UNIUNEA EUROPEANĂ

GUVERNUL ROMÂNIEI

Instrumente Structurale
2007 - 2013

# COST-EFFECTIVENESS ANALYSIS

## HANDBOOK

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The Handbook was prepared by experts who supported the implementation of the contract „Development of the capacity for the Cost-Benefit Analysis”, project co-financed by ERDF through TAOP.

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# 1. ABBREVIATIONS

| | |
|---|---|
| **CBA** | Cost-Benefit Analysis |
| **CEA** | Cost-Effectiveness Analysis |
| **CF** | Cohesion Fund |
| **ERDF** | European Regional Development Fund |
| **EU** | European Union |
| **FDR** | Financial Discount Rate |
| **GD** | Government Decision |
| **IRR** | Internal Rate of Return |
| **MA** | Managing Authority |
| **MCA** | Multi-criteria Analysis |
| **NSRF** | National Strategic Reference Framework |
| **OP** | Operational Programme |
| **PA** | Priority Axis |
| **ROP** | Regional Operational Programme |
| **SDR** | Social Discount Rate |
| **SOP** | Sectoral Operational Programme |
| **VAT** | Value Added Tax |

# 2. INTRODUCTION

## 2.1 OBJECTIVES

The present handbook, on Cost-Effectiveness Analysis (CEA) has the following objectives:

- explaining ***why CEA should be used***, ***in which typical situations can be used and how can it be used*** (presenting the principles, concepts and terminology of the method, the forms/techniques of the CEA etc.).
- clarifying the use of ***CEA as alternative to CBA or in conjunction with CBA***.
- ***identifying the investment types in which case the CEA method can be used***.
- offering ***practical exemplification*** (general presentation and practical example) on when and how CEA should be used per investment types, considering the uses of CEA.

The above mentioned objectives are tackled in the framework of the evaluation and selection of the projects financed by ERDF and CF and the method is approached as a tool to be used in this process and its description must be seen in this context.

The handbook is intended for the use of both the bodies in charge of management of Structural Instruments by helping them in choosing the most suited method for the evaluation and selection of projects as well as to the applicants for funds by guiding them on how to apply this method.

## 2.2 WHY USE CEA

In the framework of Structural Instruments, during investment projects appraisal process, the most used tool to support financing decision is Cost-Benefit Analysis. This tool means to identify, measure and compare the costs and benefits expressed in monetary terms. Sometimes it is very difficult to monetise all economic, social and environmental benefits, or it is too costly. If the financing decision is already done (by law, or by compliance with different regulations), using Cost-Effectiveness Analysis could be more efficient and easier to use.

But the most common area where CEA is used is during feasibility stage of an infrastructure investment, in the Option Analysis section of Feasibility Study.

CEA results are useful for those projects whose benefits are very difficult, if not impossible to be evaluated in monetary terms, while the costs can be predicted more confidently. CEA is less helpful when a value, even an indicative one, can be given to the benefits and not just to the costs. In this case CBA is more appropriate. CEA is often used in economic evaluation of healthcare programmes, especially immunisation programmes, education and environmental investment projects.

CEA is not useful in order to decide if a specific project will receive finance or not. CEA is not useful to appraise a specific project. CEA means comparison between projects with the same objectives, or it means comparison between options of the same project, in order to achieve its objective.

As a conclusion, cost-effectiveness analysis is a tool for projects comparison when a single dimension of outcomes matters. The benefits should be homogeneous. Due to these issues, its application is limited.

Also, without valuation of benefits, CEA can only measure technical efficiency rather than allocative efficiency.

## 2.3 WHAT IS CEA

Cost-effectiveness analysis (CEA) is a tool that can help to ensure efficient use of investment resources in sectors where benefits are difficult to value. There is a vast class of projects whose benefits either do not have a readily accessible market price or are not easily measurable in monetary terms. If the benefits of the project are measured in some nonmonetary unit, the NPV and IRR criteria for deciding whether we finance a project cannot be used.

CEA is a tool for the selection of alternative projects with the same objectives (quantified in physical terms). CEA can identify the alternative that, for a given output level, minimises the actual value of costs, or, alternatively, for a given cost, maximises the output level. For example, the evaluator can compare by simple ***output/cost*** or ***cost/output ratios*** different projects that have the same aim.

There are two main techniques for comparing projects those benefits are not readily measurable in monetary terms: *cost-effectiveness* and *weighted cost-effectiveness.* The main difference between the techniques is the measurement of benefits. CEA is not helpful in the case of projects with multiple objectives. In the case of multiple objectives a more sophisticated version of the tool could be used, the **weighted cost-effectiveness analysis**, which gives weights to objectives to measure their priority scale. Also, if the benefits are measured in some single nonmonetary (physical) unit, is called cost-effectiveness.

*What is CEA and how can it help us in decision making*

- Compared to CBA, CEA is used when social and environmental benefits and costs are difficult to monetise; using CEA does not need to express benefits in monetary terms; this make CEA less costly than CBA, and easier to be evaluated.
- CEA is best used to decide which alternative maximises the benefits (expressed in physical terms) for the same costs or, vice versa, which one minimises costs for the same objective. The cost-effectiveness ratio allows projects to be compared and ranked according to the costs necessary to achieve the established objectives.

*CEA limitations:*

- Since the objectives cannot be converted into a common numeraire or accounting unit, CEA cannot be used to decide on a project taken in isolation, nor to decide which of two projects would give the better return in two different contexts
- Using CEA as alternative to CBA is strongly limited: CEA could not be used in order to asses/ appraise a certain project: even the project may be highly effective at meeting its objectives, it may be relatively inefficient and the objectives could have been met using fewer resources if an alternative approach had been adopted
- CEA is not useful in financial analysis; it does not provide information about financial profitability of a project;
- CEA alone is not sufficient to justify a project; even it provides information in order to select an option, it does not provide anything about financial sustainability of the selected project /

alternative. In most of the cases it is applied to project which do not generate revenues (healthcare, education, environmental projects aiming compliance with mandatory norms and regulations).

# 3. GENERAL THEORETICAL FRAMEWORK OF CEA

Used in projects with a span life bigger than one year, CEA use some key issues similar with CBA, such as:

a) **time horizon**

**b) discounting and discounting rate**

**c) type of costs**

**d) Present Value (PV) of the costs**

**e) incremental approach**

and others, such as:

**f) cost-effectiveness ratio**

**g) unit costs and DPC**

* * *

### a) Time horizon

The individual analysis timeframe of an alternative depends on the projected period of investment and operating phase respectively. The former can be taken from the construction schedules, while the latter is determined by the economic lifespan of the investment and its components. As a rule, serviceable life comes to an end when the accruing costs begin to outweigh the achievable benefits. Given the fact that it is difficult to predict this point in time, the anticipated operating life is based on average life expectancy figures taken from comparable projects.

