COST-BENEFIT ANALYSIS (CBA) - KEY FACTOR IN EVALUATION OF INVESTMENT PROJECTS

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Abstract

In Romania, at present, at the level of the real economy, more and more complex investments are needed to reduce the gap with the EU member states in terms of the degree of development. Given that the investment decision is the basis of any development strategy of a company, the economic growth and well-being of domestic companies depend to a large extent on capital, infrastructure, human resources, technical knowledge and productivity. All these elements imply, to a certain extent, the decision to spend now, in the hope of future benefits, relying on a future, sometimes distant and uncertain. Thus, in the process of substantiating the investment decision, the cost-benefit analysis (CBA) has the role to facilitate the efficient use of company resources, being a quantitative method of estimating the need and opportunity of an investment project, providing multiple information on economic and financial activity, at both the micro and macroeconomic levels.

Keywords: cost-benefit analysis, investment project, investment decision, net present value, internal rate of return

JEL Classification: D24, D25, G32

1. General aspects of cost-benefit analysis (CBA)

Cost-Benefit Analysis (CBA) is a complex tool used in the evaluation of investment projects, to identify and evaluate the effects of these investment projects on the business as a whole, as well as their contribution to increasing the economic and financial performance

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of the business. Any cost-benefit analysis involves adding up the benefits of a management decision or strategy and comparing the benefits with the associated costs.

A cost-benefit analysis can be used to:

- ✓ determine whether an investment is sound, whether the benefits outweigh the costs and, if so, how much.
- ✓ compare the total costs with the total expected benefits.
- ✓ estimate the time required to realize the benefits of the investment.

The purpose of the cost-benefit analysis is to identify the efficiency of the allocation of financial resources, both on each investment project and at the company level. Thus, in practice, the CBA is a tool of economic-financial analysis necessary for the evaluation of the financial and non-financial information, available, regarding the investment projects initiated by the company and which provide a series of answers as clear as possible to a series of questions, being useful to the company's management in substantiating the investment decision:

- ✓ Is it necessary to invest?
- ✓ Is it appropriate to invest?
- ✓ Is it efficient to invest?
- ✓ which of the options for implementing the investment decision is the most efficient from an economic, financial and social point of view?
- ✓ What are the sources of financing of the investment project?

From a practical point of view, a detailed description of the cost-benefit analysis was made by Randall (1987) and Henley & Spash (1993) who showed that the purpose of the CBA is to determine whether the sum of the effects of an investment is greater than the company's net profit of the company, which represents the sum of the financial and non-financial benefits given by a rational operation. CBA differs from a simple financial assessment where all gains (benefits) and losses (costs) are taken into account. CBA proves its usefulness in drawing up feasibility studies for choosing the optimal variant from the economic, social and technological point of view of investment projects. It should not be confused, however, with the cost-income analysis (LCA), which allows the choice of the optimal project option for purely economic reasons. It is true that in both cases a series of common indicators are used such as: Internal Rate of Return - IRR, Net Present Value - NPV, Cost-To-Value Ratio - RVC, Cash-flow - CF. What differentiates the two methods of analysis is the fact that CBA versus LCA also takes into account non-financial elements, not only financial elements, conducting a much broader and more complex study.

2. Structure of the cost-benefit analysis model (CBA)

CBA's role is to facilitate a more efficient distribution of the company's resources, being a quantitative method of estimating the need and opportunity of an investment project based on the calculation of the ratio between future benefits and costs. The CBA also provides multiple information on economic and financial activity at both micro and macroeconomic levels. The CBA is also developed to estimate the socio-economic impact of the investment project, by identifying and quantifying the monetary effects of both financial and non-financial investment.

Cost-benefit analysis, sometimes called cost minimization analysis, is essential to determine if we need to promote a new project. There are six steps to a successful cost-based analysis:

Step 1: Calculation of the cost of maintaining the current status

This step helps to:

- ✓ Calculate the potential costs of doing nothing and determine whether it is feasible to start a new project or not. Sometimes doing nothing is better that any other action. On the other hand, doing nothing can lead to significant losses
- ✓ Build the structure of the analysis: involves analyzing the current situation of change and determining all options for action
- ✓ identify the potential stakeholders: Detects who will be affected by the change, who will bear the costs and who will reap the benefits.

