The Use of Cost-Benefit Analysis in Public Investment Project Complex Appraisal

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Abstract. **The article deals with the problems of evaluating the efficiency of investment project implemented in public sector. Standard appraisal methods based on projected profit and expenditure are not applicable due to intangible nature of public project generated benefit. The article reviews foreign experience and examines the possibilities of using the cost-benefit analysis for public investment project evaluation. The first part presents the basic principles of analysis. The second part provides the interpretation of the results generated by the application of cost-benefit analysis on investment project implemented in the public health sector. The article aims to reveal the usefulness and limitations of cost-benefit analysis in public investment project appraisal.**

Keywords – **public investment project, complex appraisal, cost-benefit analysis.**

I. Introduction

The main objective of all developing countries is a fast growth of national economy and increase of competitiveness. In a national economy development policy, implementing the mentioned objective, the distribution of resources – public investment – is intended for achieving as high as possible state economic growth in the short-term. There would be no economic problems if there were enough resources for satisfying all the needs. However, available resources are always limited comparing to public needs. In fact, economical, technical and scientific progress provides preconditions for expansion as well as for efficient and rational use of production resources, which in turn allows to produce more economic goods over time. Nevertheless, needs grow faster than economic opportunities.

Under limitation of resources, it is necessary for resources to be used more efficiently, i.e. according certain criteria considering social and economic goals of society.

Today‘s solution of public sector investment projects‘ implementation and management problems requires professional knowledge and practical experience. Investment activity is one of the riskiest areas, because there is no strong guarantee that everything is precisely planned, analysed and estimated, because results become visible only when the activity of an investment object starts.

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There are various methodologies for investment projects evaluation, however, while analysing the scientific literature it was noticed that these methods are often intended for efficiency measuring of business development or financial benefit providing projects. While evaluating public projects the main difference is in the fact that here other project’s effects are important, not only profit.

Thus in order to determine the expedience of public investments a reliable complex project appraisal technique is necessary, which would allow to select the best project conforming to national needs.

II. Cost-Benefit Analysis Application and the Demand for Complex Appraisal

Standard methods for investment efficiency evaluation, based on valuating profits and investment expenses, are often difficult to apply because of public investments‘ intangible nature. S. Puškorius [7] notes that financial part of investment projects implemented in public sector is important but evaluation should not be limited to this part. Evaluations of the broader extent should be performed considering the impact on economy and social welfare. Public investment project which seems to be favourable financially can appear to be inappropriate in socioeconomic terms, thus the project should be appraised systemically [7], i.e. considering financial, socioeconomic and risk assessment aspects [10].

Under such assumption it is decided to apply a cost-benefit analysis method as a framework for complex appraisal method formation. After determining that investment project economic, financial and social evaluation provides a possibility for estimation of certain ratios indicating efficiency, but does not allow to compare objectively the projects under analysis, it was decided to add a complex evaluation stage to the appraisal method [9].

Cost-benefit analysis facilitates decision-making process related to investment selection in public sector for directors of organizations [1, 2]. The main rule of the method determines that the project should be undertaken only if discounted benefit of the analysed project exceeded the discounted costs (funds) of investment [4].

The general analysis of cost-benefit comprises of the following three steps:

- determination of all the factors (favourable and unfavourable) which can be caused by the project;
- financial evaluation of costs and benefit;
- selection of the best alternative with net social benefit (when total benefit exceeds total costs) [6].

The application of cost-benefit analysis is related with necessity to select the respective criteria of benefit, to choose efficiency evaluation methods and select the discount rate.

For the model being developed **N.Kaldor-Hicks benefit estimation criteria** [7] can be proposed. Its main principle is

that investment project is acceptable if the welfare of the group of interested persons increases because of project implementation and can compensate losses for those whose welfare decreases. It means that strategic project should be intended for implementation if its aggregate value added exceeds aggregate costs irrespective of what groups of inhabitants will receive increased welfare and who will receive the decreased welfare.

Determining the discount rate. Discount rate plays an important role in future cash flows evaluation. The extent of the discount rate influences the present value of the future cash flows. The higher the discount rate, the less influence future data has on the final result. There are two discount rates distinguished in cost-benefit analysis – financial and social [8].

In long-term projects evaluation discount rate is a critical point: the project which seems attractive with a low discount rate can be unprofitable with a higher discount rate.

