

MODEL FOR EVALUATING THE ECONOMIC EFFICIENCY OF INVESTMENT PROJECTS: ARCHITECTURE AND MAIN ASPECTS OF APPLICATION

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Abstract. *Evaluation of investment projects is a complex multilateral process which also entails a great responsibility as its results form a basis for adopting investment decisions. These decisions, to a large extent, depend on the reliability and justification of the evaluation results: therefore, the process must be based on clear logic, acceptable assumptions and the duly selected methods that have been tested in practice. The paper contains an overview of the main principles of investment projects' evaluation and a detailed analysis of the main requirements for the model architecture and its evaluation process.*

The authors propose a model for evaluating the economic efficiency of investment projects that has been described in detail and tested in practice. The model consists of a coherent evaluation scheme made of three phases and detailed algorithms of internal procedures. Such an architecture of the model enables a comprehensive analysis of investment projects of different types and a validation of the objectivity of evaluation results.

Key words: *evaluation of investment projects, investment project, evaluation principles, economic efficiency, evaluation model*

Introduction

Increasing investments in the national economy is one of the most effective means to promote both the overall economic growth and the structural reforms in order to achieve stable economic growth rates. This is particularly relevant in the present phase of the development of the economies of Lithuania and of other European Union Member States still under the adverse impact of the global economic crisis.

The efficiency of investments largely depends on the appropriate drawing up of investment projects. A continuous creating of a company's value can only be ensured by a sound investment project comprising a detailed analysis of all the assumptions underlying its implementation, a correct calculation of the expected cash flows, and an in-depth assessment of risks.

A detailed analysis of works by Lithuanian (Ali auskas et al., 2005; Rutkauskas, 2006; Tomaševič, 2010) and many foreign (Brigham, Ehrhardt 2002; Damodaran, 2004; Lessel,

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2007; Виленский et al., 2004; Теплова, 2008) researchers has shown that the aspects of applicability of different methods to evaluate the investment projects' efficiency have not been sufficiently studied, although these aspect can have a considerable effect on the results, scope and content of analysis.

Purpose of the paper: to propose a model evaluating the economic efficiency of investment projects, based on the discounted cash flow methods and adapted to the Lithuanian business environment.

Study methods: general methods of analysis of scientific literature, expert evaluation, analysis and synthesis of financial and economic indicators were applied. The working out of the technique is also based on the methods of modelling the business processes, business value, capital costs, etc.

1. Investment projects. Key aspects of analysis and assessment

The process of adopting investment decisions consists of many phases and is implemented through investment projects. A duly prepared investment project is a tool for all the participants and stakeholders of a business idea, by means of which objectives are defined and measures to achieve the objectives are described. The overall efficiency is assessed by specific economic methods, on the basis of which a proposed project is accepted or rejected. Thus, the quality and proper management of the process of preparing and implementing an investment project is of utmost significance for ensuring successful business development and a constant growth of investments in the national economy.

A project is a sequence of interrelated events which take place in a certain period and are designed for achieving a unique and clearly defined result. A project can also be described as a unique study having a clearly defined objective, limited resources for achieving this objective and set start and end dates, and comprising several interrelated activities (Bivainis et al., 1997; Ali auskas et al., 2005; Turner, 1999; Kerzner, 2001), or as a temporary activity the purpose of which is to create a unique product or service (PMBOK Guide, 2004). Three main distinctive characteristics of a project can be identified: 1) uniqueness of activity (a combination of the field of activity, means, tasks and other factors making a project unique); 2) limited resources (time, personnel, money, etc.); and 3) defined objective (a specific measurable result being sought) (Lessel, 2007).

An investment project can be analysed in two ways. In the narrow sense, an investment project is a set of documents in which the objectives of an investment project are defined, its results are analysed, its efficiency is appraised, and a detailed implementation plan is described (Turner, 1999; Brigham, Ehrhardt 2002; Ковалев, 2000). The Republic of Lithuania Law on Investments provides a similar definition of an investment project. The law states that an investment project is a document that substantiates the purposes of investment financially, technically and socially, determines return on investments (in

case of commercial projects) and other performance indicators, and identifies funds and financing sources for the implementation of the project (Republic of Lithuania Law on Investments No. VIII-1312 of 7 July 1999). In the broad sense, an investment project can be defined as a plan of actions aimed at attaining the objectives of a project (Helfert, 2001). This description matches the aforesaid definitions of a project best, and in this paper the term “investment project” is used in the broad sense.

Since an investment project is a unique set of different actions and means, it should be divided into individual objects of management (Теплова, 2008). Project management requirements (including those applicable to investment projects) are defined in the standards published by the International Organisation for Standardisation (ISO). Thus, ISO 10006 „Guidelines for Quality Management in Projects“ (the standard adopted in Lithuania LST ISO 10006:2008 “Quality Management Systems. Guidelines for Quality Management in Projects“ is equivalent to ISO 10006:2003) contains the key requirements for all phases of project preparation and implementation. Project management processes and product quality assurance require a structured and consistent approach, ensuring that the needs of consumers and other stakeholders are understood and met. The standards do not specify which processes are necessary for project management; however, guidelines for the required components of the potential processes are provided.

