

E355 Engineering Economics Spring 2022
Homework #4

“I pledge my honor that I have abided by the Stevens Honor System”

By: Alexander Gaskins, Daniel Goldberg, and Samuel Gavrilov

4.1 The Daily Planet, a prime retail company, is considering buying new land in Smallville for \$900,000 to build a high tech distribution center on it. Three different buildings are being analyzed.

Building Size	2 acres	4 acres	7 acres
Initial Cost (excludes land)	\$ 750,000	\$ 860,000	\$ 920,000
Resale value* of land + building after 20-year horizon	\$ 1,600,000	\$ 2,592,000	\$ 2,096,000
Annual net income	\$ 150,000	\$ 250,000	\$ 225,000

* Resale value considered a reduction in cost, not a benefit.

Using benefit–cost ratio analysis and an 16% MARR, determine which alternative, if any, should be selected.

a) Using PW, calculate the B/C Ratios of 3 building designs. [3 points]

$$\left(\frac{P}{A}, 16\%, 20\right) = \left[\frac{0.18-0.15}{5.353-6.259} = \frac{0.18-0.16}{5.353-x}\right] = 5.957$$

$$\left(\frac{P}{F}, 16\%, 20\right) = \left[\frac{0.18-0.15}{0.0365-0.0611} = \frac{0.18-0.16}{0.0365-x}\right] = 0.0529$$

2 acres:

$$\frac{B}{C} = \frac{150000\left(\frac{P}{A}, 16\%, 20\right)}{750000-1600000\left(\frac{P}{F}, 16\%, 20\right)} = 1.343$$

4 acres:

$$\frac{B}{C} = \frac{250000\left(\frac{P}{A}, 16\%, 20\right)}{860000-2592000\left(\frac{P}{F}, 16\%, 20\right)} = 2.0602$$

7 acres:

$$\frac{B}{C} = \frac{225000\left(\frac{P}{A}, 16\%, 20\right)}{920000-2096000\left(\frac{P}{F}, 16\%, 20\right)} = 1.657$$

b) Conduct an incremental B/C analysis. [2 points]

(4-2) Acre:

$$\frac{(250000-150000)(5.957)}{[860000-2592000(0.0529)]-[750000-1600000(0.0529)]} = 10.35582 > 1, \text{ Consider 4}$$

(7-2) Acre:

$$\frac{(225000-150000)(5.957)}{[920000-2096000(0.0529)]-[750000-1600000(0.0529)]} = 3.10774 > 1, \text{ Consider 7}$$

(7-4) Acre:

$$\frac{(225000-250000)(5.957)}{[920000-2096000(0.0529)]-[860000-2592000(0.0529)]} = -1.727 < 1, \text{ Consider 4}$$

c) Based on your analysis, which alternative should be selected? [1 points]

Based on the previous results, the 4 acre option should be selected, as it presented the largest $\frac{B}{C}$ ration compared to its competitors. It's validity was confirmed through the incremental $\frac{B}{C}$ analysis, which showed the 7 acre and 4 acre options to be favorable, with the 4 acre option being preferable when compared to the 7 acre option.

4.2 Consider two similar types of equipment manufactured by two different companies, and you want to decide which you should buy. If the MARR is 10%, calculate the value of S that makes the two alternatives equally desirable based on AW. [3 points]

Alternative	A	B
Initial Cost	\$ 70,000	\$ 90,000
Uniform Annual Benefit	\$ 99,000	\$ 100,000
Salvage Value	\$ 28,000	S
Useful Life, in years	20	20

Alternative A:

$$AW_{Benefits} = F\left(\frac{A}{F}, 10\%, 20\right) + A = 28000(0.0175) + 99000 = \$99,490$$

$$AW_{Costs} = P\left(\frac{A}{P}, 10\%, 20\right) = 70000(0.1175) = \$8,225$$

$$\frac{B}{C} = \frac{99490}{8225} = 12.096$$

Alternative B:

$$AW_{Costs} = P\left(\frac{A}{P}, 10\%, 20\right) = 90000(0.1175) = \$10,575$$

$$\frac{AW_{Benefits}}{10575} = 12.096$$

$$AW_{Benefits} = \$127,915.20$$

$$S(0.0175) + 100000 = \$127,915.20$$

$$S = \$1,595,154.29$$

4.3 Mr. Botticelli recently purchased new painting equipment for his new art school and spent \$120,000. After its 5-year useful life, the equipment can be sold for \$25,000. Prepare a table showing the depreciation expenses and the book values for the DDB and SOYD depreciation methods.

