PROJECT COST-BENEFIT ANALYSIS: AN IMPROVEMENT TO CONSTRUCTION PROJECT MANAGEMENT PROCESS

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Abstract

In perspective, the importance of attention to application of financial analysis results in the project management process of project financing, improving its quality, and economic interpretation of the analytical indicators, is growing.

Analysis of the progress of financial volume of concluded contracts over 2010, separated by dimension codes, reveals that the greatest progress belongs to the field of construction, where contracts for 374.4 million euro were concluded in 2010.

The purpose of the article is to analyze construction and infrastructure projects submitted for financing from the European Union structural fund resources, their cost-benefit analysis (CBA), and to assess the financial, social and economic indicators planned in the project submission against the actual post-project implementation indicators of the project life cycle.

During the analysis of project applications submitted by municipalities, the authors carried out an in-depth assessment and recalculation of the CBA of infrastructure projects. The analysis was based on a comparison of the indicators initially defined in the project submittal and the actual situation following the implementation of the project.

Introduction

The structural funds of the European Union envisage a total of 4.53 billion euro for Latvia in the planning period of 2007-2013, for the financing of various types of projects [1].

The EU structural funds are financial tools created in the European Union for the purpose of mitigating the differences in development levels of various regions. The objective of the structural funds is to use long-term financing to even out both the social and economic inequality among the EU member countries.

The purpose of the article is to analyze infrastructure projects submitted for financing from the European Union structural fund resources, their cost-benefit analysis, and to assess the financial, social and economic indicators planned in the project submission against the actual post-project implementation indicators of the project life cycle process.

The following tasks were set to fulfil this purpose:

1. Define core elements of cost-benefit analysis and evaluate their compliance with the project management theory.
2. Study the cost-benefit analysis method documentation in the project initialization phase.
3. Assess the financial, social and economic indicators using the actual project indicators, and to assess the projects' potential financial, social and economic indicators for various project life cycles.

The results of the study were reflected using empirical data analysis, and analysis of the legislation and methods, and scientific literature.

1. Methods of Dynamic Analysis of Projects

Dynamic methods of estimation start from the point that between the moment of investment in engineering-investment project and the moment of realization of effects, based on such projects, there must be an adequate period of time. Since the static methods disregard the chronological structure of the cash-flows the dynamic methods eliminate this disadvantage. The benefit from dynamic methods is that calculation includes the value of money in the time frame [2].

Cost-benefit analysis (CBA) is the implicit or explicit assessment of the benefits and costs (i.e., pros and cons, advantages and disadvantages) associated with a particular choice. Benefits and costs may be monetary (pecuniary) or non-monetary (non-pecuniary, "psychic").

In addition, a CBA is designed to:

- Be verifiable and repeatable;
- Provide an objective, accurate basis for decisions; and
- Be as streamlined as possible, avoiding unnecessary calculations.

CBA is an essential tool for estimating the economic benefits of projects. In principle, all impacts should be assessed: financial, economic, social, environmental, etc. The objective of CBA is to identify and monetise (i.e. attach a monetary value to) all possible impacts in order to determine the project costs and benefits; then the results are aggregated (net benefits) and conclusions are drawn on whether the project is desirable and worth implementing. Costs and benefits should be evaluated on an incremental basis, by considering the difference between the project scenario and an alternative scenario without the project [3].

The technique used is based on:

1. forecasting the economic effects of a project,
2. quantifying them by means of appropriate measuring procedures,

3. monetising them, wherever possible, using conventional techniques for monetising the economic effects,
4. calculating the economic return, using a concise indicator that allows an opinion to be formulated regarding the performance of the project.

The usefulness of introduction of investment projects in their cost-benefit analysis is characterized by three main parameters: NPV (Net present value), IRR (Internal rate of return), or B/C (benefit-cost ratio). It is mandatory that these indicators be calculated when carrying out the financial and economic analysis before investment project applications for the EU Structural Fund and Cohesion Fund financing are submitted.

