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ELABORATION OF THE SENSITIVITY ANALYSIS IN THE COST-BENEFIT ANALYSIS OF INVESTMENT PROJECTS FINANCED FROM ERDF AND CF

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This document has an informative character.

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1. INTRODUCTION

In the context of preparing a CBA for a given project, several steps must be carried out, among which is the risk analysis.

The following steps are carried out as part of the risk assessment:

- o Sensitivity analysis
- o Probability distribution of critical variables
- o Risk analysis
- o Assessment of acceptable levels of risk
- o Risk prevention

The sensitivity analysis represents the starting point for risk analysis[1] of the project and the major risks should be considered by all the parties involved either beneficiaries, donors, lenders or even the target groups.

Sensitivity analysis studies how the variation in the numerical output of a project can be quantitatively assigned to different sources of variation in basic input parameters. It thus provides a check of robustness of the numerical results of a project and more specific it highlights the major risks that may affect the entire cycle of the project starting with the implementation.

When talking about sensitivity analysis approach we need to mention both deterministic and stochastic terms, or easier to digest, the structured or the random methods. The former assumes that the basic economic parameter stems from a known interval (in higher dimensions: a compact set) and quantifies the spread of the corresponding equilibrium output variables. The latter treats the parameter as a stochastic variable with known distribution and calculates mean and variance of output variables accordingly. On other words, deterministic sensitivity analysis can be numerically implemented by a step by step formula. On the other side, the stochastic sensitivity analysis is implemented by a Monte-Carlo or a Gauss-Quadrature algorithm.

In economics as well as other model based sciences, a modeller has to do a sensitivity analysis to show the validity of results of his numerical simulations.

A sensitivity analysis is the study of how the variation in the output of a project (numerical or otherwise) can be assigned, qualitatively or quantitatively, to different variations in input parameters. It thus allows for an assessment of the results, as it translates the range (confidence intervals) of fundamental (input) parameters into the model into ranges (confidence intervals) of economic (output) variables. The econometrician Edward Leamer makes it quite clear: "A fragile inference is not worth taking seriously. All

[1] For details on risk analysis, please consult WP 10

scientific disciplines routinely subject their inferences to studies of fragility. Why should economics be different? What we need are organized sensitivity analyses." (Leamer, 1985).

Frey et al. (2004) defines sensitivity analysis as the assessment of the impact of changes in input values on model outputs. Similarly, Saltelli et al. (2000) define sensitivity analysis as the study of how the variation in the output of a model can be apportioned, qualitatively or quantitatively, among model inputs. The answers sought from application of sensitivity analysis should always be clearly listed. The usefulness of sensitivity analysis can then be assessed based on whether the available methods of sensitivity analysis can address the questions under consideration in a manner that is appropriate to the characteristics of the model. Key motivations for performing a sensitivity analysis include identification of key sources of variability and uncertainty in order to facilitate project development, verification, and validation; prioritization of key sources of variability and uncertainty in order to prioritize additional data collection and research; and general model refinement (Frey et al., 2004).

In the context of CGE (computable general equilibrium) models, we ask whether the choice of basic parameters of the project, e.g. elasticity's or time preference parameters, lead to stable equilibrium values of economic variables, e.g. GDP or labor participation. Usually, we refer to the equilibrium of the benchmark scenario. Quite importantly, a sensitivity analysis depends on the existence of equilibrium for a sufficient range of parameters: If the project is not solvable for parameter values close to the ones we have chosen as benchmark values, the results are instable and thus worthless.

The sensitivity analysis used to measure the risk takes into consideration the identification of the factors that have the biggest influence over the net present value in general and more specific for EU funded projects over the financial and economic ratios resulting from the financial modelling of from the Cost Benefit Analysis (including the funding gap rate for those investment projects where required) and indicate their impact within the entire project cycle duration.

Sensitivity analysis may help identify weak design options and pinpoint the need for obtaining additional information on some variables. It may also help convey some idea of project downturns.

2. THE CASE

2.1 METHODS OF USING THE SENSITIVITY ANALYSIS IN THE CBA

In this section we will refer to the methodological approaches for sensitivity analysis and its applicability.

2.1.1 APPROACHES

As mentioned before, basically there are two methodological approaches to sensitivity analysis: a deterministic and a stochastic approach.

Deterministic sensitivity analysis assumes that the tuple of basic parameters is an element of a given subset of all possible parameter choices. It seeks to determine upper and lower bounds on the corresponding subset of economic outcomes of the project.

Stochastic sensitivity analysis treats the vector of parameters as a stochastic variable with a given distribution, rendering economic equilibrium of the model into stochastic variables. It aims at calculating the first moments of these variables, with the variance indicating the robustness of the results.

The choice a modeller has to make in a sensitivity analysis is, however, not only a methodological, but also a numerical one. Sensitivity analysis can involve more or less calculations of equilibrium, so that usually there is a trade-off between accuracy and calculation time. This holds already true for a comparison of the deterministic and the stochastic approach, and is particularly relevant for the case of a multidimensional sensitivity analysis.

A good sensitivity analysis should conduct analyses over the full range of plausible values of key parameters and their interactions, to assess how impacts change in response to changes in key parameters.

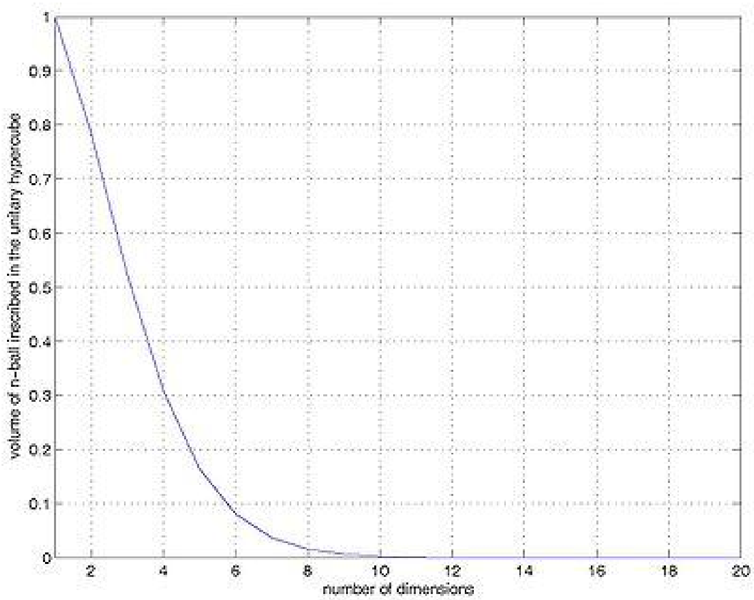
In general, the viability of investment projects is based on IRR and NPV criteria. Moreover, in case of EU funded projects where CBA application is indicated, there are many other criteria giving the project viability such as: funding gap, socio-economical impacts, regional strategy, CO2 emissions etc. Therefore, in the economic analysis of the projects there are some aspects of project feasibility which may require sensitivity and risk analysis. Sensitivity analysis estimates the effect on achieving project objectives if certain assumptions materialize or not.

In sensitivity analysis a common approach is that of changing one-factor-at-a-time (OAT), to see what effect this produces on the output. OAT customarily involves:

- Moving one factor at a time and
- Going back to the central/baseline point after each movement.

This appears a logical approach as any change observed in the output will unambiguously be due to the single factor changed. Furthermore by changing one factor at a time one can keep all other factors fixed to their central or baseline value. This increases the comparability of the results (all ‘effects’ are computed with reference to the same central point in space) and minimizes the chances of computer program crashes, more likely when several input factors are changed simultaneously. The later occurrence is particularly annoying to modellers as in this case one does not know which factor's variation caused the model to crash.

The paradox is that this approach, apparently sound, is non-explorative, with exploration decreasing rapidly with the number of factors. With two factors, and hence in two dimensions, the OAT explores (partially) a circle instead of the full square (see figure). In this case one step along the abscissa moving from the origin, followed by a similar step along the ordinate—always moving from the origin, will leave us inside the circle and will never take us to the gray corners.



