AN OVERVIEW OF COST BENEFIT ANALYSIS FOR WEEE RECYCLING PROJECTS

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ABSTRACT
This paper aims at providing the characteristics of a cost - benefit analysis (CBA) in the field of waste electric and electronic equipment (WEEE) in order to simplify the completion of this analysis for recycling projects. The paper is structured into three parts. The first part of the paper summarizes the history of the method and its usefulness for both private and public sector. The literature review offers an insight into the relevant past literature in the field of CBA showing the connections across multiple studies. The third part describes the steps and components of cost-benefit analysis in the field of WEEE by means of a formal analysis, emphasizing the essential aspects regarding the economic and financial evaluation of an investment project.

KEYWORDS: *cost – benefit analysis, investment, project, WEEE.*

JEL CLASSIFICATION: *Q50, Q53, Q56.*

1. INTRODUCTION

Cost-benefit analysis (CBA) is a formal analysis technique used in public and private investment projects (Rakhra, 1991) as well as in programs and policies (Stoica, 2005) in order to make a comparative assessment of all the benefits and costs anticipated. Moreover, it represents an attempt to measure the costs endured and gains earned by a community or a private company after the project is implemented.

CBA proves its usefulness in preparing feasibility studies (from an economic, environmental, social or technological perspective) for selecting the optimal alternative of investment projects (Hanley and Spash, 1993). It should not be confused with the analysis of the cost-income ratio, which allows selecting the optimal alternative for purely financial reasons.

This analysis technique is specific to the private sector, but it is also used in the public one (Sugden and Wiliams, 1978). The method has emerged in the nineteenth century in the United States of America. In 1808 Albert Galatin, secretary of the USA Treasury, proposed a method of analysis and assessment based on comparing the costs and benefits of financial and non-financial investment projects regarding the water transport (Bănacu, 2004; Dinu, 2011). Later, in 1844, the Frenchman Jules Dupuit, considered the intellectual father of benefit-cost analysis, highlighted the importance of the feasibility studies in public investment projects which should also contain a cost-benefit analysis (OECD, 2006).

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The CBA method began to demonstrate its practical utility in 1902 in the United States of America. In that period, the method was used in the economic analysis of irrigation projects (Fischer et al, 2007). Three decades later, the method has been substantially developed and has shown its importance in the projects for preventing and combating flooding (Dobes, 2008). In 1958, Otto Eckstein emphasized the usefulness of CBA in evaluating investment projects in the hydrological field. He correlated the use of CBA with economic welfare in the consumer society.
In 1960s the method began to be used in Great Britain in the transport sector contributing to building the M1 motorway and the Victoria Line on the London Underground (Barry, 2008).
Since the 1970s the method has been used in other projects, predominantly publicly funded (OECD, 2006). The majority of them were large-scale projects, such as nuclear power plants, refineries and chemical plants or infrastructure works, airports, tunnels (for example Channel Tunnel), highways or railways, but also small to medium projects such as ecological rehabilitation, integrated waste management, natural parks, activities or services with high environmental impact (Bănacu, 2004).
Over time, government bodies have introduced laws and regulations establishing the requirement of using cost-benefit analysis in the evaluation of public-funded projects (Fuguitt and Shanton, 1999). Since the 1970s, the European Union, the USA, Japan and Canada have passed laws stipulating that the impact analyzes of the environmental projects must use CBA techniques. Moreover, a lot of international institutions (World Bank, *International Bank for Reconstruction and Development,* European Bank for Reconstruction and Development) imposed the obligation to use CBA method in the investment projects financed by them. Therefore, CBA has been included in the methodologies for the preparation of feasibility studies (Ocineanu and Bucşă, 2013).
CBA has been used with good results in profit-making enterprises as well as in the comparison of public expenditure programs. However, the method is very complex both due to the future costs and benefits and the social benefits that are *difficult* to quantify in monetary terms (Dănulețiu, 2006). The purpose of using CBA in a sector is to set up pragmatic administrative rules in order to to *allocate resources efficiently*.