One of the most general descriptions of the discount rate is alternative capital costs [4]. Three main methods can be used to determine financial discount rate:

- estimation of minimum alternative capital costs;
- estimation of maximum discount rate limit;
- estimated discount rate [5].

Minimum alternative capital costs refer to the annual rate of return on national investments or government securities.

Maximum limit of discount rate refers to the value of return of the best possible and rejected investment. In practice it often appears to be the long-term financial return on investments into portfolios of international securities.

Estimated discount rate is used on purpose to avoid the complex calculations of discount rate. In such situations the discount rate is used, which is determined and recommended by certain state institutions. As there are no estimated discount rate in Lithuania, it is proposed to use the real discount rate of investment projects‘ financial analysis, which is recommended by the European Commission. It amounts to 5 percent [6].

The value deviating from 5 percent norm can be motivated because of

- specific macroeconomic conditions of the country;
- the nature of investor: for example, discount rate can be higher for public and private sector partnership projects;
- specific features of the sector.

The social discount rate is used in economic analysis while evaluating the attitude of society towards the future benefit or future costs compared with today‘s benefit or costs. Under imperfect capital market, social discount rate can differ from financial discount rate [8].

There are many methods of this rate determination in literature and in the world practice. The 10 percent rate of economic return set by the World Bank is quite a high rate and it can be applied only to the best projects [5].

Often countries determine lower social discount rate than that set by international financial institutions. In European Union countries this rate usually varies between 4 and 6 percent [13].

The main methods of social discount rate estimation are as follows:

- traditional method, which determines that public investments should have the same return as private ones;
- alternative method, based on the long-term economic growth ratio;
- third method estimates the standard discount rate which reflects the real growth forecasts [5].

As in financial discount rate case, Lithuania does not have a determined standard social discount rate, thus it is recommended to use the discount rate provided by the European Commission, which amounts to 5,5 percent and most adequately reflects the main ideas of all the mentioned methods [6].

III. Development of Model for Public Investment Projects Appraisal

According the main principles of cost-benefit analysis, performing appraisal of public sector infrastructure development investment projects, the following seven tasks should be accomplished:

1. evaluation of socioeconomic environment and project goals;
2. detailed description of the project;
3. analysis of alternatives and opportunities;
4. financial analysis of the project;
5. economic analysis of the project;
6. risk assessment;
7. complex appraisal (see. Fig. 1).

Evaluation of socioeconomic environment and project goals. The first logical step in project appraisal should be a qualified description of socioeconomic context and goals, which are intended to reach during the period of investment, both directly and indirectly. Such description should include determination of relations in between the project goals and interests of investors [3]. This part would allow to assess rationality of the project for potential project investors.

Goals of the project should be coherent with investments in a logical way, as well as with political and program priorities. Cost-benefit analysis aims at structuring the anticipations of project supporters in the right direction [6]. It cannot answer all the questions related to future effect, but it concentrates towards determination of microeconomic changes when evaluating the general economic impact on the project.

Detailed description of the project. Performing detailed description of the project, evaluation framework must be defined. A project always has a direct influence on users, employers, investors, suppliers and indirect impact on other third parties [3].

Analysis of alternatives and opportunities. A typical analysis of opportunities shows if local conditions are suitable for the project (for example, that there will be no physical, social, institutional restrictions), demand of services will be sufficient in the future (including long-term perspective), appropriate technologies and required human resources and management will be available, the plan of the project is explained comparing with possible alternatives („to do nothing“, „to perform minimum changes“ and „to perform changes“) [5].

