

IE2111 ISE Principles & Practice II

Lab 3 - Understanding Key Uncertainties in Project

Objectives and Learning Outcomes

In this lab-based tutorial, you will learn how to perform sensitivity analysis

1. Perform One-Way Range Sensitivity Analysis to generate Tornado and Spider Diagrams using the Sensit Excel Add-in.
2. Perform Break-Even Analysis using Rainbow Diagrams and Excel Table command.

Problem Description

ISEM Company has recently successfully developed a new product. The market demand of this product is estimated to be 15,000 units per year at a sale price of \$10 per unit. The product life is expected to be 10 years. The product can be manufactured using two alternative methods using different manufacturing technologies as follows:

Alternative A: Advanced manufacturing technology

This involves adopting a recently develop advanced manufacturing technology and requires an expensive automatic machine tools with intelligent sensors system. Relevant data for this alternative are given below:

- Initial cost: \$230,000.
- Useful life: 10 years.
- Salvage value: \$10,000

- Manpower requirement and costs:
 - Production output: 8 units per hour
 - Number of operators needed: 1
 - Skill level: High
 - Manpower cost: \$12 per hour per operator

- Annual maintenance and other costs:
 - Maintenance manpower: \$25,000
 - Moldings & Tooling: \$5,000
 - Spare parts: \$5,000

- Direct material costs: \$3 per unit.

Alternative B: Conventional manufacturing technology

This involves using an existing manufacturing technology which requires cheaper conventional machine tools operated low-skill workers. Relevant data for this alternative are given below:

- Initial cost: \$90,000.
- Useful life: 5 years.
- Salvage value: \$1,000

- Manpower requirement and costs:
 - Production output: 6 units per hours
 - Number of operators: 3
 - Skill level: Low
 - Manpower cost: \$8 per hour per operator

- Annual maintenance and other costs:
 - Maintenance manpower: \$10,000
 - Moldings & Tooling: \$3,000
 - Spare parts: \$2,000

- Direct material costs: \$3 per unit.

Exercise

ISEM management is not sure which of the two alternatives to select, and you have been engaged as a consultant to advice the company.

ISEM's CEO has instructed you to use a before-tax *MARR* 12% and a study period of 10 years in the analysis. In addition, you may use the repeatability assumption where needed. Income tax do not need to be considered in this analysis as the company has been granted special tax exemption by the Economic Development Board for this investment project.

1. Base Model Development & Analysis

Use Excel to perform before-tax cash flow analysis on the two alternatives based on the base case scenario data. You may use the Excel template provided.

Some useful formulas:

- Annual Revenue = Annual production volume \times Unit selling price
- Annual direct manpower cost = Annual production volume \times Variable manpower cost per piece
- Annual Direct Material cost = Annual production volume \times Direct material cost per unit
- Annual Overheads = Annual Maintenance Manpower + Annual Moldings & Tooling + Annual Spare parts
- $AW(12\%) = - \text{Initial Investment } [A/P, 12\%, N] + (\text{Annual revenue} - \text{Annual direct manpower cost} - \text{Annual Direct Material cost} - \text{Annual Overheads}) + \text{Salvage value } [A/F, 12\%, N]$

Q1.1 What are the AW for the two alternatives under base case scenario?

$AW(12\%)$ of Alternative A = _____

$AW(12\%)$ of Alternative B = _____

Q1.2 Are the two alternatives financially feasible under base-value scenario?

Alternative A is financially feasible / infeasible

Alternative B is financially feasible / infeasible

Q1.3 Which alternative is preferred under base-value scenario?

Alternative A / Alternative B / None

2. Break-Even Analysis on Annual Production Volume

Uncertainty in Annual Production Volume has been identified by the company as a major concern.

Using Excel Table function, compute the AW of the two alternatives when the Annual production volume is varied from 13,000 to 17,000 in step of 500.

Plot a rainbow diagram and determine the followings:

Q2.1 Alternative A is financially feasible when the Annual production volume is in the following range:

Q2.2 Alternative B is financially feasible when the Annual production volume is in the following range:

Q2.3 Alternative A is preferred to Alternative B when the Annual production volume is in the following rate:

3. Break-Even Analysis on Unit selling price

Unit selling price of the product has also been identified by the company as a major concern.

Using Excel Table function, compute the AW of the two alternatives when the unit selling price is varied from \$9.00 to \$11.00 in step of \$0.10.

Plot a rainbow diagram and determine the followings:

Q3.1 Alternative A is financially feasible when the Unit selling price is in the following range:

Q3.2 Alternative B is financially feasible when the Unit selling price is in the following range:

Q3.3 Alternative A is preferred to Alternative B when the Unit selling price is in the following range:

4. One-Way Range Sensitivity Analysis

ISEM management is not very comfortable with the results based on the base case data as the company does not have much experience in advanced manufacturing. In addition, there are still many uncertainties in the data to be considered.

You proposed that one-way range sensitivity analyses be performed on the base model to better understand the key uncertainties and hence raise the company's confidence in adopting the best alternative.

Expert's estimates of the possible range of values for each of the uncertain variables are given in the table below:

	Uncertain Variable	Alternative A Advanced Manufacturing			Alternative B Conventional Manufacturing		
		Low	Base	High	Low	Base	High
1	Annual production quantity	13,000	15,000	17,000	13,000	15,000	17,000
2	Unit selling price	\$9	\$10	\$11	\$9	\$10	\$11
3	Annual maintenance Cost	\$24,000	\$25,000	\$26,000	\$9,000	\$10,000	\$11,000
4	Annual moldings & tooling cost	\$4,500	\$5,000	\$5,500	\$2,500	\$3,000	\$3,500
5	Annual Spare parts cost	\$4,500	\$5,000	\$5,500	\$1,500	\$2,000	\$2,500
6	Manpower cost/worker/hour	\$9.00	\$12.00	\$15.00	\$7.00	\$8.00	\$9.00
7	Output per hours (pieces)	7.5	8	8.5	5.5	6	6.5
8	Variable material cost per unit	\$2.80	\$3.00	\$3.20	\$2.80	\$3.00	\$3.20
9	Salvage value	\$6,000	\$10,000	\$14,000	\$0	\$1,000	\$2,000

Using the Sensit Excel add-on, generate Tornado and Spider Diagrams for AW of the two alternatives.

Q4.1 From the tornado diagram, which are the 3 most sensitive variables?

Q4.2 From the tornado diagram, which are the 3 least sensitive variables?