The internal rate of return (IRR) and the net present value (NPV) are both discounted cash flow techniques and models. This means that each of these techniques looks at two things: 1) the current and future cash inflows and outflows (rather than the accrual accounting income amounts), and 2) the time at which the cash inflows and outflows occur. In other words, these models consider the time value of money: a euro today is more valuable than a euro in one year; a euro received in three years is more valuable than a euro received in five years, and so on [4].

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} - I_0 \quad (1)$$

where

I_0 – initial investment;

CF – cash flow income at the end of t^{th} period;

r – discounted rate;

n – number of project implementation years [5].

CBA is most commonly used for *public decisions* – policy proposals, programs, and projects, e.g., dams, bridges, traffic circles, riverfront parks, libraries, drunk driving laws, and anything else the government might fund. For Major projects the EC requires Member States to submit a Cost-Benefit Analysis (CBA) and then takes a specific co-financing decision. The applicant should show to the EC that, after a suitable CBA, the project's economic net present value is positive, if negative, the project will be immediately rejected. In the case of revenue generating projects, the financial profitability is assessed in order to establish whether the project actually needs a grant and to what extent this applies.

LVL 1 in hand today is worth more than a promise of EUR 1 in the future because:

- money can be used in the meantime (i.e. for earning interest or with alternative investments)
- inflation may lower real value of money
- unforeseen circumstances may prevent you receiving the money you have been promised [6].

The financial plan should demonstrate financial sustainability, which is that the project does not run the risk of running out of money; the timing of fund receipts and payments may be crucial in implementing the project. Applicants should show how in the project time horizon, sources of financing (including receipts and any kind of cash transfers) will consistently match disbursements year by year. Sustainability occurs if the net flow of cumulated generated cash flow row is positive for all the years considered [7]

Basically cost-benefit analysis is made up of three parts:

- a technical-engineering part in which the context and technical characteristics of the project are identified;
- a financial analysis that represents the starting point for the CBA and that leads the analysis from the point of view of the private investor;
- an economic analysis, the true core of CBA, which, starting with the financial analysis that serves to identify all the income and expenditure items and the relative market prices, applies a series of corrections that allow us to pass from the point of view of the private investor to that of the public operator [8].

An investment project is accepted or rejected depending on its NPV (Table 1).

Table 1

Net present value in decision making [9]

If	It means	Then
NPV > 0	The investment would add value to the organization	The project may be accepted
NPV < 0	The investment would subtract value from the organization	The project should be rejected
NPV = 0	The investment would neither gain nor lose value for the organization	We should be indifferent in the decision whether to accept or reject the project. This project adds no monetary value. Decision should be based on other criteria, e.g. strategic positioning or other factors not explicitly included in the calculation.

The situation where NPV = 0 requires an additional interpretation. Such investment project produces a zero effect; therefore, undertaking such a project is rarely proposed in practice. The main reason is the investor's opinion that the project could become loss-making if even slightest changes in the market situation occur. However, upon eliminating the probability of such risk and given the absence of more profitable alternative investments, the project could be undertaken as the investor is indifferent to other options producing the same effect. In addition, the company (or investor) may have other objectives, – for example, upon increasing production volumes to get a larger market share, attain some social/public objectives, etc. [4].

CBA provides the project planner with a set of values that are useful to determine the **feasibility of a project from an economic standpoint.** Conceptually simple, its results are easy for decision makers to comprehend, and therefore it is greatly favoured in project assessments. The end product of the procedure is a benefit/cost ratio that compares the total expected benefits to the total predicted costs. In practice CBA is quite complex because it raises a number of assumptions about the scope of the assessment, the time-frame, as well as technical issues involved in measuring the benefits and costs [10].

