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17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
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RISK MANAGEMENT IN TRANSPORT INFRASTRUCTURE PROJECTS

Ksenija Čulo[1], **Vladimir Skendrović**[2]
[1] *University J.J. Strossmayer in Osijek, Faculty of Civil Engineering, Croatia*
[2] *Freelance Consultant*

Abstract

Project risk management is generally seen as a systematic process whereby risks are identified, assessed and provided for. Risk management has to be an endless process consisting of phases which enable continuous improvement in decision-making and performance improvement [1]. The delivery of modern transport infrastructure projects is very complex and they require strategies that appropriately reflects the uncertainty and variety of risks they are exposed to. In addition, infrastructure projects involve a large number of different stakeholders entering the project life cycle at different stages with different roles, responsibilities, risk-management capabilities and risk-bearing capacities, and often conflicting interests [4]. The fact that risks can materialize in later stages, but have actually been caused in earlier stages, requires an end-to-end risk management view, as opposed to an individualized responsibility. Proper front-end project planning is all about shaping the project's risk profile so it can be managed during execution, and execution is all about aggressively mitigating the risks. A more comprehensive approach to risk management would address the key issues facing all parties and stakeholders involved in a transport infrastructure project [4].

Keywords: construction risks, risk management, transport infrastructure projects

1 Introduction

Project risk management is generally understood as a systematic process whereby risks are identified, assessed and provided for. This function involves a deliberate sequence of risk assessment followed by risk treatment. However, this process has to be continuous and endless. The first step in the project risk management process is risk assessment consisting of two phases: risk identification and risk analysis. Risk identification is the phase during which threats, weaknesses and the related risks are identified. To ensure that no risk is unintentionally excluded, this process has to be comprehensive and systematic. It is very important that during this phase all risks are identified and recorded, regardless of the fact that some of them may already be known and likely. The first step is to create a comprehensive list of sources of threats, risks and events that might have an impact on the accomplishment of the project objectives. These events might prevent, degrade or delay the accomplishment of those objectives [1]. In general, a risk can be related to or characterized by [1]:

- origin of risk
- a threat that can be a certain incident, activity or event
- impact, consequences or results of risk
- a specific reason for risk occurrence
- protective and control mechanisms
- time and place of risk occurrence.

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Good information and thorough knowledge of the project and its internal and external environment are very important in risks identifying process. Historical information about the analysed project or similar projects may also prove very useful as they can lead to reliable predictions about current and future issues. However, only identifying what may happen is seldom sufficient. It is important to study all possible and significant causes and scenarios, because there are many ways an event can occur. Methods and tools used to identify risks and their occurrence include checklists, judgments based on experience and records, flow charts, brainstorming, systems analysis, scenario analysis and engineering techniques [1]. The next phase is an analysis of risks identified during the identification phase. This phase takes into consideration the 'likelihood' and the 'consequences' of the risk event. The objective of the analysis is to make distinction between the minor from the major risks and also to contribute to the assessment and management of risks. During this phase the level of the risk and its nature are assessed and understood. This information is the basis for a decision whether risks need to be treated or not and also for choice of the most appropriate and cost-effective risk treatment [1].

2 Risk analysis

Risk analysis normally involves [1]:
- examination of the risk sources;
- evaluation of impact consequences;
- likelihood that those consequences may occur and the factors that affect them; and
- assessment of any existing controls or processes that may minimize risks.

Likelihood is a qualitative or quantitative assessment of chance that a risk event will happen. This process combines information about estimated probability, past or experience. If possible the process takes account of past records, pertinent experience, industry practice, available literature or expert judgement. Risk analysis may vary in detail according to the risk, the purpose of the analysis, and the required safeguard level of the relevant information, data and resources. Analysis can be qualitative, semi-quantitative, quantitative and a combination of these [1]. Consequences are qualitative or quantitative valuations of the outcome of an event touching objectives. The process of determining consequences takes into account information about assessed or calculated effects, past and experience. Consequences can be articulated in several terms of monetary, technical, operational and/or human criteria. During this phase decisions need to be made about which risks need treatment and which do not, taking into account the treatment priorities. The decisions made are usually based on the level of risk; however, they may be related to thresholds identified in terms of: a) impacts, b) likelihood of event occurrence, c) total impact of a series of events if they occur at the same time. The results of risk assessment are shown in what is usually called.

Table 1 Risk assessment matrix [2].

Risk Rating					
Likelihood	**Consequences**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Disastrous**
Rare	L	L	M	M	H
Unlikely	L	L	M	M	H
Possible	L	M	H	H	H
Likely	M	M	H	H	VH
Almost certain	M	H	H	VH	VH

3 Risk treatment

Once the risk assessment has been done, it should be decided on risk treatment, i.e. on choice and implementation measures aiming at modifying or mitigating risk. Risk treatment options can include [2]:

- avoiding the risk by deciding not to start or continue with the activity that give rise to the risk,
- taking or increasing the risk in order to pursue an opportunity,
- removing the risk source,
- changing the likelihood,
- changing the consequences,
- sharing the risk with another party or parties (including contracts and risk financing), or
- retaining the risk by informed decision.