Step 2: Costs identification.

Identify the costs associated with the project and which may have a significant impact such as:

- ✓ Upfront/Unexpected costs
- ✓ Tangible/Intangible costs
- ✓ Ongoing/Future costs
- ✓ Cost of any potential risks

All these potential costs of each project have to be compared to all expected benefits.

Step 3: Benefits Identification.

In this step, the potential benefits resulting from the implementation of the project are determined. the following questions will be answered:

- ✓ What additional income will come from the investment?
- ✓ What will be the return on investment?
- ✓ What is the time horizon for long-term benefits? The higher it is, the more uncertain the potential benefits.

Step 4: Calculating the value of costs and benefits.

All costs and benefits must be calculated in the same currency unit. The monetization of costs includes the cost of human resources (How many employees does it take to complete the project?, Will staff be hired?, What equipment is needed?, Does existing equipment need to be replaced?, Will professional training be required?)

Monetizing benefits may not be as easy as costing, as accurately predicting revenue can be difficult (the value of intangible benefits, such as maintaining employee satisfaction, ensuring employee health and safety, or strengthening the company's market position).

Step 5: Creation of a timeline for expected costs and revenue. The timeline is used to align, define, and track the expectations of all interested parties. In addition, the timeline can help plan for upcoming costs and revenue impacts, which will let companies manage and adjust as necessary as things change.

Step 6: Cost-benefit comparison:

Calculation of total costs and total benefits according to the plans made. Comparing the two values will determine if the benefits outweigh the costs. Use the NPV to adjust future cash flows and costs, performing sensitivity analysis, evaluation of results.

The following issues need to be considered when comparing costs and benefits: inflation, opportunity cost, discount rate, investment recovery period, etc.

$$Payback\ time = Total\ cost / Revenue(benefits)$$

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The phased structure of the CBA according to the provisions of the European Commission (Directorate General for Regional Policy) for investment projects financed from European funds, is presented schematically in Figure 1:

1. Analysis of the general context of the project	• identifying the investment objectives as well as the scenarios that will be analyzed; • identifying and classifying the costs and benefits of each analyzed project variant; • identification of funding sources;
2. Financial analysis	• if the NPV> 0 project does not require additional financial support; • if NPV <0 the project requires additional financial support (move to the next stage);
3. Economic analysis	• fiscal corrections are made, externalities are evaluated and market prices are transformed into shadow prices; • if NPV> 0 the company does not need investments; • if NPV <0 the company needs investments (move to the next stage);
4. Sensitivity analysis	• identification of critical variables and potential impact on changes in financial and economic performance indicators;
5. Analysis of risk factors	• the probable risks associated with each project variant can be expressed as an estimated average and standard deviation of the performance indicators;
6. Presentation of results	• comparison of scenarios (project variants); • recommendation of the optimal technical and economic scenario; • justification for choosing the recommended scenario;

Figure 1: The structure of the CBA for investment projects financed from European funds

In general, the CBA involves the following steps:

A. Economic-financial analysis. The objective of this analysis is to determine the financial performance of the project during the reference period, in order to identify the most appropriate sources of funding for it. This analysis consists mainly in calculating the interpretation of the value of performance indicators based on the flows of cumulative discounted net cash (derived from total investment costs, total operating costs and total revenue for the analysis period).

The indicators used, in general, in the economic-financial analysis are:

Financial profitability of investment costs determined using indicators:

✓ *Net Present Value (NPV).* Represents the difference between the sum of all financial benefits (marginal income and savings / reductions in financial costs) and financial costs (investment and operating costs). If NPV <0, it means that the project needs additional funding. In other words, the project is not financially viable, if it will not have income, will have financial losses. In this case, the decision on the financing of the project will be made on the basis of economic analysis.