2. Project Dynamic Analysis Research

The authors' research selection included a CBA of projects supported within the framework of the activity 3.6.1.1. *Promotion of National and Regional Development Centre Growth for Balanced State Development* of addendum to the action programme *Infrastructure and Services* financed by the European Regional Development Fund. The programme is one of the most significant structural fund programmes aimed at the growth of the national and regional development centres, as it provides financing for various municipality infrastructure projects.

In the planning period of 2007-2013, the activity 3.6.1.1. *Promotion of National and Regional Development Centre Growth for Balanced State Development* of the *Polycentric Development* priority of addendum to the *Infrastructure and Services* has 209,216,720 LVL available, which includes an ERAF co-financing of LVL 177,834,211, and a national public co-financing of LVL 31,382,509 (a State budget grant).

In the 2007-2013 planning period some specific European Union fund projects have to perform their cost-benefit analysis (CBA) in compliance with the European Union guidelines.

As part of the 3.6.1.1. activity, 69 municipality infrastructure projects have been supported. Analysis of the municipality project submissions and CBA revealed that none of the 69 project submittals provides a detailed comparison of project alternatives.

9 of the 69 projects approved were implemented by January 1, 2011. The research performed by the authors provides an in-depth analysis of the completed projects.

Nevertheless, all CBAs analyze alternatives *with the project* and *without the project*, but do not justify the expected project approach and the selected alternative. In 4 project applications the submitter had not indicated the operational costs in case the project is not implemented, thus indirectly proving that the implementation of the project would cause the everyday operational and infrastructural costs to increase. That means that the result of the cost-benefit analysis is erroneous and the B/C ratio in the 4 projects after recalculation is below 1, i.e., the project is not acceptable.

During the analysis of project applications submitted by municipalities, the authors carried out an in-depth assessment and recalculation of the cost-benefit analysis of infrastructure projects. The analysis was based on a comparison of the indicators initially defined in the project submittal and the actual situation following the implementation of the project.

In contrast to the theoretical cost-benefit analysis models, the European Union and Latvian national CBA guidelines (Planning period 2007-2013, working document No. 4 *Methodical Instructions for Cost and Benefit Analysis)* state that the length of cash flow periods must correspond to the project's life cycle, which includes the project's implementation period. Consequently, the project's life cycle is not separated from the *product's* life cycle.

Table 2

Comparison of the main parameters of project cost-benefit analysis

No.	Main elements and parameters	Initial values		Updated values	
		Value undiscounted	Value discounted	Value undiscounted	Value discounted
1.	Project's life cycle (years)	20		**20**	
2.	Financial discount rate (%)	5%		**5%**	
3.	Investment costs total (LVL, undiscounted)	3 813 788		**1 444 250**	
4.	Investment costs total (LVL, discounted)		3 813 788		**1 444 250**
5.	Project's residual value (LVL, undiscounted)	1 879 073		**729 918**	
6.	Project's residual value (LVL, discounted)		708 203		**275 098**
7.	Income + saved costs (LVL, discounted)		123 650		**123 650**
8.	Operational costs (LVL, discounted)		-364 744		**-364 744**
9.	Net income = income + saved costs – operational costs + project's residual value (LVL, discounted)		467 110		**34 005**

Table 2 shows the considerable change from the initial calculation is due to an investment cost reduction from 3,813,788 LVL to 1,444,250 LVL, which has a potentially significant positive effect on the benefit volume. As a result, the residual value of project investments decreases as well – from 1,879,073 LVL to 729,918 LVL, which in turn has a negative effect on the benefits.

Table 3

Change in financial analysis indicators

Indicator	Values (initial)	Values (updated)
Financial net present value of the investment (FNPVc), LVL	-3 346 679	-1 410 245
Financial internal rate of return on the investment (FRRc)	-4.51%	-6.28%
Financial net present value of capital (FNPVk), LVL	-107 875	-188 111
Financial internal rate of return on capital (FRRk)	4.1%	0.5%

Analysis of the actual financial indicators of a project (Table 3) leads to a conclusion that, even though the investment costs have decreased, the net present value has reduced as well and the internal profit norm has decreased to 0.5%. Of the macroeconomic indicators, construction cost and work wage decrease has affected the financial analysis.