2. LITERATURE REVIEW

In the literature, CBA is perceived as a method of formal analysis of benefits and costs (Stoica, 2005) used in different fields such as construction, industry, transport, tourism or agriculture for evaluating the desirability of *investments projects* (Dreze and Stern, 1987) in *both* the *public* and the *private sector.* In the public sector it is associated with authorities' intervention and with the assessment of actions and programs undertaken at different points in the administrative system (Clinch, 2003). In the private one it is used for evaluating business investment projects.
The literature contains many definitions and clarifications regarding the use of CBA method.
A description of CBA has been made by Henley and Spash (1993) as well as Randall (1987). According to these authors, the purpose of CBA is to highlight that the sum of the impact effects is not greater than the net benefit of society. The net benefit of society is the sum of monetary and non-monetary benefits that result from the rational exploitation of the environment.
Furthermore, Bănacu (2004) defines cost-benefit as an economic ratio (economic efforts, costs), an environmental ratio (ecological effects - damage/improvement of the natural environment) and a social ratio (social effects regarding the creation or disappearance of jobs, protection of human health, improvement in living standards, benefits of education, training).
Other authors (Johansson, 1993; Quah and Toh, 2012) emphasize the contribution of this method in evaluating the impact of investment project depending on the estimated costs and benefits of each alternative. Moreover, Carpenter et al (2009) highlight its importance in selecting those projects and policies that ensure maximization of net benefit in the society. In this regard, the method

requires a standard *series of calculations* that will produce useful estimates in the field of study as well as pertinent assumptions (Cellini & Kee, 2010).
However, other authors consider that the method has several weaknesses because it does not always provide an objective analysis of costs and benefits. In addition, in some cases, there is no transparency regarding the selection of alternatives (Hahn & Sunstain, 2002; Ackerman et al, 2005). Moreover, CBA has been strongly criticized in the literature from several perspectives: the Kaldor and Hicks (potential) compensation test in welfare economics, the social welfare function, etc. (OECD, 2006; Jones and Kasamba, 2008).
Despite criticism about its limitations, some authors have recognized the advantages of using this method: it reduces the unequal distribution of information regarding the efficient allocation between citizens, politicians and bureaucrats; it provides a common database for all those involved in the decision making process, reducing information asymmetry (Florio, 1990; Schmid, 1998). Furthermore, one should not forget that its key role is to determine the best solution from all options identified (Wegner & Pascual, 2011).
According to Clinch (2003), the common unit of account used in this method is represented by money, regardless of the currency involved. All relevant factors should be quantifiable and measurable in monetary terms. This quantification allows the comparison of benefits and costs over a lengthy period of time and thus the choice of the optimal variant (Henrichson and Rinaldi, 2014).
Moreover, CBA allows users to know the results of each variant and to justify their decision by means of costs and benefits estimated (Shim and Siegel, 1989). The method may be extremely useful in large-scale investment projects, showing investor if it is better to spend money or save them (Linn, 2011).
The basic concepts of CBA are the costs and benefits (OECD, 2006) which are linked to people welfare (Clinch, 2003). On the one hand, the benefits tend to increase the welfare, and on the other hand, the costs determine a lower living standard income level. Moreover, in the public sector a policy or a program is advantageous if the social benefits outweigh the social costs (Gaman et al, 2013; MEDIATION, 2013).
Văcărel (2007) mentions the existence of several ways of classifying benefits and costs used in CBA. Therefore, one can distinguish between direct and indirect benefits and costs as well as between tangible and intangible benefits and costs within two boundaries: real benefits and costs (with physical quantification); pecuniary benefits and costs (value expression).
Furthermore, according to Richard Musgrave, in education programs, direct tangible benefit could be the increased future earnings of students while intangible indirect benefits should be the reduction of crime costs or the occurrence of a more informed electorate (Manole, 2011).

3. STEPS AND COMPONENTS OF COST-BENEFIT ANALYSIS FOR WEEE INVESTMENT PROJECTS

The use of cost-benefit analysis contributes to determining the financial sustainability as well as profitability of the WEEE project. The method also justifies its usefulness through the following aspects:

1. It highlights the economic and financial viability of the WEEE project;
2. It enables the identification of possible errors in the design or implementation phase (incorrect information, unrealistic hypotheses, etc.);
3. It enables the correction needed to properly conduct the WEEE project.