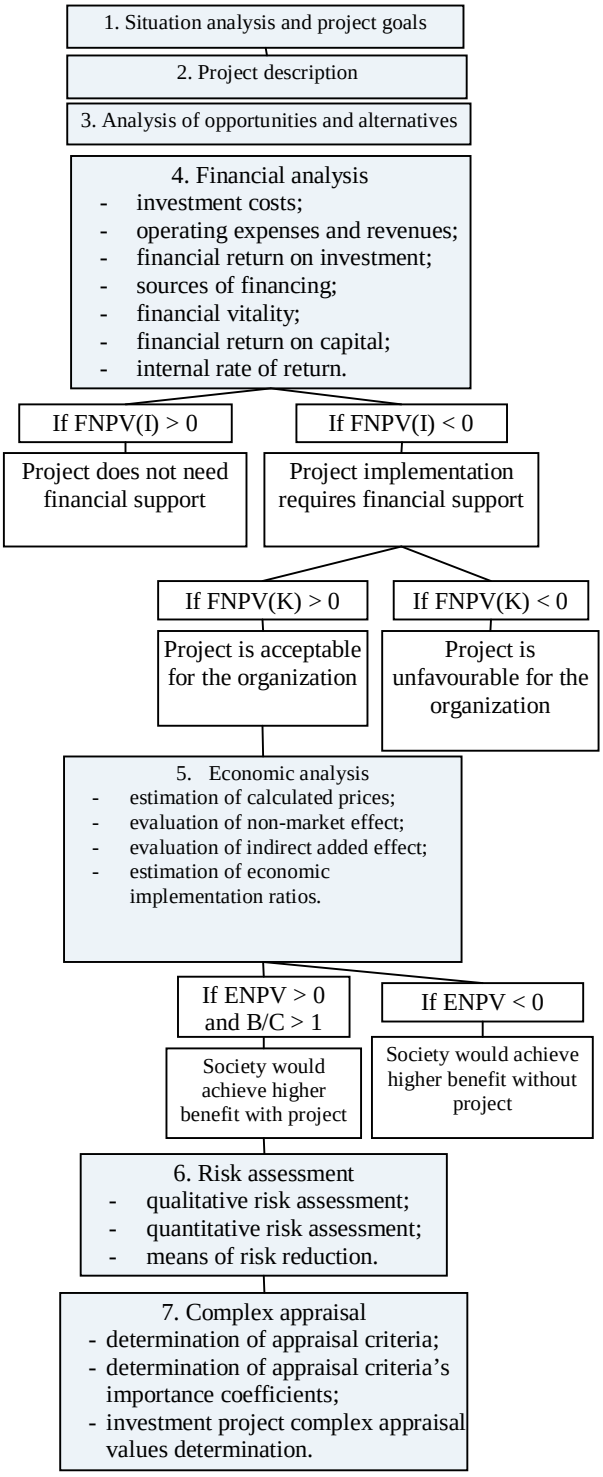

Fig. 1. Project appraisal scheme

After describing all the alternatives, selection of the optimal alternative must be performed.

Financial analysis of the project. The main objective of financial analysis is to estimate indicators of the project's financial activity with the help of project cash flow forecasts. The method being used for financial analysis is the analysis of the discounted cash flows [9].

The described method of financial analysis possesses the following characteristics [3]:

§ Only those cash flows, i.e. real amount of cash is used which is paid out according the project. Therefore, for example, non-cash items of accounting, such as depreciation or reserves for contingencies, should not be included in discounted cash flows analysis. However, if the proposed project is reasoned with thorough risk analysis, contingencies can be included into required costs, not exceeding 10 percent of all investment costs of the sum left after subtracting the contingency costs. Nevertheless, contingencies should not be included into costs intended for financing, because they do not make cash flows.

§ Cash flows should be analysed only in the year they appear and according certain reporting cycle. If economically useful project operates longer than the related reporting cycle, the residual value should be taken into account. It should be calculated as a present value of the anticipated cash flows in the economic lifetime exceeding the duration of the reporting cycle.

§ While summing (adding or subtracting) cash flows originated in different years, the time value of money should be taken into account. This is why future cash flows are discounted with present value.

§ Financial analysis is performed using incremental method: project evaluation is based on difference between costs and benefit of scenario „to do nothing" and alternative scenario „to perform changes".

The following data must be evaluated while performing financial analysis:

- general costs of investments;
- general costs of activity and revenues related with project implementation;
- residual value of assets;
- financial return on investments: financial net present value (FNPV(I)) and financial rate of return (FRR(I));
- sources of financing;
- financial vitality;
- financial return on own (national, for example, in the case of ES structural assistance) capital: financial net present value (FNPV(C)) and financial rate of return (FRR(C)).

Project evaluation includes only those expenses and revenues which are related with exploitation of assets created in project period and are experienced because of project implementation. In other words, project activity expenses and revenues include only additional (intended for the project) cash flows.

Project activity expenses and revenues are recommended to present in their real values, not correcting them because of inflation.

Financial return on investments can be evaluated by estimation of financial net present value and financial rate of return on investment (FNPV(I) and FRR(I)). These ratios indicate the ability of the real revenues to compensate investment costs regardless of the way of financing. In order to ask for financial support from state budget or EU structural funds, FNPV(I) must be negative and FRR(I) must be lower than the discount rate used in analysis.

