A BROADER VIEW OF RISK MANAGEMENT PROCESS IN PROJECTS

[1]ZOLTAN SEBESTYEN, [2]TAMAS TOTH

[1,2]Budapest University of Technology and Economics, Eotvos Lorand University

Abstract - Risks have to be managed with great care so that the final goal of delivering a successful project can be reached. The paper extends the risk management process with the value-based risk monitoring framework developed by the authors, where the primary purpose is to detect and monitor risks jeopardizing the expected project return, and if necessary, to start action plans in order to avoid losses. An important characteristic of the suggested integrated model is that it takes into consideration that risks are time-varying, that is, as time passes, the uncertainty of the occurrence of a risk changes. In this paper, the traditional risk management process is extended with the value-based approach, where risk factors are measured on a linear scale.

Keywords - Integrated Methods, Project Risk Management, Risk Management Process

I. INTRODUCTION

Project risk management is about controlling unexpected issues that might affect the level of activities in the project, or the whole project itself. Project risk management became one of the most important aspects of project management so much so that significant international organizations issued standards on it (e.g., [1]). Risk management is one of the ten competency areas in the PMI's PMBoK (Project Management Institute's Guide to the Project Management Body of Knowledge). Project risk is defined by the PMI's risk management standard as, "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives." [1] Risks have an inherent uncertainty, their occurrence is not predestined, so they have to be managed with great care. The ultimate goal of project risk management is to achieve project success. There are several issues of project success [2] that are not subject to investigation in this study. To achieve this goal, the risk management process has to serve the optimization of risks. The optimization process is responsible for balancing the probabilities and both the positive and negative impacts of risks. According to the PMBoK, a well balanced portfolio of risk requires the following steps: Planning Risk Management, Identifying Risks, Qualitative Risk Analysis, Quantitative Risk Analysis, Planning Risk Responses, Implementing Risk Responses, and Monitoring Risks [3]. Project risk management remains a relatively undeveloped discipline, therefore besides the category-based models, the methodological details for practical use are still not standardized. However, the practical side of project risk management is important, because 83% of organizations are frequently high performers in project management practice risk management, and these perform very well in reaching their goals, while at the same time only 49 percent of low performers do so, with far less success (see, [4]). The current study focuses on integrating risk management into a common risk management process. There are three principles of the proposed risk management framework. On the one hand, the suggested model takes into account the minimum requirements of the owner. On the other hand, the model has to be able to operate and perform evaluation in the whole life cycle of the project, not only in the first, risk management phase. Furthermore, it is important that the evaluation process can be conducted easily in practice without solid financial knowledge. Firstly, there is a brief survey on the traditional, category-based literature. Secondly, after this review of the traditional project risk management approaches, the process is presented with suggestions for the extension. In this section, there are recommendations how to integrate the traditional process with the value-based model. Finally, the fundamentals of the developed model are summarized.

II. TRADITIONAL PROJECT RISK MANAGEMENT CONCEPTS

The prevailing concept of risk management is about risk classification. The traditional risk management methods are widely presented in the literature [5], [6]., moreover, there are numerous industrial applications [7]–[9]. The general purpose of comprehensive project risk management is to mitigate the risks with categorization [10], [11]. Project risk management has been an area targeted by researchers from the 1950's. In the last decades, subjective elements of risks have gained more and more attention [12], [13]. Obviously, the objective, quantitative side of project risk management still remained the most intensively researched area. Derived from the traditional risk classification concept, mathematical models, such as various probabilistic (e.g., [14]–[16]), and deterministic approaches (e.g., [17]) the analytic

hierarchy process (e.g., [18]), fuzzy approximation and composition (e.g., [19]), artificial neural networks (e.g.,[20]), Bayesian networks (e.g., [21],), and Markov modelling (e.g.,[22]) are developed and applied to risk assessment. For a while, integration efforts concerning project management and other professional areas appeared, reference [23] has successfully established a relevant relationship between risk management and project management, but the time for the synthesis with other distant fields has not yet come. The paper extends the risk management process with the value-based risk monitoring framework developed by Toth and Sebestyen [24], where the primary purpose is to detect and monitor risks jeopardizing expected project return, and if necessary, to start action plans in order to avoid losses. An important characteristic of the suggested integrated model is that it takes into consideration that risks are time-varying, that is, as time passes, the uncertainty of the occurrence of a risk changes [25]. The traditional risk management process is extended with the value-based approach, where risk factors are measured on a linear scale.