Retained or residual risks are understood as risks that the management meaningfully takes. The final step in the risk management is to establish a risk treatment (response) plan and to monitor and control risks. This is the process of implementing risk treatment plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating identifying of the risk process throughout the project. A risk treatment plan is usually shown in a document known as Risk Register and it should identify:

- proposed action,
- responsibility,
- resource requirement,
- timing, and
- reporting and monitoring actions required.

4 Risk management in transport infrastructure projects

Insufficient infrastructure is one of the biggest obstacles for economic growth and social development [3]. However, the fact is that the delivery of modern infrastructure projects is very complex. The long-term character of such projects necessitates a strategy that appropriately reflects the uncertainty and diversity of risks they are exposed to. In addition, infrastructure projects involve a large number of stakeholders entering the project life cycle at different stages with different roles, responsibilities, risk-management capabilities and risk-bearing capacities, and often conflicting interests. This is even truer for major transport infrastructure projects which have a rich history of problems. Cost overruns, delays, unsuccessful procurement, or unavailability of private financing are commonplace. These problems are not limited only to the past. Because transport infrastructure projects have become and will continue to become significantly larger and more complex, losses due to the cost of undermanaged risks will probably continue to increase [4]. There is also a paradox here. At the same time as more transport infrastructure project are built it is becoming clear that many such project have poor performance records in terms of economy, environment and public support. Consequently, because of cost overruns and delays the projects that have been promoted as effective vehicles to economic growth, they become possible obstacles to such growth [5].
Most of transport infrastructure projects suffer from significant under-management of risk at practically all stages and throughout the life cycle of a project. Poor risk assessment and risk treatment early on during the project concept and design phase lead to higher risks and financing shortages appeared later on. Risk is also undermanaged at the later stages of projects, diminishing a significant share of project values. Project owners often fail to see that risks created in one phase of the project can have a substantial impact during its later phases [4]. The risks of large transport infrastructure projects often do not get properly allocated to the parties that are in the best position to manage them or those that have a better capability to absorb these risks. Finance providers are often the direct losers from poorly allocated or

undermanaged risks. Even in public-private-partnership (PPP) projects, private-risk takers and their management techniques are often introduced too late to the process to influence risk management and allocation, and consequently they cannot undo the mistakes already embedded in the projects. One critical consequence is an increase in the cost of financing PPP projects and a greater need for sovereign guarantees or multilateral-agency support. In the end society at large bears the costs of failures, often in the form of missed or slowed growth [4]. Private investment are becoming increasingly rare. Banks are under severe regulatory pressure to avoid or limit long-term structured finance. Many are either reducing or completely leaving their infrastructure-financing businesses. Other potential investors such as pension funds and insurance companies, either have regulatory constraints or are in the very early stages of considering direct investments and are now building up the necessary expertise. This may explain why the budget-financed public-procurement processes are still the prevailing financing solution to deliver transport infrastructure projects. However, contrary to private sector risk takers, public infrastructure sponsors rarely apply state-of-the-art risk management tools and techniques, despite consequences of losing public money during a time of increasingly constrained public budgets [4].

5 Construction risk in transport infrastructure projects

The main stakeholders in the construction phase are asset owners and financiers. The length of construction phase is defined as the time period from decision to build until works are finished and operations have begun. Contractors are responsible for on-time, on-budget, and on-quality delivery. Very often contractors either fail to fulfil their contract obligations, which can result in cost overruns, delays, and defects, or are only capable to perform their contractual obligations at the cost of reduced profitability of their business. Inappropriate original planning and performance management of resources and cost is one of the key drivers of such failures, and this is compounded in many cases by a failure to identify potential threats early in the process. In addition, there is often a focus on the management of individual contracts, which means that the effects of multiple contracts at the portfolio level are ignored. Management of the relationships between clients, suppliers, and subcontractors can be confused, and often this comes back to poor contractor selection in the early phases. Results can be cost and budget overruns that may have a substantial impact on a wider economy. Delays to the opening of Hong Kong airport, for example, resulted in a loss of more than $600 million to the economy [4]. A life-cycle approach can minimise many of these problems. Owners need to design appropriate methods to measure contractor performance. This means establishment of a proper documentation and log system for following progress that allows the owner to get the information needed for management of the contractor successfully. This could include a detailed monthly schedule, with measureable key performance indicators linked to the contract [4]. Key Performance Indicators (KPIs) [6] are quantifiable measurements (metrics), agreed to in advance, that reflect the critical success factors of an organization or a project. KPIs evaluate the success of a particular activity or a project in which it engages. Success is sometimes a simple achievement of a certain operational goal and sometimes it can also be defined as making movement toward strategic goals. Accordingly, selecting the right KPIs depend on a good understanding of what is important to project sponsors. Because there is a necessity to understand well what is important to project sponsors, numerous techniques are related to the choice of performance indicators. A very convenient way to select KPIs is to use a management framework such as the balanced scorecards. In order to be measured, KPIs are associated to target values. Thus, the degree of the measure can be evaluated as meeting expectations or not. KPIs should be defined in a way that are understandable, meaningful, and measurable. A KPI must follow so called SMART criteria. This means that (i) it has a Specific purpose for the business, (ii) it is Measurable in order to get a real value of the KPI, (iii) the determined standards have to be Achievable, (iv) the KPI should be Relevant to the success of the organization, and lastly (v) the KPI must be Time bound, meaning that the values or outcomes are revealed for a relevant time period. As found by Standard & Poor's study [7] the most common sources of construction risk are:

- Untested or unverified technologies, technical standards, and process invention;
- Poor performance descriptions disposed to interpretation;
- Large, complex, specialized, or extremely technical requirements with a long-lasting construction stage;
- Varying legislative and regulatory environments;
- Aggressive scheduling with slight contingencies, often to meet politically delicate deadlines;
- Incomplete or late detailed design;
- Multisite programs on operational sites with limited access;
- Long linear construction sites;
- Inexperienced contractors;
- Substantial dependence on skilled trades or specialist subcontractors, or specific materials;
- Imperfect due diligence, improper understanding of ground conditions or investigative works, and inheritance issues associated with existing assets;
- Multiparty interfaces;
- Unfinished expropriation, lack of permits, approvals, consents or licences; and
- Complex project relationships, dependencies and restrictions.

One of the most significant consequence of poor risk management in transport infrastructure project is a cost overrun. A study [8] has shown that cost overrun is a universal phenomenon in transport infrastructure projects regardless of project types, geographical location and historical period. The sample used was the largest of its kind, including 258 transport infrastructure projects in 20 countries worth approximately US$90 billion. The study shows that:

- ninety percent of transport infrastructure projects experienced cost escalation,
- average cost escalation was 28 % for all project types,
- cost escalation exists across five continents and appears to be a global phenomenon,
- cost escalation has not declined over the past 70 years; thus, no learning curve seems to take place.

It should be noted that these figures include only construction costs, i.e. they not include financing costs. With financing costs included, the figures would be significantly higher and would be more sensitive to the time factor, because financing costs contain mainly accrued interests. Financing costs are predominantly sensitive to long delays, because delays postpone income while interest keep accumulating. Delays may result in projects finishing in the so-called 'interest trap', where a mixture of increasing construction costs, delays and cumulative interest payments cannot be covered by income [8].
Also, the dependency of cost escalation on duration of implementation phase has been definitely recognised in transport infrastructure projects. There is a good reason to be worried about sluggish preparation and implementation of such projects. Sluggishness may be extremely expensive. Therefore, before a project sponsor decides to go ahead, every effort should be made to conduct preparation, planning and evaluation aiming at elimination of such problems; otherwise they may re-emerge in form of delays during implementation. It was found that in the period from the decision to build a project until construction ends, it may be expected that the project will incur an average cost increase of 4.64 percentage points for every year. Consequently, for a 1 billion dollar project, each year of delay would cost on average 46 million dollars [8]. The study also found that regarding bridges and tunnels, bigger projects have higher percentage of cost increase, whereas this seems not to be the case for road and rail projects. It was also found that for all project types, bigger projects do not have a larger risk of cost escalation than do smaller ones [8].

6 The road to better risk management

It is clear that a more comprehensive methodology for risk management is necessary throughout project life cycle to strongly improve outcomes in transport infrastructure projects. Good risk-informed project management needs the following [2]:

- A broad conceptual framework that introduces risk management throughout the project life-cycle;
- A set of practical methods and tools that assist decision makers in making design choices and manage project risks more proactively and consequently more effectively; and
- An implementation framework, starting at the beginning of the design stage throughout the life-cycle of a project.

It is important to understand that risk management is not an isolated function; it is part of and should be completely integrated with the overall project management. Flyvbjerg et al [8] describe ways in which better risk management can be achieved. According to the authors, the reason for poor performances is that many of the participants in the process have tendency to underestimate costs, overestimate revenues, undervalue environmental impact, and overvalue economic development results. Transport infrastructure project are typically owned and managed by the public sector using budgetary resources or state guaranteed loans. Mismanagement of risk can reduce a significant share of project value. This would mean that there will be no adequate value for public money invested into the project. However, it is not the type of ownership that matters. The study [8] shows that the prevalent belief that the private sector is naturally more efficient than the public sector is an oversimplification. Kind of accountability seems to matter more to risk management than type of ownership. Therefore, the essential problems are lack of accountability and unsuitable risk sharing, which can be improved by restructuring the institutional arrangements of decision making and to establish accountability at the project preparation and evaluation stages. After the decision to build a project, it is of critical importance that the project organisation and project management are set up and function in a manner that minimise risks.

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