3.1. Investment description

The investor in the WEEE recycling projects should take into account that the waste represent a mixture of metals, plastics, glass or other materials. Most of them can be dismantled and recycled without creating serious environmental problems. However, certain pieces can be dangerous,

causing severe damage to the environment as well as problems related to labor protection not only during their use by consumers but also during the dismantling process.
WEEE is a complex mixture of hazardous and non-hazardous substances, and their management requires a specialized system for the collection, transport, treatment and final disposal. The improper disposal of WEEE (unapproved facilities, etc.) causes irreversible environmental pollution, especially if they are incinerated or stored without pretreatment operations.
The first step of the cost-benefit analysis involves identifying the activity in which resources (human, capital, etc.) are combined in order to achieve the objectives in a period of time. In other words, the investor should focus on the main objectives of the investment as well as on the predicted results after the project implementation. Setting the project objectives is essential for future steps, especially for the identification of scenarios (options).
The project should describe in detail the current situation in order to be understood by the experts-evaluators or by the implementation team. Moreover, the project should be the best option from all the options taken into account. It should also comply with the specific legislation in the field of WEEE and general law on public procurement, competition, etc.
In order to have a credible estimation of costs and benefits, it is essential to analyze the social, economic and institutional contexts in which the investment project in the field of WEEE will be developed and implemented. The assessment of macro-economic and social conditions of the area where the project will be implemented is also important because the project's economic performance is influenced by its environment characteristics.
After project identification, it is necessary to define the limits of the analysis. Certainly, the project has both direct effects on users, workers, investors, suppliers, etc. and indirect effects on third parties. The level of analysis should be closely related to the project size. Although there is no standard scale, the projects at certain levels may have similar effects. In general, waste management projects are usually (but not always) of local interest.

3.2. Options analysis

A CBA should focus on at least three options. The decision making process will take into account the possible options in each case and the type of investment. If the project falls within investment small scale (in terms of value) and it is not affected by variables with high uncertainty, the CBA could be simplified (for example, it may require only two choices instead of three).
The identification of project options in the field of WEEE requires taking into account many variables: location, capital expenditure, operating costs, pricing policies, etc. Their combination may lead to a large number of feasible options. However, not all feasible options are relevant for the decision making process. Therefore, it is necessary to limit to a few options deserving a detailed assessment (the analysis of all feasible options leads to unjustified waste of time and money).
All options should be consistent with the objectives of the project. It is not recommended to describe and analyze options that are feasible, but are not consistent with the requirements and objectives of the project.

3.3. Financial analysis

The financial analysis indicates whether the project will generate a positive net cash flow during the evaluation period (checking the profitability) and the cumulative cash flow from the start of investment till the final prediction is negative (checking the sustainability).
The analysis of the investment project’s cash flow includes both the evaluation of the cash outflows (investment costs as well as operating and maintenance costs of the WEEE factory) and cash inflows (income). Compared to the economic and social analysis, in the financial analysis the cash flows do not include amortization, reserves and other accounting items.
If the WEEE factory is built and operated by the same entity, the analysis is done from the operator’s point of view who will manage the investment objective. In other situations, it could be

necessary to separate the analysis on the different entities and then to consolidate the data in a final and inclusive analysis, taking into account that an entity's cash inflows could represent outflows for the other entity. This situation occurs when the infrastructure is developed by an entity and it is operated by another entity. Moreover, it is important that the financial viability of the project should be sustainable for all stakeholders.

The central objective of the financial analysis is to assess the financial performance of an investment in a WEEE factory during the reference period in order to determine the most appropriate funding of the investment. From this perspective, the financial analysis should take into account the following steps:

1. Estimating revenues and costs of the WEEE factory and assessing the implications of these parameters on cash flow;
2. Determining the funding gap in achieving the investment project and identifying the best mechanisms to attract funding;
3. Defining the financing sources of investment and analyzing the financial profitability.
4. Checking whether the estimated cash flow could ensure the proper operation of the WEEE factory. The investment project is financially sustainable if there is no risk of running out of cash during the operation.