Financial vitality of the project should be evaluated determining if amounted (not discounted) cash flows are positive during the whole reporting cycle [6]. For this reason while checking cash flows investment expenses, all (own, national or EU) financial resources and net revenues should be taken into account. The residual value is not considered unless the assets are liquidated in the last year of the respective analysis.

It is important to ensure project vitality during the whole project life-cycle. Estimated separate financial ratios in the long period can show investment profitability, while financial vitality indicates whether project will have enough incomes when the external financing is over [3].

While calculating own (national) capital (FNPV(C), financial profitability FRR(C), financial resources invested in project, excluding subsidies, are assumed to be payable funds, but not investment costs [6].Capital incomes should be used when they are actually paid out to project or returned (in case of credit).

The purpose of own capital profitability estimation is an attempt to consider project implementation from the perspective of public services provider or private subject. In order to reach such evaluation result one simply needs to concentrate on the own sources of financing of project implementing subjects, including the sources which can possibly be a national contribution, private subjects' contribution, if applicable, and a requirement to return credits and interest for the third financing parties.

Positive cash flows are composed of only general activity revenues and residual value of the acquired assets.

Financial net present value of capital is a sum of discounted cash flows, which are comprised for project organizer because of implementation of investment project. Financial return on capital describes the return for project benefit recipient.

In the process of evaluation the revenues acquired while performing the project should be adequately considered in order to modulate subsidies according the rate of project general financing and own funds return and in order to avoid surplus of financing. For determination of the amount of subsidy a "lack of financing" method should be applied [8].

Economic analysis of the project. Cost-benefit analysis requires a research of project net influence on economic welfare, which is performed in the following steps [3]:

- identification of respective ratios of economic evaluation; determination of factors' price (benefit or loss provided by the project is evaluated in monetary terms);
- evaluation of external factors which are also expressed in monetary terms;
- evaluation of indirect project factors;
- discounting of estimated benefit and costs provided by the project using selected social discount rate;
- estimation of economic ratios such as economic net present value (ENPV), economic rate of return (ERR), benefit-costs ratio (B/C).

Logic principle of economic evaluation is that project expenses should be evaluated according alternative costs, and results – according consumers' willingness to pay [2, 6]. It is worth noticing that alternative expenses not necessarily correspond the set financial costs, as well as market prices of the respective period, which can be distorted or absent, not always reflect the willingness to pay. Economic analysis is performed according society point of view. For performance of economic analysis a discounted cash flow analysis method is used.

The following corrections should be made for evaluated cash flows during the economic analysis [5]:

- fiscal corrections;
- shadow prices corrections;
- external factors corrections.

The purpose of fiscal corrections and shadow prices corrections is to correct „imperfections" of market prices, i.e. prices are corrected with regard to possible market prices distortions because of subsidies, taxes, etc. In investment project appraisal fiscal and shadow prices corrections can have a strong influence on final results.

It is worth noticing that consequences for economics should be evaluated quantitatively as much as it is possible. Often especially economic benefit of investment project explains its application, so this part should achieve a special attention [10]. However, this part is also most complicated. Evaluation of social and environmental benefit for society in monetary terms always causes many discussions and contradictions (for example, how much a saved person's life is worth?), thus applying any method of benefit evaluation in monetary terms it is necessary to provide its explanation. In case it is not possible to express benefit in monetary terms, one need to describe the benefit itself quantitatively as precise as it is possible (for example, 100 person's lives saved).

After evaluation of economic influence of investment project, financial analysis should be supplemented with economic analysis data and applying social discount rate the following ratios are estimated [6]:

- economic net present value (ENPV): if the value is positive – project is efficient and should be implemented, if negative – project implementation should be delayed;
- economic rate of return (ERR): it should be higher than social discount rate;
- benefit-cost ratio (B/C): it should be higher than 1.

Economic rate of return and benefit-cost ratio provide interesting information, because they do not depend on the size of the project. Thus ERR is a net value, which allows to compare similar projects regardless their size. However, these ratios can have certain disadvantages in computational technique. Depending on the nature of cash flows in certain cases internal rate of return can be multiple or uncertain. Economic rate of return, as well as benefit-cost ratio is independent from the size of the project being evaluated. But the value of the benefit-cost ratio can depend, for example, on what is considered in particular case – benefit or costs reduction.

