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Risk management in construction projects

Paweł Szymański[a]*

[a]*Poznań University of Technology, Plac Marii Skłodowskiej-Curie 5, 60-965 Poznań, Poland*

Abstract

In the era of galloping globalization, there is no way not to talk about the risk, which has become an indispensable part of everyday life. The risk is present everywhere, in every area of life. One such area is the construction industry, where risk is ever-present element of a great puzzle. Effective risk management, does not apply to the resignation of the risk, which is seemingly the cheapest option activity. The basic problem of this option, however, is its senselessness economic, because what is potentially profitable, it is by definition risky and something that does not pose a risk, it is interesting from an economic point of view, and thus, does not bring tangible benefits. Therefore, the effective risk management will be to find a "golden mean" in its management, in relation to the implemented project. On the one hand it will involve protection against the risk of negative side, by means of detailed identification and classification of risk, resulted in a comprehensive analysis. On the other hand, the management should be based on checking the maximum benefits of these decisions, using all the tools of mathematical and analytical. A detailed analysis, taking into account all aspects of escorts, including even stakeholder analysis will allow us to effectively risk manage what the future will translate into tangible benefits for our project. Identification of project risks, based primarily on determining what its types may affect the project, together with an indication of their characteristic parameters, and estimating the probability of its occurrence on the project. These conditions can be divided into three groups: assurance, uncertainty and risk, under which, in turn, preserve the three types of investors: risk preference, neutrality toward risk and pure risk aversion and its measurement. The result of risk identification and analysis of the project, will be a list of events showing the cause and the probability of an event, and its final assessment of the impact on the environment.

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* Corresponding author..
E-mail address: pawel.s.szymanski@put.poznan.pl

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1. Introduction

In the era of progressive globalization it is hard to avoid risk, which has become an indispensable part of everyday life. Risk is present everywhere, in every aspect of our life. One of such aspects is the construction industry, where risk is an inherent element. Effective risk management does not mean the removal of risk, which would seemingly be the cheapest option. From economic point of view this option is pointless because what is potentially profitable is by definition risky and activity that does not pose a risk is not economically interesting, and thus, does not bring tangible benefits [7].

2. Identification and risk assessment

Each project is associated with risk-taking. Enterprises and institutions should be prepared for the occurrence of possible risks. Very often companies have a strong tendency to take risk at the beginning of their activity and therefore many of them become bankrupt in the first two years from their foundation. However, financial institutions and banks have very poor appetite for risk. They run their business so as to be resistant to risks because they operate the assets of their depositaries. As part of portfolio they choose to implement those projects whose variance (uncertainty) is acceptable. Therefore, before the implementation each project should undergo risk analysis performed along with the identification of possible risks. Identification of risks in construction projects is based primarily on determining what types of risks may affect the project, identifying their characteristic parameters and estimating the probability of their occurrence in the project. The need for risk identification stems from the decision-making conditions under which an investor is at the moment [1].

The result of the project's risk identification and analysis is a list of incidents showing their causes, probability and final environmental impact assessment. In 1921, Frank Knight defined clearly the difference between risk and uncertainty: *"Uncertainty is to be seen in a decidedly distinct way from the well-known concept of risk, from which it has never really been separated. (...) The main point is that in some cases the risk is a measurable magnitude, while in others it has a completely different nature; depending on the type we have to deal with there are far-reaching and fundamental differences in the understanding of this phenomenon. (...) It seems that measurable uncertainty or the actual risk, which is a term we are going to use, is so different from the immeasurable uncertainty that in consequence it does not constitute uncertainty"* [5].

2.1. Risk types and examples

The most common risk division is classified in terms of occurrence frequency and the scope of impact. In general terms, the division is as follows:

Risk in terms of frequency:

- *Systematic risk*, otherwise market risk independent of entity control,
- *Specific risk relating to specific projects*, along with all variants.