- ✓ *Internal Rate of Return (IRR).* Represents the financial discount rate for which NPV = 0. If the IRR has a lower value than expected by the company, it means that the project needs funding. As in the case of the NPV, the project is not financially viable, and the decision on the financing of the project will be made on the basis of indicators from the economic analysis.
- ✓ *Discounted benefits ratio, discounted costs (RBC).* If RBC <1, the conclusions are the same as for VNA and IRR. It should be noted that this indicator alone is not useful in analyzing the financial performance of an investment project. It is only used in conjunction with previous indicators.

Financial sustainability of the investigation project. The essential problem is an application of the evolution of cash flow, in care, during the analysis of the project, the financial resources will cover the annual costs. Thus, a project is financially sustainable when its operation does not involve the risk of negative cash flows. In other words, an investigation project is sustainable if the net cash flow accumulated in receipts and payments is positive. From this point of view, it is very important to correlate the time receipts (income or any other type of number entries / transfers) with the payments (payment obligations to suppliers, employees, creditors, state, etc.). Their level depends. on one hand, on the level of income / expenses, and on the other hand on the terms of collection / payment negotiated with customers / suppliers. As a methodology to be followed, after estimating costs and revenues, the updated flows of costs and revenues over the entire project reference period are determined. Sustainability occurs if it can be demonstrated that the project generates a positive cumulative net cash flow for each year for financial projects.

It should be mentioned that the sustainability analysis also includes cash inflows generated by contracting financing sources, respectively cash outflows resulting from project financing (loan repayments and interest payments). From the perspective of the difference between cost / income and cash flow, only the interest paid for the use of borrowed capital constitutes costs, while repayments do not represent costs, but cash outflows that decrease the total cash flow for the year.

The financial analysis offers an optimal alternative solution with the lowest discounted cost per unit of discounted benefit obtained. It can be applied if it has an impact, to different project variants, it is the same. If differences are identified between the impact of the different project variants, the financial analysis can no longer capture these elements and the process must be continued in the economic analysis, in order to capture all the identified externalities. If some of the benefits generated by the project cannot be quantified in monetary terms and factors that have the project are needed, it is necessary to convert them into numerical values. Only after this monetary quantification of the positive or negative impact on costs / benefits, a final hierarchy of project variants can be achieved.

Thus, while *the financial analysis* aims to determine the need for financing and the need for financing, *the economic analysis* is what justifies the decision of investors to co-finance the project or not. Economic performance indicators are also interpreted in the same way as financial performance indicators, except that:

- ✓ market prices are converted into shadow prices, which better reflect the opportunity cost of goods and services.
- ✓ externalities are taken into account and given a monetary value.
- ✓ costs and benefits are discounted at a real discount rate.

B. Sensitivity analysis is the first step in the analysis of a project carried out in an uncertain environment, because it takes into account all the variables that can affect a project and that must be taken into account by all parties involved (beneficiaries, financiers). In essence, the purpose of the sensitivity analysis is to determine the extent to which the project results are sensitive to the change of one of the input variables in the model. Thus, the evaluation of project variants must also include the determination of the degree of uncertainty regarding the implementation period of investment projects. The sensitivity analysis consists in identifying the critical variables and their potential impact on the change of the economic-financial performance indicators.

Identification of critical variables is done by changing the percentage of a set of investment variables and then calculating the value of economic and financial performance indicators. For example, if a project variable that increases or decreases by 1% produces a change of more than 5% (range of elasticity) of the NPV, it will be considered critical.

Here are some examples of critical variables:

- ✓ Price dynamics: inflation rate, wage growth rate, utility price, variation of prices of goods and services, etc.
- ✓ Data on demand: specific consumption, demand formation, etc.
- ✓ Investment costs: construction duration, hourly labor cost, hourly labor productivity, etc.
- ✓ Operating costs: prices of goods and services used, hourly rate of staff, price of utilities, etc.

Quantitative parameters regarding operating costs: specific energy consumption and other goods and services, number of employees, etc.

- ✓ Quantitative parameters regarding revenues: volume of services provided, productivity, number of users, market share, etc.
- ✓ Accounting prices (costs and benefits): factors for converting market prices, the cost of avoided delays, shadow-accounting prices (shadow prices) of goods and services, valuation of externalities, etc.