From the perspective of investment projects financed from other sources than the investor's own capital, the financial analysis involves the following steps:

1. Making estimations for total capital commitment, including the initial investment costs as well as the maintenance and repair costs during the lifetime of the investment project.
2. Making estimations of the revenues from the investment project operation.
3. Calculating the financial performance indicators of the project (Financial Net Present Value and Financial Internal Rate of Return).
4. Identifying the funding sources.
5. Checking the project financial sustainability
6. Calculating the financial performance indicators of the project from the perspective of the personal capital/national contribution (Financial Net Present Value of Capital - FNPV (K) and Financial Internal Rate of Return of Capital - FIRR (K)).

The time horizon for which the financial estimations are made is called reference period. The predictions about the WEEE factory should be made for a period close to its economic lifetime, but long enough to cover the medium and long-term impact. The environmental protection and sustainable development project, including the investment in a WEEE factory, have an optimum reference period of 30 years.

The financial analysis carried out as part of a major project's CBA uses *market prices* (which include VAT and indirect taxes) in order to check the balance of the investment and the sustainability of the project.

The cash flows accumulated in different years during the evaluation period require a fair discount rate. The financial discount rate allows taking into account the influence of time factor on the value of money and it reflects the opportunity cost of the investor’s capital.

In general, it is recommended to use a discount rate of 5%, except when the average return expected should be greater than the recommended value due to the nature of investor (for example, to ensure an adequate return of the private capital in public-private partnership projects) or to the average return obtained in the specific field of activity.

The macroeconomic forecasts for some indicators such as inflation, unemployment, consumer price index, index of purchasing power, population dynamics, household consumption and other parameters influencing the operation of the WEEE factory are very important. Therefore, they should be taken into account when making the financial estimations during the evaluation period. In this case, it is recommended to use forecasts and official statistics relevant to the field of the investment objective.

The decision to invest is based on a comparison between cash outflows (costs) and cash inflows (benefits) generated by the investment project. In this regard, the costs represent a key variable included in the cash flow forecast.

CBA focuses on the future as well as on the financial projections required for the *setting* up and *operation* of the investment objective. Past experience is relevant only as a reference standard for estimating the future benefits and costs. In this context, the costs incurred in the past as well as the benefits obtained should not be taken into account in the CBA.

The investment costs represent the capital cost incurred for building up the investment objective. They include all expenses related to the purchase or production of tangible or intangible assets, as well as the initial investment in working capital, if required.

The initial costs of investment include the following components:

1. Fixed assets – has the largest share in the investment costs and represents the cash outflows arising from the acquisition of all tangible assets necessary for project implementation.

Setting up the WEEE factory requires investments in technological lines for treating the components and materials contained in the WEEE, costs for assembling the technological lines, cost of authorization to work etc. Other elements necessary for carrying out the activities are the equipment for handling the WEEE, such as moto forklifts, small cranes, mobile containers, etc., facilities for temporary storage of the WEEE which will be dismantled (containers, etc.) and also administrative spaces (offices, workshops, etc.).

2. The operating costs of installations, technologies and equipment (costs with acquiring the licenses and patents, costs with preliminary studies, technical studies and impact studies, feasibility studies and other preparatory studies, costs incurred in the implementation phase, consulting services, costs of hiring and training the staff involved in the implementation project etc.).

3. The initial investment in working capital (net current assets) represents the difference between the current assets (inventories, receivables) and current liabilities (short-term debts to suppliers, employees or other creditors) and it is important for the productive investment.

In conclusion, the estimation of the initial investment costs is done independent of the financing sources or the eligibility criteria for accessing them. It refers to economic and technical resources involved in the project investment.

3.4. Estimation of annual maintenance and operating costs as well as revenues

The operating costs of the investment project include all payments provided for purchasing goods and services which are not included in the investment costs.

