PROJECT MANAGEMENT RISK ASSESSMENT - AN OVERVIEW OF THE METHODS

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Abstract: Risk management is one of the key element in project management processes. There are numerous tools available to support the various phases of the risk management process. Issues related to project risk management are widely analysed both by national and international centres. The aim of the article is to present selected methods of project risk assessment. The methods will be characterised through prism of five basic areas: operations research methods, simulation methods, probabilistic and statistical methods, sensitivity analysis and efficiency adjustment methods.

Keywords: project risk assessment, project management methods, project management

1 Introduction

Risk management is one of the key element in project management processes. There are numerous tools available to support the various phases of the risk management process. What is more, risk management assures that almost all problems are discovered early enough so that there is time to recover from them without missing schedules or overspending the budget[1].

Within the currently accepted view of project management as a life cycle process, project risk management (PRM) is seen as a process that accompanies the project from its definition planning, through its execution and control phases up to its completion and closure[2].

Rodrigues-da-Silva and Crispin points out that a process of risk management in projects is a rational chain of practices taken by decision-agents in order to keep the implementation of the project under certain conditions. As a result the decidents need to identify, analyse and evaluate the risks and use their organizational structure and administrative practices in order to act on the risks in favor of the project. That is way the analysis and assessment of project risk is essential for project success.[3]

The aim of the article is present selected methods of project risk assessment. The methods will be characterised through prism of five basic areas: operations research methods, simulation methods, probabilistic and statistical methods, sensitivity analysis and efficiency adjustment methods.

2 Literature review

Issues related to project risk management are widely analysed both by national (Kuchta, Skorupka, Górski 2012, Skorupka 2003, Tarczyński, Mojsiewicz 2001, Wiśniewski 2007) and international centres (Peixoto et. al. 2014, Tamak&Bindal 2013, Raz&Michael 2001, Larson&Grey 2011, Teller&Kock 2013, Fortune et al. 2011, Schroeder&Hatton 2012).

According to T. Raz and E. Michael the management of risk in projects is one of the main topics of interest for researchers and practitioners working in the area of project management[4]. Williams[5] confirms this trend with survey on the topic of project risk management, in which there were included 241 literature references. Boehm[6] suggested a process consisting of two main phases: risk assessment, which includes identification, analysis and prioritization, and risk control, which includes risk management planning, risk resolution and risk monitoring planning, tracking and corrective action. Fairley[7] presents 7 steps. Chapman and Ward[8] outline a generic PRM process consisting of nine phases.

Elkington and Smallman claim that project risk management is essential for the project's success[9]. Accoridng to Leung, Tummala and Chuah the formal risk management approaches can provide a useful insight into the project and provide more information to improve the quality of investment decisions.[10]

3 Risk assessment methods

There are many methods of project risk assessment and the criteria for its classification. However, the most transparent and comprehensive division seems to be the one presented by Ostrowska[11]. The proposed division consists of five areas: operations research methods, simulation methods, probabilistic and statistical methods, sensitivity analysis and efficiency adjustment methods. All the areas will be listed and explained below.

3.1 Operations research methods

Operational research methods allow you to find the optimal solutions. As for the risk assessment analysis the most popular methods are Critical Path Method (CPM) and PERT method. However, Ostrowska argues that game strategy also deserves an attention, while it takes into account different combinations of uncertain factors[12].

Critical Path Method (CPM)

CPM was first developed in 1957 by Morgan walker of the Engineering Services Diivision of DuPont and James Kelly of Remingto Rand. At present, CPM is widely empoyed in different areas of industrial activities[13].

CPM is a deterministic approach, where only one time estimate is used for each activity, and there is no statistical treatment of uncertainty. This method includes a mathematical procedure for estimating the trade-off between project duration and project cost. It features analysis of rellocation of resources from one job to another to achieve the greatest reduction in project duration for the least cost.[14]

Program Evaluation and Review Technique (PERT)

Pert is used to track the planning activities required to complete a large-sale, nonrepetitive project. This method was developed in 1958 by the US Department of Defense to assist with the Polaris submarine launch balistic missle project. PERT has the potential to reduce the time and cost required to complete a project because activities can be sequenced efficiently. It is useful when

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certian tasks have to be completed before others if the project is to be completed on time.[15]
The use of PERT has decreased sharply in recent years, according to Meredith and Mantel, due to the fact that large majority of project management software generaes CPM networks. All in all, the two methods are quite similar and often combined for educational presentation.[16]

3.2 Probabilistic and statistical methods

These methods are based on probability and statistical data. The probabilistic and statistical risk assessment methods are based on the assumption that the different results of the calculation of benefits can be attributed to different probability of their occurrence in a given period of time[17]. The basic values used in this methods are based on: the probability of occurrence of certain factors, standard deviation and variance. These methods are used to analyze the risk of implementation and realisation of the investment. A popular tool used by the probabilistic and statistical analysis of investment risk is a decision tree.[18]

Decision tree is a graphical method of expressing, in chronological order, the alternative actions that are available to the decision maker and the choices determed by chance[19]. Decision tree method is a technique for assessing the effectiveness of the investment project particularly useful in projects of multiple execution phases, in which uncertainty is resolved at specific points in time.[20]

The advantage of the decision tree is undoubtedly the organisation and representation of complex investment projects and assignment of weights to decisions taken during the entire project life cycle[21].