Economic net present value is more confident and should be applied as a core orientation indicator while evaluating projects and making decisions on project suitability for financing [6]. But in order to compare two similar but

different size projects this ratio can provide a misleading information.

Not all the socioeconomic impact can always be quantitatively estimated and evaluated. Thus along with operating ratios evaluation, a non-monetary value should be taken into account, especially the one related with impact on employment, environment protection, social equality and equal opportunities. Such effect is evaluated in complex appraisal stage.

Risk assessment. The following three steps are proposed for risk assessment:

- qualitative risk assessment;
- quantitative risk analysis;
- identification of risk reduction means.

In the process of qualitative risk evaluation, with the help of various expert methods, all risk and uncertainty factors and their impact on the project is identified. In order to determine how important the identified factors are for project implementation, the probability of risk factor occurrence must be determined. In this case the probability of all the factors' occurrence should be set to 1, and probability of every factor should be expressed depending on the likelihood of its occurrence. The evaluation of risk factors' probabilities, as well as impact of risk factors, is performed by the experts.

This stage of appraisal helps to answer the question of what are the main risk factors which construct unfavourable conditions for attainability of project results.

During quantitative risk analysis, using results achieved by qualitative analysis, first of all the factors (x_i) are distinguished, which have a critical impact on project goals achievement. Performing sensitivity analysis, increasing or decreasing the values of the mentioned factors, the selected project efficiency indicators (y) change. On this stage of project appraisal we can determine how much percent project efficiency indicator *y* will increase if factor x_i increases by 1 percent [9]. According recommendations of the European Commission, the factors whose 1 percent change influences 5 percent change of the selected efficiency indicator are assumed to be critical [6].

Complex appraisal. Complex appraisal provides a possibility, based on efficiency ratios evaluated in the former steps, to find one indicator generally describing the investment project [11]. Also this step allows to compare quantitatively different projects.

Complex evaluation can be performed in such a manner [9, 11]:

1. Commission of experts determines evaluation criteria and presents requirements for calculating criteria values. It is proposed to use the following indicators estimated during investment project analysis as evaluation criteria:
   - financial rate of return on capital (FGN(K));
   - economic rate of return (EGN);
   - cost-benefit ratio (S/N);
   - core risk factors, evaluated during sensitivity analysis;
   - project impact on inhabitants employment (number of new workplaces);
   - number of new workplaces, adjusted according average salary;
   - application of new technological processes (the number of processes);
   - quantitatively evaluated economical value of the project (in health care sector, for example: ratio of ambulatory and in-patient treatment; decreasing number of hospitalized patients (units); the change of average time being spent at hospital (percent); bed turnover change; bed occupation; increasing of services accessibility – the change of provided services, illness reduction (percent); saved lives (cases), disability reduction (cases)) [12, 13, 14].

   The presented list of criteria can be supplemented with other criteria, which better reflect the appropriateness of the project to solve particular problems, or it can be shortened depending on the peculiarities of the financing program.
2. The next appraisal step is determination of the importance coefficients of evaluated criteria. A pair criteria comparison matrix should be used for this goal. Performing pair comparison of criteria, experts do not assign any quantitative evaluation for the analysed criteria, they just compare those criteria in pairs determining the ratio of similarity.
3. The highest and lowest values of every criteria are selected out of the results of the appraised projects, an interval between the highest and the lowest value is found and a value of the score is determined for every criteria. Project criteria values are determined with regard to other criteria.
4. The values of investment project complex evaluation are determined with regard to the importance of evaluation criteria.

IV. Practical Application of Public Investments Complex Appraisal Model

Appraisal of public sector investment projects is quite complicated, thus application of any developed model must be verified by practical calculations. In order to verify the model developed during the research, the evaluation of two health-care sector infrastructure development investment projects, intended for European regional development fund and Lithuanian state budget funds financing according 2007-2013 years Cohesion promotion action program has been performed.

After performing calculations of financial evaluation (see Table 1), it was determined that financial subsidy can be assigned for both projects under evaluation (FNPV(I)<0). Estimated projects' financial capital present value shows that financing of the project is also expedient with regard to the implementing organization (FNPV(C)>0).