CBA use very often a reference time period pending of investment type (like the EU Guidance on the methodology for carrying out cost-benefit analysis). The advantage of exceeding service lifetimes is expressed by monetary residual values.

In cost-effectiveness analysis *the concept of residual value does not exist*. So, the time horizon for an investment with some components which should be replaced over a number of years will be large enough to avoid residual values. Similar, in case of differing service lifetimes of the alternatives reviewed, a longer analysis period will have to be chosen.

Using CEA in Option analysis section of a CBA, the recommended time horizon for CBA is to be used for all options. Using CEA in order to compare different projects / alternatives in order to rank them in project appraisal process, could lead to different period of years as time horizon. Using averages as cost-effectiveness ratio will flatten the influence and will make the results comparable. Different techniques could be used in order to make present costs comparable, if it is the case.

*Examples*:

In an education infrastructure project, building a new school project has a time horizon of 30 years, meanwhile procurement of scholar buses project has 8-10 years time horizon, but could be analysed for a period of 30 years, taken into consideration 3 time investment.

In a water supply or sewerage networks, the time horizon si 50 years, while in wastewater treatment plant the time horizon is 25-30 years, and for dams and reservoirs the time horizon is 80 years or more.

### b) Discounting and discounting rate

Cost-effectiveness analysis takes into consideration both costs and benefits which occur in different years.

In order to make them comparable, discounting technique is used. Discounting is a technique that enables us to compare the value of a currency in different time periods. An euro received today is worth more than an euro received tomorrow because the euro received today enables us to increase our consumption today, whereas the euro received in the future can increase only future consumption. This does not have anything with inflation, only with the postponement of consumption and reflect the preference for present.

Discounting is the opposite operation of compounding: in order to see the future value of an euro over a number of years, compounding technique is used; while in order to see the present value of an euro spent after a number of years, the discounting technique is used.

*Future value of one euro in year t =* $(1+i)^t$

*Value today of an euro received in year t =* $1/(1+i)^t$

*Where i = compounding / discounting rate.*

In cost-effectiveness analysis, the discounting rate does not express the efficiency or the cost of capital; it is only a method to make values occur in different years comparable. In this respect, a national discounting rate to be used in CEA for different projects must be set up and revised from time to time. This discounting rate could be the same with that one proposed for CBA, or different. If it will be different, this value should be lower than that one used in CBA, because it is not related to profitability or to the cost of money. We propose that the cost-effectiveness standard real discount rate to be set up at 5%.

When framing sensitivity analyses to assess the level of discounting rates and its impact on the project's profitability, a range from 2 % to a maximum of 8 % should be considered. This would sufficiently support the decisions-makers' opinions. Applying lower discounting rates in costs calculations would rather favour alternatives with high investment costs, while higher rates would favour those involving higher running costs.

Discounting rate has an important role when the cost-effectiveness ratio is used in priority setting of a public policy, such as health policy. In this case, different discounting rates are used for costs and for effects (benefits in physical terms). A higher discounting rate is in the favour of projects with higher costs in future, and in disadvantages projects with higher effects in the future. In this type of projects, the financial discount rate is used for costs and the social discount rate is used for effects.

### c) Type of costs – costs finding

For each alternative to be evaluated all cost-effective and decision-relevant determinants have to be identified – sorted by cost types (initial investment costs, running costs, reinvestment costs) – and the respective costs have to be compiled by order of magnitude.

Depending on the status of the project planning, reference is herein made to cost estimation and cost calculation as well as cost information from previous biddings and submissions. In the course of this process the cost data obtained will steadily gain in stability and validity. In case of previously realised 'historical' measures, the cost finding process is also referred to as cost determination.

Costs will be classified as follows:

| By the aspect of | Cost Type |
|---|---|
| time and frequency of occurrence | investment costs, running costs, reinvestment costs |
| cost allocation to the parties concerned / cost-bearing units and<br>non-involved third parties, respectively | individual (direct) and general (indirect) costs, social costs |
| cost behaviour in response to changes in the status of capacity utilisation | fixed and variable costs |

Costs findings are similar with CBA. More details about types of costs and cost findings have been presented in the Working Paper no. 4 regarding **Costs used in cost-benefit analysis for the investment projects financed through ERDF and CF Investments and running costs.**

*It is noticed that no residual value occur in the cost-effectiveness analysis.*

### d) Present Value of costs; costs in real and nominal terms

Because the costs are varying from a year to the other, in order to make alternative projects or alternative options of a project comparable, present value of the total cost should be applied.

$PVTcost = \sum(C_t/(1+i)^t)$

Where:

PVTcost = present value of total cost

$C_t$ = cost occur in year t

i = discounting rate

When the time horizon is the same, and the value of outcome, in physical terms, is the same, the Present Value of Total cost is the main indicator used to select an option. This method is known as “least cost method”.

If the time horizon of the alternatives differs, or the value of outcome differs, it is necessary to measure how much additional cost means the additional effects (e.g. with one alternative we can serve 100 people per years, with another alternative we can serve 125 people per year, but with an increase in total cost of 100.000 lei; which alternative is the optimal one? Total people needed the services being 200 persons).

During time horizon, the nominal cost could vary, due to inflation. But the value of effects, measured in physical units, does not take into consideration the inflation. In this respect, the cousts should be expressed in real terms (constant values of the basic year).

That means in the project preparation will be determine an annual cost for operation and maintenance, and this will be kept constant during the whole time horizon.

Sometimes this is not real, even we use constant prices. There are some cost components which vary in time due to different reasons, except inflation. Some examples of these categories are: wages / salaries (manpower cost), fuel, power. For these categories is to be assumed a constant increase in cost value, according to macroeconomic assumptions.

### e) Incremental approach

Although one could compare the simple ratios of costs to effects (C/E) for each alternative, the correct comparison is based on ration on incremental costs to incremental effects, since this tell us how much we are paying in addition for more beneficial measure / project. In particular, when the alternative projects are competitors and mutually exclusive, an incremental analysis is required in order to rank the projects and single out the one that is most cost-effective.

### f) Cost- effectiveness ratio

CEA ratio is the result of dividing present value of total costs (PVTcost) by effects / benefits expressed in physical terms. Both, costs and benefits will be considered incremental (system with project for analyzed alternative minus system without project-BAU)

Sample of calculation of CEA ratio:

$$\text{CEA ratio} = \frac{PVTCost_{with\ project} - PVTCost_{BAU}}{Effect_{with\ project} - Effect_{BAU}}$$

### g) Unit costs and Dynamic Prime Costs

**<u>Unit cost</u>** is a static index computed as a ratio between total investment cost (un-discounted) and benefits in physical terms, such as: investment per pupil, investment per cube meter of wastewater treated, investment per ton of $CO2$ reduced. The formula is:

PU = I/E, where:

PU=unit cost;

I=total investment cost

E= effects / benefits of the first year of operation, in physical terms.

Example of using static unit cost: indicator "specific investment" defined as Total investment cost / expected production in ton (value of design capacity).