In practice, investment projects can be evaluated from very different standpoints, and this process is usually called project analysis or expert examination (Бланк, 2006; Lessel, 2007). A project efficiency appraisal itself can sometimes become an object of analysis or expert examination, even though such appraisal is made after completing the examination of other aspects. The types of evaluation can differ significantly:

- an analysis of an investment project’s efficiency consists of an analysis of data and design documentation; any other available information is adopted as it is, assuming that its reliability and accuracy are sufficient for the analysis;
- an expert examination of a project has a different task – to determine whether the available information is reliable, accurate and complete (Виленский et al., 2004).

It is proposed that an analysis of an investment project’s efficiency should be made in three stages: 1) appraisal of the efficiency of a conventional static project; 2) risk and uncertainty assessment; and 3) preparation of a feasibility study for the project (Richardson, Richardson, 1992; Turner, 1999; Cibulskienė, Butkus, 2007). The authors have identified three factors that determine the complexity and content of the analysis: uncertainty, significance of the project for a company, and the amount of information required for the analysis.

As we see, in addition to a certain consistency of appraisal, the scope of analysis is defined. For projects with a low significance and uncertainty, conventional methods of efficiency appraisal are sufficient and, vice versa, projects of particular significance,

characterised by a high degree of uncertainty, require an in-depth analysis in the preparation of a technical feasibility study.

It is obvious that the larger the scope of the project, the greater responsibility has to be assumed by parties involved in its implementation. In any case, a comprehensive analysis of a project must be made, forming a basis for the determination of the degree of responsibility for the adoption of decisions and for the control over implementation of the project. On the other hand, the factor of uncertainty related to different obstacles and difficulties is present in any project. Therefore, it is difficult to exactly determine the economic efficiency of a project. While there are certain rules for risk assessment, often the decisions are based on intuition (Mackevičius, 2007).

Project life cycle is another important factor in the investment projects' analysis and appraisal. The content of project analysis and the accuracy of appraisal change depending on the project implementation phase. In the initial phases, when there is a shortage of information and the project has not been fully defined as yet, only a preliminary appraisal is possible; the purpose of such appraisal is drawing a general conclusion on the expediency of the further development of the project (Mackevičius, Tomaševič, 2010; Теплова, 2008; Kerzner, 2001).

After investors and other stakeholders confirm their intentions concerning the further development of the project, a need to have more information on different aspects of the project's implementation arises. The need is met by a technical feasibility study in which financial and economic aspects of the project are examined in detail and an assessment of related areas is provided. In the operating phase of the project, the purpose of analysis is related to operating issues, and the analysis allows obtaining information necessary for management decision-making. On completing the project, there is a need to receive a summarised information on the results of the project, to compare the results with the targets, and to obtain valuable information for the future investment decisions.

Despite significant differences among various investment projects in terms of their objectives and implementation means, appraisal of projects' efficiency must be based on the same principles. They can be grouped as follows (Виленский et al., 2004):

- methodological principles – most general principles of appraisal, the application of which depends on the reasonable behaviour of entities irrespective of the objectives or types of projects;
- methodical principles – principles ensuring the economic justification of the project's appraisal and decisions adopted on its basis; and
- operating principles – application of these principles will facilitate and simplify the appraisal procedures and ensure a sufficient accuracy of the appraisal.

Based on the above principles, a model for the appraisal of the efficiency of an investment project of any complexity can be developed. The structure of the model, the methods used and the scope of analysis are determined by specific requirements set by

the appraiser or the customer and by the specific character of the project. Development of a more sophisticated dynamic model is usually started from determining and forecasting the project's cash flows. The further assessment of cash flows is based on the same methodological, methodical and operating principles. The complexity of the analysis also depends on the availability of information and the objectives of the analysis.

A forecast of economic, social and other results of an investment project takes into account all internal and external factors that constitute constraints of the project. It should be noted that the longer the period of an investment project, the more difficult is the assessment of future environmental factors and the forecast of participants' behaviour and the financial-economic result of investment process (Ryan, Ryan, 2002);. Therefore, dividing an investment project's implementation process into interim phases is expedient. The concept of a project's lifecycle can be used for this purpose.

2. Requirements for the architecture of the model for the appraisal of investment projects' economic efficiency

Investment decisions have to be adopted quickly (otherwise one might lose the opportunity to occupy a free market niche or make use of other circumstances for which timing is crucial), accurately (otherwise a project might be loss-making), and at the lowest cost possible (as expenses for an investment decision adoption process may vary from 0.2 to 3% and are deemed to be lost investment) (Виленский et al., 2004; Ustinovičius, Zavadskas, 2004).