Risk in terms of impact scope:

- *Fixed risk,* concerning the whole economic system,
- *Variable risk,* otherwise non-fixed concerning a given enterprise.

Besides, we distinguish the following risk types:

- *Financial risk*,
- *Time-related risk*, risks connected with failure to implement the undertaking or individual activities,
- *Technical risk,* connected with failure to provide quality of the finished project,

- *Market risk,* risks arising from market reaction to the course and outcome of the project,
- *Nature risk*, risks resulting from the environment, an area which man is not able to anticipate,
- *External risk,* risks arising from the socio - economic environment,
- *Risk related to the human factor and workplace safety,* risks inherent in executive teams.

In a construction project risk division will refer to 5 main groups:

1. Preliminary design.
2. Tender.
3. Detailed design.
4. Construction works.
5. Financing the investment.

Preliminary design - the rejection of the project may result in loss of expenditures incurred during implementation. This is the result of the following types of risks that must obligatorily be taken by the enterprise:

- risk of poorly recognized competition,
- risk of poorly recognized preferences of the investors,
- risk of poor self-esteem,
- risk of overestimating the costs of the project (too expensive in the light of investor's capabilities).

Tender - the tender is a prerequisite for the commencement of the project. This fact determines the need for a specific approach to this stage of the construction process. This stage is burdened with the following risks [2, 6].

- risk of corruption,
- risk of tender cancellation,
- risk of bad quote for the project (defining the limits of profitability),
- risk of using predatory pricing by competitors,
- risk of incurring excessive costs (or too low) for marketing and lobbying,
- client's reliability risk

Detailed design - a stage which forms the backbone of the final project. In this stage we have the following risks:

- risk of improper design team selection,
- risk of overestimating the costs of the project,
- risk of decrease of aesthetic level (requires the knowledge of investor preferences), risk of improper technology selection (type of construction, materials).

Construction - shapes the implemented project. Risks associated with the implementation of construction works include:

- risk of protests (e.g. ecologists, local population)
- risk of badly recognized soil structure (e.g. quicksand),
- risk of bad work schedule,
- risk of equipment failure,
- risk of employees' absence (illness, strike)
- risk of employees' qualifications (employees' performance),
- risk of poor management of material resources, supplies and personnel,
- risk of timely supply of construction materials,
- risk of construction materials quality,
- risk of maintaining standards,
- risk of insufficient control,
- risk of extending the scope of work,
- risk of poor work organization.

Financing the investment - is the area covered by the greatest risk. It includes:

- risk of political instability of the country,
- risk of economic instability of the country,
- risk of inflation,
- risk of improper cost plan,
- risk of recession in the industry,
- risk of client credibility,
- risk of contract precision (change of objectives during the project, lack of precise preliminary objectives, badly defined scope of work and subject for commissioning)
- risk of law compliance and enforcement.

3. Risk planning and reacting

Planning how to cope with risk is an extremely difficult task, which needs to be undertaken already at the stage of project planning. The level of involvement at the initial phase in most cases translates into the overall risk coping process. In order to properly go through the whole process of risk management in the contract you need to begin from the same starting point, namely the development of a risk management plan. As we shall see later, this plan will appear repeatedly in various studies and research methods. The base points of such a plan are primarily the main assumptions of the project, which outline the nature and direction of the project. In the next stage you should determine the risk management policy of the company/entity to be able to allocate and define the roles and responsibilities of personnel in the project. At the same time, we independently examine the attitude of project's participants to be able to eliminate negative feelings to the project as early as possible. Obviously, it is sometimes a very difficult task because in most cases the risk is associated with the possibility of losing benefits, which as we know is a wrong theory [3, 9].