Value of benefits, in physical terms, could vary during project life. The unit cost does not account these differences during operation period. There is a possibility that a more expensive device will serve a longer **period than the cheaper one. The unit cost will give a priority to the latter even if the difference in operational period is so large that the true cost of achieving expected effect is lower for the former. So, the unit cost should not be used in CEA.**

**Unit annual cost** is the present value of the total cost divide by number of years of time horizon and by effects / benefits of the first year of operation, in physical terms.

PUa=PVTCost/T/E

PUa=Unit Annual Cost

PVTCost=present value of the total costs

T=number of years in time horizon

E= expected effects in the first year of operation (or design capacity, for example).

This index gives as a better image of the effectiveness of alternative / option/ project.

In the most cases, the effects do not have the same value in every year of analysis. For this situation, another way to compute the Unit annual cost is to divide the annualized cost of the project to the annual average of effects.

The annualized cost of the project results as uniform distribution of the present value of total costs over the time horizon:

PUa=ACC/EE

ACC=PVTCost * $(i*(1+i)^t)/((1+i)^t-1)$

EE=∑E/t

t=lifetime (no. of years)

i=discounting rate

E=annual effects expressed in physical terms

This way for annual unit cost ensure a better measurement and gives a more precise estimates of effectiveness of an alternative /option/project. This index is very useful when different investments have the same effects, but still do not reflect the true cost-effectiveness of an investment.

For environmental or social projects, the time when the effect occurs is very important. Equal distributions of effects over the lifetime of the investment hide this issue. Imagine a polluted lake that is revitalized either next year or ten years later; or a primary school rehabilitated next year, or five years later. The PUa rank similar a project which produce 10 units effect in the first year and 1 effect unit in each of the following 9 years and a project which produce 1 units in every first 9 years and 10 units in the tenth. The measurement of cost-effectiveness should take into account the distribution of the effects over the time.

Even PUa is not the ideal way to measure cost-effectiveness of a project, sometimes, when the prediction of the distribution of effects is difficult to be done, an average of them could be use and it produces a good estimation. These are the cases when using a more sophisticated method to calculate CEA ration will depend on imprecise projections which does not generate any value added in evaluation process.

**Dynamic Prime Cost**

This is a dynamic index which takes into consideration the distribution over the lifetime of costs and effects. It is much spread used in Germany and have been applied in Poland by National Fund for Environment and water management to ISPA investments (Raczka 2002). DPC is similar to Cost/Benefit ratio from CBA, but the benefits are expressed in physical units.

$$DPC = \frac{\sum C_t/(1+i)^t}{\sum E_t/(1+i)^t}$$

DPC=Dynamic Prime Cost

$C_t$= costs in year t

t= year in the lifetime

$E_t$=effects in year t, in physical units

DPC is the ideal measure of cost-effectiveness of an investment. It is sensitive to change in distribution of costs and effects over the time.

* * *

**How could be use CEA in appraisal process:**

Evaluation consists of calculating cost-effectiveness ratios to:

(i) determine the cost of producing a predetermined output utilizing unit costs;

(ii) compare costs of project outputs with sector standards or with costs of similar projects;

(iii) select the most cost-effective way of attaining such an output and;

(iv) compare the costs of producing different levels of outputs.

**Evaluation of a CEA**

Main criteria to estimate the CEA quality are:

**(1) strong analysis of cost,**

**(2) good enough analysis of effect(s), and**

**(3) comparison involving costs and effects**.

# 4. WHEN TO USE CEA; CHOOSING BETWEEN CBA AND CEA

The choice between CEA and CBA depends on type of the investment, time constrains and availability of data.

**In project development process, during feasibility stage, CEA is used in selection of technical options in order to achieve the project objective, measured by an outcome indicator. In project appraisal process, CEA is related to economical analysis of a project, avoiding difficulties met in applying different types of corrections and disputable methodologies for valuating externalities used in CBA.**

Cost-effectiveness is appropriate whenever the project has a single goal that is not measurable in monetary terms, for example: to provide education (mandatory school) to a given number of children. Weighted cost-effectiveness is appropriate when the projects aim to achieve multiple goals that are not measurable in monetary terms. If the projects aims could be measurable in monetary terms and data on methodology for monetizing them are available, CBA is the most appropriate technique. If one of the main objectives is to prove financial viability of the project and to calculate the appropriate portion of grant / subsidy, CBA is the most appropriate tool in appraisal process. Financial viability could not be an issue in case of investment those respond to compulsory regulations. In this case, CEA is the appropriate tool. Sometimes, would be useful to use a combination of CEA with financial analysis.

There are some investment sectors where CEA could be a superior alternative to CBA:

a) environmental infrastructure investments aiming to comply with EU ecological standards;

b) education (mainly primary school), because this stage in education is mandatory by law;

c) health infrastructure;

d) other social infrastructure, such as those regarding children protection or elderly care.

For these sectors CEA is more recommended because:

- Allow to select the project that brings the benefit with the lowest cost for society.
- Ensure efficient use of investment resources in sectors where benefits are difficult to value.
- Cost-effectiveness is very useful in evaluating interventions that aim to improve the health of a population.
- In the case of evaluation that requires joint consideration of multiple outcomes weighted cost-effectiveness method should be used.

**a) Environmental infrastructure investments**

Those environmental investments aiming to comply with EU environmental standards ask a very sophisticated economical analysis in order to decide if the project will receive the financing. But the monetization of environmental benefits is very difficult to be done in these cases; the aim of the project is “complying with EU standards” and this is mandatory. In this case the appraisal procedure should rely rather on cost-effectiveness analysis. The relevant appraisal question is “what is the lowest cost of complying?”.

**b) Education infrastructure (mainly primary school)**

Educational projects have significant impact on employment market and on standard of living (level of incomes). Usual, their effects / benefits are measured with indicators such as: increasing employment rate, incremental income for graduate of the school. If the time between graduate and employment is quite short for high school, university and MBA or PhD, for elementary school, which is mandatory, it is impossible to determine this type of indicators.

The table below presents the most appropriate tools for appraisal of projects in educational sector.