To comply with these requirements, methodical and technical measures as well as effective algorithms joining these measures into a single system, i. e. a model, are necessary. Any model is an abstraction of reality of a certain level of detail, reflecting

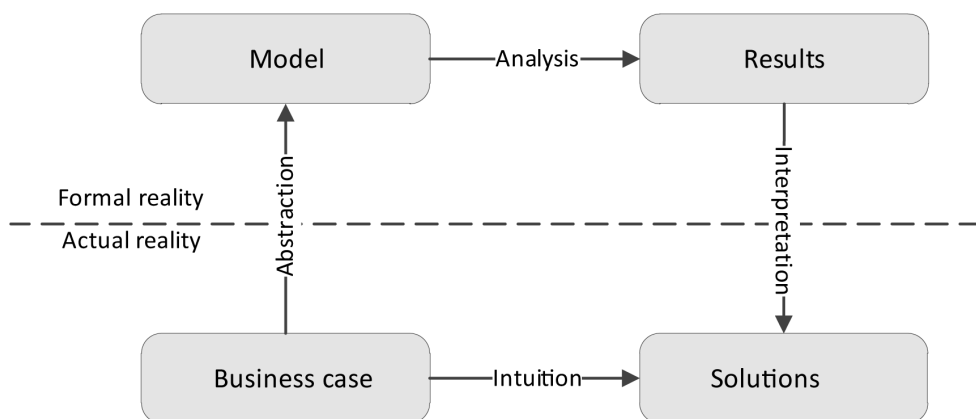


FIG. 1. Modelling process

Sources: compiled by the author based on Ginevičius, 2009; Жапов, 2008.

its developer’s understanding of the causal relationships in the real world (Tjia, 2009; Swan, 2005). A model has the following characteristics: 1) it always simplifies reality to a larger or smaller extent; 2) its accuracy should ensure that (a) the result meets the minimum requirements set by the appraiser; (b) the level of detail is determined by data availability; and (3) its analysis requires an amount of time not larger than the time available to the appraiser (Жапов, 2008).

Development of a model is particularly important in cases when the situation is most uncertain and its prospects are unknown (Ginevičius et al., 2009). The chart below shows a modelling process that has been conventionally split into two parts: the lower part depicts the actual reality (a specific business case with potential solutions) and the upper part represents a formal simplified reality imitating the functioning of the former.

Modelling does not represent a strictly defined research method. In addition, models of any type are developed by people as no expert systems (except for very narrow areas) to automate this process exist. Therefore, some authors (Swan, 2005; Tjia, 2009, Дубина et al., 2004) relate modelling to certain creative abilities and art. Figure 2 shows the main phases of developing a model, used for business models of different complexity.

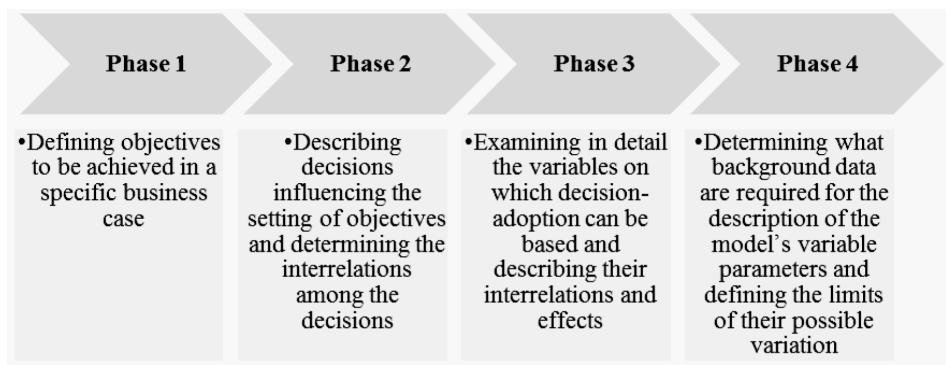


FIG. 2. Main phases of developing a model

Sources: compiled by the authors based on Tjia, 2009.

In practice, models are extremely diverse; therefore, an abstract model of general nature has been described. A more detailed classification of models according to their business functions, subjects, industries and other features is provided in Table 1.

According to the above classifications, the model developed by the authors can be classified as a financial, economic, strategic or tactical model (taking into account the phase in the lifecycle of a project being considered), which is, at the same time, a determined model with a probability analysis of certain parameters. If a model is treated part of a company’s information system, it can be attributed to the efficiency management system (EMS) of the company (Petrauskas et al., 2009).

TABLE 1. Classification of models

Classification	Examples
By business functions	Financial, marketing, cost accounting, operational models
By subject	Research, technical, economic models
By industry	Military, transport, telecommunications, public sector models
By time interval	For a time interval, for more than one time interval
By organisational level	Strategic, tactical, operational
By mathematical properties	Linear, non-linear
By method of depiction	Spreadsheets, calculators, software
By level of definition	Determined models, probability models

Sources: Теплова, 2008; Жаров, 2008.

The following minimum model requirements have been identified according to the general model formation principles described above:

- correct representation of economic logic and business processes;
- control by pre-set input parameters; and
- maximum automation, i. e. the pre-set parameters can be changed automatically, without additional manual calculations or auxiliary measures leading to a change in the results.

An investment project is a complex multi-stage process covering different aspects of a company's operations; therefore, a model for its appraisal must consist of several modules, which can be analysed individually and which have their inner logic with the input and output parameters.

