Exercise: Cost-Effectiveness Analysis

Total time**: 60 minutes**

Learning Objectives:

By the end of this exercise, participants will be able to:

- Outline key steps in carrying out a Cost-Effectiveness Analysis (CEA)
- Discuss the advantages and disadvantages of using Cost-Effectiveness Analysis as a tool in appraisal of adaptation options.
- Conduct a simple Cost-Effectiveness Analysis on adaptation options.

Context: Improving public water supply for the Desert nation

The Desert nation has a population of around 60,000. About half of the population lives in the city Oasis. With limited groundwater supplies, the Desert nation relies heavily on rainfall for their freshwater. Drought is therefore a major threat to water security. The Desert nation is also highly vulnerable to flooding from rising sea level and sand storm surges that are becoming more frequent and severe due to climate change.

Water is provided from a mix of public and private (household rainwater tanks) systems. The main public source is an airport catchment. Water is collected from the paved runway and stored in a reservoir, treated using sand filtration and chlorination, and then pumped to the communities. However, in recent years there have been water shortages, particularly during drought periods. This could worsen with changes in rainfall patterns due to climate change. For the water supply to become secure and resilient to climate change impacts an additional 100 liters per person per day of freshwater is required above the current amount.

To address the issue of water security five possible options for adding water to the public water supply were identified:

1) Reline the storage reservoir to reduce losses
2) Install an evaporation cover on the storage reservoir to reduce losses
3) Repair and/or replace leaking distribution pipes
4) Improve the airport runway catchment by repairing cracks in the runway
5) Increase the size of the airport catchment from the planned runway expansion) using asphalt.

A cost-effectiveness analysis is needed to establish the most cost efficient option of achieving the set outcome. In this case study the desired outcome is a reliable supply of piped water for the residents of Desert land. According to international standards the minimum requirement is 250 litres per person per day. However in order to cater for uncertainties related to climate change the government is targeting 300 litres per person per day. Under current conditions the system is only able to supply 200 litres per person per day. The planning horizon is 5 years.

To achieve the desired outcome, adaptation options are required to close the deficit of 100 litres per person per day. The cost of each option to achieve this target has been calculated as follows:

	Project options				
	Reline Reservoir	Evaporation cover	Repair leaking pipes	Airport runway maintenance	Expand airport catchment
Value of costs (USD)	100,000	50,000	2,000,000	150,000	2,500,000

Using a discount rate of 10%, carry out a Cost-Effectiveness Analysis on the five adaptation options to calculate the net present value for each option and advise the government of Desert nation, which two options would be the most cost-effective in supplying the desired outcome of an additional 100 litres of water per day?

CEA = number of incidents prevented or benefits achieved/costs for implementation.

For the cost-benefits analysis (CBA)

The case is the same only, now the monetary value of the benefits has been added. In this case the benefits are due to lower incidences of water-related health problems. The total value of the benefits is presented below:

The value and an investment analysis is needed to identify the least cost/highest benefit option (ratio).

	Project options				
	1. Reline Reservoir	**2. Evaporation cover**	**3. Repair leaking pipes**	**4. Airport runway maintenance**	**5. Expand airport catchment**
Value of costs (USD)	100,000	50,000	2,000,000	150,000	2,500,000
Value of the health benefits (USD)	20,000,000	1.000,000	30,000,000	500,000	4,00,000
Benefits/cost ratio (BCR)					

After carrying out the CEA to identify the net present values for each option for a lifespan of 5 years with a 10% discount rate, divide the value of the benefits with the net present value for each option to obtain the quantity of benefits per spent monetary unit, i.e 1 USD/litter of water. In this case

Based on the costs and benefits of the project options, the net present values (NPVs) and benefit–cost ratios (BCRs) for the different options need to be identified.

Carry out a Cost-Effectiveness Analysis and a Cost-Benefits Analysis on the 5 adaptation options and advice government of Desert nation which two options to implement to improve their water supply.

<u>Instructions for the CEA:</u>

Please, see attached the worksheet.

STEP 1
Define maintenance costs and lifespan – in this case, they are pre-defined

STEP 2 – Year 0
Add construction costs and maintenance costs and fill total in <u>Year 0</u> (present year), assuming that construction is conducted in Year 0 and maintenance costs need to paid.
Example: for the first option, for Year 0 you have to fill in 105,000

STEP 3 – Years 1-5

Discount maintenance costs with the given discount rate of 10%/year, as follows:

Year 1 = maintenance costs Year 0 (original costs) x (**1/1.1 to power 1** = 0,91)= maintenance cost Year 0 x 0,91
(Note: you do not need to fill in the construction costs again in Year 1, as you do not have to re-invest in construction costs. Therefore, you only have to fill in the discounted maintenance costs.
Example: for the first option, for Year 1, you have to fill in 5,000x0,91=4,500)

Do the same for the next years
Year 2 = maintenance costs year 1 x (1/1.1 to power 2 = 0, 83)
Year 3 = maintenance costs year 2 x (1/1.1 to power 3 = 0,75)
Year 4 = maintenance costs year 3 x (1/1.1 to power 4 = 0,68) – see also instructions below for options with a lifespan of less than 5 years
Year 5 = maintenance costs year 4 x (1/1.1 to power 5 = 0,62)

Best practice is to first make a table with the discount multiplier (i.e. 1.1 to power 2 = 1,21). For this case, this table is given to you due to limited time available:
Year 1 = 0,91
Year 2 = 0,83
Year 3 = 0,75
Year 4 = 0,68
Year 5 = 0,62

If you want to calculate the above numbers yourself, see the following example:
1 divided by 1.1 to power 1 is equal to 1 divided by 1.1 = 0,91
1 divided by 1.1 to power 2 is equal to 1 divided by (1.1 X 1.1) = 1/1,21 = 0,83

<u>Instructions for Year 4 – for options with a lifespan of less than 5 years.</u>
If the life span is shorter than the timeline for the present value -- in our case two measures have a 4 years lifespan for a timeline of 5 years -- then in year 4 you add to the discounted maintenance costs + the construction costs discounted with 1.1 to power 3. The total amount for year 4 is a sum of the discounted construction costs = 75,000 + discounted maintenance costs = 1,904,85 = 76,904,85

In year 5, you continue with discounting further only the maintenance costs, because the re-construction costs were paid once in year 4.

Instructions for options with a lifespan of more than 5 years
If you want to know the net present value in 5 years, as in this case, there is no need to calculate the costs for more than 5 years.

STEP 4
At the end, you sum up all costs from year 0 to year 5. The result is the net present value (NVP) in 5 years, which you can use to compare the options.

In addition, you can conduct a sensitivity analysis by testing all with a higher and lower discount rate, e.g. 5 and 20% to see if the results are sensitive to discounting. For a rate of 20%, you will have to discount with 1.2 to power 1, 2, 3…

If you get different options as cheapest with different discount rates, then you can conclude that they are sensitive to discounting.

We do not discuss the need for discounting in this training – it is used by economists and required by the banks. In short, economists value future investments less than current investments and use the discount rates to estimate future costs accordingly.

In reality, organizations use different discount rates. Before using discount rates for appraisal, ask an advise by your financial officers about the discount rate used by your organization.

STEP 5

Now, you have calculated the net present value for each option for meeting the target of 100l per day 36,500 l per year for 5 years. The lower the value, the more cost-effective the option is.

Since,

CEA = number of incidents prevented or benefits achieved/costs for implementation

You can also presented the outcomes as various indicators, for instance value of meeting the target per invested dollar..