Elimination of deterministic dependence between variables. Deterministically dependent variables will distort the results. In this case, it is necessary to eliminate redundant variables, by choosing the most significant variables. The variables taken into account must be, as far as possible, independent variables.

The analysis of elasticity is performed sequentially, determining the impact of the variation of each critical variable on the financial indicators. By repeated point determinations on intervals of variation +/- x% thus, the elasticity curves of each analyzed variable can be drawn. For significant variables, their impact elasticities (high, intermediate, low) can be evaluated.

C. Analysis of risk factors. In general, risk is defined as the probability that a negative effect or event will occur, which indicates that an economic action may generate losses, in particular due to incomplete information or inconsistent reasoning when making the investment decision. In this case, risk management focuses on eliminating the negative aspects introduced by the probability of risks, and the analysis will study, in particular, the possible threats that may affect the profitability of investment projects in the future.

Investment projects are subject to various forms of risk, which may have an impact on expected performance. Exogenous as well as endogenous factors specific to the operational and functional structure of the company may have a different manifestation over time than initially anticipated and, thus, the greater the observed deviations, the greater the risk that the project will not ensure the expected efficiency.

Thus, during the CBA a series of risk categories may appear, such as:

- ✓ incorrect estimation of project results (too low costs, too high benefits, discount rate and unrealistic deadlines).
- ✓ project-specific risks (unforeseen price increases, incorrectly executed works, additional costs not foreseen in the project estimate).

The results of the risk analysis can be expressed as an estimated average or standard deviation of the economic-financial performance indicators.

Here are some examples of risk reduction recommendations:

- ✓ analyzing the project stages (design, execution, operation)
- ✓ analyzing the evolution of prices and markets for each good, service or work
- ✓ collecting historical data from several suppliers and from several markets
- ✓ inclusion of insurance premiums for certain transferable risk categories
- ✓ training of the personnel responsible for the operation and maintenance of the equipment, etc.

Finally, the CBA will provide an analysis of the results obtained, regarding:

- ✓ comparison of the proposed scenarios, from a technical, economic, financial, sustainability and risk point of view.
- ✓ selection and justification of the optimal recommended scenario, with argumentation based on the criteria / indicators used in the analysis process.
- ✓ description of the optimal recommended scenario, correlated with the qualitative, technical and performance level resulting from the proposed technical-economic indicators.

- ✓ the efficiency and feasibility of the recommended optimal scenario, in the conditions of reimbursable / non-reimbursable financing related to the investment expenses.
- ✓ social and economic benefits obtained as a result of the project.

3. Indicators used in cost-benefit analysis (CBA)

The analysis of the viability of an investment project is currently performed by analyzing the economic-financial indicators related to the investment objective. It is important to mention that if the technical-economic indicators that are the object of the economic-financial analysis, register an exceeding of the variation intervals in which they can fall, it is necessary to restore the technical-economic documentation and resume the procedure of approving the new indicators and variation intervals.

Thus, the most used indicators in CBA, according to the specialists, are: the cash flow generated by the project (CF), the net present value (NPV), the internal rate of return (IRR) and cost-benefit ratio (CBR).

Net present value (NPV) is the first criterion for assessing attractiveness in order to formulate the investment decision. Defined in the cash flow ratio, the NPV compares the sum of the current cash flow values released during the useful life of the investment and the total cost generated by the investment, expressed in current value.

$$VAN = -\sum VA(I_h) + \sum VA(CF_h)$$

- ✓ If NPV> 0 the respective project is the closest to the idea of maximum profit desired by investors, being the measure of its contribution to the economic value of the company.
- ✓ If NPV = 0 does not mean, however, that the project is not profitable; it produces profit only for the recovery of invested capital.
- ✓ If NPV <0, it is unacceptable, because the rate of return is lower than the discount rate used in NPV calculations that fulfills the role of criterion for testing the efficiency (return) of an investment.