Another important factor in developing a model for the appraisal of investment projects is the model architecture which must have a linear form. The linear form of a model is understood as consistency and a phased character of analysis rather than the mathematical expression of the methods used.

Maximum automation is one of the key requirements for an investment project appraisal model. Even the most advanced appraisal algorithm, if used manually, cannot serve as a proper tool for a reliable analysis and appraisal of investment projects due to its static character, high probability of errors and other factors related to data processing, presentation of information, and data exchange.

3. Model recommended for evaluating the economic efficiency of investment projects

The recommended model for evaluating the economic efficiency of investment projects is presented in Fig. 3. It is proposed that the evaluation should be a three-phased process:

1. Developing the project's financial model.
2. Selection and application of the method for evaluating the project's investments.
3. Analysis and interpretation of results and drawing up of conclusions.

Each stage is further divided into 2–3 substages called modules describing larger groups of evaluation actions which, in their turn, comprise individual steps.

While all the three stages are closely interrelated, the necessity of each of them is determined by several aspects. Each stage requires different types of information, qualifications of analysts, and participation of decision-makers. The methodological basis differs from stage to stage as well. The first stage is based on the theoretical grounds of corporate economics, accounting, working capital management and efficiency assessment. In the second stage, financial management and investment efficiency evaluation methods are applied. The third stage requires knowledge of strategic, risk and investment management as well as practical experience.

The individual stages of the model and their components are shown in Fig. 4–6. As shown in the figures, each stage consists of a number of internal procedures which have also been structured and described. This enables the application of the model for evaluating investment projects in economic sectors by interest groups that differ in complexity and value. The model can be considered to be a universal tool assisting in making an objective financial and economic evaluation of the investment concerned; however, there are certain assumptions underlying the reliability of the results. The most general of them are: 1) reliability and sufficiency of baseline date; 2) a correct description of internal processes of the investment project; 3) reliability of forecasts; 4) correct description of the main risks; 5) commercial focus of the investment project (only some of the model’s procedures are suitable for public (non-commercial) projects).

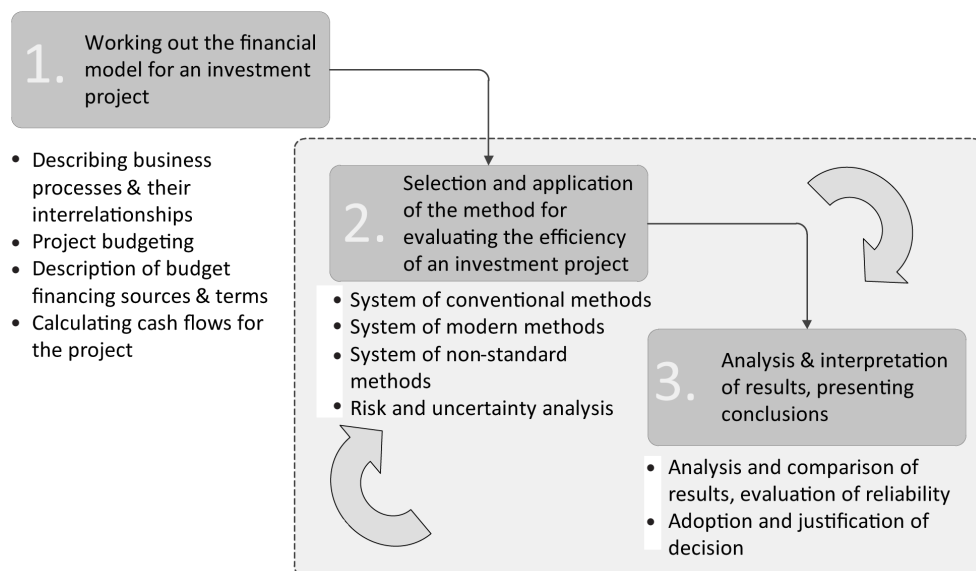


FIG. 3. Model chart and main evaluation stages

Source: compiled by the authors.

The recommended model is highly formalised; this reduces the influence of potential artificial corrections. However, a full elimination of subjectivity or elements of expert evaluation is neither possible nor expedient (in particular, for the purposes of long-term forecasts).

The purpose of Stage I in the evaluation is to develop a financial model for an investment project, enabling the description of the projected business processes and the determination of cash flows on their basis (Step 1.1). In the financial model development phase, attention should be focused on the correct description and presentation of the project's business processes.

The next step (1.2) is of a more technical nature and involves the preparation and entry of basic data required for the calculations. Normally, source data are not suitable for use in a model; therefore, additional calculations are required to form the requisite data structure. It should be emphasised that Steps 1.1 and 1.2 are related to Step 3.1 when the project's cash flow calculation method is selected. Where the cash flows are to be calculated based on the scenarios of the company's operations "with the project" and "without the project", all the algorithms must be adapted to the company's operations as a whole. Thus, the scope of the basic data varies depending on the option. Business development projects that provide for a release of a new product or launching a new activity should be evaluated based on the direct cash flow calculation method.

