A COOPERATIVE RISK MANAGEMENT APPROACH FOR LARGE INFRASTRUCTURE PROJECTS

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Abstract: *Large Infrastructure projects face many risks due to their complex technical and social conditions. But who is handling a risk is often not the result of an adequate risk distribution, it is more a function of power. And even though systematic risk management should be a basic element of a professional project management, it is not normative in the execution phase and it is unusual in the design phase of these projects. Contractors often take only risks into account, which are obvious or described by the client. They often disregard risks, because it seems to be no "space" in the bid because of the market situation. Clients rarely have a systematic risk management in their projects and are not focused on a fair risk allocation, they try to allocate as much risks as possible at the contractors side. This paper presents an approach for a cooperative and integral risk management for infrastructure projects, the design and the execution phase included. Recent literature and field study results are considered. This holistic approach includes elements as the clients process responsibility, life cycle orientation, a minimizing concept, risk transparency, a risk list, cooperative risk management, risk controlling and risk reviews.*
Keywords: *Risk Management, Infrastructure Projects, Design Phase, Cooperative Risk Management*

1 Infrastructure projects and risks

1.1 Introduction

A high quality of infrastructure is worldwide a very important precondition for economic success and growth. Due to their unique character and their systemic uncertainties Infrastructure projects (ISP) are typical projects with specific risks. Many risks could be prevented or reduced, if there would be more systematic and corporate risk management. This paper suggests an approach for systematic and corporate risk handling in infrastructure projects.

1.2 Specifics of Infrastructure Projects

ISP consist of typical elements with strong influence on their design and execution:

- earth or rock as most important material,
- large line works,
- influence of weather,
- often works under traffic,
- difficult logistics,
- separation of design and execution,
- public tendering and funding,
- public focus and
- client monopoly.

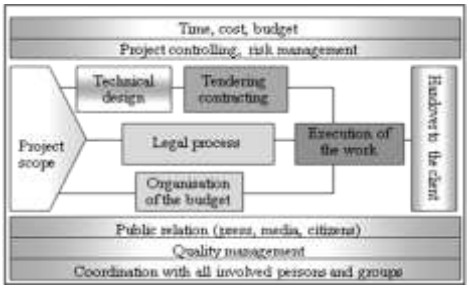

Figure 1. Project tasks in infrastructure projects

The main phases of ISP are feasibility study, technical design, legal approval, tendering and execution. In many countries the public participation in the

legal process makes them very complex to plan. The tasks in ISP are various as shown in figure 1.
Often infrastructure projects are designed and executed in a standard form, where the project owner ("client") and his consultants do the design of the project in all technical and legal phases. The permission of work comes after a longsome procedure with participation of many authorities, citizens and NGOs. It demands a detailed design and belongs typically to the clients risk sphere. Dependant on this, the financing is provided by the government. The client calls for tenders and decides often predominantly or even completely due to price criterion. A single or a general contractor then executes the project work. After completion the client takes it over for service. This procedure separates client and contractor in two parties with the same working direction, but with different objectives – optimizing the building or the profit. This form is strongly influenced by European and national regulations and by the legal process.

1.3 Infrastructure Projects and Costs

ISP need a lot of public money and so they are public, or they become public, when the costs run over. We have enough examples for cost overruns in large ISP. Hartmann & Ashraf (2004) refer to an international inquiry that about 50% of the examined construction projects had cost overflows of 40 up to 200%. Flyvberg et. al. (2009) indicate between 25% and 196%; they assume that a substantial risk for overrun exists and cannot completely be eliminated, but moderated. Schach et. al. (2006) analyzed large railway projects and state cost overflows until 350%. Hertogh et. al. (2008), conclude that cost overruns are born in the design phase.

The costs are influenced by many various risks and by the quality of risk management in a project from its birth to the start of service. The handling of risks influences the total costs of a project as well as the cost reliability. Thus, it is crucial to identify all risks and to minimize them as much as reasonable.

1.4 Infrastructure Project and risks

Infrastructure projects face many typical risks and cost and time overruns seem to be normal. They are partially caused by disturbances or failures, which may be avoided or reduced by a systematic risk management (Hertogh et. al. 2008, Flyvberg et. al. 2009). Hertogh et. al. (2008) state that the environment of large infrastructure projects is very dynamic and complex which causes various risks, which are hard to calculate. They state as well that the application of new solutions or new technologies demands adapted risk analysis and particular supplements on costs and time. All risks cause consequences in cost, time, quality and stakeholder satisfaction.
Cooke & Williams (2009) classify risks into feasibility, design, funding, tender, time, commerce and methods. Girmscheid & Busch (2008) categorize into legal, time, finance, technique, management and environment. Chapman (2001) differs between the classes environment, industry, client and project. In this paper we classify risks into 7 clusters in order to treat them in design (d) and execution (e): technique (d, e), legal approval (d), society (d), management (d, e), weather (d, e), contractor risks (e) and complexity (d, e).

