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Economic Analysis of Engineering Projects (CPEN 481)
Assignment 4

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1 Problem 1

Question: List three examples of the potential costs and benefits that should be considered in evaluating a potential nuclear power plant. Give three examples of stakeholder viewpoints that will need to be considered.

Solution:

(a) Costs:

(i) Capital costs: the cost of construction, licensing and permit fees, land acquisition, and equipment.

(ii) Operation and maintenance costs: ongoing costs such as fuel, personnel, and other operating expenses.

(iii) Waste disposal costs: the cost of disposing nuclear waste, which can be a long-term liability

(b) Benefits:

(i) Reliable electricy generation: nuclear power plants generate electricity at a high rate and are reliable

(ii) Reduced greenhouse gas emissions: compared to fossil fuels, nuclear power generation results in fewer greenhouse gas emissions.

(iii) Economic benefits: the operation of a nuclear power plant can bring jobs and economic development to a region.

(c) Stakeholder viewpoints:

(i) Environmental organizations: they may be concerned about the environmental impact of a nuclear power plant, including the potential for radioactive leaks and the long-term storage of nuclear waste.

(ii) Government agencies: government agencies may be concerned about the financial viability of a nuclear power plant, the potential risks associated with the technology, and the impact on the local community.

(iii) Energy companies: energy companies may be concerned about the financial costs and benefits of building and operating a nuclear power plant, as well as the regulatory and political environment.

2 Problem 2

Question: The Highridge region needs an additional supply of water from Steep Creek. The engineer has selected two plans for comparison: Gravity plan: Divert water at a point 10 km upstream on Steep Creek and carry it through a pipeline by gravity to the district. Pumping plan: Divert water at a point on Steep Creek that is nearer to the district, and pump it through 2 km of pipelines to the district. The pumping plant can be built in two stages, with the building, infrastructure, and one pump (half-capacity) installed initially, and the other pump (other half of capacity) installed 10 years later.

	Gravity	Pumping
Initial Investment	\$2,900,000	\$1,500,000
Investment in 10^{th} year	0	400,000
Operation, maintenance, replacements, per year	10,000	25,000
Average power costs		
first 10 years	0	70,000
next 30 years	0	110,000
Average annual benefits		
First 10 years	\$220,000	\$220,000
Next 20 years	\$390,000	\$390,000

Use a 40-year analysis period and 7% interest. Assume no salvage values. Which plan is better, applying the conventional benefit-cost ratio method? Calculate B/C ratios to the hundredths place, and recommend which plan is better.

Solution:

discount rate	7.00%

Gravity

year	costs	power costs	benefits	discounted costs	discounted benefits
0	2900000			2900000	0
1	10000		220000	9345.7943925234	205607.476635514
2	10000		220000	8734.3872827321	192156.520220107
3	10000		220000	8162.9787689085	179585.532915987
4	10000		220000	7628.9521204753	167836.946650456
40	10000		390000	667.80381015314	26044.3485959725
sum				3033317.0884264	3398384.02689121
2. Calculate B/C ratio					1.12

Pumping

year	costs	power costs	benefits	discounted costs	discounted benefits
0	1500000			1500000	0
1	25000	70000	220000	88785.046728972	205607.476635514
2	25000	70000	220000	82976.679185955	192156.520220107
3	25000	70000	220000	77548.298304631	179585.532915987
4	25000	70000	220000	72475.045144515	167836.946650456
40	25000	110000	390000	9015.3514370674	26044.3485959725
sum				3222177.1489728	3398384.02689121
2.Calculate B/C ratio					1.05

Plan 1: Gravity, Plan 2: Pumping	
PW of diff costs	188860.0605
PW of diff benefits	0
Calculate diff in B/C ratio	0

Figure 1: Problem 2 B/C Ratio Analysis

From the figure above, we can see that strictly from a benefit/cost perspective, the gravity plan would be better. We can also see that when compared to gravity, pumping would cost more but yield the same benefits. So the differential benefit/cost ratio would be 0. This means that switching from gravity to pumping would give yield no benefit.

3 Problem 3

Question: A car dealer is leasing a computer with software for $3,000 a year. As an alternative, she could buy the computer for $4,500 and lease the software for $1,900 a year. Any time she decided to switch to some other computer system, she could cancel the software lease and sell the computer for $500. She decides to buy the computer and lease the software.

(a) What is the payback period? Round to one decimal place (x.x years).

(b) If she kept the computer and software for six years, what would the conventional benefit-cost ratio be, if the interest rate were 10%? Assume the salvage value is treated as a benefit. Round to 2 decimal places.

Solution:

a)

Initial Cost	4500
Annual Benefit	1100
Repayment Prd	4.090909091

Annual Lease	3000
Alt:	
Initial Cost	4500
Software Lease	1900

b)

interest rate= 10.00%

Year	Costs	Benefit	Discounted Benefits
0	4500		0
1		1100	1000
2		1100	909.090909090909
3		1100	826.446280991735
4		1100	751.314800901578
5		1100	683.013455365071
6		1600	903.158288086044
Total:	4500		5073.02373443534
B/C Ratio:	1.127338608		

Figure 2: Problem 3: Implicit incremental analysis

(a) When we compare the savings between leasing the computer and the software and just leasing the software, we get an annual benefit of $1,100. Furthermore, we can see that the time it takes to get back our investment on buying the computer outright and leasing the software would be 4.1 years.

(b) If the interest rate is 10%, we can see from Figure 2b that the B/C ratio would be 1.13.

4 Problem 4

Question: A proposed bridge will cost $38 million to build and $1,800,000 per year to maintain. The bridge should last 40 years. Time-saving benefits to the driving public are estimated to be $9,000,000 per year. Damage to adjacent property owners due to ongoing noise is estimated to be worth $2,600,000 per year. It is uncertain what interest rate should be used to evaluate the project: calculate the break-even annual interest rate that results in a B/C ratio of 1. Round your answer to 1 decimal place (x.x%).

Solution: Using LibreOffice Calc's goal seek function, with the formula being the benefit/cost ratio with a target value of 1, and the manipulated variable being the interest rate, we get a desired interest rate of 12.0%.

years		Cost	Benefit	Discounted Cost	Discounted Benefit		
	0	38000000	0	38000000	0	interest rate=	0.119739544
	1	4400000	9000000	3929485.2293838	8037583.42373958		
	2	4400000	9000000	3509285.0381694	7178083.03261925	B/C Ratio	1
	3	4400000	9000000	3134019.0279964	6410493.46635631		
	40	4400000	9000000	47727.868827244	97625.1862375448		
Total		214000000	360000000	74347826.086957	74347826.0869565		

Figure 3: Problem 4: Goal Seek

5 Problem 5

Question: If a net present worth analysis for a stream restoration plan indicates that the net present worth (NPW) is greater than zero, does that guarantee that the plan is the best possible (optimal) solution? Why or why not? You may wish to use a graph in your explanation, but do not need to.

Solution: There may be alternative solutions which yield greater a greater net present worth. Additionally, going solely on net present worth says nothing about feasibility, whether or not the costs of the project exceed the client's budget, or the plan does not utilize the budget effectively.