Investment projects are subjected to various forms of risk that can impact the performance expected by the beneficiary. The factors coming from the external environment, as well as the endogenous factors specific to the operational and functional structure of the investment objective can have in time a different manifestation than the one anticipated initially, and thus, the bigger are the noticed deviations, the higher is the risk of the project to fail to ensure reaching the expected results.

In a general sense, the risk represents "the probability that a specific adverse effect or event will occur in a given population", which shows that a future economic action can generate losses, especially because of having incomplete information when making decisions or because of the inconsistence of logical reasoning. The risk management will focus in this case on eliminating the negative aspects introduced by the risk probability, and the analysis will especially study the potential threats that can affect the projects profitability in the future.

The modern approach of the risk concept sees risk as constancy in the socio-economic activities. Besides the losses it can cause, sometimes irreversible, it can also constitute an opportunity for the enterprisers, with the condition to adopt adequate strategies.

A complete definition of risks that incorporates the two aspects (threat and opportunity) considers risk as being an uncertain event or condition that in case of manifestation will have a positive or a negative impact over the project's objective. The project risk includes the threats over the objective, as well as the opportunity to improve these objectives.

2.1.2 STEPS IN CARRYING OUT THE SENSITIVITY ANALYSIS

Sensitivity analysis allows the determination of the 'critical' variables or parameters of the model. Such variables are those whose variations, positive or negative, have the greatest impact on a project's financial and/or economic performance. The analysis is carried out by varying one element at a time and determining the effect of that change on IRR or NPV.

The criteria to be adopted for the choice of the critical variables vary according to the specific project and must be accurately established on a case-by-case basis. As a general criterion, the recommendation is to consider those variables or parameters for which an absolute variation of 1% around the best estimate gives rise to a corresponding variation of not less than 1% (one percentage point) in the NPV (i.e. elasticity is unity or greater).

The procedure that should be followed to conduct a sensitivity analysis includes the following steps:

A. identification of variables

B. elimination of deterministically dependent variables

C. elasticity analysis

D. choice of critical variables.

Some examples for the identification of the variables used to calculate the output and input of the financial and economic analyses, grouping them together in homogeneous categories are presented below:

Identification of critical variables

Categories	**Examples of variables**
Price dynamics	Rate of inflation, growth rate of real salaries, energy prices, changes in prices of goods and services
Demand data	Population, demographic growth rate, specific consumption, sick rate, demand formation, volume of traffic, size of the area to be irrigated, market volumes of a given commodity
Investment costs	Duration of the construction site (delays in realization), hourly labor cost, hourly productivity, cost of land, cost of transport, cost of concrete aggregate, distance from the quarry, cost of rentals, depth of the wells, useful life of the equipment

	and manufactured goods
Operating costs	Prices of the goods and services used, hourly cost of personnel, price of electricity, gas, and other fuels
Quantitative parameters for the operating costs	Specific consumption of energy and other goods and services, number of people employed
Prices of outpits	Tariffs, sales prices of products, prices of semi-finished goods
Quantitative parameters for the revenues	Hourly (or other period) production of goods sold, volume of services provided, productivity, number of users, percentage of penetration of the area served, market penetration
Accounting prices (costs and benefits)	Coefficients for converting market prices, value of time, cost of hospitalisation, cost of deaths avoided, shadow prices of goods and services, valorisation of externalities
Quantitative parameters for costs and benefits	Sick rate avoided, size of area used, added value per hectare irrigated, incidence of energy produced or secondary raw materials used

B. Deterministically dependent variables would give rise to distortions in the results and double counting. If, for example, labour productivity and global productivity appear in the model, then the latter obviously includes the former. In this case, it is necessary to eliminate the redundant variables, choosing the most significant ones, or to modify the model to eliminate internal dependencies. The variables considered must, as far as possible, be independent variables. Additionally, variables should, as far as possible, be analysed in their disaggregated form: for example ‘revenue’ is a compound variable, but either ‘quantity’ or ‘price’ or both separately may be critical.

C. It is advisable to carry out a preliminary qualitative analysis of the impact of the variables in order to select those that have little or marginal elasticity as in the following Table.

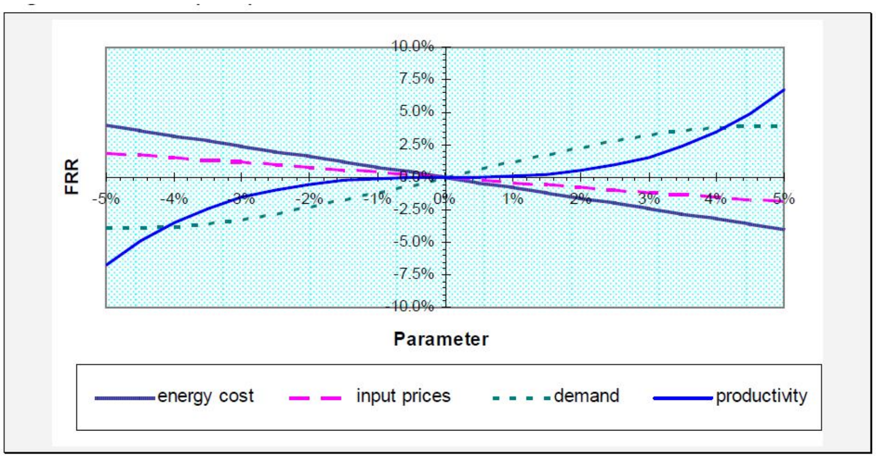
Categories	Parameters	Elasticity		
		High	Intermediate	Low
Price dynamics	rate of inflation	X		
	change of personnel costs		X	
	change of energy prices			X
	change of prices of goods and services			X
Demand data	specific consumption	X		
	rate of demographic growth			X
	volume of traffic	X		
Investment costs	hourly labour construction cost	X		

The subsequent quantitative analysis can be limited to the more significant variables. Having chosen the significant variables, one can then evaluate their impact elasticities by making the calculations. Each time, it is necessary to assign a new value (higher or lower) to each variable and recalculate the NPV, thus noting the differences (absolute and percentage) compared to the base case. Since, generally speaking, there is no guarantee that the impact elasticities of the variables will always be linear functions, it is advisable to verify this, repeating the calculations for different arbitrary deviations.

D. At the end of this selection, the critical variables will presumably be few, unless the threshold value chosen for performance elasticity is exaggeratedly small. In a project for a hospital, motorway or even an industrial plant, the key variables are few (for example the total value of the fixed investment, the size and timing of returns, the interest rate) and they dominate the effects of the others (for example, the prices of minor inputs).

An example of a possible result of the sensitivity analysis is shown below: according to the aforementioned general criterion (a variation of the variable of 1% corresponds to at least one percentage point variation in NPV), the critical variables are demand and productivity, while energy cost and input prices are below the threshold.

Sensitivity analysis



Switching value

The switching value of a variable is that value that would have to occur in order for the NPV of the project to become zero, or more generally, for the outcome of the project to fall below the minimum level of acceptability.

The use of switching values in sensitivity analysis allows appraisers to make some judgments on the riskiness of the project and the opportunity of undertaking risk-preventing actions. For example if one of the critical variables of a transport project is 'forecasted demand' and its switching value is -20%, then the proposer can evaluate if the conditions for such a decrease exist and, in a positive case may consider preventing actions (e.g. tariffs reduction).

The following provides some examples of switching values for an agricultural project:

Variable Switching Value (%)

- Yield per hectare - 25
- Construction costs 40
- Irrigated area per pump -50
- Shadow exchange rate 60

Source: adapted from Belli et al. (2001).

2.1.3 APPLICATIONS FOR SENSITIVITY ANALYSIS

The idea of sensitivity analysis is central to the structuring and solving of decision models using decision-analysis techniques. The main issues of sensitivity analysis is that we do not always know with complete certainty the values for parameters (probabilities, costs); the sensitivity analysis is always performed for a long period, based on assumptions for the evolution of macroeconomic indicators, population, production, etc.; the sensitivity analysis is performed in order to see how the problem outcome can change relative to the values for key parameters.