2 Actual state in Risk Management

2.1 General review

Cooke & Williams (2009) mention the importance of risk management as part of the project planning. They describe the principle of risk management and important risks on the client's and the contractor's side. Harris & McCaffer (2006) consider that losses and wastage from uncertainty in a project can be

moderated by rigorous application of risk management techniques as a part of production process improvement. They mention the principal elements of risk management. For Girmscheid & Busch (2008) systematic risk management is a key competence for successful contractors. They describe all aspects and elements of risk management with focus on the contractor's aspects. Their systematic project risk management is a management skill, which strengthens the company. Dayyari (2008) developed an approach for a feed-forward- and feedback-oriented risk management for contractors. Chapman (2001) states that project risk management can provide a decisive competitive advantage to building sponsors. He describes the main steps of the process of risk identification and assessment for design projects. Akintoye & MacLeod (1997) observed that formal risk analysis and management techniques are rarely used due to a lack of knowledge and doubts on their suitability. They show that risk analysis of construction projects is seldom formally requested by clients. Walewski & Gibson (2003) found out that only few project participants have an understanding of all the risks involved. Often people do not know to whom the risks are allocated and there is no common view of risk since owner, designer, and constructor have differing project goals and objectives and historically adverse relationships are usual. Flyvberg et. al. (2009) state that too many feasibility studies assume projects to exist in a predictable world of cause and effect where things go according to plan. German regulations and codes for design and planning of ISP (HOAI 2013, BMV 1985) contain no standards for risk management. Codes as ISO 31000 give only general recommendations for the risk management process.

2.2 Results from the practice

In addition to the above mentioned literature, results of field studies at our chair show revealing details about the use of risk management in the German construction world. In a study about cooperation (Spang et. al. 2009/2) half of the participants (clients and contractors) see the actual situation as not cooperative and 44% do not see a winner.

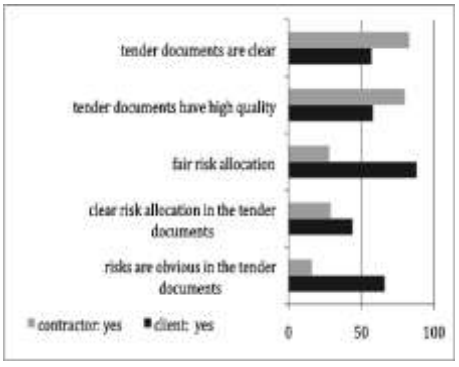

Figure 2. Tender risks (Spang et. al. 2009/2)

Figure 2 shows typical critical points about risk allocation in the relationship client-contractor. To solve the cited risk problems contractors and clients suggested better descriptions and allocation of risks, clear and fair tender documents and improved design.

A study with contractors (Spang et. al. 2009/1) shows that only 43% of them have a project risk management and 65% of these apply it systematically. Problems are a lack of culture (36%) and organizational faults (29%).

In a study with consultants and clients 74% of the participants see medium up to high need for changes in the design regarding risk management (Spang & Sözüer 2009).

The analysis of 15 large infrastructure projects in Europe (Hertogh et. al. 2009) resulted in best practices to control risks: a) project changes lead to new risks, b) cooperation between client and contractor facilitates risk control, c) risk management must be an obligatory element in all

phases of an ISP, d) a holistic risk approach is necessary, e) proactive stakeholder management reduces environmental risks, f) uncertainties must become transparent and must be discussed with all participants and g) open communication and adequate organizational culture are predominant for a successful risk management.

2.3 Conclusions

In respect of the analysis in the above chapters the following conclusions are drawn for design and execution of ISP:

a) The state of the arts for the basic risk management elements is well researched and known.
b) Many papers describe risk management in the execution phase by contractors.
c) No general standards for risk management exist at all.
d) A life cycle oriented holistic risk management with client, consultant and contractor does not exist.
e) Risk management is no usual element of the design phase of ISP.
f) Cost pressure often inhibits risk management and risk buffers.
g) Clients and contractors try to reduce their risks by shifting them to the other.
h) Contractors use risk management in the bidding phase, but they have no knowledge of risks in the design phase.
i) Clients often have no knowledge about the risks in their projects.
j) In the design phase, the most important project phase in respect of risk minimizing, risk management must be obligatory and standardized.

3 Cooperative risk management approach

The preceding chapters show that there is enough knowledge about the elements of risk management and for risk management in the execution phase. But no general standard in the design phase and no holistic, cooperative risk management exists. This approach makes an attempt to fill this gap and aims at the following objectives:

1. Reduce project cost and time by avoiding risks or reducing risk probability.
2. Minimize cost and time overruns by reducing the consequences from risks.
3. Improve cost and time stability by a risk management standard for the project life.