3.1. Impact of stakeholder analysis on the project

Stakeholder analysis is one of the numbers of tools of planning methods as well as risk management; although it might seem that it is the next stage of risk identification. Risk identification in this analysis is only just one element that forms the basis for further research. It is based mainly on the exact description of all parties interested in project's implementation. This applies to individuals and legal entities; the spectrum of considered individuals can and in fact should be broad. The field of activity in this matter depends solely on us. It is worth noting that stakeholder analysis also applies to groups which might be affected negatively by the project. In order to create this analysis we can use all sorts of methods such as questionnaires, surveys, community interviews. This type of analysis is characterized by strict rules including the rule of gender or origin equality. It guarantees the implementation of the project according to the best social and ethical standards. Stakeholder analysis should be carried out to meet a number of reasons affecting our enterprise:

- socio-economic characteristics;
- interests, objectives, expectations, etc.;
- sensitivity to issues related to the activities of the project;
- potential, knowledge, experience;
- implications and conclusions for the project.

Stakeholder matrix appearance and form is optional. It is important, however, that it clearly shows the key features, namely, the positive and negative influence on the project. Built on the basis of community interview risk matrix can, for example, be based on two indicators – the scale of stakeholders impact on the project and the degree of party's interest in the project. Depending on what scheme is applied, the scale of assessment may be described as in Figure 1, where the assigned symbols mean created groups characterized by the following features:

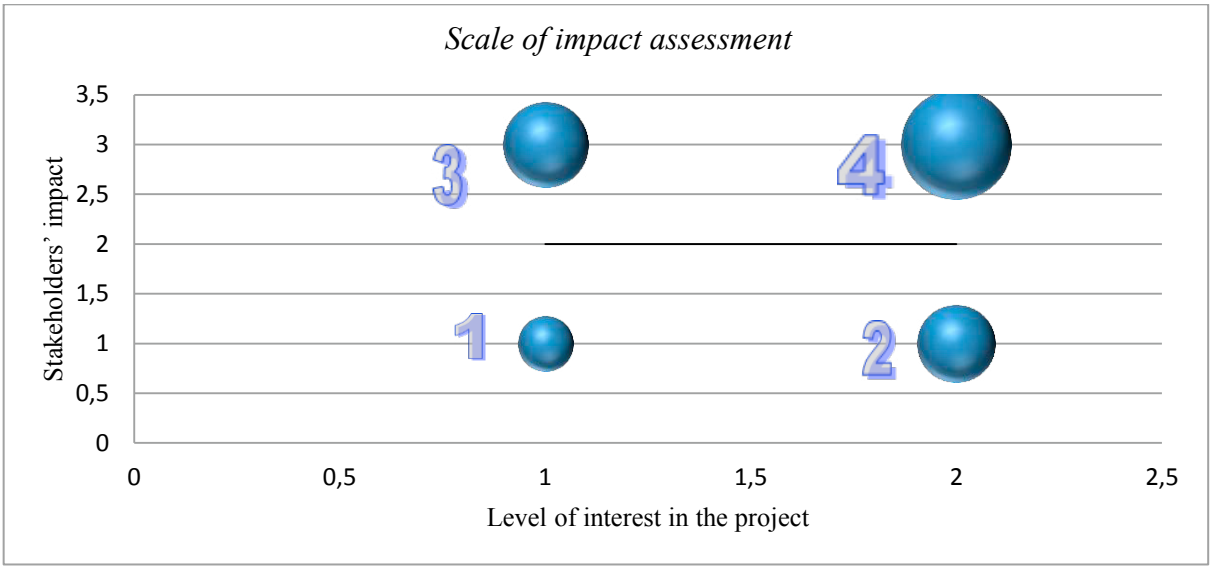

Figure 1. Example assessment scale used in risk matrix construction

1) Low interest in the project by the parties and slight impact on the project itself;
2) High level of interest in the project with slight impact on the project;
3) Low level of interest in the project but large impact of stakeholders on the project;
4) High level of interest in the project and large influence of stakeholders on the project.

Based on this kind of assessment scale we can create a risk matrix assigning all individuals to the above groups (1 to 4). In this easy and transparent manner we can obtain a group of prioritized stakeholders, both in terms of positive and negative influence on the project.