Sensitivity analysis answer to the question "What makes the difference in this decisions?". The issues addressed in the decision model are those important. The literature review cannot help us to identify the "optimal" sensitivity analysis procedure. To a great extend, the building of the model is an art.

Sensitivity analysis can be used

- To simplify models
- To investigate the robustness of the project predictions
- To play what-if analysis exploring the impact of varying input assumptions and scenarios on the project results
- As an element of quality assurance (unexpected factors sensitivities may be associated to coding errors or misspecifications).

It provides as well information on:

- Factors that mostly contribute to the output variability
- The region in the space of input factors for which the model output is either maximum or minimum or within pre-defined bounds (Monte Carlo filtering)
- Optimal — or instability — regions within the space of factors for use in a subsequent calibration study
- Interaction between factors

Sensitivity Analysis is common in physics and chemistry, in financial applications, risk analysis, signal processing, neural networks and any area where models are developed. Sensitivity analysis can also be used in model-based policy assessment studies. Sensitivity analysis can be used to assess the robustness of composite indicators, also known as indices, such as the Environmental Performance Index.

Sensitivity analysis can help in a variety of circumstances, such as:

- to identify critical assumptions or compare alternative model structures
- guide future data collections
- detect important criteria
- optimize the tolerance of manufactured parts in terms of the uncertainty in the parameters
- optimize resources allocation model simplification or model lumping, etc

2.2 KEY PARAMETERS USED IN THE SENSITIVITY ANALYSIS

The presence of risks in the economic environment is relatively constant, and their large diversity makes necessary to *identify the elements that could be subjected to risks* and which can identify the projects' viability and their analysis from this point of view, in order to diminish the negative consequences.

A. Seen as economic processes, the investment projects draw in numerous resources whose value consumption make *the investment cost*: expenses for obtaining and setting up the land, infrastructure expenses, design and technical assistance expenses (licenses, agreements, authorizations, designing, project audit, technical assistance and construction site inspector, organizing the vendee procedures), expenses with the basic investment (constructions and works of intervention, expenses with independent acquisitions), other expenses (organization of the building site, commissions, taxes, legal fares, financing costs, various and unpredicted expenses), operating expenses (training the personnel for exploitation, technological evidences, trials, lapping, expertise when received).

The expenses with the implementation of the project are direct and immediate, they usually run their course during a period of 1 to 3/5 years and because of this they are relatively easy to quantify and their assessment has a high precision level.

Besides the cost of achieving the investment, the global cost of the investment project will be given by the operating cost generated by setting in motion the investment object, and this must be accurately estimated for the complete economic functioning period of the made investment.

Taking into consideration the potential price variations or the variations of the quantities needed to achieve the project leads to the idea of influencing the cost parameters and to the occurrence of the risk to diminish the results. Thus, bigger difficulties to estimate accurately the economic parameters occur during the project exploitation, because this period has a farther time horizon.

B. During the process of assessing the *economic effects*, we must take into account the quantifiable direct effects that need an adequate estimation for a long period of operating the investment objective, as well the indirect effects, which usually don't have a value expression, their forecast being more difficult because of this.

In the field of implementing the investment projects, the effects can have a physical expression, as well as a value expression. The quantitative results of the projects are obtain by using the production capacity of the objective and are expressed in the achieved physical production or the volume of the physical sales on categories of products. The types of the effects expressed as a value are numerous and from their category are selected and ranked those results that become an economic criterion in the economic and financial assessment of the investment project: the exercise's production, the turnover, the added value, the net profit, the cash flow, the treasury flow, operating incomes, etc.

The quality and efficiency assessment of an investment project is actually based on an estimation of the future cash-flows resulted from the activity of an enterprise (from the public or the private sector), identifying the key factors and the potential risks, using a conceptual model or a framework that takes into account all these factors, as well as testing the project's capacity to place the company on a successful position on the market.

The directions of action that allow studying the risks faced by investment projects are:

- Identifying the risk sources, meaning to point out the areas that interact with the project during the achievement and operating of the investment objective and which can be affected in the future by an unpredictable evolution. These can be the economic, financial, technical, environmental, legal, social, etc., fields. Risks can also occur because of other cause, such as the wrong determination of the project's opportunity, errors in the economic phenomena prognosis, the lack of correlation between the financing sources and the objectives that need to be implemented;
- Establishing the risk types that can impact the project. The risks are ranked, the most important being considered the ones with a high occurrence frequency noticed at similar projects or estimated by experts;
- Assessing the risk level with the help of various techniques of risk assessment, such as: critical point, position indicator, variation coefficient, sensitivity analysis, etc;
- The analysis of various potential situations in the future, evaluating the risk occurrence consequences and the extent to which it affects the economic-financial viability of the project. The impossibility to accurately prevision the information used in assessing the projects (the production and service volume, the qualitative level, prices, consumptions, etc.) causes the expected results to vary because of the risks;

– Mentioning the risk control strategies, meaning to indicate the necessary actions to minimize the risk occurrence probability, to diminish or eliminate them.

Generally, risk analysis means the efficiency and profitability analysis of the projects in conditions of incertitude and risk, conditions in which the variation of the influence factors (parameters) manifests with a certain probability.

A sensitivity analysis highlights the critical factors affecting the project's viability. This allows the decision-makers or project manager to pay attention to these factors during the implementation stage. Parameters subjected to sensitivity analysis for EU funded projects include:

- different timing of the project's operation
- changes in the capital outlays
- changes in the price of market goods, and
- changes in social and environmental benefits and costs

Additionally, in ordinary investment projects the following parameters shall be subject to sensitivity as well:

- the discount rate
- length of the project planning horizon

To undertake a sensitivity analysis, it is necessary to model the assumption and calculations to generate the required results. It is usually most convenient to do this in the form of a spreadsheet. The model should clearly identify all of the data and assumptions made and include the formulae leading to the result for which sensitivity is to be investigated.

Some of the parameters used will be known with a high degree of accuracy and these can remain fixed throughout the analysis. For other parameters or assumptions there may be varying degrees of uncertainty. These parameters are the ones to be varied. The starting point in the analysis is to set these parameters at the values considered most likely to be correct.

The sensitivity analysis then entails varying each parameter in turn within a plausible range by a geometric factor; for example the parameters could be varied between known maxima and minimum, or doubled or halved. With each range, the result is inspected. Where the result varies to a large degree, then the variable parameter must be accurate. Where the result varies only marginally, then an approximate value may be considered appropriate, or the parameter might even be excluded altogether. A useful discipline in sensitivity analysis is to initially set a target for variation in the result (commuting value), e.g. ±5%, ±10%, ±20%. Trial and error or direct calculation can be used to estimate the required accuracy of the varied parameters.

For example, the key factors which have to be taken into consideration when performing the sensitivity analysis for water and wastewater application are presented in the following table:

Possible Key Variables	Quantifiable Variables	Underlying Variables
Demand	Population growth Achieved coverage Household Consumption Non Domestic Consumption Unaccounted for Water	Price Elasticity Income Elasticity
Investment Costs (Economic & Financial)	Water Demand Construction Period Real Prices Conversion Factors	
O&M Costs	Personnel Costs (wages/No. of staff, etc.) Cost of Energy Cost of Maintenance Efficiency of Utility	
Financial Revenues	Quantity of water consumed Service level Income from connection fees	Service Tariffs UFW (bad debts)
Economic Benefits	Service/product Demand Resource Costs Savings	Willingness to Pay
Cost Recovery	Tariffs/revenues from sells Subsidies	

Source: EIB methodology and Author's approach

Sensitivity analysis can be used for optimal experimental design, e.g. determining initial conditions, measurement positions, and sampling time, to generate informative data which are critical to estimation accuracy. A great number of parameters in a complex model can be candidates for estimation but not all are estimable. Sensitivity analysis can be used to identify the influential parameters which can be determined from available data while screening out the unimportant ones. Sensitivity analysis can also be used to identify the redundant species and reactions allowing model reduction.