NPV is a tool for evaluating the investment decision, based on the idea that the goal is to increase the value of the company and the wealth of shareholders. So projects that are characterized by maximum NPV are preferred. Therefore, only projects characterized by NPV> 0 are accepted as profitable. In economic and financial terms, a positive NPV investment means that it has the capacity to repay during the economic life the invested capital, respectively that it has an overall return, of the initial capital at least equal to the discount rate used in the calculations, and of to produce excess cash flow. The higher the NPV, the higher the return and the more attractive the investment. The most efficient and opportune investment project is the one that ensures a maximum surplus between ∑VA (CFh) and ∑VA (Ih) (figure 2).

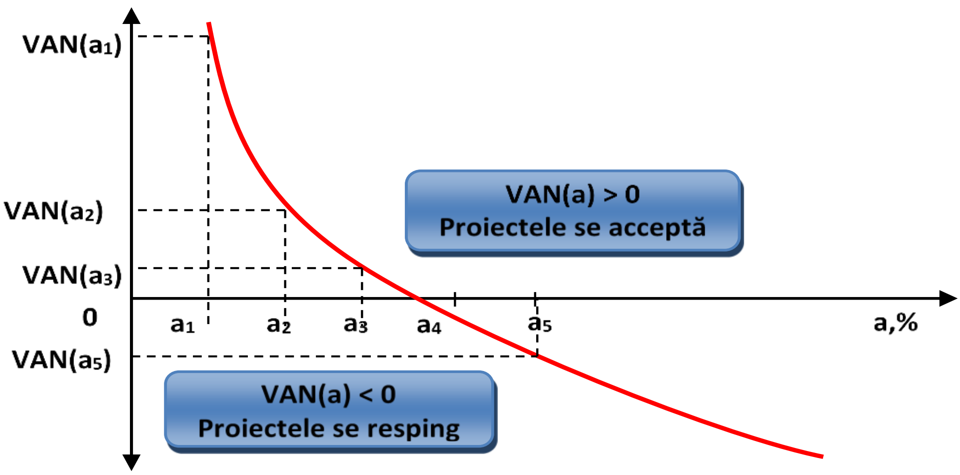

Figure 2. Graphical representation of NPV (decreasing hyperbolic function)

The profitability index (γ) characterizes the level of the ratio between the NPV and the investment funds that generate the NPV. This indicator completes the efficiency analysis in relative terms, in the form of the relative net advantage per unit of investment cost measurement.

$$\gamma_1 = \frac{NPV}{I_t} \times 100$$

$$\gamma_2 = \frac{NPV}{VA(I_t)} \times 100$$

To express the ratio (γ) as an index (coefficient), the relation is used:

$$\gamma_3 = \frac{VA(\sum CF_h)}{VA(I_t)} = 1 + \frac{NPV}{VA(I_t)} = 1 + \gamma_2$$

The profitability index allows the selection of efficient investment projects, being acceptable those projects where γ3> 1 and their ordering according to the decreasing value of the index γ. For projects where γ3 = 1, the NPV will be zero (NPV = 0). The higher the γ3 index, the more efficient the projects.

The optimal design variant is the one that meets the criteria γ2 and γ3 maximum. Of the projects with NPV> 0, however, only the one with γ2> It is accepted, respectively NPV (Pj)> i and It and γ3> 1 + a. If the projects are incompatible, the decision after the maximum γ is different from the decision after the maximum NPV. The maximum criterion γ will lead to the choice of the project that requires lower investment costs, compared to those selected after the maximum NPV (Pj).

The profitability index (γ1), ordering the efficient projects, allows the elaboration of the most advantageous investment strategy, taking into account the limits of the funds available for financing the investments, using as a criterion of maximum NPV optimization.