III. INTEGRATED PROJECT RISK MANAGEMENT CONCEPT

From a financial aspect, the goal of a project is to achieve a higher expected internal rate of return than is possible from capital market investments with similar relevant risk. Lately, it has turned out that there are other several industry-specific objectives besides the financial ones, and these can be even more important [26]. To introduce a new approach to traditional category-based risk management from the area of the theory of finance, the harmful events must be identified. These harmful events are the financial bottlenecks, and have a negative impact on the project. On the one hand, the organization must be liquid, and has to maintain a positive cash flow (L_t) in each year (t) (1)

$$L_t = g(x_{1,t},...,x_{n,t},...,x_{N,t}) \geq 0 \qquad \forall t \in [0,T] \qquad (1)$$

n = (1,…,N) refers to the nature of the parameter, and t = (1,…,T) refers to the given time period in years. On the other hand, the debt service coverage ratio ($DSCR_t$) cannot decrease below the value (C_t) that is specified by the loan contract in each year (2).

$$DSCR_t = v(x_{1,t},...x_{n,t},...,x_{N,t}) \geq C_t \qquad \forall t \in [0,T] \quad (2)$$

The integrated model concentrates on one of the three typical harmful events. Firstly, the expected internal rate of return or the economic internal rate of return is less than or equal to the minimum requirements of the owners. Secondly, the yearly cash balance is negative. Thirdly, the yearly debt service coverage ratio is less than the specified value. In the integrated approach, risk management is based on the financial valuation of the project, and the risks are measured by the probability of the occurrence of critical deviance of the value-driving parameters from their expected values calculated in the planning phase of the project. This is the principle of the value-based financial risk management process [27]. Value-driving parameters become critical, when their deviations result in zero or negative NPV to the owners. The aim of risk monitoring is to follow some selected value-driving parameters and when they are in the intervention zone, launch the predefined action plans to restore the normal value-making process, and to reinitialize the business model.

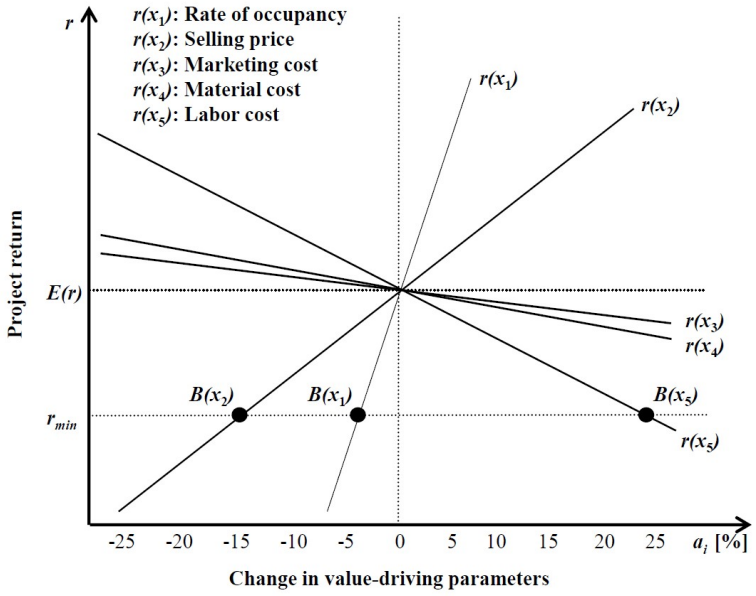


Fig. 1. Sensitivity analysis

Risk analysis is a continuous process during the whole life cycle of the project. The value-driving parameters are in the focus of the integrated process. Value-driving parameter ($x_{n,t}$) can be any arbitrary variable that can have any effect on the financial condition of the owners of the project. The economic

break-even point (B (x_n)) is the critical value of each value-driving parameter that can be determined (3).