TABLE 1
PROJECT FINANCIAL EVALUATION RATIOS

Project	P1	P2
FNPV(I)	-2.597.580	-3.712.408
FNPV(C)	55.600	135.835
FRR(C)	0,07	0,08
Level of lacking financing	0,92	0,90

The results of economic evaluation stage are presented in Table 2. This stage of evaluation provides the most important information for project's financing institutions – whether benefit generated by the investment projects exceeds investments required for project implementation. As one can see from evaluation results presented in Table 2, both projects in economical terms are profitable and suitable for implementation.

TABLE 2
PROJECT ECONOMIC EVALUATION RATIOS

Project	P1	P2
ENPV	467.370	324.495
ERR	0,08	0,07
B/C	1,29	1,16

The obtained financial evaluation results show that second project is financially more useful, but economic evaluation ratios show that first project generates higher economic benefit evaluated in monetary terms. However, these results are not sufficient in order to make a motivated decision – which project (if there is a possibility to implement only one project) should be selected. In order to make an objective decision it is necessary to complement the evaluation with determination of economic benefit which is impossible to express in monetary terms.

On risk assessment stage, performing project sensitivity analysis for determined core risk factors, it becomes clear that project sensitivity for those factors is not equal. Efficiency ratios of the first project are most sensitive with regard to economic preconditions' and financial preconditions' inaccuracies, while the results of the second project are more sensitive with regard to economic preconditions' inaccuracies and increase of value of investments and acquired services (see Table 3).

Based on sensitivity analysis, 1st project has two "sensitive" factors, 2nd project – one factor. As both projects face with risk critical for project results, thus it is important to design an efficient plan of reaction on the determined risk. Estimated core risk factors will be included in complex appraisal stage.

TABLE 3
PROJECT RISK ASSESSMENT RESULTS

Factors	**Increase of investments' and acquired services' value**		Determination of inaccurate financial preconditions		Determination of inaccurate economic preconditions	
Project	**P1**	**P2**	**P1**	**P2**	**P1**	**P2**
FNPV(C) change when factor is increasing or decreasing by 1 %	5 %	2 %	6 %	2 %	-	-
ENPV change when factor is increasing or decreasing by 1 %	-	-	-	-	10 %	20 %
B/C change when factor is increasing or decreasing by 1 %	-	-	-	-	1 %	1 %

On complex appraisal stage the values of 1st and 2nd project criteria are estimated and complex appraisal ratios of every project are determined (see Table 4).

TABLE 4
COMPLEX APPRAISAL OF PROJECTS

Name of criterion	P1	P2
Financial rate of return on capital (FRR(C))	0,07	0,08
Economic rate of return (ERR)	0,08	0,07
Benefit-cost ratio (B/C)	1,29	1,16
Core risk factors, evaluated during sensitivity analysis	3	1
Application of new treatment methods (number)	4	2
Change of average time spent in hospital (percent)	0	1,6
Saved lives (cases)	1	2
Disability reduction (cases)	2	5
Complex investment project's appraisal	7,33	14,00

Performed calculations allow to conclude that 2nd project is superior financially, economically, socially and with regard to risk, and if there are no possibility to implement both projects, first of all the 2nd project should be financed. If there are enough funds, both projects should be implemented.

V. CONCLUSIONS

To sum up, the following conclusions can be made:

1. After performing comparative analysis of investment projects' appraisal methods it was determined that cost-benefit analysis method can be applied while evaluating planned investment projects of public services providing organizations. The method allows to evaluate thoroughly the impact of planned investment projects in financial, as well as in broader – socioeconomic aspects. Cost-benefit analysis method also has certain disadvantages – detailed forecast of investment project impact in the long period (financial, as well as economic and social data) is related with data error risk.
2. Complex appraisal of investment projects provides a possibility, based on the estimated efficiency ratios, to find one ratio in general describing the investment project. Also, this stage allows to compare similar projects quantitatively in terms of financing.
3. The proposed method of public investment projects complex appraisal has theoretical as well as practical

advantages, because a detailed analysis of public investment projects of various types can be performed, the weight (importance) of complex appraisal criteria is estimated, there is a possibility to include various evaluation criteria, depending on financing program peculiarities.

4. The application area of the proposed public investment project appraisal model is defined – health care sector, but its application is quite broad. The developed model allows to evaluate separate projects, disclosing their financial, socio-economic benefit and to assess implementation risk; it also provides a possibility to evaluate and compare alternative (mutually incompatible) investment projects.

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