3.3 Sensitivity analysis

The sensitivity analysis (what if analysis) is used for identification of risk span and its limitations. Its purpose is to determine the relevance of the possible consequences of changes in the value of output variables and their impact on the project[22]. It is a cost-effectiveness analysis of the investment project with the assumption of deviations of the different variables included in the project[23].

The main tool of sensitivity analysis is break even point (BEP) of the investment and payback period of capital expenditures. In addition, safety margin associated with the project is also determined, and as a result the comparative analysis of critical values of the different options is assessed.[24]

Sensitivity analysis involves two major steps. In the first one, scenarios describing the value of each variable in the future are being defined – usually 3: optimistic, pessimistic basic. According to Rogowski and Michalczewski in the second stage, for the tested scenarios, cost-effectiveness measure (usually NPV) is determined.

The sensitivity analysis constitutes a starting point for scenario analysis[25], which uses information previously obtained. According to Larson and Grey scenario analysis is the easiest and the most commonly used technique for analysing risks. In this method each risk event is assessed in terms of: probability of the event and impact of the event. In other words, risks need to be evaluated in terms of the likelihood the event is going to occur and the impact of consequences of its occurrence.[26]

3.4 Simulation methods

Simulation methods are used wherever it is difficult to study real objects or processes. They give possibility to investigate the influence of several variables on the efficiency of investments and the ability to simulate the risk.[27]

The principal advantage simulation methods is the ability to simulate multiple studies of the same object or process, due to the presence of the same parameters. A major disadvantage is the need for a very good representation of reality through mathematical models. This leads to a situation where time is of the research process definitely disproportionate to the time of preparation of the research opinion. The result of the application of simulation methods can be the identification of risk factors impact on the project.[28]

The most commonly used simulation method is Monte Carlo simulation. The concept of using Monte Carlo simulations to analyse the project is based on identifying the selected input variables in the model used to measure the efficiency of calculation.[29]

Simulation methods in contrast to the sensitivity analysis and scenario analysis allow to examine of the impact of all, less and more complex, combinations of variables on the effectiveness of the project, not only each variable individually.[30]

3.5 Efficiency adjustment methods

According to Skorupka, Kuchta and Górski efficiency adjustment methods of investment projects are well formalized and applied in practice. The effectiveness of these methods depend on the correctness of the assessment of the effectiveness of projects (performed using NPV and IRR).

There are two most commonly used efficiency adjustment methods: Certainty Equivalent method (CE) and Risk Adjusted Discount Rate.

Risk Adjusted Discount Rate (RADR)

The risk adjusted discount rate method calls for adjusting the discount rate to reflect project risk. Accoridng to Dayananda this

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method seems to be most frequently used by practicioners31. Three situation can be observed:

1 the risk of the project = the risk of the existing investments of the firm → the discount rate used is the average cost of capital of the firm,
2 the risk of the project > the risk of the existing investment of the firm → the discount rate used is higher than the average cost of capital of the firm,
3 the risk of the project < the risk of the existing investment of the firm → the discount rate used is less than the average cost of capital of the firm.

The risk adjusted dicount rate can be denoted as follows:[32]

$$r_k = i + n + d_k$$

where,
r_k - the risk adjusted dicount rate for project k,
i – the risk-free rate of interest,
n – the adjustment for the firm's normal risk,
$(i+n)$ – measures the firm's cost of capital,
d_k - the adjustment for the differential risk of the project k. It may be positive or negative depending on how the risk of the project under consideration compares with the existing risk of the firm.

While the risk adjusted dicount rate is calculated, the project is accepted when the net present value (based on risk adjusted dicount rate) is positive.
Despite the popularity of risk adjusted dicount rate mathod, it suffers from two major limitations[33]:
it is difficult to estimate dkconsistently (it is often determined arbitrary),
the method assumes that the risk increases with time at a constant rate.

Certainty Equivalent method (CE)

Certainty Equivalent method modifies NPV not by the adjustment of the discount rate, but by correcting the values of cash flow. Under the certainty equivalent method, the net present value is calculated as follows:[34]

$$NPV = \sum_{t=1}^{n} \frac{\alpha_t \bar{C}_t}{(1+i)^t} - I$$

where,
NPV - net present value,

$\bar{C}_t$ - expected cash flow for year t,

α_t - certainty equivalent coefficient for the cash flow of the year t. The value of the certainty equivalent coeeficient usually ranges between 0,5 and 1. Value of 1 implies that the cash flow is certain or the management is risk neutral.
i - the risk free interest rate
I - the initial investment (about which it is assumed the there is no uncertainty).
This method is particularly useful when the cash flows in different periods are characterized by different levels of risk. This phenomenon is common while predicting the value of future cash flows. Cash flows more distant in time are usually subjected to greater inaccuracy, which can be to a certain extent corrected by suitable equivalent.[35]

4 Conclusions

A number of methods are used to deal with the risk in project management process.

The degree of suitability of each method depends on the specific requirements of investors risk propensity and project background. In different projects there can be used combination of many methods or one of them.

Risk assessment methods are used to determine the size and risk measurement. At the same time it should be emphasized that the application of them determines the success of the investment.

Sensitivity analysis and scenario analysis involve „what if" analysis. Simulation analysis is used for developing the probability profile of a criterion of merit by randomly combining values of variables that bear on the chosen criterion. Decision tree analysis is useful tool for analysing sequential decisions in the face of risk. Risk adjusted discount rate method and certainty equivalent method are methods of incorporating risk in decision process.[36]

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