The financial indicators change substantially due to the decreasing construction costs. The FNPVc indicator improves materially, as the absolute investment decreases, but the FRRc is negatively affected as the project's predicted residual value diminishes considerably, and the project investment-related activity costs retain their initial level. The FNPVk and FRRk indicators are affected, too, which can be explained by substantial decrease in the project's residual value.

Still, it is important to define the social and economic benefit of implementation of the projects based on definition of social and economic analysis and potential benefits.

During analysis of the projects' social and economic evaluation, the authors found definitions of the following indicators, which are not directly related to the operations performed as part of the project and the effect on which by the project is difficult to assess:

- Population increase,
- Employment increase,
- Decrease in unemployment,
- Increase in GDP per capita,
- Increase in the numbers of tourists,
- Municipal income increase.

When updating the social and economic calculations, the authors did not include in the cost-benefit analysis indicators that are not directly related to the project implementation or directly influenced by the project. The calculations included the actual accountancy indicators at the end of the project implementation period. The social and economic calculations included the value of benefit in terms of money. Although the FNPV resulting from the financial analysis is negative, a positive economic value of the project benefits must be proven in order to receive the state and EU support. The social and economic calculations are the ones where mistakes are made most often, since municipalities define their benefits in cash, without a clear and justified assessment methodology for the resulting indicators.

Table 4

Change in social and economic analysis indicators

No.	Main parameters and indicators	Values (initial)	Values (updated)
1.	Economic net present value (ENPV)	2 440 820	974 329
2.	Economic rate of return (ERR)	20.67%	6.8%
3.	Benefit/cost ratio (B/C)	2.68	1.15

Seeing that the programme includes financing of projects related to performance of the autonomous functions of municipalities, their financial net present value (NPV) in all of the CBAs included in the research selection was negative. It can be explained by the fact that municipality infrastructure and operation do not always give sufficient income to cover the investment and operational maintenance costs. At the same time, the implementation of such projects is important to ensure the municipalities can carry out their functions defined by the legislation.

Table 5

Cash flow calculation for an infrastructure project for a 5-year life cycle

Item No.	Years / Factor	0	1	2	3	4	5
1.1.	**Economic benefit**		**122 790**	**289 006**	**345 852**	**345 852**	**345 852**
1.2.	**Economic costs**	**-479 948**	**-1187673**	**-397 658**	**-50 828**	**-52732**	**-52 732**
1.2.1.	Investment costs	-479 948	-1 156 487				
1.2.2.	Operational costs		-31 186	-397 658	-50 828	-52 732	-52 732
1.2.2.1.	*Everyday operation costs*		*-31 186*	*-72 339*	*-50 828*	*-52 732*	*-52 732*
1.2.2.2.	*Periodic operational costs*			*-325 319*			
1.3.	**Net cash flow**	**-479 948**	**-1064883**	**-108 652**	**295 024**	**293 120**	**293 120**

Analysis of an infrastructure project's economic calculation results from a 5-year life cycle period and leads to a conclusion that, due to the considerable investment costs, the economic benefit does not exceed the economic costs, which results in negative net cash flow.

Table 6

Social and economic analysis results for a 5-year project life cycle

Financial analysis indicator	Calculation, LVL
Economic benefit	1 449 352
Economic costs	-2 221 571
Net cash flow	-772 219
Economic net present value (ENPV)	-874 800
Economic rate of return (ERR)	-17.57%
Benefit/cost ratio (B/C)	0.65

The results of the calculation demonstrate that over the period of five years the project is disadvantageous not only from the point of view of a financial evaluation, but also that of social and economic analysis. The economic net present value is 874,800 and the economic rate of return – 17.57%. From the calculation of the benefit/cost ration for a 5-year project life cycle period, it was concluded that it is 0.65 and fails to reach the establish level of 1, which would grant a positive decision on project financing.