The annual operation of a WEEE factory requires the following costs:

1. Staff costs – salaries and social contributions, overtime pay, training, hiring experts/ consultants in waste management etc.
2. Utility costs – electricity, gas, water and sewage, heating, telephone, internet access, web site maintenance etc.;
3. Maintenance and repair costs – maintenance of public spaces (access roads, signs, marks, parking, green spaces, etc.), maintenance of hazardous area, maintenance of technological lines, maintenance of equipment, maintenance of storage space, etc .;
4. Rental costs (if the space for the construction is rented);
5. Costs for repayment of loans, interest and fees (if necessary);
6. Other costs: information campaigns, participation in trade fairs, social responsibility projects, educational events in the field of WEEE etc.

The investment projects generate their own revenues from selling goods and services. The transfers or subsidies, VAT and other indirect taxes levied on the consumer/client are not included in the estimation of future income generated by the investment project.

The financial analysis takes into account the benefits of monetary nature (financial or operational benefits) that influence the cash flow. The investment in a WEEE factory could generate the following revenue categories:

1. Revenues from WEEE commercialization as second-hand products.
2. Revenue from commercialization of WEEE recoverable components.
3. Revenue from capitalization of ferrous metals contained in electronic products.
4. Revenues from the capitalization of non-ferrous metals (copper, aluminum, zinc and lead).
5. Revenues from the waste plastics recovered from WEEE.
6. Revenues from the waste glass recovered from WEEE.

3.5. The financial sustainability of the investment project

The investors' ability to manage the setting up and operation of the WEEE factory during the reference period is critical to the success of the investment and for achieving the objectives. From this perspective, the investment project should be financially sustainable without any difficulties regarding the fulfillment of its financial obligations during the reference period.

The financial sustainability involves having a cumulative positive cash flow for each year of the projections. Therefore, there should be enough cash for smooth running of operations every year (without the risk of lacking liquidity). Demonstrating the financial sustainability of the project makes it necessary to weigh cash inflows with cash outflows for the entire reference period of the project. After estimating costs and revenues, the discounted cash flows for costs and revenue throughout the reference period of the project are determined by using the discount rate.

In order to determine the profitability of the investment project, it is necessary to calculate the financial performance indicators, on one hand for the overall investment, and on the other hand for the capital invested. The financial performance indicators of the investment project are Financial Net Present Value (FNPV) and Financial Internal Rate of Return (FIRR).

FNPV represents the amount calculated when the estimated investments and operating costs of the project are deducted from the present value of the projected revenues. The investment project is profitable in the financial sense if FNPV has a positive value.

If FNPV has a negative value, it means that it has been calculated only for the lending period which is very short compared to the lifetime of the project. If this indicator was calculated over a longer period, it would be positive and would increase the firm's capital.

FIRR represents the discount rate for which FNPV is zero or which equals the present value of the financial cash flows projected for the reference period. If this indicator is less than the cost of the capital, the project is not profitable. When it is higher than the cost of capital, the project is acceptable because it will generate a positive FNPV.

The profitability indicators are calculated taking into account all the investment costs of the project, regardless of its sources of funding. If FNPV is positive and FIRR is higher than the discount rate, the project is profitable. If FNPV is negative and FIRR is lower than the discount rate, the project is not profitable and therefore it needs financial support (it could be eligible for European funding).

The profitability indicators of the invested capital are determined by taking into account only the capital invested by the investor. They show that the project is profitable if a part of the value invested is covered by grant and hence the pressure on project promoter decreases. If FNPV (K) is close to zero and FIRR (K) is close to the discount rate, it means that the percentage of grant funding is correct. If the indicators are below the level considered acceptable, it means that the project is not generating enough income and requires a higher percentage of grant funding. If the indicators exceed a certain limit, it means that the project rate of return is exaggerated and therefore it should be justified.

3.6. Economic and social analysis

The economic and social analysis measures the economic, social and environmental impact of the investment projects in the field of WEEE. According to the current legislative framework, the economic and social analysis is mandatory only for major investment projects. This analysis determines if the project contributes significantly to total economic welfare.

The economic analysis measures the project benefits depending on the following: the costs avoided due to project implementation and the external benefits arising from the implementation which are not included in the financial analysis.