For example, we can mention some key indices of sensitivity analysis:

- Relative contribution of exposure pathways

- Inspection of risk equation
- Sensitivity ratios (i.e., elasticity)
- Sensitivity scores (i.e., weighted sensitivity ratios)
- Graphical techniques with results of Monte Carlo simulations (e.g., scatter plots)
- Correlation coefficient (or coefficient of determination)
- Normalized multiple regression coefficients
- Goodness-of-fit test for subsets of the risk distribution

Risk categories for investment projects

A first step in the risk analysis of the investment projects is to identify the various potential risk categories that can affect their viability. Moreover, due to the fact that risks could occur anytime during the implementation phase, it is important to take them into consideration when assessing key parameters in sensitivity analysis.

A. A category of potential risks that impact the enterpriser's activity in its relationship with the market is manifested in the marketing sector. ***The strategic risk*** consists in diminishing the enterpriser's market share and leading him to financial losses. Measuring the impact of this risk class is done by determining the variation of the market share owed mainly to the change in the demand of products specific to the company.

In case the relationships with clients and suppliers won't materialize at the level foreseen in the contracts, a ***commercial risk*** could occur. It will be felt by losing some clients, which means the estimated production will not be completely turned into account, incomings won't cover costs and therefore the earnings will drop. At the same time, the commercial risk could lead to unfulfilled relationships with suppliers, which means the cost will be inflated with sums derived from preparing the supply, namely commercial meetings, preliminary studies, drawing up the supply for products, which also lowers the financial results of the project.

The legal risk comes from failing to subsume to the legislation in effect during the operating of the objective, because of potential changes of the legal stipulations regarding payment terms, taxation systems, norms, regulations. The consequences of the legal risk occurrence are obvious in the payment of penalties or in the occurrence of debts. The penalty losses are calculated depending on the number of days of delay, the daily cost and the average level of the resource recording the loss. For debts, the impact of the legal risk is given by measuring the direct and indirect prejudice occurred as a result of not cashing-in in time the sums owed by third parties.

The financial risk means the possibility to record additional financial expenses (the rise of the interest rate, unfavourable exchange rate), which will lead to diminishing incomes or even financial losses. It can be measured through the analysis of cash flows and loan cost.

The operational risk is related to changing conditions that affect the operating activity of the investment objective. Known also as economic risk or operating risk, the operational risk impacts the production costs statement and the profitability level of the project. The rise of the costs of raw materials, fuels, energy, work force or other resources over the initial estimations means an increase of the total efforts and an adequate drop in the earning in comparison to the expected level. The operational risk actually manifests in relation with the decrease of the investment objective's capacity to generate profit under the influence of the inadequate management of assets.

The maintenance and service risk is related to exceeding the costs established in accordance with inaccurate estimations of the repairs expenses, to unforeseen malfunctions of the endowments, to accidents, etc.

B. A structuring of the risks according to the elements taken into account for the calculus of the investment project's efficiency can also be done as follows: risks for the effort parameters called *cost risks* and risks for the effects parameters, called *income risks*. These categories of risks exercise an important influence over the enterpriser that starts an investment for modernization and expansion, thus having a high impact. The risks to fail to achieve the incomes or to exceed costs are amplified for strategic investments, which have as a materialization period a farther time horizon.

The investment projects that target to reduce the operating expenses and the projects for the improvement of the work conditions have a lower risk level.

C. Depending on the level of manifestation, the risks that affect the investment project can be:

- *Individual risks* that measure the impact produced by the variation of the economic parameter over the results, assuming the company has no other assets than those resulted through the project;

- *The company risk* affects the total earnings of the enterpriser, integrating the assets obtained from the investment in the total patrimony of the company. This is the risk of the enterprise as a whole as a result of implementing the investment projects;

- *The market risk* refers to the risk of the project from the point of view of the investor who owns a diversified stock portfolio.

Because the company risk and the market risk are difficult to measure, most often the individual risk specific to a project can approximate the other risk categories, because this risk is actually a direct influence on the risk for the enterpriser or for the investor.

In the area of investment projects in the pre-investment stage, the achievement level of the parameters specific for projects and the performance level can't be established with precision based on statistical information. The pre-established indicators levels will have a certain evolution in the future; they will be achieved with a certain probability, thus contributing to the size of the project risk.

The risk analysis for projects is tied to the *probabilistic risk conception*. The chances to reach the project's parameters can be established by experts based on their own intuition and experiences (one of the sources could be brainstorming) as trust levels granted by them for the production of the anticipated phenomena, meaning the probability to reach a certain level of the project's parameters is assessed.

Another association method of the occurrence probability for the variables of the project is to establish a precise range of values around the value of the parameter used in the basic version.

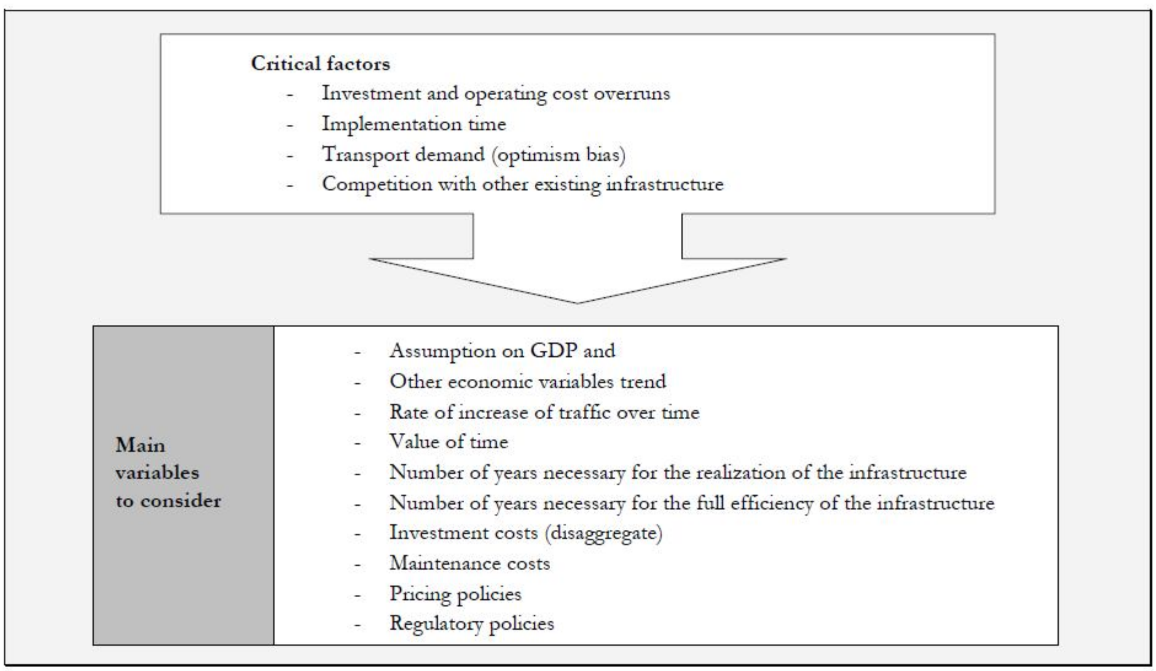
The distribution of the probability for each option can be assimilated with the one obtained on experimental basis, in conditions as close as possible to the conditions of the project or in case of similar projects. Other methods to determine the probability distribution for the parameter of a project can also be used, such as: Monte Carlo Simulation, Decision Trees and Force Field Analysis. The models used for the risk analysis are many and they target to quantify the risk level in order to avoid intuitive decisions and to increase decision quality: the method of the Net Present Value *NPV*, the statistic indicators method, the payback period method, Return on Investments *ROI*, the sensitivity analysis, the method of the Internal Rate of Return *IRR*, the decision tree method, simulation, etc.