$$NPV = \sum_{t=0}^{T} \frac{s(x_{1,t}, \dots, x_{n,t}(1 + B(x_n)), \dots, x_{N,t})}{(1+r)^t} = 0 \quad (3)$$

where r refers to the cost of invested capital, B (x_n) expresses the changes of parameter x_n that occurs evenly in every year, which makes the project's net present value equal zero. That is, a larger change in the value of x_n makes the project value-destroying. The breakeven point B (x_n) is a point of reference in the calculation of the probability that changes in parameter x_n. The question is how to find the region where the value-driving parameters are larger than B (x_n). In this case, this component becomes value-destroying, and more attention should be paid by the management. In this region, the value driving parameters may be responsible for the poor performance. Based on Fig. 1 [28], the sensitivity analyses can be conducted to select the relevant value-driving parameters describing the project's total risk the best. Based on Fig. 1, the occurrence of a harmful event can be determined. If the probability distribution function is identified properly, the probability of the value-driving parameter becoming value destroying is calculated. If the probability density function of occupancy ($f(x_1)$) is known, by integrating over minus infinity to $B(x_1)$, one can determine the probability (P) that the value of the value-driving variable is less than the break-even point (7). Thus, the variable deviates sufficiently in the negative direction to render the project value-destroying. Finally, retrieving the probability of becoming harmful to the project is the ultimate aim of this process. Let us assume that the random variable follows normal distribution in Fig.2. [29]

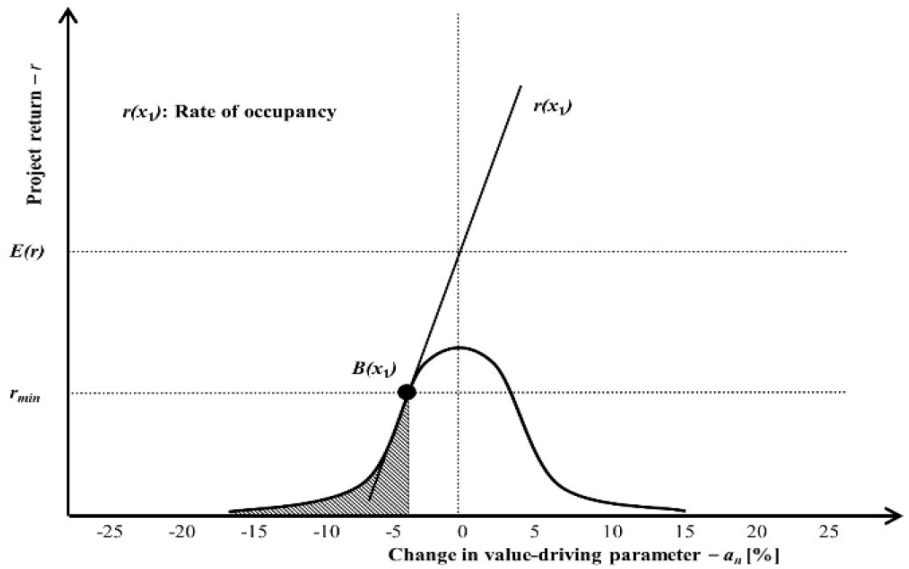


Fig. 2. Probability of the occurrence of a harmful event

The probability when changes in parameter x_n are over B (x_n) is calculated by Equation (4). The project manager is interested in the probability that changes in parameter x_n are larger than B (x_n).

$$P(-\infty < a_n \leq B(x_n)) = \int_{-\infty}^{B(x_n)} f(x_n) dx_n \quad (4)$$

IV. EXTENDING TRADITIONAL PROJECT RISK MANAGEMENT PROCESS

Let us consider the traditional risk management process, review the basic steps, and complete the process based on the integrated concept after an evaluation. In the PMI's standard work the integrated risk management of the projects are part of an organization's portfolio (or program) [3]. The owners and the managers of risks are at different levels and are in various clusters of projects. Certain risks are within the boundaries of the project, some others lie outside the project, but still inside the organization, and there are ones outside the organization. These risks must be identified and handled at the right level, and by the proper risk owner. The point in managing projects in an integrated way is to gain the highest value for a level of risk exposure, that is, the positive effects of risks should exceed the negative ones. Here it must be emphasized that the risk owner is not the owner of the project, and they have different interpretations. In our suggestion, the owner has as special a role in project risk management as in the theory of finance. Therefore, in the integrated concept, the extensions of the risk management process are based on the owner itself.