In this analysis the benefits should be seen from the perspective of two key issues. First, the revenues identified in the financial analysis will be corrected by applying a conversion factor. This factor allows the conversion of the prices between the economic and the financial ones. Secondly, the attention should focus on the positive externalities arising from compliance with environmental standards. Moreover, these externalities should have a monetary equivalent.

In the economic cost-benefit analysis the costs are expressed in accounting prices. Moreover, compared to the financial costs, the economic costs of the project are measured in terms of 'resource' cost or 'opportunity' costs.

The achievement of project objectives may generate some environmental or health effects which should be evaluated and included in the project. These effects do not influence the project outcomes in the financial analysis, but they should be taken into account from social and economic perspective. In fact, the economic costs could be considered negative externalities, requiring their monetization within the economic analysis.

The economic analysis could be briefly described through the following steps:

- Conversion of market prices into accounting prices
- Monetization of non-market impacts
- Inclusion of additional indirect effects (only if needed)
- Update of the estimated costs and benefits
- Calculation of economic performance indicators (Economic Net Present Value, Economic Rate of Return, benefit/cost ratio).

In order to set the economic, social and environmental performance of the investment projects in the field of WEEE, it is essential to make corrections for both revenue and costs. The corrections to be taken into account in the economic analysis are the following:

- Fiscal corrections which are necessary because some transfers from one agent to another should be seen as pure transfers, without having an economic impact. For example, the subsidies provided by the government to the WEEE investors represent a pure transfer offering advantages to the beneficiaries, but not creating economic value.

  The fiscal corrections are made to indirect taxes (VAT), subsidies and pure transfer payments (employer's obligation to pay social security contributions) which are generally included in the eligible costs and/or operating or maintenance costs. However, the prices should also include direct taxes. In addition, if certain indirect taxes/subsidies are aimed at correcting externalities, then they will be included in the analysis.
- Corrections of the externalities which require taking into account the positive and negative impacts of the project.

The negative impacts should be included in the economic costs, while the positive ones in the benefits. The economic costs may arise during the construction (for example, the construction blocks the access to certain buildings, roads or do not allow citizens to conduct some activities) and during the lifetime of the project (construction may damage the natural environment). The benefits

could be also highlighted both during the construction of WEEE infrastructure (temporary jobs) and during the lifetime of the project (reduction of the amount of WEEE at local or regional level, etc., increase of land value due to the project, growth of small local businesses, etc.).
The prices used should reflect the economic value of the resources taken into account. The conversion of the project costs from market prices to economic prices involves the breakdown of costs into the following categories:

a. Commercialized products
b. Unsold products
c. Skilled workforce
d. Non-skilled workforce
e. Land acquisition
f. Financial transfers/payments transfer

An investment project in the field of WEEE could generate positive externalities as well as negative externalities depending on the activities set and the specific characteristics of the project.
A project could have many negative externalities that are not included in the opportunity costs. However, they should be taken into account in the economic analysis because they affect the environment (loss of landscape, reduction of land value due to noise and odor, or emissions growth produced by the activities within the project).

After identifying externalities, it is necessary to assign them a price in order to be included in the economic analysis. This situation could cause difficulties because the externalities do not have a fixed market price, making it necessary to use approximations. In general, it is recommended to take into account the externalities which could be monetized or estimated in the best way possible.
All the significant effects estimated in the investment project should be included in the economic analysis, where quantification is possible. The analysis should contain both the positive effects generated by the project and the negative ones.
In general, the projects have great impacts with or without major effects. The assessor or assessment team of the project demonstrates that many effects have been assessed and determines if they are important. If these effects (positive or negative) are important, a realistic monetary value will be assigned to them.

The proper conversion factors applied to the financial values of operating revenues should represent the most relevant non-commercial benefits generated by a project. If the conversion factors have not been correctly estimated or the project does not produce income, the alternative approaches may be used in order to assess the non-commercial benefits. One of the most commonly used method is "the willingness to pay", which enables to estimate a monetary value by taking into account the users' preferences (identified or declared). In other words, the consumer preferences are taken into consideration either indirectly by studying its behavior in a similar market or directly by administering ad hoc questionnaires (which is often less credible).
The capitalization of externalities could sometimes be difficult (especially their environmental impact), although they may be settled easily. For example, a project may cause environmental damage and its effects are difficult to quantify and to accurately measure. In such cases, an approach of "transfer of benefits" could be useful because it is applied to the project shadow prices that have been estimated in other contexts, for example for other projects or programs. If the transfer of benefits cannot be conducted due to lack of data, the environmental impact should be determined at least in physical terms. This would make possible a qualitative assessment in order to provide decision-makers more elements for the final decision.