The internal rate of return (**IRR**) is the discount rate (a), which equates the sum of the present value of cash flows with the sum of the present value of investment costs, so that the net present value is zero, that is:

$$\sum CF_h\left(1+a_j\right)^{-h}=\sum I_h\left(1+a_j\right)^{-h}$$

IRR is determined when the NPV tends to become equal to 0. Therefore, the IRR represents the discount limit rate, for which the realization of NPV is canceled: NPV (a = IRR) = 0

In the NPV coordinate system and the discount rate (a), the position, and the moment when the IRR value is obtained are observed in figure 3:

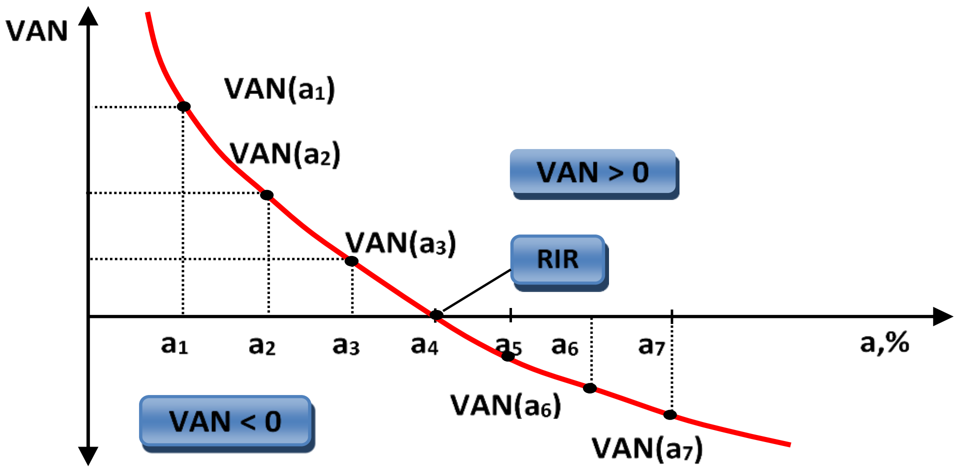

Figure 3. Determining the IRR value

On the NPV curve, IRR is a particular point, when NPV = 0, and intersects the abscissa. The IRR level is reached when NPV (a) = 0 and IRR = a. From an economic point of view, if IRR = a, the project generates a cash flow equal to the invested capital and during the economic life ensures an annual return of% of the capital, not yet depreciated, existing at the beginning of each year.

If a> IRR, the investment ceases to be efficient, because VA (It) becomes larger than the volume ∑VA (CFh) and NPV will have a negative value (NPV <0).

If a <IRR, the NPV is positive and therefore the investment project becomes acceptable.

It results that the establishment of IRR derives directly from the NPV calculation, but, this time, the desired quantity is not NPV, but IRR and its level is identified by successive tests, there being no direct calculation relationship for IRR. Analytically, to determine the IRR, we start from the equality:

$$\sum CF_h(1+IRR)^{-h}=\sum I_h(1+IRR)^{-h}$$

In order to determine the IRR, proceed as follows: the NPV is calculated at different discount rates, chosen at random. From time to time we come to determine what is the discount rate that leads to the cancellation of the NPV. Finally, to specify the IRR, the relation is used:

$$\mathrm{IRR} = \mathrm{a_{min}} + (\mathrm{a_{max}} - \mathrm{a_{min}})\frac{NPV_{amin}}{NPV_{amin} - NPV_{amax}}$$

a_{min} = is the lower discount rate leading to NPV> 0, but very low in absolute value, located immediately above the abscissa in the NPV chart (a);

a_{max} = is the higher discount rate used in the calculations and which leads to NPV <0, low in absolute value, located immediately below the abscissa in the NPV chart (a).

IRR has the function of a fundamental criterion for accepting / rejecting investment projects and formulating the investment decision. For alternative investment projects that are characterized by close NANs, approximately equal, priority is given to the project with maximum IRR.

In using IRR as a selection criterion, we will take into account the following requirements:

- ✓ projects with IRR calculated higher than as IRRdat, desired are accepted.
- ✓ if the projects are independent, the one that IRR (Pj)> a, and NPV (Pj, a)> 0 is accepted.
- ✓ if the IRR is equal to the discount rate (IRRdat = a), then the choice after IRR and after NPV leads to the same option.