3.2. Qualitative and quantitative risk analysis

Qualitative risk analysis will be mainly based on the correct estimation of project's risk probability and scale of accompanied effects [4]. It will also help determine which of the potential hazards should be analyzed and verified first and which of them can be "put away" in time due to slight probability of occurrence. The results of qualitative analysis will form the basis for taking key decisions on which risk factors:

- require continuous monitoring including breaks for suspension of planning and decision-making concerning the classified risk;
- will be eliminated as a result of change of project's profile or complete withdrawal;
- will be transferred to another entity taking part in the project, which will be able to deal with resulting consequences;
- require compensated actions under the implemented project.

Qualitative analysis uses a number of tools in assessment and classification of risk. The most important of these include:

- indicative assessment of probability of risk factor occurrence and its impact;
- risk index assessment matrix;
- estimated assessment of risk significance to the project;
- study of project assumptions stability and project sensitivity to any changes of these assumptions;
- data ranking techniques in terms of usability for risk analysis;

- determining risk index as the resultant of probability of a particular risk factor occurrence and the significance of risk to the project in case of occurrence of a particular risk factor [7].

On the basis of that analysis we can also develop the scale of risk impact. A comprehensive risk analysis has to be accompanied by a quantitative method of analysis which will detail the considered issue. To determine risk based on quantitative analysis it is necessary to have such data as: probability of risk in a considered project that is best determined on the basis of a sufficiently large, homogeneous and reliable data sample, and valuation of risk consequences. Based on the collected information, we will determine a weighted arithmetic value, which we will treat as a measure of risk calculated by the following equation [1,8].

$$WV = \text{probability} \times \text{consequences}$$

Quantitative analysis as well as qualitative analysis may be based upon the same output data. However, the tools necessary to carry out the later vary slightly from the former but still concern the probability of risk occurrence. The quantitative analysis also helps determine with high accuracy the probability to meet deadlines or costs of the project and sets trends in the further proceedings with risks. In conclusion, it might unequivocally be stated that both qualitative and quantitative analyses revolve around the estimation of risk and its consequences. However, qualitative analysis outlines the backbone for operation, and quantitative analysis presents tangible benefits of these analyzes - figures, numeric data that are the basis for further research. Unfortunately, in practice it often happens that the tests are conducted using only one of these methods, which give an incomplete view on the matter. Therefore, for the sake of safety of performing these analyzes, as well as bearing in mind the best outcome of the studies, these analyzes should be carried out simultaneously.

3.3. Different ways of responding to risks

After classifying all risks that occur or may occur in the project actions need to be undertaken to propose specific countermeasures for each of the identified risk. These actions can be twofold. Firstly, they may aim to complete neutralization of negative impacts on the project or focus on reducing the pejorative influence. These reactions can be divided into four main groups:

- Acceptance of risk (active, passive) – involving acceptance of project's risk at a specific level. We accept all the consequences arising both from lack of time as well as financial resources.
- Transfer of risk - associated with the transfer of hazard to another entity demonstrating the ability to neutralize risk. One form of transfer is a direct transfer of losses effects to another entity. The principal form of such an activity is insurance, which allows legal transfer of occurring effects. An example of risk transfer is to commission an 'uncertain' task to the contractor or transport services to the shipping company.
- Reduction, risk mitigation - are actions that reduce the probability of an event and overcome the effects of risk, for example, through the creation of resources inventories or balancing one risk by another and thus reducing the overall risk. The principle of risk mitigation may be introduced at each stage of the project, from the planning period and organizational activities.
- Avoiding risk - involving either preventing the occurrence of risk or the removal/elimination of risk from the entire research process. In this case we do not take the risk that exceeds the acceptable level allowed by us [10].