**4-1 Most Appropriate Tool by Education Level and Objective of Project Component** [1]

| Educational level / type | Project objective | Evaluation tool |
|---|---|---|
| Primary, secondary | Expand coverage<br>Improve pupils test scores<br>Reduce recurrent costs of education | Cost-effectiveness(CEA) or Weighted cost-effectiveness (WCEA)<br>CEA or WCEA<br>CEA |
| Secondary (general or vocational), teacher training, vocational training | Increase supply of graduates (e.g. teachers)<br>Improve students scores<br>Improve graduates' labour market prospects | CEA or WCEA<br>CEA or WCEA<br>Cost Benefits Analysis (CBA) |
| University | Improve graduates' labour market prospects | CBA |

c) **Health infrastructure**

The following table present how to judge if the CEA could be applied in appraisal of health investment projects/ programme:

**4-2 Increasing Complexity of Economic Analysis in Health investments**[2]

| Scope of comparisons (in increasing order of complexity) | Best choice of appraisal tool | Examples (from health sector) |
|---|---|---|

[1] Sourse: adapted from Psacharopoulos, from: Belli, P., Anderson, J. R., Barnum, H.N., Dixon, J. A., Tan, J-P, 2001, Economic Analysis, of Investment Operations. Analytical Tools and Practical Applications, WBI, World Bank, Washington D.C.
[2] From Belli, P., Anderson, J. R., Barnum, H.N., Dixon, J. A., Tan, J-P, 2001, Economic Analysis, of Investment Operations. Analytical Tools and Practical Applications, WBI, World Bank, Washington D.C.

| | | |
|---|---|---|
| Single intervention<br>Single disease<br>Single age group | Cost-effectiveness, when definition of effects is narrow | Tuberculosis therapy<br>Measles immunization<br>Family planning methods |
| Multiple intervention<br>Multiple diseases<br>Single age group | Broader definition of effects:<br>Weighted cost-effectiveness analysis (cost-utility analysis) | Child health programme<br>Immunization programme |
| Multiple intervention<br>Multiple diseases<br>Multiple age groups | | Formulation of primary health care programme<br>Public health strategy |
| Alternative delivery systems and Interventions across the sector | | Preventive Health Care vs. hospitals<br>Preventive vs. curative<br>Lower vs. upper-level services |
| Health sector investments compared to investments in other sectors<br>Complex project objectives | Cost-Benefit Analysis | Education vs. Health<br>Health vs. Agriculture<br>Complex project with both health status and economic efficiency objectives |

**d) Social infrastructure**

For social infrastructure is very difficult to estimate, in monetary terms, the benefits. They are, generally speaking, related to the welfare of the target groups: for elderly, the outcome could be measured in number of healthy years gained by persons of target groups, but the value of one life year is sometime a very controversial issue. This type of measure of outcome could be discriminatory; so, if we have reliable source of data, such as some studies, we could use a CEA ratio equal to costs per life year gain; if we do not have these type of data from reliable sources, we still could use CEA, defining CEA ration as costs per person from target group. Of course, using DPC for CEA ratio calculation, cost per person could be the best index for comparison of projects or of alternative options for the same project.

**e) Other area of use for Cost-effectiveness Analysis**

CEA is widely used not in investments, but in assessing different alternatives to implement public policies and / or programmes.

CEA is the standard evaluation tool for different educational policies and programmes: comparing different approaches such as e-learning, small groups with teachers, self-study materials, peer tutoring; the effects are scores on tests. In this case, the test should be the same in order to have comparable effects.

CEA is widely used in Romania in evaluation of different medical procedures. Separate studies have been developed for different diseases, especially where the costs are quite high. Different approaches and different treatment schemas are compared using CEA ratio defined as cost per year of live saved for each method.

Before '90s, in Romania CEA has been used instead of CBA in the most of investments: the investment decision was only political, so different options in order to achieve a specific production of an output have been compared using CEA ratio (in the most cases defined as specific investment cost=total cost of investment/no of years/expected (designed) production in tones).

**Choosing between CEA and CBA**

| *CEA* | *CBA* |
|---|---|
| CEA is a tool to select alternative projects with the same objectives (quantified in physical terms). | CBA is a tool to justified the financing decision based on consideration of all costs and benefits related to a project |
| In CEA, the output/ cost ratios of different projects are compared aiming to lower interventions cost. | In CBA the project return is compared with capital (financing) cost, In other words, Internal Rate of Return is compared with discounting rate. |
| CEA is used when measurement of benefits in monetary terms is impossible, or the information required is difficult to determine or in any other case when any attempt to make a precise monetary measurement of benefits would be tricky or open to considerable dispute. | For CBA all inputs and outputs should be measured and expressed in monetary terms. |

In the actual programming period, the process of project appraisal is a continuous one, and this approach do not allow CEA usage, because the appraisers evaluate the projects one by one, without any comparison between them. In order to use CEA in a continuous process, the managing authorities should develop benchmarks for recommended CEA ratios. CEA ratios should be in line with program indicators and targets and reflect the contribution of the projects to these targets and associated costs. Benchmarks CEA ratios would be developed during programming stage, in line with operational programmes, based on statistical data from previous programming periods. They will be up-dated based on data from the new implemented projects.

# 5. HOW TO PERFORM CEA

While cost-effectiveness is a simple economic concept, literature that shows how to make it operational is surprisingly small, and focused on healthcare area (in order to justify an option in a healthcare programme such as immunisation, compared with treatment of a disease).

For this reason, the section which follows presets a proposal of the consultant.

The identified methodological steps in CEA are:

1. Project definition;
2. Description of project alternatives;
3. Analysing of applicability of CEA method;
4. Cost finding and costs calculation (evaluation of total costs for each alternative);
5. Making alternatives comparable;
6. Measurement of the impact (in physical terms);
7. Calculation of the cost-effectiveness ratio;
8. Sensitivity analysis;
9. Overall assessment, conclusions.

## 5.1 PROJECT DEFINITION

The first step is identification of the expected result of the project and quantification in physical terms (number of children to be educated in primary / mandatory school, quantity of wastewater to be treated in order to comply with EU regulations, number of roads accidents avoided, number of life saved a.s.o.).

Project goals, objective and outputs should be identified and corresponding indicators should be quantified.

One of the objectives may be considered predominant, answering to the programme objective, and corresponding outcomes could be homogeneous (e.g. cubic meters of wastewater, number of children).

## 5.2 DESCRIPTION OF PROJECT ALTERNATIVES

In order to select the best alternatives in order to achieve the define objective, these alternatives should be described in enough details, to allowed to determine both investment costs and O&M costs. Note: for a specific project, all alternatives analyzed should reach the project's objective.

In addition to these alternatives, the "without project" (or BAU) scenario should be defined.

## 5.3 ANALYSING OF APPLICABILITY OF CEA METHOD

Next step is to decide if CEA is the most appropriate method to evaluate the project or the project alternatives.

a) For Option analysis:

If the project has only one objective, its outcomes are clearly determinate, and they are homogeneous, or could be done comparable by equivalence factors, then CEA is the best way to compare project technical options. For example, we can use cost/person or cost/ cubic meter or cost/CO2 tone saved, or cost /year of life gained, and the option with the smaller ratio could be selected.

If do not have only one objective with homogeneous outcomes, the CEA is not useful; in order to decide on the most appropriate option, a multi-criteria analysis, using present value of total costs as one of the criteria, would be recommendable.

b) For appraisal of alternative projects:

Projects should have the same objective, the financing decision should be already done, for that type of projects; the idea is to rank similar projects in order to establish which ones will be in the budget limit.

