



**Interuniversity Learning in Higher Education on  
Advanced land Management – Egyptian Country  
(ILHAM-EC)**

**COST-BENEFIT ANALYSIS**

**In-class exercises**

**Practical session**

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During the session you will use two main functions in Excel:

1. NPV
2. IRR

The NPV function is used to calculate the Net Present Value as explained in the lecture. In other words, given a range of values over time and a discount rate, the NPV function in Excel will calculate their present value. The format of the NPV function in Excel is as follows:

=NPV(rate, <valuerange>), where rate is the discount rate and <valuerange> is a range of values

The IRR function is used to calculate the Internal Rate of Return. The format of the IRR function in Excel is as follows:

=IRR(<range>, [guess]), where <range> is a set of net benefits over a time period and [guess] is an optional approximate answer provided to Excel (i.e. a number that you think is close to what the IRR is going to be) – this is to ‘help’ Excel find the IRR. Excel will carry out a fixed number of iterations starting with your guess value to calculate the IRR. However, in most cases, you will not need to give a guess and Excel will manage to find a correct answer with a small number of iterations (we will not be providing a ‘guess’ in this exercise). Excel will return #NUM! if it is unable to converge towards a value. Note that the IRR function must have both positive and negative values in the range, otherwise you will get #NUM! returned.

## ***Practical exercise 1: Calculating indicators of economic efficiency***

Use the Excel file titled 'CBA exercise ILHAM-EC.xlsx' and the sheet named "Exercise\_1".

You have been asked to carry out a cost benefit analysis for a 10 year project. In the table you have been provided with the costs and benefits of each year and a discount rate of 10%. **PLEASE FILL ALL THE EMPTY CELLS HIGHLIGHTED IN YELLOW IN THE EXCEL SHEET BY FOLLOWING THE STEPS BELOW.**

### **Steps (part 1):**

1. Calculate the Net Benefits (B minus C)
2. Calculate the discount factor (DF) using the following equation and set  $r=10\%$  (cell B1).

$$DF = \frac{1}{(1 + r)^t}$$

Where " $r$ " is the discount rate and " $t$ " is the corresponding year.

Remember that you can 'fix' the cell of the discount rate by adding two \$ signs (\$B\$1) or by pressing F4.

Remember that to raise a number to a power, you can use the symbol ^.

Don't forget to add all the necessary parenthesis to the formula.

(example for year 1) =1/((1+\$B\$1)^A4)

3. Calculate benefits in present value (PV Benefits) by multiplying the benefits registered each year by the corresponding DF.
4. Calculate costs in present value (PV Costs) following the same procedure.

### **Part 2:**

We are now going to calculate the Net Present Value (NPV) using two methods:

- The manual method (slow method)
  - The fastest method (using Excel's NPV function)
5. Calculate the sum of PV Benefits in cell D15

6. Calculate the sum of PV costs in cell D16
7. Calculate NPV manually in cell D17 (slow method)
8. Calculate NPV in cell D19 using NPV function and 'net benefits' data (fastest method). For this, you need the **discount rate** and the **discounted net benefits** per year. How to use the NPV function in Excel: go to "Formulas", "Insert function", and search for "NPV".

### Part 3:

9. Calculate the IRR using Excel's function

For this, you just need the non-discounted net benefits. You do not need to provide with a 'guess' to Excel.

10. Calculate the Benefit-Cost ratio (BCR), i.e. the ratio between the discounted benefits (PV benefits) and discounted costs (PV costs).

### Answer the following questions:

1. What happens to the DF over time? Explain why.
2. Compare the benefits and costs with the present value benefits and costs of each year. What happens? Why?
3. What is the value of NPV? What does it tell you?
4. How do you interpret the IRR? In your view, is it a high or a low IRR? What does it tell you about the economic efficiency of the project?
5. How do you interpret the BCR?

6. Do you think is a good idea to look at the three indicators (i.e. NPV, IRR and BCR)? Why?
7. If you were a decision maker, would you proceed with this project given this information?

## ***Practical exercise 2: Selecting among alternatives***

Use the sheet named 'Exercise 2'.

The local government of a fishing village with a strong tourist industry is considering the implementation of a project to reduce nutrient loads and achieve improved in-stream water quality. The project seeks to set effluent controls in industries currently impacting the water quality. The nutrient discharges are leading to oxygen depletion and algal blooms. The project is believed to improve the status quo which provides inadequate waste water treatment. The project is set to begin in 2017 and the benefits are expected to last for ten years.

In the table provided you can find the following information:

- **Current fish catch** (in tonne/year) (i.e. fish catch for year 1)
- **Sell price of the catch** (in £/tonne). This price is expected to remain the same throughout the 10 years period, and will be the same with and without the project.
- **Costs of fishing**, assumed constant throughout the 10 years (in £/year)
- **Annual catch growth rate**, i.e. how much more or less fish is caught every year with respect to previous years (in %) with and without the project.
- **Residual value** at the end of year 10, i.e. the value of the equipment and infrastructures that remain at the end of the project (e.g. in the status quo this is the value of the small fishing boats that fishermen already have; with the project, this is the value of the small fishing boats plus the value of the pumps, the building, etc. of the infrastructure that was put in place to reduce the effluents).
- **Capital costs** of the project (zero in the case of the status quo, since the project is not put in place)
- **Operational and maintenance costs** of the status quo (e.g. costs of running the boats) and the project (costs of running the boats, plus the costs of maintaining the pumps and the building).