In view of the negative results of the 5-year project life cycle, the authors analyzed the potential calculation results for an 11-year project life cycle. The results show that the benefit/cost ratio rose to 1.39. The economic rate of return grew from negative to 8.12% in the meantime.

In social infrastructure improvement projects, social and economic benefit and positive evaluation in the case under question can only be achieved in the long-term (Table 7).

Table 7

Cash flow calculation for an infrastructure project for an 11-year life cycle

Item No.	Assumptions \ Year	0-5	6	7	8	9	10	11
1.1.	**Economic benefit**	**1 449 352**	**345 852**	**345 852**	**345 852**	**345 852**	**345 852**	**345852**
1.2.	**Economic costs**	**-2 221 571**	**-55 794**	-52 732	-52 732	-52 732	-52 732	-52 732
1.2.1.	Investment costs	**-1 636 435**	-3 062					
1.2.2.	Operational costs	**-585 136**	-52 732	-52 732	-52 732	-52 732	-52 732	-52 732
1.2.2.1.	*Everyday operation costs*	**-259 817**	-52 732	-52 732	-52 732	-52 732	-52 732	-52 732
1.2.2.2.	*Periodic operational costs*	**-325 319**						
1.3.	**Net cash flow**	**-772 219**	**290 058**	**293 120**	**293 120**	**293 120**	**293 120**	**293120**

According to the CBA methodology established by the European Commission, when project life cycle is increased (including the project implementation period) to 11 years, it can be concluded that in the 6th year of the project life cycle the net cash flow values become positive. The results of the social and economic analysis for 6th year of the project life cycle are shown in the Table 8.

Table 8

Social and economic analysis results for an 11-year project life cycle

3.1.	Economic benefits	**3 524 464**
3.2.	Economic costs	**-2 541 025**
3.5.	Net cash flow	**983 439**
4.1.	Economic net present value (ENPV)	243 357
4.2.	Economic rate of return (ERR)	8.12%
4.3.	Benefit/cost ratio (B/C)	1.39

Upon analysis of the cost-benefit analyses performed by project submitters and the method documentation by the European Commission, the authors concluded that the European Union has already defined the project life cycles of various fields using method documentation, encompassing periods of 15 to 40 years (Table 9).

This unified approach is used only for the assessment of the project programme level, while the project and product life cycle should be determined according to the actual circumstances. The CBAs analyzed by the authors also showed that the recipients of the financing planned for extra investment in the created infrastructure after 5-15 years. Such additional investments in infrastructure are essentially new projects in existing objects, therefore the base project life cycle should be set shorter than indicated in the method documentation; according to the authors' financial and social and economic indicator recalculation, and a project's social and economic benefits have a positive effect only in the long run.

Table 9

Project life cycle in different fields [2]

Field	Length of project life cycle (years)
Energetics	25
Water management, environment infrastructure	30
Railroad	30
Ports and airports	25
Road infrastructure	25
Industry	10
Other services	15

In 5 of the implemented 9 projects the municipalities suggested amendments to the project financing contracts, asking for exclusion of indicators that they could not prove by the end of the project implementation term, e.g. increase in the number of inhabitants, GDP, or popular satisfaction. Considering that the indicators were included in the initial social and economic cost-benefit calculation, the changes influence the results of the performed CBA.

A related problem is that the objectives themselves are often not well thought through or clearly articulated, clouding the development of appropriate performance monitoring indicators and making monitoring and evaluation even more difficult. Results in cost/benefit analyses tend to be notoriously inaccurate, as large infrastructure projects systematically have high cost overruns. To make matters worse, the projects that have the most exaggerated benefits and the highest cost overruns tend to generate much lower benefits than expected.