If the judgement should be done for a specific project, it is necessary to have some benchmarks for acceptable values of CEA ratio by comparing with other similar projects, or by given standards.

If the projects do not have the same objective, CEA could not be used.

*Example of objectives*:

- treatment of a wastewater according to EU norms;

- providing primary education;

- providing assistance for birth and new born care;

- proving assistance and healthcare for persons over 65 years;

- providing safety and care for pre-school children.

## 5.4 COST FINDING AND COSTS CALCULATION (EVALUATION OF TOTAL COSTS FOR EACH ALTERNATIVE)

In order to compare alternatives / options/ or alternative projects, the most important step is cost findings and cost calculation (or cost estimation).

There are different methods to determine the costs, according to the status of the project planning:

- Cost estimation performed during the preliminary planning phase (pre-feasibility study)
- Cost calculation performed during the design phase (detailed feasibility study, EU application forms)
- Cost estimate submitted after award of contract (tendering procedures, results of submission)
- Cost determination performed on the basis of the actually accrued costs (acceptance procedure, EU final reports).

Additional costs in order to achieve results will be determine as difference between the project's costs and the costs for "without project"(BAU) scenario.

Using constant costs (evaluation in real terms) in recommended in the scope of CEA.

After cost estimation, the calculation of present value of total cost should be done using discounting.

## 5.5 MAKING ALTERNATIVES COMPARABLE

In the case of different alternatives with the same time horizons with different investment and recurrent costs and different level of the same benefit achieved during the entire life cycle of the project, the question is: How could these projects be compared? In this case, an annual equivalent value of costs should be compared with the annual benefit level.

In this step the definition of the CEA ratio became the key issue: using annual unit cost or DPC make the alternatives comparable.

## 5.6 MEASUREMENT OF THE IMPACT (IN PHYSICAL TERMS)

This step is very important, but it is considered as the trickiest one. For this step, the empirical methods on collection of primary data on positive effects are the most applied. The previous experience, from similar projects and the project developer expertise is very important.

Project identification is the key and logical framework approach is useful in order to verify if these objectives, outcomes and indicators are defined and estimated.

Values of the effects would be monitories during project lifetime and they are the measurement of the project's success.

CEA process assumes the incremental approach in measurement of effects. Only additional effects will be considered for CEA ratio calculation.

## 5.7 CALCULATION OF THE COST-EFFECTIVENESS RATIO

First step in calculation of CEA ratio is definition of the ratio: what methodology to be use?

One of the methods presented in the section 3g should be selected;

- unit cost

- annual unit cost or

- DPC.

Whenever possible, DPC will be preferred.

A section in the CEA Report will present the definition and methodology for CEA ration calculation.

## 5.8 SENSITIVITY ANALYSIS

Being projections into the future, the costs determined for the alternatives will inevitably be more of less affected by moments of uncertainty and risk[3]. This is in particular so on account of the longevity of complex infrastructure measures. Among such potentially unstable planning information are also calculation parameters like discounting rates, useful lifetimes of plants and components, or relative price shifts.

[3] Within the framework of the same project in which the present handbook was prepared, two distinct Working Papers were also elaborated: Working Paper No 9 "Elaboration of the sensitivity analysis as part of the CBA" and Working Paper No 10 "Elaboration of the risk analysis as part of the CBA". For more details on how to carry risk and sensitivity analysis, please refer to these papers.

## 5.9 OVERALL ASSESSMENT, CONCLUSIONS

The overall appraisal will include a table with the arithmetic results of the aforementioned steps as well as all other arguments being of relevance for the decision-finding process.

It will lead to a proposal that is to be seen as the basis for the ultimate selection of measures/ projects/ alternatives.

In addition to CEA, an analysis of sustainability of the recommended measure / project / alternative could be necessary in order to justify the financing decision.

# 6. CEA IN NON-MAJOR PROJECTS BY SECTORS (TYPE OF INVESTMENT)

## 6.1 OVERVIEW

Since CEA was not previously used but in a couple of instances for the evaluation and selection of projects alternatives (especially for projects financed through SOP Environment) statistical data for compiling CEA information on the use of this tool for non-major projects and for certain type of investments is completely missing. Therefore, the proposed instances for using CEA will have a high degree of subjectivity and will be based mostly on scientific review of the method and on own approach of the author.

## 6.2 SECTOR 1 – ENVIRONMENTAL PROJECT IN WASTE-WATER

Note: In Romania CEA is not used in appraisal of water and wastewater projects. Due to luck of example from Romania, the wastewater invetment in Poland will be presented below[4].

### 6.2.1 PRESENTATION OF THE CHARACTERISTICS FOR THE SECTOR

From the experience gained in the preparation of ISPA applications in Poland it appeared that the Cost-Effectiveness Analysis had a number of advantages against the more often used Cost Benefit Analysis (CBA). The latter was particularly convenient in the appraisal process of environmental infrastructure investments.

Applying a Cost Benefit Analysis (CBA) showed on the type of projects financed through the ISPA programme is practically impossible: The CBA compares a discounted flow of benefits with a discounted flow of costs. If benefits outweigh costs, then investment is economically efficient and should be supported by public means. If not, the investment should be abandoned. However, the nature of the investments co-financed by ISPA is such that they cannot be abandoned since the municipalities and utilities are obliged to meet EU standards. The investments must be implemented in order to be in compliance with EU legislation. Hence, the logic of the CBA is broken since the investments have to be undertaken even if the costs outweigh benefits.

The appropriate questions for this type of projects is not “do benefits outweigh costs” but rather”what are the lowest costs for meeting the environmental standards” – thus making the Cost-Effectiveness Analysis (CEA) the more appropriate method.

Usually an average CBA for investments to co-financed by ISPA in Poland have been plagued by so many methodological mistakes that it is not informative while they always proves economic efficiency. Neither local politicians nor civil servants care about this as they consider the CBA as a necessity. They do not understand this tool and were not able to incorporate it to a decision-making process. In fact what is a difference between ENPV equal to EURO 2 million and to EURO 20 million? There is absolutely no difference as long as it is above zero. So, consultants are asked for producing a plausible result.

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[4] The sourse of data: EVALSED (*ec.europa.eu/.../**evalsed**/index_en.htm)* – SourceBook2: Methods and Techniques; Jan Raczka, Warsaw University- paper submitted to the Fifth European Conference on evaluation of The Structural Funds „Challenges for evaluatioon in an Enlarged Europe”, Budapest, June 2003

This is not a case of the CEA. This approach is informative both to local politicians and to civil servants which manage ISPA. Following section shows applications that prove strengths of a cost-effectiveness concept.

### 6.2.2 CEA ELABORATION (PROJECT IDENTIFICATION, ALTERNATIVES IDENTIFICATIONS, DEFINITION OF BENEFIT / OUTPUT, DETERMINATION OF COSTS, CEA RATIOS, COMPARISON OF ALTERNATIVES AND CONCLUSIONS)

Grudziadz (Poland) is a city inhabited by 100.000 persons. The town is surrounded by a number of densely populated districts, most of which connected to the sewerage system. However, there are certain suburbs, with varying population densities that are not served by this sewerage system. The city therefore submitted an application proposing a central sewerage system for these suburbs.