- Step 1: Specifying the project alternatives

In this exercise you have been given the **alternatives**, i.e. **stay in the status quo** or **introduce the infrastructures** to set effluent controls from the industries. What other solutions could you have considered?

- Step 2: Deciding Standing

It has been decided that only the local fishermen and the local government are to be considered as having any standing in the CBA. Who else would you have proposed to have a standing in this project?

- Step 3: Catalogue impacts

From the information provided, identify what are the impacts (look at “Basic data and effects” in the excel spreadsheet)

Both the fishermen’s board and government agree that the project would represent an improvement over the current status quo. However, different stakeholders could have different preferences. What other impacts might you have considered if other groups you identified in step 2 were to be given standing?

- Step 4 and 5: Quantify and monetise the impacts

The data section provides with the selling price of the catch (250\$/tonne of fish caught) and the existing fish catch (tonne/year) in year 1 (40 tonne/year). This should allow you to calculate the initial value of catch (£/year) in year 1. This applies to with and without the project, i.e. fill cells B9 and C9.

**E.g. multiply the selling price of the catch by the existing fish catch**

You also know how much the catch grows or decreases through the years with and without the project (annual catch growth rate (%)). With this information and the initial value of catch, you should be able to monetize the impacts of the project in £/year (yearly value growth of fish catches sales). (fill cells B11 and C11).

- Steps 6 and 7: Discount Benefits and Costs and calculate NPV (and other indicators of economic efficiency)

*In order to calculate the PV for the costs and benefits of each option (with and without the project), carry out the following steps (start with the ‘Status Quo’, i.e. without project). You will start with a discount rate  $r = 7\%$ .*

*Status Quo - Benefits:*

1. Transfer ‘value of catch’ data from the data section to the analysis section assigning it to year 1.

**Copy paste value of B9 to C26**

2. Calculate the value of catch for each of the years by filling in the remaining cells in the ‘Value of catch’ (VC) row according to the annual ‘catch growth rate’ (i.e. how much benefits there are considering that the catch decreases yearly at a 6% rate). Use the formula:

$$VC_t = VC_{t-1}(1 + cgr)$$

Where  $VC_t$  is the value catch of a certain year (starting with year 2) and  $VC_{t-1}$  is the value catch of the previous year. Remember to use the dollar sign (\$) to fix the catch growth rate.

(example for year 2 value of the catch)  $=C26*(1+\$B\$10)$

3. Assign the residual value to year 10 and zeros to the rest of the years in that row. Explain why you are doing so.

Because is the remaining value at the end of the project, so it has to be accounted for on that year

4. Calculate total benefits per year by adding the 'Value of catch' and 'Residual value' per year.
5. Calculate net present value of 'Value of catch', 'Residual Value' and 'Total Benefits' using the NPV function (fastest method). Remember to use the dollar sign (\$) to fix the discount rate. Verify that the sum of the former two is equal to the latter (cell B28).

#### *Status Quo - Costs:*

6. Transfer costs data for the status quo from the data section to the analysis section (capital, O&M, cost of fishing – note that the latter is in the table Basic Data and Effects) for all years.
7. Calculate total costs by adding capital, O&M and costs of fishing per year.
8. Calculate net present value of 'Capital', 'O&M', 'Cost of Fishing' and 'Total Costs', using the NPV function (fastest method). Remember to use the dollar sign (\$) to fix the discount rate. Verify that the sum coincides.

#### *NPV, BCR and IRR*

9. Calculate the net present value (NPV) using the equation (fastest method).
10. Calculate the benefit cost ratio (BCR): total net benefits / total net costs.
11. Calculate the internal rate of return (IRR): use the net benefits. Remember that you don't need to provide Excel with any 'guess' in this case.

#### *With the project*

12. Repeat the same procedure now if the project was put in place.

Answer the following questions:



1. Under the status quo, when are positive net benefits expected during the period? Is the same expected with the project? Why is that?
2. Interpret the NPV in both cases. Will the alternative project deliver any improvements? Explain what caused these improvements, if they exist.
3. Interpret the BCR in both cases. Which one is more attractive?
4. Interpret the IRR in both cases. Explain if it makes sense to continue under the status quo or if it is better to undertake the project.

Step 9: make a recommendation

5. If you were a decision maker, would you implement the alternative project given this information?

### ***Practical exercise 3: Sensitivity Analysis***

Use the sheet named "Exercise 3".

Conduct a sensitivity analysis by varying the value of the social discount rate (use 7%, 10% and 15%). Change the discount rate in Exercise 2 sheet and copy paste the values in the sheet of Exercise 3, in the table provided.

You can either enter the values manually by first copying them in your notebook, or copy paste them directly in Excel. If you copy them, remember to paste the values only (Paste Special: Values).

Answer the following questions:

1. How does the NPV for both options change when using larger discount rates? Why?

2. How does the BCR for both options change when using larger discount rates? Why?
3. What happens with the IRR? Why?
4. Is the alternative project viable with any of the different discount rates?