We will give an example of one of these methods, namely the *sensitivity analysis*, because it's a largely used method for the economic-financial analysis of investment projects. It give the possibility to identify the critical variables of a project, it allows establishing the financial sustainability level of the project given by the potential changes of the influence factors and it serves, at the same time, to measure the project risk in order to justify decisions.

Variables considered at the level of investment type

Regional and local transport infrastructure

Due to their criticality, it is advisable to carry out a sensitivity analysis of the money values assigned to the goods without any market, i.e. values of time and externalities. Other sensitivity tests may be focused on investment and operating costs or on the expected demand, in particular the generated traffic.



Environment

Critical factors
- Demand elasticity
- Key input dynamic costs
- Recovered product prices
- Costs of remediation and other environmental costs

Main variables to consider	
	- The change in demand for waste disposal related to the diffusion of new products or new technologies - The change in behaviours - The variation in economic or population growth or decrease - Energy costs - Raw materials costs - Variations in the sales price of recovered products - The dynamics of costs over time of some goods and critical services for certain projects - The cost of electricity - The cost of fuel - The cost of remediation and decontamination of the sites

Social infrastructure

Education and training infrastructures

Critical factors
- Investment and operating costs
- The demographic dynamics in the catchment's area
- The success of the educational programmes

Main variables to consider	
	- The rate of growth of the population in the catchment's area - The future composition of the population in the catchment's area - The current enrolment rate - Effective enrolment rates compared to potential ones - The percentage of pupils who complete the whole training

Hospitals and other health infrastructures

Critical factors

- Reliability of epidemiological data for the catchment's area
- Operating and investments costs
- The risks incurred by administering new diagnostic or therapeutic treatment, etc.)

Main variables to consider	- The percentage incidence of pertinent morbidity, disaggregated by pathological type, age range, sex, profession, etc. - The cost of personnel - The cost of maintenance - The cost of new equipment - The cost of replacing old equipment - Possible costs deriving from the carrying out of diagnoses or treatment

Development of regional and local business environment (development of business support structures, rehabilitation of unused industrial sites, support for microenterprises).

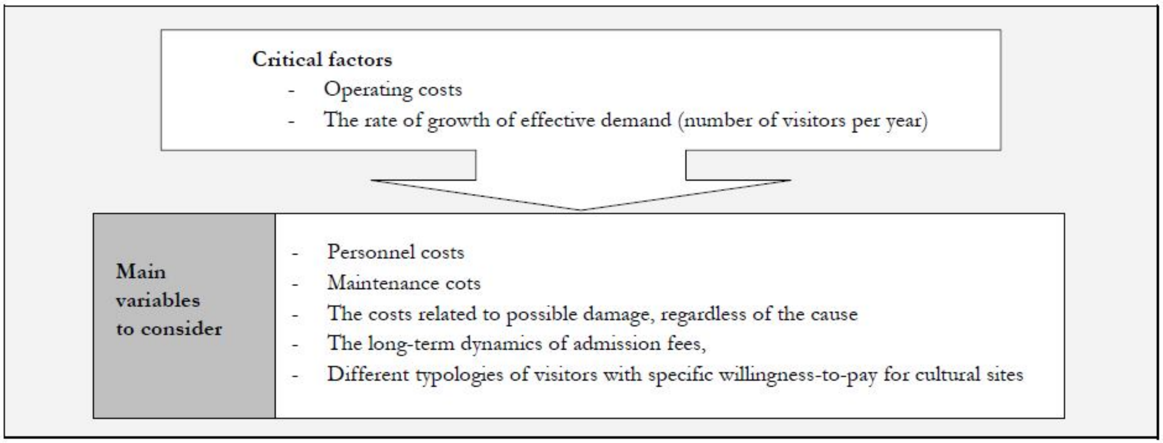
Critical factors

- Investment costs
- Difficulty in forecasting the real rate of penetration in the catchment area, from the point of view of both the relocation of companies and the development of new businesses

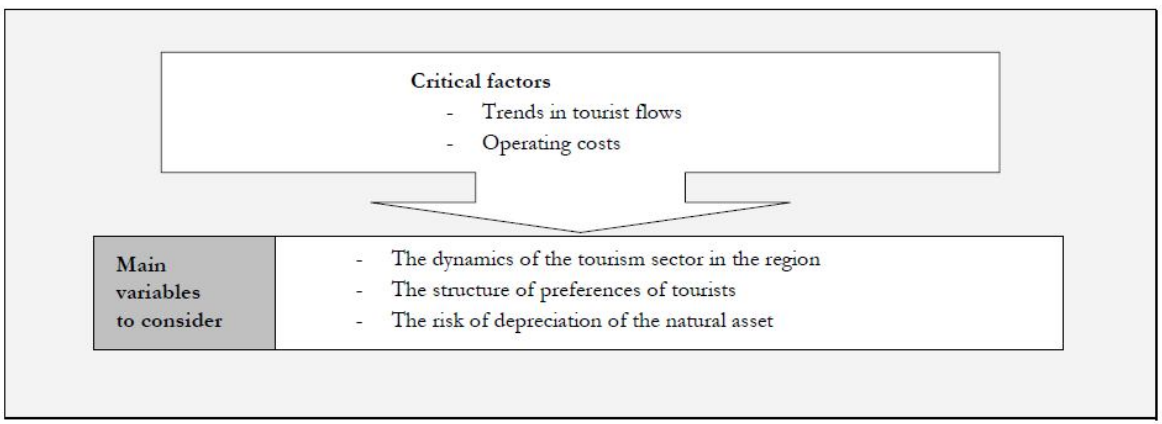
Main variables to consider	- Expropriation costs - Equipment costs - The rate of installations in the area - The birth and early mortality rate of new businesses

Tourism

Museums and cultural sites



Forests and parks[2]



Innovative and eco-efficient production systems (sustainable development of Romanian production system and enterprise development).

Industries and other productive investments

[2] Tourist flows refer to the amount of tourists visiting in a given period of time

Critical factors

- Economic growth
- Market demand for the products
- Product price dynamics
- Investments costs
- Operating costs

Main variables to consider	- GDP growth - Specific sector growth foreseen - Relative weight of the company on the total sector - The price of the products the company is expected to produce - The cost of the new plant - The cost of machinery - The cost of labour - The cost of raw materials - The cost of energy

Research, technological development and innovation for competitiveness (increase the capacity for RD, stimulating cooperation between RDI institutions and enterprises and increasing enterprises'' access to RDI).

Information technology and communications for public and private sectors.

Telecommunications infrastructures

Critical factors

- Future demand
- Investment costs
- Technological evolution and probable obsolescence of the infrastructure

Main variables to consider	- Growth rates for the population and businesses - Dynamics of the sales prices for services - Investment costs for technological development - Length of the substitution cycles (ageing, technical obsolescence) of the equipment installed

Increasing energy efficiency and security of supplying energy

Industry, energy and telecommunications

Critical factors

- Economic growth
- Market demand for the products
- Product price dynamics
- Investments costs
- Operating costs

Main variables to consider

- GDP growth
- Specific sector growth foreseen
- Relative weight of the company on the total sector
- The price of the products the company is expected to produce
- The cost of the new plant
- The cost of machinery
- The cost of labour
- The cost of raw materials
- The cost of energy