There were two alternatives to developing a central system:

- A conservation tank (DGC = 6.05 EURO/m$^3$);
- A domestic sewage treatment plant (DGC = 2.05 EURO/m$^3$).

However, the latter solution can only be applied on two conditions: (1) plots are large enough (at least 2000 m2), (2) a house is connected to a water network. The first condition seriously constrains the applicability of domestic sewage (wastewater) treatment plants.

Table 1. Grudziadz – sewerage in comparison to alternatives

| No. | Subproject | Inhabitants connected | Cost (1000 EUR) | DGC (EUR/m$^3$) | DGC for the best alternative | Comparison to the alternative | NPV (1000 EUR) |
|---|---|---|---|---|---|---|---|
| 1 | Collector D and its catchment area | 1376 | 2719 | 3.24 | 6.05 | Superior | -2174 |
| 2 | Pumping station PS-4 and its catchment area | 456 | 1072 | 4.37 | 6.05 | Superior | -1048 |
| 3 | Collector P (transit), PS-1, PS-2, PS-3 and their catchment areas | 820* | 775 | 7.88 | 6.05 | Inferior | -3715 |
| 4 | Pumping station PS-5 and its catchment area | 474 | 1276 | 5.03 | 6.05 | Superior | -1290 |
| 5 | Pumping station PS-10 and its catchment area | 225 | 938 | 7.68 | 6.05 | Inferior | -991 |
| 6 | Pumping station PS-6 and its catchment area | 553 | 1485 | 4.98 | 6.05 | Superior | -1485 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | Pumping station PS-8 and its catchment area | 128 | 547 | 7.95 | 2.50 | Inferior | -585 |
| 8 | Pumping station PS-9 and its catchment area | 115 | 827 | 13.20 | 2.50 | Inferior | -909 |
| 9 | Pumping station PS-7 and its catchment area | 33 | 257 | 14.38 | 6.05 | Inferior | -286 |

Note: DGC = Dynamic Generation Cost[5]; NPV = Net Present value; Source: Rączka2002

Calculation of DGC:

$$DGC = \frac{\sum_{t=0}^{t=n} \frac{KI_t + KE_t}{(1+i)^t}}{\sum_{t=0}^{t=n} \frac{EE_t}{(1+i)^t}}.$$

Where:

DGC -- Dynamic Generation Cost,

$KI_t$ -- investment expenditures in year t,

$KE_t$ -- O&M costs in year t,

$EE_t$ -- an ecological effect in year t,

i -- a discount rate,

n -- a lifetime of an investment.

The estimates of DGC for a central system in different locations were compared with relevant alternatives. If a domestic sewage treatment plant was feasible, then it was the cheapest solution (2 areas). The central system was the best option in only 4 out of 9 areas.

### 6.2.3 USING CEA IN EVALUATION AND SELECTION PROCESS

This analysis provided a justification for limiting the proposed investment package. The National Fund of Environmental Protection and Water Protection acknowledged the results and asked the city for amending the application respectively. The reaction of the City was also positive - being surprised by differences in costs, the management of the City appreciated the results and accepted an exclusion of sub-investments that were not cost-effective. This example showed that the CEA is informative both to local politicians and the implementing agency. All interested parties received transparent and precise information about true costs of investments.

[5] In Romania it is known as DPC = Dynamic Prime Cost

While the option analysis is the best application of the cost-effectiveness concept, the additional information can be obtained from comparing investments undertaken in different cities. This approach is interesting to the implementation agency.

An example is taken from the feasibility study for Sosnowiec. The City would like to construct a collector (called "Bobrek") which will serve a number of districts as well as from neighboring cities. It is not possible to carry out a standard analysis of options as there are not any feasible alternatives. Still it is possible to compare a cost-effectiveness measure for the collector with other investments that have been already supported by ISPA. The rationale is simple – the financing agency should not oppose to co-financing investments that are at least as cost-efficient as those investments that have been already accepted.

Table 2 – DGC for the "Bobrek" collector

| City | Type of investment | DGC (EURO/m³) | |
|---|---|---|---|
| | | Lower limit | Upper limit |
| Jelenia Góra | Sewage systems | 1.71 | 3.74 |
| Mielec | Collectors and sewage systems | 0.92 | 2.46 |
| Suwałki | Sewage systems | 1.83 | 4.46 |
| Sosnowiec | "Bobrek" collector | 1.37 | |
| Szczecin | Collectors and sewage systems | 0.59 | 2.72 |

Source: The City of Sosnowiec 2003.

Table 2 presents values for the lower and upper limits. The values of the lower limit refer to the least expensive sub-projects included in an investment program in a given city, and the values of the upper limit refer to the most expensive project. In the case of Sosnowiec, there is only one project, so DGC has been placed in the middle.

The DGC for Sosnowiec, equal to 1.37 EURO/m³, is acceptable. It is lower than the value of the lower limit for Jelenia Góra (1.71 EURO/m³) and Suwałki (1.83 EURO/m³). The difference in comparison to the upper limit values is striking. DGC for the 'Bobrek' collector is more than 2 times lower than the upper limit value for most other projects. The investment in Sosnowiec is cost-effective from the point of view of the society. The environmental effect can be achieved at low costs on the side of the society. So, the allocation of a grant is justified.

This example shows strength of the cost-effectiveness approach. The implementing agency can compare investments from the same area. If high estimates of DGC are observed, it can put a question what is a reason. Having an answer, a decision maker can either accept high costs (no alternatives and an important ecological effect) or reject an application. So, the CEA produces useful information and rationalizes a decision process.

### 6.2.4 PROPOSED BENCHMARKS FOR CEA RATIOS

Using DPC as CEA ration could has the advantage of benchmarks from previous EC financed projects, as in example above ("Brobek"). The managing authority should build data bases with benchmarked values, upper and lower limits, for specific types of investment components or for a specific system (such as for 100.000-150.000 e.i., for 50.000-100.000 e.i. a.s.o.).

Projects having DPC value lower than a specified limit, for achieving environmental effect imposed by regulations, could receive financing.

### 6.2.5 CONCLUSIONS

Cost-effectiveness is an adequate approach to ecological investments that respond to compulsory standards.

Dynamic Generation Cost/ Dynamic Prime Cost is the best measure of cost-effectiveness since it takes into account: operation and maintenance costs, a lifetime of an investment, a profile of an ecological effect. Being easy in calculation, DGC is the best proxy of a long run average cost.

Cost-Effectiveness Analysis produces informative results. They can help in shaping an investment package as well as in making a ranking.