DDB:

Year	Dt	$\sum Dt$	BV
0	-	-	120000
1	$(2/5)*120000$	48000	72000
2	$(2/5)*72000$	76800	43200
3	$(2/5)*43200$	94080	25920
4	95000-94080	95000	25000
5	0	95000	25000

Depreciable value = 120000-25000 = 95000

DDB Rate = $\frac{2}{5} = 40\%$ For depreciable life

SOYD:

Year	Dt	$\sum Dt$	BV
0	-	-	120000
1	$(5/15)*95000$	31666.66667	88333.33333
2	$(4/15)*95000$	57000	63000
3	$(3/15)*95000$	76000	44000
4	$(2/15)*95000$	88666.66667	31333.33333
5	$(1/15)*95000$	95000	25000

Sum of Years Digits = 5 years = 1+2+3+4+5 = 15

4.4 The Reiph Transportation Company is planning to buy a new fleet of trucks requiring an initial investment of \$1,000,000, and \$2,500,000 annually to maintain and operate. The expected life of the new fleet is 10 years. The revenue is estimated to be \$5,000,000 per year and the salvage value is expected to be \$250,000. The MARR is 18%. Conduct a sensitivity analysis based on the given information.

a) Calculate the PW of the Base case based on above given data. (Do not use AW or FW) [2 point]

$$PW = A \left(\frac{P}{A}, i, N \right) + S \left(\frac{P}{F}, i, N \right) - P = 2500000 \left(\frac{P}{A}, 18\%, 10 \right) + 250000 \left(\frac{P}{F}, 18\%, 10 \right) - 1000000$$

$$PW = 2500000(4.494) + 250000(0.1911) - 1000000 = \$10,282,775$$

b) Calculate the PW for the range of -10% to +15% for initial cost. (Do not use AW or FW) [4 point]

-10% of Initial Cost (IC):

$$IC_{-10\%} = \$1,000,000(1 - 0.10) = \$900,000$$

$$PW = 2500000(4.494) + 250000(0.1911) - 900000 = \$10,382,775$$

+15% of Initial Cost (IC):

$$IC_{+15\%} = \$1,000,000(1 + 0.15) = \$1,150,000$$

$$PW = 2500000(4.494) + 250000(0.1911) - 1150000 = \$10,132,775$$

c) Calculate the PW for the range of -8% to +12% for annual revenue. [4 points]

-8% of Annual Revenue (AR):

$$AR_{-8\%} = \$5,000,000(1 - 0.08) = \$4,600,000$$

$$A = 4600000 - 2500000 = \$2,100,000$$

$$PW = 2100000(4.494) + 250000(0.1911) - 1000000 = \$8,485,175$$

+12% of Annual Revenue (AR):

$$AR_{+12\%} = \$5,000,000(1 + 0.12) = \$5,600,000$$

$$A = 5600000 - 2500000 = \$3,100,000$$

$$PW = 3100000(4.494) + 250000(0.1911) - 1000000 = \$12,979,175$$

d) Prepare a tabular distribution by using PW as FoM. [5 points]

Parameter	% Change in Parameter	Value	FOM (PW)	Deviation from base	% Deviation from base
Initial Cost					
Upper Limit	15%	\$ 1,150,000.00	\$ 10,132,775.00	\$ (150,000.00)	-1.46%
Base Case	0%	\$ 1,000,000.00	\$ 10,282,775.00	\$ -	-
Lower Limit	-10%	\$ 900,000.00	\$ 10,382,775.00	\$ 100,000.00	0.97%
Annual Revenue					
Upper Limit	12%	\$ 5,600,000.00	\$ 12,979,175.00	\$ 2,696,400.00	26.22%
Base Case	0%	\$ 5,000,000.00	\$ 10,282,775.00	\$ -	-
Lower Limit	-8%	\$ 4,600,000.00	\$ 8,485,175.00	\$ (1,797,600.00)	-17.48%

e) Rank order the input variables for their impact of the PW. [2 points]

Parameter	% Change in Parameter	%Change in FOM	Sensitivity Ratio	Rank Order
Initial Cost				
Upper Limit	15%	-1.46%	0.097	Low
Lower Limit	-10%	0.97%	0.097	
Annual Revenue				
Upper Limit	12%	26.22%	2.185	High
Lower Limit	-8%	-17.48%	2.185	

f) Prepare a sensitivity graph comparing the percentage of change in parameter from the base case and the respective PW. [2 points]