4. Risk management and control

4.1. Management process

According to research by Brown and Chong the management process can be carried out in four different ways. However, the selection of appropriate way to respond to risk is the result of much research and conditions. Therefore, reactions presented below may serve us only as an example of how in a given situation the

investor/contractor/interested party may proceed when making decisions on emerging risks because the management methods listed and characterized below are only selected cases:

1. Avoiding risk - that is an attempt to change the current partner for the project in order to avoid the expected risk. Avoidance may also manifest itself in resigning from investing in endangered process.
2. Risk mitigation - reduction of risk by limiting exposure to it or simply by minimizing the anticipated damage.
3. Dispersion of risk – namely, the creation of such environment for the investment in which the potential risk will be able to disperse, and thus, minimize the negative effects. An example of such action may be to create a consortium to carry out the planned project.
4. Absorbing risk - that is, action to strengthen own position to be able to bear the shock associated with occurrence of certain events, risks, etc. This can be done by increasing the number of personnel, changing the location of the project, creating time buffers to undertake key actions or creating capital reserves [2].

Basically the management process consists of six phases

Table 1. Phases of risk management process

Process phases	Proposed actions
Risk identification and early warning system	- determining the causes of risk; - determining possible consequences; - identifying entities affected by risks.
Risk analysis	- determining the probability of event; - determining the consequences of event.
Formulating variants	- identifying possible alternatives; - analyzing expenditures and costs of different variants.
Risk assessment	- declaring readiness and determining ability of the entity to make decisions; - determining the actual level of risk; - qualifying the use of possible alternatives to manage risk.
Decisions and actions in the area of risk (risk control)	- choosing tools; - setting priorities; - using optimal combination.
Control, monitoring and evaluation of undertaken activities	- checking and ex post evaluation of impact of undertaken actions; - new formation of risk management process in the case of wrong decision; - further use of tools which ensured success in risk management.

4.2. Risk management cycle

Thoughtful and strategic risk management primarily maximizes the effect of positive events and minimizes the negative effects, thus increasing the chance of project's success. Effective actions are possible if we have developed a proper project management cycle. Properly adopted scheme not only help make difficult and controversial decisions but above all provide invaluable information to investors on what action to take and according to which scheme to achieve the best results with minimal effects of 'negative' risk. Below is presented an example risk management cycle consisting of four main stages:

Figure 2. Example risk management cycle.

4.3. Methods and tools in risk management

The management process would not be possible without the help of methods that are commonly available on the market. Selection of the correct method is the key action in risk management. Note, however, that to succeed we will often be forced to use a few of them in order to justify the firm conviction that our hypothesis is correct and justified. The most common methods include:

- Brain storming
- Delphi method
- SWOT analysis
- Ichikawa method
- Sensitivity method
- Modelling and computer simulations
- Risk matrix.

To fully explain the issue of tools and techniques in risk management it should be mentioned that there are a number of mathematical methods focusing on estimating the scale of risk probability. They allow primarily formalizing incomplete knowledge and analyzing the risks associated with inability to anticipate the future. However, the main methods include:

- PERT method
- Decision trees
- Probabilistic methods and probability theory
- Fuzzy sets
- Artificial neural networks

5. Conclusions

Various studies, both scientific-research as well as derived strictly from everyday life have shown that risk is a measurable entity and therefore predictable. Modern science provides us with many tools and methods to identify and measure risk such as newer and more perfect programs and systems to calculate the scale and magnitude of risk occurrence. Also our knowledge on this subject changed over the last few years. Construction companies and investors started to appreciate the tools in the form of schedules or computer analysis for effective investment

planning. It was realized that a correctly executed project plan and risk identified at the outset may at a later stage turn into success for the project. Such measures have become necessary taking into account at least the delays in the implementation of many key investments.

In conclusion, risk management in a project is not limited to noting down all the pros and cons or putting a label 'negative risk' on each disturbing and causing thrill of positive emotions event. Management is a complex, long-lasting and far-reaching process that begins long before the investment and sometimes lasts even after its completion. To wisely manage risk does not mean to avoid it but to identify it correctly and determine all associated opportunities and hazards.

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