Stage I, Model 2 includes two steps: Step 2.1 – drawing up the project's budget and a detailed investment schedule; Step 2.2 – description of the project's financing structure and conditions. It is very important to draw up the budget execution plan as accurately as possible and to define a specific financing structure. These parameters determine both the distribution of cash flows in time and the discount rate; therefore, they have a direct effect on the result variables (NPV, IRR and other indicators of investment efficiency).

A successful implementation of Steps 3.1 and 3.2 is determined by a correct completion of the previous tasks. With an appropriate modelling of business processes and having data sufficient for the description of the requisite parameters, the calculation of cash flows and their allocation to different activities are not a complicated task in the presence of techniques worked out for its carrying out. Therefore, Step 3.3 is the most important among Steps 3.1 to 3.3 as it analyses the effect of different factors upon the project's cash flows. It is important to identify the factors that can have the strongest effect on the characteristics of the project's cash flows and to examine thoroughly the effect.

Stage II involves the selection and application of the methods for evaluating the efficiency of investments. It is comprised of two modules that describe the aspects of methods' selection and risk assessment: 1) different methods to evaluate the efficiency of investments are applied; 2) a risk and uncertainty analysis is made.

The investment project evaluation methods and the relevant techniques proposed by the author form a basis for the implementation of Steps 1.1 to 1.3. The systems of

traditional and non-conventional methods aimed at value creation can be applied as auxiliary ones. This is because non-conventional methods result in over-simplification, and the results obtained do not reflect the real situation, whereas the methods focused on value creation are not widespread in practice (in particular, in Lithuania) and their results are very rarely used as a basis for decision-adoption.

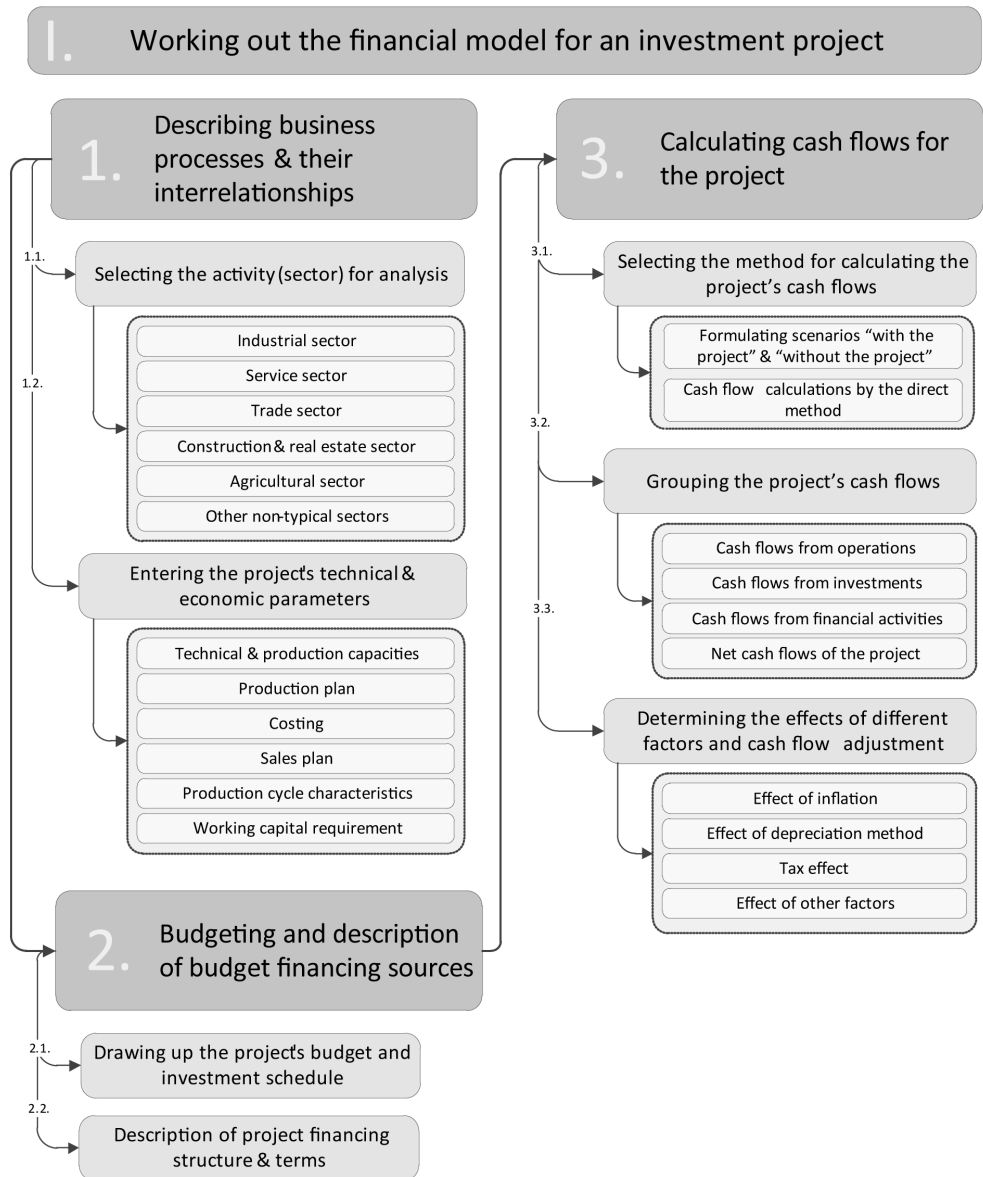


FIG. 4. Stage 1 – working out the financial model for an investment project

Source: Tomaševič, 2010.