A. Plan Risk Management

In the Plan Risk Management phase, the risk management method must be selected along with the risk itself, and how important it is to the stakeholders

and participants. All the subsidiary risk plans must conform to the global project risk management plan. The degree, the type, and the visibility of risk management are defined by the scope of the process and who are involved in it. The planning process is affected by the integrated risk model. New types of risk assessment points must be scheduled, which will be part of the risk management plan. As the PMI (2017) states, the risk appetite of stakeholders including the owner is recorded in the risk management plan [3]. The appetite for risk is quantifiable and measurable. The integrated model is in line with this condition.

B. Identify Risks

In the phase of Identify Risks, all the individual and global risks are identified and documented. The organization reveals the sources of overall project risks. The identification process is a continuous activity during the whole life cycle of the project. All project stakeholders are encouraged to introduce new individual or global risk sources into the risk management process. The PMI (2017) highlights project manager, project team members, project risk specialist, customers, external experts from application area, end user, operations managers, stakeholders, risk management experts as relevant stakeholders [3]. There is no doubt that these participants have an important role in project risk management, yet the owner's significance is not outlined, as the integrated model is based on the owner's risk appetite via its minimum requirement. The risk register, which contains a list of risks with their size and complexity, differentiates the causes and effects of risks. To list the risk in the register ensuing from the owner's risk appetite is recommended.

C. Perform Qualitative Risk Analysis

The phase Perform Qualitative Risk Analysis is responsible for ranking project risks. The ranking process can be conducted in many ways, organizations even possess their own special methods, but all the methods are built on the assessment of probability of occurrence and the impact on the project. There is no difference between the principles of qualitative and quantitative methods in this sense. This process has to rank the risks by weighting the impacts with the probabilities using soft methods. One of the most important step of this process is risk categorization. Recently, widely used project risk management methods apply risk categories to identify the most important risk sources. Categorization can be conducted in several ways, finding common characteristics or root causes. Once a group of risks with the highest exposure is identified, greater attention can be paid to it. The Probability and impact matrix, and the Hierarchical charts are typical category-based tools for risk management. The Probability and impact matrix can be created for each objective. The matrix helps graphically to categorize the risks into groups in the dimensions of probability of occurrence and impact. If the categorization is conducted by three dimensions, the two dimensional matrix is insufficient. Hierarchical charts display risks in two dimensions by the two axes, but the size of a graphical figure (usually disks, bubbles) represents a third dimension (e.g., acceptance level). There are several meaningful ways of categorizing risks besides their impact (e.g., schedule, cost, quality). According to reference [30] the guiding principle for the grouping of risks is based on risk breakdown structure (RBS) or work breakdown structure (WBS), and the aim of this process is to assign the groups to proper risk management plans and actions. The RBS generally focuses on the causes of risks handled by additional management attention, while the WBS is built on functional disciplines maintained by more leadership attention and organizational involvement.

