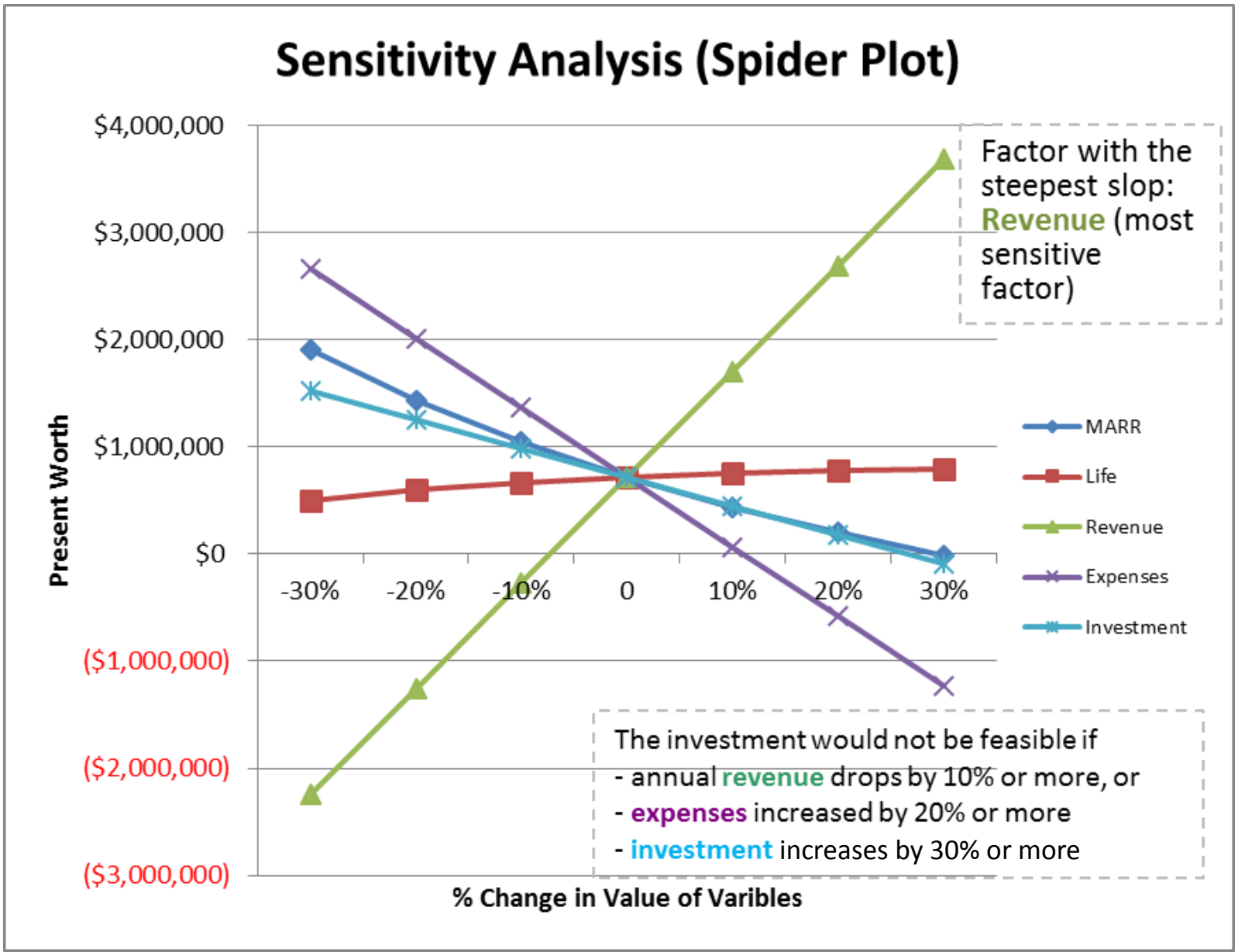
= Initial Investment + PW (Annual Cash Flow) + PW (Salvage Value)
= - $2,680,000 (**1+30%**) + ($2,560,000 - $1,680,000) (P/A, 25%, 15) + 0
= - $**3,484,000** + $880,000 (P/A, 25%, 15) + 0 = - $87,849

Only the factor under study changes. The rest factors will remain at their best estimated values.

An e-learning video is available for sensitivity analysis in the following link:

https://drive.google.com/file/d/0B74OhMtE0KcyaExzWXNtQTIxcFk/view?usp=sharing

Sensitivity Analysis



Conclusions

- In all economic studies, the time value of money must be considered.
- Remember that uncertainties are part and parcel of economic projects.
- Always carry out sensitivity analysis to ensure robustness of your decision.

(Going Further) Payback Period = 7 years

End of Year (N)	Net Cash Flow	PV of Cash Flow @ i = 25%	Cumulative PW @ i = 25% through year N
0	$ (2,680,000)	$ (2,680,000)	$ (2,680,000)
1	$ 880,000	$ 704,000	$ (1,976,000)
2	$ 880,000	$ 563,200	$ (1,412,800)
3	$ 880,000	$ 450,560	$ (962,240)
4	$ 880,000	$ 360,448	$ (601,792)
5	$ 880,000	$ 288,358	$ (313,434)
6	$ 880,000	$ 230,687	$ (82,747)
7	$ 880,000	$ 184,549	$ 101,802
8	$ 880,000	$ 147,640	$ 249,442

Learning Objectives

- Recognize the need for sensitivity analysis
- Apply techniques to quantify investment risks
- Develop a Spider Plot using MS Excel and identify the sensitive parameters from Spider Plot
- Conduct risk assessment of investment using Spider Plot

E213 Engineering Cost Decisions (Topic Flow)

Application of ABC costing method in cost management

Application of different cost estimating techniques

Comparison of alternatives using the concept of equivalence

Alternatives evaluation using single, uniform series and uniform gradient cash flows

Project evaluation using MARR and Equivalent Worth method

Project evaluation based on Internal Rate of Return and External Rate of Return

Evaluate alternatives of equal life spans using payback method

Evaluate alternatives with different life spans

Evaluate public projects through incremental B/C analysis

Depreciation estimation and consideration in economic analysis

Tax consideration in economic analysis

Replacement analysis application

Risk and uncertainties handling in economic analysis

Today's learning