Energy transport and distribution

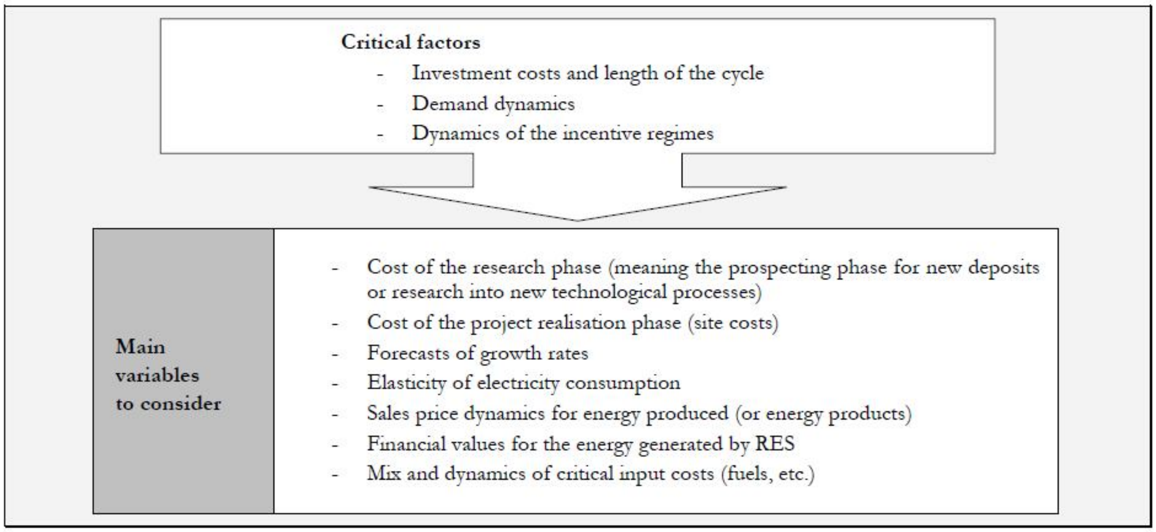
Critical factors

- Demand dynamics
- Operating costs

Main variables to consider

- Forecasts of growth rates
- Forecasts of the elasticity of electricity consumption
- The dynamics of purchase prices of gas and electricity, conveyed by the transport and/or distribution infrastructure and often purchased abroad
- The dynamics of the sale prices of substitutes electricity or gas

Energy production and renewable sources



2.3 CASE STUDY

The case study is based on a simulation for a big project with an investment value of 78,308,832 EUR which will be implemented by a private company in order to provide public services.

All assumptions made regarding the basic variables used in the models are subject to uncertainties, so that a certain variation (both positive and negative) of the variables is always possible. The sensitivity and risk analysis deals with the evaluation of the impact of given percentage changes in a variable on the performance of the project and the assessment of the probability that a project will perform successfully, as well as the variability of the outcome compared to the best estimate (or base case) previously made.

The procedure used for assessing risks in this case is based on:

- Sensitivity analysis: which assesses the impact of assumed changes in variables and parameters used in the model on the financial indicators (IRR and NPV), and identifies the “critical” ones, which are those, whose variations have the greatest impact

- Risk probability analysis: associates a probability distribution to each critical variable and calculates the cumulative probability for different scenarios, both optimistic and pessimistic, by combining the probabilities of the individual variables.

The sensitivity analysis is composed of three parts:

· Analysis (1) shows the effects of variation in key parameters on the “financing mix”;

· Analysis (2) shows the effects of variation in key parameters on the “financial results”;

· Analysis (3) shows the effects of variation in key parameters on the “economic results”.

Sensitivity Analysis (1)

Sensitivity Analysis (1) shows the effects of variation in key parameters on the "financing mix", that means the composition of EU Grant funds, State Budget funds, Local Budget funds and loan funds.

The analysis is carried out for variations of +/-1%; +/-5%; and +/-10% for the following **parameters**:

- Investment cost,
- Operating cost,
- Revenues.

Investment Costs

The results of the sensitivity analysis regarding variations in investment costs are presented in the following table:

Variation in investment costs		EU Grant	Co-fin. loan	State budget	Local Budget	Total
1	Base case	**78.67%**	**7.45%**	**12.03%**	**1.85%**	**100.00%**
2	Sensitivity case 2 (-1%)	78.61%	7.52%	12.02%	1.85%	100.00%
3	Sensitivity case 3 (-5%)	78.35%	7.83%	11.98%	1.84%	100.00%
4	Sensitivity case 4 (-10%)	77.99%	8.25%	11.93%	1.84%	100.00%
5	Sensitivity case 5 (+1%)	78.73%	7.37%	12.04%	1.85%	100.00%
6	Sensitivity case 6 (+5%)	78.96%	7.10%	12.08%	1.86%	100.00%
7	Sensitivity case 7 (+10%)	79.23%	6.79%	12.12%	1.86%	100.00%

The impact of variation in investment costs is not significant. A variation of the investment costs by 1% leads to a 0.06% change in the EU grant percentage. The contingencies considered for the project can easily cover any reasonable variation in investment costs.

Operating Costs

The results of the sensitivity analysis regarding variations in operating cost are presented in the following table:

Variation in operating costs		EU Grant	Co-fin. loan	State budget	Local Budget	Total
1	Base case	**78.7%**	**7.4%**	**12.0%**	**1.9%**	**100.0%**
2	Sensitivity case 2 (-1%)	76.4%	10.1%	11.7%	1.8%	100.0%
3	Sensitivity case 3 (-5%)	67.3%	20.8%	10.3%	1.6%	100.0%
4	Sensitivity case 4 (-10%)	56.0%	34.1%	8.6%	1.3%	100.0%
5	Sensitivity case 5 (+1%)	80.9%	4.8%	12.4%	1.9%	100.0%
6	Sensitivity case 6 (+5%)	85.0%	0.0%	13.0%	2.0%	100.0%
7	Sensitivity case 7 (+10%)	85.0%	0.0%	13.0%	2.0%	100.0%

The impact of variation in operating costs is significant. A variation in operating costs by 1% leads to a 2.3% change in the EU grant percentage.

Revenues Forecast

The results of the sensitivity analysis regarding variations in revenues forecast are presented in the following table:

Variation in revenues		EU Grant	Co-fin. loan	State budget	Local Budget	Total
1	Base case	**78.7%**	**7.4%**	**12.0%**	**1.9%**	**100.0%**
2	Sensitivity case 2 (-1%)	81.2%	4.5%	12.4%	1.9%	100.0%
3	Sensitivity case 3 (-5%)	85.0%	0.0%	13.0%	2.0%	100.0%
4	Sensitivity case 4 (-10%)	85.0%	0.0%	13.0%	2.0%	100.0%
5	Sensitivity case 5 (+1%)	76.2%	10.4%	11.7%	1.8%	100.0%
6	Sensitivity case 6 (+5%)	66.2%	22.1%	10.1%	1.6%	100.0%
7	Sensitivity case 7 (+10%)	53.8%	36.7%	8.2%	1.3%	100.0%

The impact of variation in revenues is significant. A variation in revenues by 1% leads to a 2.5% change in the EU Grant percentage. In order to mitigate this risk the approach recommended for the operating costs is to be considered.

Sensitivity Analysis (2)

Sensitivity Analysis (2) shows the effects of the same variations for the same key parameters as outlined above on the "financial results":

· NPV/C and FIRR/C;

· NPV/K and FIRR/K;

both "before community assistance" and "after community assistance".

The analysis is also carried out for variations of +/-1%; +/-5%; and +/-10% for the following **parameters**:

· Investment cost,

· Operating cost,

· Revenues.

Investment Costs

The results of the sensitivity analysis regarding variations in investment costs are presented in the following table:

Variation in investment costs	**Before community assistance**	**After community assistance**

	NPV/C	FRR/C	NPV/C	FRR/C	NPV/K	FRR/K
Base case	-83,154,188	-5.67%	-12,743,565	-0.19%	-11,306,082	-0.65%
Sensitivity case 2 (-1%)	-82,257,801	-5.66%	-12,551,285	-0.17%	-11,128,177	-0.63%
Sensitivity case 3 (-5%)	-78,672,254	-5.62%	-11,782,163	-0.07%	-10,416,554	-0.51%
Sensitivity case 4 (-10%)	-74,190,321	-5.57%	-10,820,760	0.06%	-9,527,026	-0.35%
Sensitivity case 5 (+1%)	-84,050,574	-5.68%	-12,935,846	-0.22%	-11,483,988	-0.68%
Sensitivity case 6 (+5%)	-87,636,121	-5.72%	-13,704,967	-0.30%	-12,195,611	-0.78%
Sensitivity case 7 (+10%)	-92,118,054	-5.76%	-14,666,370	-0.40%	-13,085,139	-0.90%

The impact of variation in investment costs is significant. A variation of the investment costs of 1% leads to a non significant change in the NPV/C (before community assistance).