D. Perform Quantitative Risk Analysis

The multi-dimensional concept of qualitative risk analysis underlies the phase Perform Quantitative Risk Analysis. On the one hand, this phase is optional, on the other hand, the analysis is numerical here. Quantitative risk analysis enables a reliable evaluation of risks. Frequently, the quantitative process is required by decision-maker stakeholders. The prerequisite of this assessment is the availability of relevant, quantifiable ratio scale data. A fundamental question in this phase is how to analyze the collected data. The analysis is usually based on simulation that determines the effects of risks, sensitivity analysis, or decision tree analysis. In a special sense, the integrated risk assessment method is in accordance with the phase of qualitative risk analysis. Therefore, the integrated risk management process must be conducted in this phase. The categorization of risks is a typical step for performing quantitative or qualitative risk analysis. Let us refer to two up-to-date cases of how researchers established a sophisticated risk management model with risk categories. Yan et al. (2019) conducted risk assessment for the construction of urban rail transit projects. They built the assessment model on combining vague set and matter-element theory. Besides the vague fuzzy matter-element model applied for a real transit project case, the conceptual novelty of this research is a new identification matrix that merges risk breakdown structure and work breakdown structure. Risk identification is conducted either by empirical analysis methods or by the systematic safety analysis method. The empirical analysis method is supported by experts' knowledge, opinions and logical judgement. The systematic safety analysis method identifies the relationship between people, equipment and the environment (e.g., Safety Check List, Preliminary Hazard Analysis, Failure Modes and Effects Analysis, Event Tree Analysis,

Fault Tree Analysis, and naturally risk breakdown and work breakdown structure). The WBS identifies risks by systematically decomposing the work. In this case, the authors used the 4M1E (man, machine, material, method, environment) method. In the new WBS-RBS Identification Matrix, the WBS process is displayed as a column vector, while the RBS basic risk source is presented as a row vector. The whole method was developed with the use of the WBS-RBS matrix, and it has to be emphasized that the process includes the construction of risk categories. For this project, assessment indexes were identified, but there is no sign of the risk derived from the owner's point of view (operations, safety, management/communication, machine specification, machine operations, material specification/quality, material storage, planning, weather etc.) [31] Khodeir and Nabawy (2019) presented another case study about identifying key risks in an infrastructure project. The research created a full risk register via identifying key threads originated from the internal and external environment of the stakeholder's organization. This case has a specific characteristic. The project risk management process is iterative, because new risks arise during the life cycle of the infrastructure project. This type of projects involves complex category-based risk analysis. The authors identified 30 risk factors (e.g., technology, HR, quality control, planning, policy, market). This case study mentions a strong owner's perspective as well. The pace of the owner's decision making process (owner slow decision), and owner interference are in the set of risk factors to be analyzed. Although the owner as a risk management issue is taken into consideration, in this study the owner's interest is still missing. [32]

E. Final Phases

In the phase Plan Risk Responses, to address project risks, activities for the plan and documents had to be defined. The responses include reviewing options, choosing strategies, and triggering actions. Properly selected responses are responsible for exploiting opportunities, and reducing threats stemming from risks. The project team including project manager selects the sufficiently important project risks, and gives the appropriate response. The appropriate response can be selected from a set of strategies. It is important to understand what the effects of the risk in question can be. If there are threatening effects, the project manager can escalate, avoid, transfer, mitigate, or accept it. If there are opportunities, very similar tools are to be employed: escalate, exploit, share, enhance, and accept. The last two steps are the phases of Implementing Risk Responses and Monitoring Risks. The planned and agreed responses are executed here to decrease individual project threads, and to increase individual project opportunities. In this phase one of the major mistakes is that the risk management process is incomplete. The risk management process includes a throughout identification and analysis, risk plans (with lessons learned register, risk register, and risk report), but no effort and action are taken to finish it. Once the actions are initiated, the risks are evaluated and analyzed against the plan. The implementation of the risk management plan is being monitored. A proper tracking process results in decisions based on current information about project risks. Traditionally the data analysis consists of technical performance analysis and reserve analysis. The tools and techniques of monitoring are audits and meetings besides the data analysis.

V. CONCLUSION

To deliver successful projects, project risk management seems inevitable. The paper introduces the concept of an integrated project risk management process that takes an unusual aspect into consideration. The fundamentals of the model are introduced and presented. This study extends the risk management process, describes what the phases of the project risk management process are, and how to conclude the assessment with the value-based risk monitoring framework developed by the authors. In this paper, the traditional risk management process is extended with the value-based approach, where risk factors are measured on a linear scale. The suggested model handles the time-varying feature of risks as well, namely, the uncertainty of the occurrence of a risk changes as time passes.

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