III. Selection and application of the method for evaluating the efficiency of an investment project

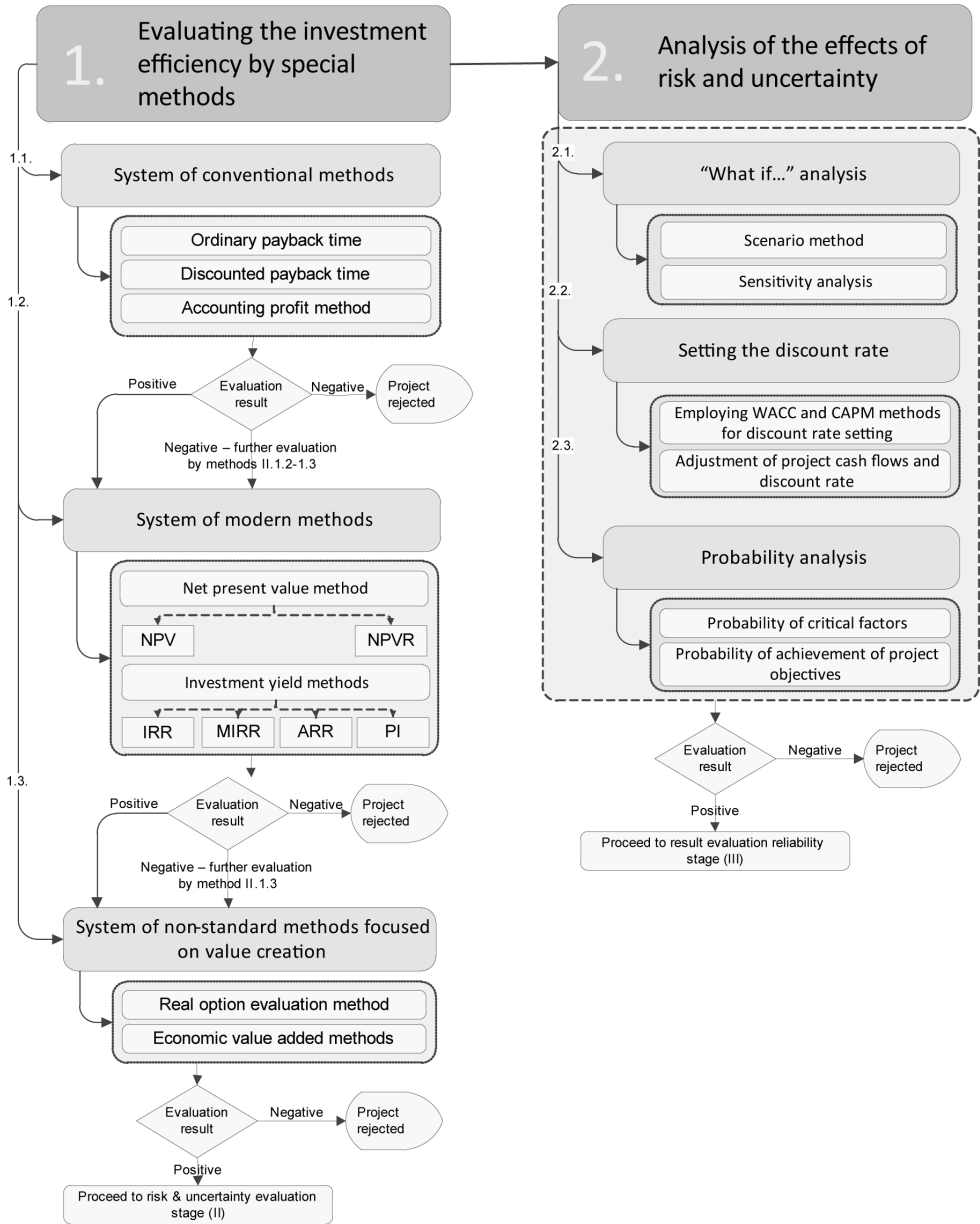


FIG. 5. Stage 2 – Selection and application of the method for evaluating the efficiency of an investment project

Source: Tomašević, 2010.