This can be covered by the contingencies considered for the project.

Operating Costs

The results of the sensitivity analysis regarding variations in operating cost are presented in the following table:

Variation in operating costs	**Before community assistance**		**After community assistance**			
	NPV/C	FRR/C	NPV/C	FRR/C	NPV/K	FRR/K
Base case	-83,154,188	-5.7%	-12,743,565	-0.2%	-11,306,082	-0.65%
Sensitivity case 2 (-1%)	-80,881,587	-5.3%	-10,470,964	0.7%	-9,033,482	0.44%
Sensitivity case 3 (-5%)	-71,791,184	-3.7%	-1,380,561	4.4%	56,921	5.03%
Sensitivity case 4 (-10%)	-60,428,180	-2.0%	9,982,442	9.3%	11,419,925	11.64%
Sensitivity case 5 (+1%)	-85,426,788	-6.1%	-15,016,166	-1.1%	-13,578,683	-1.72%
Sensitivity case 6 (+5%)	-94,517,191	-8.0%	-24,106,569	-4.7%	-22,669,086	-5.88%
Sensitivity case 7 (+10%)	-105,880,195	#DIV/0!	-35,469,572	-9.0%	-34,032,090	#DIV/0!

Revenue Forecast

The results of the sensitivity analysis regarding variations in revenue development are presented in the following table:

Variation in revenues	**Before community assistance**		**After community assistance**			
	NPV/C	FRR/C	NPV/C	FRR/C	NPV/K	FRR/K
Base case	-83,154,188	-5.7%	-12,743,565	-0.2%	-11,306,082	-0.65%
Sensitivity case 2 (-1%)	-85,650,731	-6.1%	-15,240,109	-1.2%	-13,802,626	-1.83%
Sensitivity case 3 (-5%)	-95,636,907	-8.2%	-25,226,285	-5.1%	-23,788,802	-6.38%
Sensitivity case 4 (-10%)	-108,119,627	#DIV/0!	-37,709,004	#DIV/0!	-36,271,522	#DIV/0!
Sensitivity case 5 (+1%)	-80,657,644	-5.2%	-10,247,021	0.8%	-8,809,538	0.55%
Sensitivity case 6 (+5%)	-70,671,468	-3.5%	-260,845	4.9%	1,176,637	5.63%
Sensitivity case 7 (+10%)	-58,188,748	-1.7%	12,221,874	10.3%	13,659,357	13.03%

The impact of variation in revenues is significant. A variation of revenues of 1% leads to a change of 3.00% for the NPV/C (before community assistance). In order to mitigate this risk the approach outlined for the operating costs is to be considered.

Sensitivity analysis of the cash flow statement

For the sensitivity analysis of the cash flow statement, we considered the following scenarios:

· Increase of investment costs by 10% (compared with base case);

· Increase of operating costs by 5% (compared with base case);

· Decrease of revenues by 5% (compared with base case)

The main analyzed elements are the cumulated cash for the periods 2011-2020 and 2021-2040:

Cumulated cash flow	2011-2020	2021-2040
Amount	7.8	12.9
Sensitivity analysis	2011-2020	2021-2040
Base case	7.9	12.7
Sensitivity case 2	5.4	13.6
Sensitivity case 3	(1.4)	(1.7)
Sensitivity case 4	(2.0)	(3.3)

Financial analysis	FNPV/C variation	FRR/C variation	Sensitive (Yes/No)	
Project investment cost (increase of 1%)	-1.08%	-0.16%	Yes	Sensitive
Project investment cost (decrease of 1%)	1.08%	0.17%	Yes	Sensitive
O&M costs (increase of 1%)	-2.73%	-7.61%	Yes	Sensitive

O&M costs (decrease of 1%)	2.73%	7.37%	Yes	Sensitive
Revenues development (increase of 1%)	3.00%	8.08%	Yes	Sensitive
Revenues development (decrease of 1%)	-3.00%	-8.38%	Yes	Sensitive

All of the above mentioned variables are sensitive with significant impact on the cash position of the company. In order to mitigate these risks the following measures can be considered:

- Increase of investment costs: the Operator has the contingencies considered for this project in order to finance the unforeseen increases in the investment levels.
- Increase of O&M: The O&M costs are carefully managed by the Operator. Any significant increases in the costs elements will appear in a general economic context that will be correlated also with a higher increase in revenues of the households will allow the company to additionally increase the tariff within the affordability limits.
- Decrease of revenues: Any decrease in revenues will be determined by the decrease of consumption (mainly individual consumption) which will lead to additional tariff increases in order to reach the affordability limits.

Sensitive variables-financial analysis

The following table shows the sensitive variables for the results of the financial analysis:

Base Case	**NPV**	**ERR**
Basic formula	190,563,373	20.1%

Variation in investment costs	**NPV**	**ERR**
Base case	**202,286,788**	**20.7%**
Sensitivity case 2 (-1%)	203,935,790	21.0%
Sensitivity case 3 (-5%)	210,366,069	22.5%
Sensitivity case 4 (-10%)	218,031,029	24.5%
Sensitivity case 5 (+1%)	200,621,213	20.3%
Sensitivity case 6 (+5%)	193,793,184	19.1%
Sensitivity case 7 (+10%)	184,885,258	17.6%

Variation in CO2 emissions	**NPV**	**ERR**
Base case	**202,286,788**	**20.66%**

Sensitivity case 2 (-1%)	202,291,977	20.66%
Sensitivity case 3 (-5%)	202,312,736	20.66%
Sensitivity case 4 (-10%)	202,338,685	20.66%
Sensitivity case 5 (+1%)	202,281,598	20.66%
Sensitivity case 6 (+5%)	202,260,839	20.66%
Sensitivity case 7 (+10%)	202,234,890	20.66%

Variation of acces to drinking water benefit	**NPV**	**ERR**
Base case	**202,286,788**	**20.7%**
Sensitivity case 2 (-1%)	200,880,727	20.6%
Sensitivity case 3 (-5%)	195,256,486	20.2%
Sensitivity case 4 (-10%)	188,226,184	19.8%
Sensitivity case 5 (+1%)	203,692,848	20.7%
Sensitivity case 6 (+5%)	209,317,090	21.1%
Sensitivity case 7 (+10%)	216,347,392	21.5%

Variation of improvement of water bodies (use value)	**NPV**	**ERR**
Base case	**202,286,788**	**20.7%**
Sensitivity case 2 (-1%)	201,266,070	20.6%
Sensitivity case 3 (-5%)	197,183,199	20.4%
Sensitivity case 4 (-10%)	192,079,610	20.2%
Sensitivity case 5 (+1%)	203,307,505	20.7%
Sensitivity case 6 (+5%)	207,390,376	20.9%
Sensitivity case 7 (+10%)	212,493,965	21.2%

Variation in improvement of water bodies (non use value)	**NPV**	**ERR**
Base case	**202,286,788**	**20.660%**
Sensitivity case 2 (-1%)	202,283,752	20.660%
Sensitivity case 3 (-5%)	202,271,608	20.659%
Sensitivity case 4 (-10%)	202,256,429	20.658%

Sensitivity case 5 (+1%)	202,289,824	20.660%
Sensitivity case 6 (+5%)	202,301,967	20.661%
Sensitivity case 7 (+10%)	202,317,147	20.661%

Variation in cost saving to customers - private well	**NPV**	**ERR**
Base case	**202,286,788**	**20.66%**
Sensitivity case 2 (-1%)	202,260,221	20.66%
Sensitivity case 3 (-5%)	202,153,955	20.65%
Sensitivity case 4 (-10%)	202,021,122	20.64%
Sensitivity case 5 (+1%)	202,313,354	20.66%
Sensitivity case 6 (+5%)	202,419,621	20.67%
Sensitivity case 7 (+10%)	202,552,453	20.68%