Many municipalities face problems when optimal current and capital repairs policies are applied in practice. The optimum time necessary for a more sizeable renovation or reconstruction is a year, when the present value of renovation/reconstruction costs is lowest.

Conclusion

The main advantage of CBA compared to other traditional accounting evaluation techniques is that externalities and observed price distortions are also considered. In this way market imperfections are explicitly considered, which are reflected neither in corporate accounting nor, as a rule, in national accounting systems.

The role and significance of CBA in the decision-making process for infrastructure and construction project financing, as it is important that investment be made with the financial input most appropriate given the planned benefit to come from the project's implementation process.

The CBAs analyzed by the authors also showed that the recipients of the financing planned for extra investment in the created infrastructure after 5-15 years. Such additional investments in infrastructure are essentially new projects in existing objects, therefore the base project life cycle should be set shorter than indicated in the method documentation; according to the authors' financial and social and economic indicator recalculation, a project's social and economic benefits have a positive effect only in the long run. The quality of ex ante CBA varies substantially and may not cover essential information or may even contain errors.

In particular, there could be inaccuracy in the estimate of future demand (and particularly demand overestimation) and investment cost (and particularly cost overruns). In addition, CBAs may consider project periods that differ from those indicated in the CBA guide. Other methodological adjustments carried out relate to exclusion of taxes and duties and adjustments in the calculation of externalities. A true cost-benefit analysis requires a solid grounding in economic theory and techniques, which is beyond the training of many evaluators. It may be necessary to hire a consultant if this type of analysis is desired. Critics feel that many cost analyses are overly simplistic, and suffer from serious conceptual and methodological inadequacies. There is a danger that an overly simplistic cost-benefit analysis may cause an intervention to fail, by promoting expectations that are unrealistically high, and cannot really be achieved. This may result in political backlash which actually hurts future funding prospects instead of helping. There are no standard ways to assign currency values to some qualitative goals, especially in social programs. For example, how do we value things such as time, human lives saved, or quality of life? The best-known cost-benefit studies have looked at long-term outcomes, but most program evaluations don't have the time or resources to conduct long-term follow-up studies.

The authors' analysis proves that municipality infrastructure projects are not always financially and economically efficient until additional investment is received. The European Commission should specify guidelines with a shorter post-project life cycle because every additional investment after the end of the project has to be considered a new project.

References

1. Draft National Strategic Reference Framework 2007-2013 (2007), Ministry of Finance of Republic of Latvia, 116 p.
2. Dragan Lj. Milanović, *Use of the Elasticity of Net Present Value in Risk Analysis of Investments Projects*, FME Transaction, Vol. 33, No. 1, 2005, pp. 47-52.
3. Guide to cost-benefit analysis of investment projects, European Commission, 2008, 259 p.
4. Campbell, H.F., Brown, R. P. C., *Benefit-Cost Analysis, Financial and Economic Appraisal using Spreadsheets*, Cambridge University Press, 2003, 345 p.
5. Belli, P., *Economic Analysis of Investment Operation*, World Bank, 1996, 153 p.
6. Florio, M., Vignetti, S., 2006, *Cost-benefit analysis of infrastructure projects in an enlarged European Union: Returns and Incentives*, Economic change and restructuring, 38: pp. 179-210.
7. Florio, M., *„Getting incentives right: do we need ex post CBA?"* Sixth European Conference on Evaluation of Cohesion Policy, Warsaw, 30 November – 1 December, 2009.
8. Dinwiddy, C., Teal, F., *Principles of cost-benefits analysis for developing countries*, Cambridge University Press, 1996, 133 p.
9. Belli, P., Anderson, J. R., Barnum, H.N, Dixon, J. A., Tan, J-P, *Economic Analysis of Investment Operations. Analytical Tools and Practical Applications*, WBI, World Bank, Washington D.C., 2001, 291 p.
10. Jean-Paul, R., Comtois, C., Slack, B., The geography of transport systems, Taylor & Francis, 2009, 352 p.