The risk and uncertainty analysis (module 2) is also rare in the investment project evaluation practice in Lithuania, even though in this case the reason is the lack of specific knowledge and requisite data rather than the disregard of the risk factor itself. Nevertheless, a risk analysis must be made even for the smallest projects whereas, when complex infrastructure, research and development projects are concerned, elimination of the risk factor raises doubts as to the results of evaluation of the entire project. Analysis of this type should be made as follows: Step 2.1 – analysis of the type “what if” which

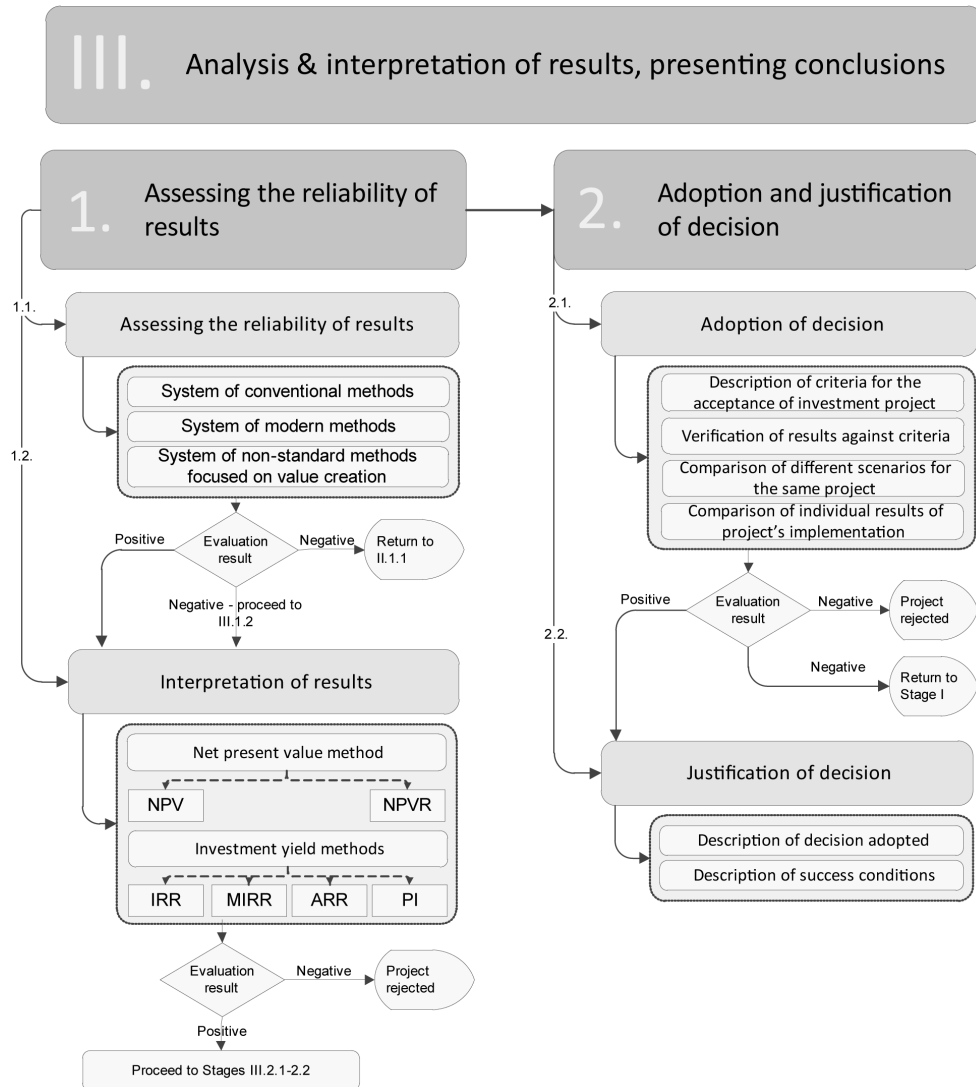


FIG. 6. Stage 3 – analysis & interpretation of results, presenting conclusions

Source: Tomaševič, 2010.

includes the assessment of sensitivity, scenarios and non-loss-making; Step 2.2 – setting of discount rate; Step 2.3 – probability analysis.

In Stage III of the evaluation, analysis of results is made and the final conclusion on the expediency of implementing the investment project is reached. Even though this is the last evaluation stage, actually Stages II and III are cyclical ones, i. e. a certain evaluation method is applied in the analysis of an investment project and the result is analysed in detail. The entirety of such interim results forms a basis for the formulation of conclusions.

The final Stage III involves two modules: 1) analysis, comparison and evaluation of reliability of the results; 2) adoption and justification of the decision. In Step 1.1 of this module, the results are analysed and compared, and their reliability is determined. All the main assumptions are reviewed and the critical factors influencing the results are considered. The probability of changes in the project's critical parameters is assessed and the correctness of the selected basic values of the parameters are checked. If the answers are positive, the evaluation proceeds to Step 1.2 in which the interpretation of the verified results takes place. A project report is drawn up; it details the main calculation assumptions and the main evaluation results. The obtained values are interpreted and explained in detail, and the results of different project scenarios are compared. Upon concluding such a preliminary project report, the final decision on the expediency of the project is adopted in Step 2.1.

This step usually involves all the stakeholders of the project, to whom the project is presented; the underlying assumptions are overviewed, and the evaluation results are examined in detail. If the results are satisfactory to all the parties, the evaluation phase is closed, reports and minutes are drawn up, and decisions on the further implementation of the investment project are adopted. In case the results raise well-founded doubts for any of the parties or all the parties agree that they are not satisfied with the results, a decision on the recalculation of the results is adopted or the project is rejected as an inefficient one.