Variation in cost saving to customers - sewage disposal	**NPV**	**ERR**
Base case	**202,286,788**	**20.7%**
Sensitivity case 2 (-1%)	201,651,419	20.6%
Sensitivity case 3 (-5%)	199,109,946	20.4%
Sensitivity case 4 (-10%)	195,933,105	20.2%
Sensitivity case 5 (+1%)	202,922,156	20.7%
Sensitivity case 6 (+5%)	205,463,629	20.9%
Sensitivity case 7 (+10%)	208,640,470	21.1%

Variation in cost saving to operator water abstraction	**NPV**	**ERR**
Base case	**202,286,788**	**20.660%**
Sensitivity case 2 (-1%)	202,284,048	20.660%
Sensitivity case 3 (-5%)	202,273,091	20.659%
Sensitivity case 4 (-	202,259,394	20.658%

10%)		
Sensitivity case 5 (+1%)	202,289,527	20.660%
Sensitivity case 6 (+5%)	202,300,484	20.661%
Sensitivity case 7 (+10%)	202,314,181	20.662%

Variation in cost saving to operator - energy consumption	**NPV**	**ERR**
Base case	**202,286,788**	**20.660%**
Sensitivity case 2 (-1%)	202,265,946	20.658%
Sensitivity case 3 (-5%)	202,182,579	20.653%
Sensitivity case 4 (-10%)	202,078,371	20.645%
Sensitivity case 5 (+1%)	202,307,629	20.661%
Sensitivity case 6 (+5%)	202,390,996	20.667%
Sensitivity case 7 (+10%)	202,495,204	20.674%

Variation in operating costs	**NPV**	**ERR**
Base case	**202,286,788**	**20.7%**
Sensitivity case 2 (-1%)	203,948,413	20.8%
Sensitivity case 3 (-5%)	210,594,916	21.4%
Sensitivity case 4 (-10%)	218,903,044	22.1%
Sensitivity case 5 (+1%)	200,625,162	20.5%
Sensitivity case 6 (+5%)	193,978,660	20.0%
Sensitivity case 7 (+10%)	185,670,532	19.3%

We considered a variable as being sensitive if 1% of its variation leads to at least 1% variation in the financial result indicator.

Sensitivity Analysis (3)

Sensitivity Analysis (3) shows the effects of the same variations for key parameters as outlined above on the "economic results" (NPV, EIRR and B/C).

The analysis is carried out for variations of +/- 1%; +/-5%; and +/-10% for the following **parameters**:

· Investment cost;

- CO_2 emissions;
- Access to drinking water benefit;
- Improvement of water bodies (use value);
- Improvement of water bodies (non-use value);
- Cost saving to customers - private well
- Cost saving to customers - sewage disposal;
- Cost saving to operator water abstraction;
- Cost saving to operator - energy consumption;
- Operating costs.

Sensitive variables-economic analysis

The following table shows the sensitive variables for the results of the economic analysis:

Economic analysis	ENPV variation	ERR variation	Sensitive (Yes/No)	Sensitive (Yes/No)
Variation in investment costs (increase of 1%)	-0.82%	-1.62%	No	Yes
Variation in investment costs (decrease of 1%)	0.82%	1.66%	No	Yes
Variation in CO_2 emissions (increase of 1%)	-0.003%	-0.002%	No	No
Variation in CO_2 emissions (decrease of 1%)	0.003%	0.002%	No	No
Variation of access to drinking water benefit (increase of 1%)	0.70%	0.42%	No	Yes
Variation of access to drinking water benefit (decrease of 1%)	-0.70%	-0.42%	No	Yes
Variation of improvement of water bodies (use value) (increase of 1%)	0.50%	0.24%	No	No
Variation of improvement of water bodies (use value) (decrease of 1%)	-0.50%	-0.24%	No	No
Variation in improvement of water bodies (non use value) (increase of 1%)	0.00%	0.00%	No	No
Variation in improvement of water bodies (non use value) (decrease of 1%)	0.00%	0.00%	No	No
Variation in cost saving to customers - private well (increase of 1%)	0.01%	0.01%	No	No
Variation in cost saving to customers - private well (decrease of 1%)	-0.01%	-0.01%	No	No
Variation in cost saving to customers - sewage disposal (increase of 1%)	0.31%	0.23%	No	No
Variation in cost saving to customers - sewage disposal (decrease of 1%)	-0.31%	-0.23%	No	No
Variation in cost saving to operator water abstraction (increase of 1%)	0.0014%	0.0008%	No	No
Variation in cost saving to operator water abstraction (decrease of 1%)	-0.0014%	-0.0008%	No	No

Variation in cost saving to operator - energy consumption (increase of 1%)	0.0103%	0.0070%	No	No
Variation in cost saving to operator - energy consumption (decrease of 1%)	- 0.0103%	- 0.0070%	No	No
Variation in operating costs (increase of 1%)	-0.82%	-0.69%	No	Yes
Variation in operating costs (decrease of 1%)	0.82%	0.69%	No	Yes

We considered a variable as being sensitive if 1% of its variation leads to at least 0.3% variation in the economic result indicator.

Switching Values for Critical Variables

The critical variables identified within the sensitivity analysis for the financial analysis are the following:

- Investment costs;
- Revenues;
- Operating and maintenance costs.

The critical variables identified within the sensitivity analysis for the economic analysis are the following:

- Investment costs;
- Operating and maintenance costs;
- Access to drinking water benefit;
- Improvement of water bodies (use value).

For these variables the switching values are presented in the following table:

Project investment cost	Maximum increase before NPV/C equals 0 (%)	-92.8%
Project investment cost	Maximum decrease before NPV/K equals 0 (%)	-63.6%
Project investment cost	Maximum increase before ENPV equals 0 (%)	244.1%
Revenue scenario	Maximum increase before NPV/C equals 0 (%)	33.3%
Revenue scenario	Maximum decrease before NPV/K equals 0 (%)	4.5%
O&M costs	Maximum increase before NPV/C equals 0 (%)	-36.6%
O&M costs	Maximum decrease before NPV/K equals 0 (%)	-5.0%

O&M costs	Maximum increase before ENPV equals 0 (%)	121.7%
Access to drinking water benefit	Maximum increase before ENPV equals 0 (%)	-143.9%
Improvement of water bodies (use value)	Maximum increase before ENPV equals 0 (%)	-198.2%

The most sensitive variables are the revenues and the operating and maintenance costs, as the switching values for these two variables regarding the NPV/K are below 5%.

Key parameters took into consideration when performing sensitivity analysis are: income from sales, operating costs (with all critical factors here as volatility, electricity price, working forces costs, etc) and the value of grant (EU non reimbursement funds).

The analysis performed shows that in order to transform VNAF/K from a negative value into a positive one, the income from sales should raise almost 4 times, which cannot be realized due to tariff constraints and volume of water/wastewater produced and distributed / collected.

3. CONCLUSIONS

Because practice proved that the risk is an inevitable phenomenon in the life of investment projects, the risk analysis has as a main objective the study of potential economic alternatives, of the achievement probability and the resulted effects. The fact the investor knows the possible unfavourable consequences guides his attitude towards the project, meaning that in order to reach the set objective, once the project is implemented he will have to also assume a certain risk level.

More than this, the risk and economical sensitivity analysis let us obtain, by implementing the project, some economical and social benefits bigger than the financial ones, which justifies the financing of the investment by non-reimbursable funds.

Choosing the key variables for performing a sound sensitivity analysis, will provide the beneficiary of the project the possibility to identify those sensitive aspects (issues) and to elaborate adequate tools for risk management (diminish all negative effects may occur during implementation and operation).

The main recommendation of this working paper is that, when performing a sensitivity analysis, in order to get the most adequate output, the following things should be very carefully assessed:

– Elaborate a matrix with all key aspects for the implementation of the project;
– Perform the prognosis in the most accurate possible way, in order to minimize the errors may occur in the preliminary results of the project (financial indicators);
– Update the analysis whenever necessary.

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