## 6.3 SECTOR 2 – EDUCATION INVESTMENT PROJECT IN PRIMARY SCHOOL EDUCATION

### 6.3.1 PRESENTATION OF THE CHARACTERISTICS FOR THE SECTOR

In the actual situation of the rural area in Romania, where the number of children is in decreasing trend, the project address to the obligation of delivery primary education to all children having the age of school.

This case study is based on a real project proposed for financing under ROP PA 3.4 – Educational infrastructure, which has been rejected.

The figures do not take into account the new norms regarding financing rules in Romanian educational system.

The new system introduces standard costs per capita (per child included in the educational system), and these data and rules for determination could be used in CEA for investments in educational infrastructure.

### 6.3.2 CEA ELABORATION (PROJECT IDENTIFICATION, ALTERNATIVES IDENTIFICATIONS, DEFINITION OF BENEFIT / OUTPUT, DETERMINATION OF COSTS, CEA RATIOS, COMPARISON OF ALTERNATIVES AND CONCLUSIONS)

The project has been proposed in a commune with a population of 10.797 inhabitants, in one of the villages with 403 inhabitants.

In present, there is a primary and secondary school, with 6 classrooms, a room for teachers and a lobby.
The actual number of children is presented below:

| Class | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. of children | 3 | 10 | 14 | 12 | 16 | 10 | 19 | 9 |

The school is functioning in 2 shifts for total of 93 children, but with a combined class for 1-4 scholar class.

The mayor wants to rehabilitated and extend the actual school, by adding a new classroom, and two labs.

The general objective of the project has been defined as: "improvement of the educational infrastructure at the commune level". Total cost of investment has been estimated at 2.017.350 lei (including VAT).

The project was rejected because the evolution of number of children in the village does not justified rehabilitation and extension of the proposed school. The applicant presented a good ERR (higher than 24%) due to new jobs created in the commune by the proposed project.

Statistical data presented in the project, regarding the demographic evolution are: a forecast of 100 new born children per year at the level of the commune. This means, for the village subject of the analysis, about 4 children per year. Considering these figures, the table below presents a forecast of pupils in the school:

| Class \Year | base year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **I** | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| **II** | 10 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| **III** | 14 | 10 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| **IV** | 12 | 14 | 10 | 3 | 4 | 4 | 4 | 4 | 4 |
| **V** | 16 | 12 | 14 | 10 | 3 | 4 | 4 | 4 | 4 |
| **VI** | 10 | 16 | 12 | 14 | 10 | 3 | 4 | 4 | 4 |
| **VII** | 19 | 10 | 16 | 12 | 14 | 10 | 3 | 4 | 4 |
| **VIII** | 9 | 19 | 10 | 16 | 12 | 14 | 10 | 3 | 4 |
| **Total** | **93** | **88** | **73** | **67** | **55** | **47** | **37** | **31** | **32** |

Two alternatives are the subject of analysis:

a) Rehabilitation and extension of the school, as proposed in the rejected project; or

b) Buying scholar buses, and redistributing children to the other schools in the commune.

The analysis is developed for eight years (life span of the buses).

The investments cost is 2.017.350 lei, including VAT, based on General Deviz, for option a). For option b) we consider will be bay 2 scholar buses, with a total cost of 517.824 lei , including VAT (source: offers found on internet).

For option a) the operating costs include: personnel costs, for teachers and support staff; costs with materials; costs for utilities and maintenance of building. For option b) the costs include: cost for staff (drivers); cost for fuel; cost for maintenance of t cars.

Comparative situation is presented below:

| Option a | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| investment costs | 2.017.350,00 | | | | | | | | |
| operating costs - personnel | | 144.000,00 | 146.880,00 | 149.817,60 | 152.813,95 | 155.870,23 | 158.987,64 | 162.167,39 | 165.410,74 |
| operating costs- materials | | 25.983,00 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 |
| utilities and maintenance | | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 |
| Total operating costs | - | 618.552,01 | 1.070.001,43 | 1.072.939,03 | 1.075.935,38 | 1.078.991,66 | 1.082.109,06 | 1.085.288,81 | 1.088.532,16 |
| Total costs | 2.017.350,00 | 618.552,01 | 1.070.001,43 | 1.072.939,03 | 1.075.935,38 | 1.078.991,66 | 1.082.109,06 | 1.085.288,81 | 1.088.532,16 |

| Option b | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| investment costs | 517.824,00 | | | | | | | | |
| operating costs - personnel | | 96.000,00 | 97.920,00 | 99.878,40 | 101.875,97 | 103.913,49 | 105.991,76 | 108.111,59 | 110.273,82 |
| operating costs- fuel | | 86.870,00 | 89.476,10 | 92.160,38 | 94.925,19 | 97.772,95 | 100.706,14 | 103.727,32 | 106.839,14 |
| utilities and maintenance | - | 103.565 | 106.671,74 | 109.871,90 | 113.168,05 | 116.563,09 | 120.059,99 | 123.661,79 | 127.371,64 |
| Total operating costs | - | 286.434,80 | 294.067,84 | 301.910,68 | 309.969,22 | 318.249,53 | 326.757,88 | 335.500,70 | 344.484,61 |
| Total costs | 703.255,03 | 755.166,92 | 706.109,60 | 634.743,34 | 556.608,61 | 471.270,98 | 378.271,44 | 277.125,02 | 167.319,49 |

### 6.3.3 USING CEA IN EVALUATION AND SELECTION PROCESS

In order to appraise an educational project, the effects to be measured and monetize are: the impact on labour market and the increase of the household income. But for primary school, which is mandatory, these effects occur to late starting to year no. 9, and sometime, exceed the analysis time horizon. For high school or for university, these indicators are relatively easy to be determinate and CBA is the recommended tool. But for primary school, the financing decision is already done, as an effect of legislation in force. The task of evaluators is to determine the optimal option in order to provide primary education for all children in the project area.

As in the above example, the applicant took into consideration different effects, without any direct relationship with the project, in order to justify the project rationale and importance. Sometimes, using wrong conversion factors, the applicant manipulates the result of ERR, in order to have expected result (in this case ERR>5,5%). In the case of this project, for a school in a village, the effect at national or regional level could not be measured, the impact is too low. In these cases the effort for developing a full CBA is too high and unjustified.

In order to obtain maximum of advantages by using CEA, a number of options should be pre-defined, and presented, together with the building new school / rehabilitation and extension of existing one option. The methodology for CEA should be detailed explain in the guidelines for applicants (types of costs for each option, and how to estimate them, standard costs to be use, defining and calculation of CEA ratio).

For the case study presented above, the results are:

| Option a | |
|---|---|
| NPV total costs | 8.142.809,81 lei |
| NPV no. Children | 432,64 |
| CEA ratio | **18.821,13** |

| Option b | |
|---|---|
| NPV total costs | 3.838.936,57 lei |
| NPV no. children | 432,64 |
| CEA ratio | **8.873,24** |

In this case, option b , having a smaller cost per child, is the recommended one.