4. Practical applications of a the model

A computer-aided version of the model was used for practical investigations. The investigations were aimed at determining the practical applications of the theoretical model and at making corrections as necessary.

The recommended model is largely automated and adapted to the resolution of various tasks related to the analysis and evaluation of investment projects. As each business process is quite unique, the model cannot be fully automated; however, type solutions for individual economic sectors and groups thereof have been developed: production, trade, real estate development, service provision and agriculture. A summarised version has also been prepared for other economic sectors, facilitating their analysis and evaluation.

In order to examine the model's applicability and specific features with respect to the above-mentioned sectors, an additional research of the sectors' investment projects has been conducted. To sum up the results of the model's practical applicability analysis, the following limitations can be identified:

- insufficient risk assessment and analysis tools (lack of imitation modelling functionalities, probability analysis solutions require improvement); there are no possibilities for evaluating the formation and efficiency of investment project portfolios;
- no statistical-econometric evaluation of forecasts is provided;
- insufficient algorithms in the model for evaluating the weighted capital costs and capital assets.

At the same time, the model has a number of advantages, the main of them being the following:

- typical solutions for certain economic sectors facilitate and speed up the initial phase of analysis and appraisal of an investment project, when the formation of its financial economic model takes place;
- effective and functional algorithms enabling an accurate (to the accuracy of a calendar month) description of the budget and financing sources of the investment project have been created;
- convenient tools for the sensitivity and scenario analysis; possibility to determine the dynamics of costs and selling prices over the forecast period by income and cost items;
- automated generation of main financial statements (balance sheet, profit and loss account, and cash flow statement); a functional algorithm for the calculation and graphic professing of a company's performance indicators;
- generation of automated reports to MS Word environment, which speeds up the process of description of an investment project and minimises the probability of technical errors.

Along with algorithms for typical business processes in different sectors, a computer-aided model can be used in both Lithuanian and foreign companies. This is because:

- the projected financial statements generated by the model comply with the National Business Accounting Standards ("VAS") and the International Accounting Standards (IAS);
- the model is a multi-lingual one (currently, there is a choice of four languages – Lithuanian, English, Russian, and Polish);
- different tariffs of main taxes and contributions (social insurance contribution, profit tax, real estate tax, income tax, value added tax, etc.) can be used, and the taxable base can be adjusted.

Additional investigations into investment projects in the main economic sectors have been conducted in order to analyse the model's constraints and the specificity of its application in the sectors.

The model for the appraisal of economic efficiency of investment projects can be successfully used in the activities of both private and public profit-seeking entities, business consultancies, commercial banks and other financial institutions, etc. All the steps of the appraisal process described in the model have a clear algorithm; therefore, the application of the model is not complicated, even though it requires special knowledge in the area under examination. Requisite methodologies have been formulated for the main appraisal phases (cash flow computation, setting of a discount rate, selection and employment of a method for the appraisal of economic efficiency). These methodologies can be applied both in the use of the recommended model and as an independent tool for the analysis of specific business cases.

Conclusions

Despite significant differences among various investment projects in terms of their objectives and implementation means, the appraisal of projects' efficiency must be based on the same principles. They can be grouped as follows: methodological principles, methodical principles, and operating principles. Based on the above principles, a model for the appraisal of the efficiency of an investment project of any complexity can be developed. The structure of the model as well as the methods used and the scope of analysis are determined by specific requirements set by the appraiser or the customer and by the specific character of the project. Development of a more sophisticated dynamic model is usually started from determining and forecasting the project's cash flows. The further assessment of cash flows is made by the same methodological, methodical and operating principles. The complexity of the analysis also depends on the availability of information and the objectives of the analysis.

Based on the examinations involving the theoretical and application aspects of the analysis and the evaluation of investment projects, i. e. the investment project's life cycle model, the cash flow calculation and the discount rate setting methods, as well as the main and auxiliary methods for evaluating the investment projects' efficiency, a model for the evaluation of investment projects, which enables the analysis and selection of alternative investment projects, has been developed.

The proposed model consists of three stages which show also the sequence of the analysis: 1) working out the financial model for an investment project; 2) selection and application of a method for evaluating the efficiency of an investment project; and 3) analysis and interpretation of the results and presenting conclusions. Each phase consists of several internal procedures which have been structured and consistently

described within the framework of the technique. This allows applying the model for the analysis of investment projects differing in their complexity, value, sector or interest groups in order to achieve an objective financial and economic evaluation.

A computer version has been developed within the theoretical framework of the model, which enables a detailed evaluation of investment projects in five main sectors. A market analysis of similar software products has shown that, although most products are multilingual, the other country-specific parameters are lacking (such as tax accounting requirements, accounting standards, etc.), as is also the mechanism of their entry and calculation. As there is no commercially available product in Lithuania with the investment product evaluation functionalities taking into account the peculiarities of national legislation, business environment and other specific parameters, the model can become an alternative to software products currently offered by foreign companies.

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