3.7. Update of the estimated costs and benefits

Clearly, the comparison of costs and benefits should be performed after their update and monetary quantification. The costs and benefits are updated with the discount rate used in all projects.
An investment project is viable if its benefits outweigh the costs. In other words, the present value of the project economic benefits should exceed the present value of the project economic costs. In practice, it means a positive ENPV (Economic Net Present Value), a benefits/costs ratio higher than 1 and an ERR (Economic Rate of Return) exceeding the discount rate used to calculate the ENPV.
The calculation of the project's economic performance could be carried out by using the following indicators (for the entire value of the project): the economic net present value (ENPV), the economic rate of return (ERR); the benefit/cost ratio (B/C).

3.8. Risk and sensitivity analysis

The purpose of this analysis is to determine the uncertainty in the investment projects implementation in the field of WEEE. Moreover, this analysis assesses the sustainability of performance indicators used in the project. In this analysis, the performance indicators taken into account are the following: *FRR/C Financial Rate* of *Return* on *Investment* and FNPV (Financial Net Present Value) for the financial analysis, ERR (Economic Rate of Return) and ENPV (Economic Net Present Value) for the economic analysis as well as cumulative cash flows (both on project and operator).
The sensitivity analysis is the first step in analyzing an investment project in an uncertain environment. It takes into account all the variables that influence a project and that should be taken into account by all entities (beneficiaries, donors, target groups). This analysis technique determines whether the project results (quantified via the change of NPV or ERR indicators) are sensitive to the change of any input variables in the model.
The sensitivity analysis helps to determine *the critical variables of the model*. The variables are positive or negative variations, with the greatest impact on the financial and/or economic performance of a project. The analysis is based on one element which varies over time and determines the change of ERR or NPV.
Setting the critical variables allows the beneficiary to identify the sensitive aspects of the project and to develop appropriate instruments for risk management (reducing all the negative effects that could arise during project implementation and operation).
The risk analysis determines the effects of risk occurrence and measures their impact on the entire investment project. It involves assigning probability distributions for each identified risk in order to determine the size of the impact.
The risk analysis consists of several steps in order to determine the risk associated with an investment in the field of WEEE: identifying the risk factors, estimating the possible deviations and identifying the measures for controlling them, implementing measures, reassessing the situation.
Each step requires a specific approach as well as different operations and responsibilities depending on type of project, size of the organization, national legal framework and risk management methodology chosen.
Investment projects in the field of WEEE involve many risks as follows:

- Changes in the construction costs due to price changes for raw materials, workforce, services purchased on the market in order to implement the investment and ensure proper operating conditions;
- Changes in operating costs due to price changes for raw materials or unexpected technical factors;
- Occurrence of natural disasters (earthquakes, floods, etc.).
- Changes in technical factors leading to technology replacement (with newer and potentially more costly mechanism);
- Changes in legislation an in the technical policy for the prevention of pollution from waste electrical and electronic products.

4. CONCLUSIONS

The purpose of CBA is to demonstrate that the project is desirable from economic and social perspective and it contributes to achieving the objectives of the investors.
In general, CBA conclusions should be described in a document having some required sections (the investments project and the beneficiaries; the description of options and costs involved, the financial analysis; the economic and social analysis; the risk and sensitivity analysis).
The extensive use of CBA could not provide the best results for all investment projects in the field of WEEE. Therefore, in these cases it is recommended to replace it with other techniques enabling an appropriate decision making for project funding.
Although cost-benefit analysis for investments in WEEE recycling follows the same methodology as any type of project, the difference is mainly in the categories of income and expenditure considered, as well as risk factors.

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