### 6.3.4 PROPOSED BENCHMARKS FOR CEA RATIOS

New legislation regarding the educational system in Romania proposes the standard cost per capita as the main indicator in order to ensure the financing of the educational system. This system includes methodology on how to calculate different levels of standard costs per capita, including for investment in infrastructure.

This system will provide benchmarks for CEA ratios to be used in appraisal of primary educational infrastructure.

## 6.4 SECTOR 3 – HEALTH INFRASTRUCTURE

### 6.4.1 PRESENTATION OF THE CHARACTERISTICS FOR THE SECTOR

This exemplification is only a theoretical one[6], since in the CEA is used only in some theoretical evaluation of different medical procedures, not for health infrastructure.

The programme has the main objective to reduce infant and maternity mortality.

In this respect, three options are to be analysed. Each of them has the same time horizon defined at ten years.

### 6.4.2 CEA ELABORATION (PROJECT IDENTIFICATION, ALTERNATIVES IDENTIFICATIONS, DEFINITION OF BENEFIT / OUTPUT, DETERMINATION OF COSTS, CEA RATIOS, COMPARISON OF ALTERNATIVES AND CONCLUSIONS)

Project identification:

At the level of region 1, three alternative projects have been analyzed:

- *project 1*: to build rural health centers ; the project aim to expanded of prenatal care and delivery care in rural health centers;

- *project 2*: improvement of district hospitals in the prenatal care area

- *project 3*: additional equipment and staff training to allow better treatment of obstructed deliveries at district hospitals

By estimating the costs and effects, results the follow table (values in million euro):

| Costs(million euro) | Investments costs | Operating costs | Lives saved |
|---|---|---|---|
| Project 1 | 1,6 x 3 years | 1,5 | 728 |
| Project 2 | 2 x 2 years | 0,75 | 432 |
| Project 3 | 0,5 x 2 years | 0,05 | 179 |

### 6.4.3 USING CEA IN EVALUATION AND SELECTION PROCESS

At the first view, the project 1 is the most effective in terms of benefits achieved, but it is also the most expensive. How can we calculate the cost-effectiveness? The most convenient way is to try to calculate cost per life saved, so to compare the costs of the projects with the annual number of lives saved.

| Costs (million euro) | Annual equivalent costs (000) | Annual equivalent Lives saved | CEA ratio |
|---|---|---|---|
| Project 1 | 1,816 | 630 | 2,88 |

[6] Source: D. Potts, 2002, Project planning and Analysis for Development

| | | | |
|---|---|---|---|
| Project 2 | 1,178 | 402 | 2,93 |
| Project 3 | 0,176 | 167 | 1,05 |

Project 3 is the most cost-effective.

### 6.4.4 PROPOSED BENCHMARKS FOR CEA RATIOS

To use CEA in assessing health infrastructure need accepted benchmarks value for one of the following CEA rations:

- cost /year of life saved;

- cost / life saved;

- cost per person treated.

The in line authority will decide which ratio will be used for each type of infrastructure and the minimum and maximum accepted benchmarks value. In the guideline for applicants, all the formulas and the standard values will be presented and standard values from previous projects will be used.

Data bases with standard values are to be developed and CBA is to be replaced with CEA for hospitals and other health infrastructures, in the frame work of a strategic programme.

# 7. LIST OF ANNEXES

The following documents are annexed to CEA Handbook:

| | |
|---|---|
| • **An answer to the proposal to use cost-effectiveness analysis for investment projects carried out by micro-enterprises** | *Annex 1* |

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**Annex 1 - An answer to the proposal to use cost-effectiveness analysis for investment projects carried out by micro-enterprises**

For the investment projects of the micro-entreprises, financed through ERDF, it was proposed to replace CBA with CEA, and to replace IRR and NVP criteria from appraisal grid.

Taking into consideration the objective of this type of investments, respectively "increasing work places", we can consider that CEA could be use by defining the CEA ratio as follow:

CEA ratio = total present incremental cost / present incremental number of jobs

Where total incremental cost = NPV (cost for with project scenario) - NPV (costs for BAU)

Present incremental number of jobs = NPV (number of jobs in with project scenario) – NPV (jobs for BAU).

If this CEA ratio is inside of acceptable limits, the project will received points according to the value of this ration.

Taking into consideration the actual evaluation grid used for the evaluation of these type of investment projects, the first criterion will be changed accordingly, considering total cost of the project, not only the aid received or the investment cost, or a new criterion could be in addition of the first one (Creating of the new jobs). For this reason, the methodology of CEA ration calculation should be provided in the Guidelines for Applicants, together with the acceptable values.

**Example:**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| investment costs | 650.260,91 | | | |
| operating costs - BAU | | 448.569,01 | 448.569,01 | 448.569,01 |
| operating costs- with project | | 474.552,42 | 474.552,42 | 474.552,42 |
| total incremental costs | 650.260,91 | 25.983 | 25.983 | 25.983 |
| no. of permanant jobs - BAU | 9 | 9 | 9 | 9 |
| no. of permanant jobs - with project | 9 | 11 | 12 | 12 |
| incremental no. of jobs | - | 2,00 | 3,00 | 3,00 |
| NPV total incremental costs | 686.685,88 lei | | | |
| NPV incremental jobs | 6,87 | | | |
| CEA ratio | **99.900,78** | | | |

If the value of 99.900 lei/new job created is acceptable, the project could receive a specific number of points, otherwise the project will be rejected.

Note that the result of calculation above is a wrong one, as long as the time horizon is max 2 years for implementation and 3 years for operating. In this case, a residual value is necessary. But a better way to receive a more reliable value of CEA ration is to define a proper time horizon, e.g. 10 years of operation and maintaining jobs. In case the results are:

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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| investment costs | 650.260,91 | | | | | | | | | | |
| operating costs - BAU | | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 | 448.569,01 |
| operating costs- with project | | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 | 474.552,42 |
| total incremental costs | 650.260,91 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 | 25.983 |
| no. of permanant jobs - BAU | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| no. of permanant jobs - with project | 9 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| incremental no. of jobs | - | 2,00 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 | 3,00 |
| NPV total incremental costs | 810.378,95 lei | | | | | | | | | | |
| NPV incremental jobs | 21,16 | | | | | | | | | | |
| CEA ratio | **38.306,61** | | | | | | | | | | |

The example above illustrates the importance of time horizon in relationship with period of maintains of expected effects and the importance of setting up of the appropriate benchmarks.

Without reference values for CEA ratio, this tool does not give us any valuable information for accepted or rejected the project.  Even it is use complementary to other criteria, CEA ration could not indicate anything if we do not have a base for comparison, or alternative projects to be compare between them.

Any comments or suggestions regarding this document may be submitted on:
*http://www.evaluare-structurale.ro/index.php/en/cost-benefit-analysis/forum*

Additional information are available on internet:
http://www.evaluare-structurale.ro

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