IRR allows us to compare investment alternatives, taking into account the timing of the investment, cash flow and profit. It does not involve setting the discount rate in advance as the NPV calculation implies. On the contrary, by first calculating the IRR, we can have a benchmark in the stability of the size of the discount rate of the financial flows of the project. But the IRR does not take into account the magnitude of the investment effort, it does not directly meet the criterion of maximizing the value of companies. At identical investment efforts (Iti = constant), the optimal option is the one that has maximum IRR, but IRR generally has the advantage of choosing projects characterized by small efforts, short execution times, very profitable and can reject projects or variants that require large funds, but it also provides high NPV. If the investment projects are incompatible, priority will be given to the project with maximum NPV and the maximum IRR is not taken into account, but the condition is that the IRR for the chosen project is higher than the cost of financing the project.

The updated cost/benefit ratio (CBR) represents the fundamental concept of the economic-financial evaluation of investments. Measuring efficiency in investment projects is based on comparing economic benefits with the volume of necessary investment and operating costs taking into account the economic influence of the time factor.

The different methods of comparing the benefits with the costs aim at establishing the connection between these parameters which is very important for measuring the efficiency but also from the point of view of knowing the possibilities to ensure the necessary funds for financing. CBR is usually based on the evaluation of the report:

$$\mathrm{CBR} = \frac{\sum \mathrm{VA}(\mathrm{CF_h})}{\sum \mathrm{VA}(\mathrm{It_h} + CE_h)} = \frac{\sum \mathrm{VA}_{BT}}{\sum \mathrm{VA}_{CT}}$$

If CBR = 1 the investment produces neither advantages nor losses.

- ✓ If CBR < 1 the investment produces losses, the costs are not recovered, which leads us to the conclusion that that project is inefficient and must be rejected.
- ✓ If CBR > 1 the project is acceptable, and the investment efficiency analysis can be continued.

Given that the CBR analysis refers to a long-time horizon, that CFh and CTh are predicted values, in order to counteract the possible deformations of the CBR due to the decrease of sales, the decrease of the sale price or the increase of operating costs in the future, it is necessary k> 1. It should be emphasized, however, that CBR is sensitive to the size of discount rates and that is why it is very important to choose the discount rate in order to avoid accepting inefficient projects or rejecting profitable projects.

Between the size of the discount rate and the value of CBR and NPV, on the other hand, the following relationships are established:

- ✓ The smaller the discount rate, the higher the value of CBR and NPV. For a = 0, VABT = CFt = ∑CFh, VACT = It + ∑CEh, and CBR and NPV take maximum values.
- ✓ As the size of the discount rate increases, CBR and NPV decrease; CBR can even become subunit, and NPV takes negative values.

These conclusions regarding the sensitivity of CBR and NPV to the size of the discount rate are useful in substantiating investment decisions. The use of a discount rate that is too small or too high, not correlated with the profitability of the activity, with the interest rate of the borrowed funds for financing the investments, can lead to unjustified or erroneous decisions.

The use of CBR in formulating options corresponds to the desire to maximize revenue per unit of costs. Such a criterion is tempting to use because it is easy to perceive and highlights the effective alternative, but it does not work properly in all cases. This indicator is often established as the most efficient variant with low values of the parameters VA (CFt) and VA (CTt), which correspond to common design solutions such as economic and qualitative performance, but cheap, which require low costs. At other times, the option identified as efficient involves very high costs and does not take into account the restrictions imposed by the financing possibilities.

4. Conclusions

Considering the above, we can conclude the following aspects regarding the cost-benefit analysis regarding the limits and benefits of this type of analysis.

Cost-Benefit Analysis (CBA) limits:

- ✓ focuses mainly on costs and benefits and less on the project objectives.

- ✓ may generate erroneous conclusions due to insufficient information and statistical data
- ✓ the use of CBA implies the existence of a fairly applied expertise
- ✓ the risk of manipulation, in the case of long-term projects with intangible qualitative benefits.

Cost-Benefit Analysis (CBA) benefits:

- ✓ allows to express an opinion on the economic and social value of the project.
- ✓ allows the hierarchy of projects.
- ✓ encourages the practice of identifying economic benefits and costs, even if they are not immediately quantifiable financially.

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