This "cooperative risk management approach" (CRM) defines a standard for a holistic risk management for infrastructure projects with the following 9 elements.

Holistic risk management means integration and participation of all relevant parties (client, consultants, contractors) in the above mentioned objectives with a fair risk distribution. Every party has to respect the elements of the CRM in all project phases. The application of CRM, as a compulsory standard in every project, has to be assured by the project owner. Thereby, risk shifting becomes impossible and all project risks will be minimized on behalf of all participants.

Client as process responsible. The client as the owner of the project has the greatest interest to minimize the risks of his project. Only he is attending the project from its start to its end. Hence, he must play the central role in risk management, i.e. coordinate all players and control the processes. He defines the standards, gets and analyses reports, opens the gates at the end of each phase and operates the risk list. He defines the lower limits for the included risks and the risks, for which other participants are responsible.

Table 1 gives an overview of the various tasks (pr=process responsible,

rb=risk bearer, d=decider, a=adviser, ri=influence on risk).

	design	tendering	execution
client	pr,d,**rb**	pr,d,**rb**,ri	pr,(d,rb)
consultant	ri	ri	-
contractor	-	ri,**rb**,(d)	ri, **rb,**d
experts	a, ri	A	a, (ri)

Table 1: Tasks of the participants of a CSP

Project life cycle orientation. RM has to be done process oriented in an end to end process from the feasibility to the start of operation. Risks have to be minimized from the start because suggestibility decreases with project progress. The knowledge about identified and treated risks has to be transferred from one phase to another, to assure an optimal risk treatment. In the design phase prevention is predominant, identified risks have to be avoided or reduced. At the end of each phase a decision about how to continue has to be taken in terms of a risk review. In the tendering phase the residual risks and a fair risk distribution have to be defined jointly with the bidders. In the execution phase a risk committee takes a central role. Risks must be an important element in deciding alternatives.

Minimizing concept means that each identified risk has to be minimized as far as possible (technical, legal, temporal) and reasonable (economical, life protective). First, risks have to be avoided, as far as not possible they have to be decreased concerning risk incidence and/or risk consequences, they may be shifted (to another party/to an assurance) and finally the residual risks have to be taken.

Risk transparency is an important base for risk minimizing. It means that knowledge and information about risks (livelihood, boundary conditions, consequences, activities) must be exchanged between the participants during the project. This transparency demands an open and cooperative communication in the project. Periodic reports and meetings are included as well as event reports and meetings and a central IT based information center. All risks (above a defined limit) have to be listed in a central risk list. Finally, all remaining risks have to be fairly allocated in the contract. Finally all relevant parties have to be informed about risks, consequences and risk treatment.

The risk list contains all risks, consequences and measurements, which have been identified along the project life. The list is transferred from one phase to the next, passing the risk review. At the end of the design phase the list contains information about all risks in the project life. For the remaining risks it is completed by proposed measurements and risk allocation and is part of the tender documents. Each bidder has to assess the risks and the measurements and to accept, to change or to complete them and add prices to the measurements. The risk list with intended measurements becomes part of the contract. It is continued in the execution phase by the risk committee. The risk list is completed by an activity matrix according table 2.

		additional fee	decision activities	new price agreement
A	risk domaine **con**tractor	-	con	-
B	risk domain **cl**ient (list)	+	con+cl	-
C	risk domain client (not list)	+	con+cl	+
D	allocation open	?	con+cl	?
E	force majeure (list)	+	con+cl	-
F	force majeure (not list)	+	con+cl	+

Table 2. Activity matrix for risk cathegories

Cooperative risk management between client and contractor in the execution phase is a vital element for a successful handling of project risks. It starts with transparency in the tendering phase. The client informs about all remaining risks in the tender documents and the bidders have to mention all risks they see in the project and the

measurements to be done with. These may be activities to be done by the contractor and to be paid by the client or a risk surcharge to be paid by the client. Next step is a fair risk allocation in the contract according to the principle: each party takes the risks it is able to manage best. The client gives a suggestion in the tendering documents, which can be discussed between bidders and client before fixing the contract. All known risks, the joined measurements and surcharges and the allocation must then be fixed in the contract. Based on this list in the execution phase a risk committee, consisting of representatives of client and contractor, is responsible for risk controlling, identifying new risks and fixing measurements and responsibilities. For solving problems a conflict resolving system is useful, consisting of decision steps, a steering committee and an adjudication board.

Risk controlling is a principal task for the project owner, supported by the other participants, to be done continuously during all project phases. It is based on the risk list which has to be modified and completed continuously by all parties. Periodically (f. ex. weekly) the known risks and the measurements have to be checked and intended activities have to be analyzed in order to identify new risks. In the design phase risk controlling is an element of the risk reviews.

Risk reviews are mandatory in each project phase. At the end of a phase the client, assisted by his partners, has to prove the risk management process and the remaining risks and to decide if he will open the gate to the next phase (with or without obligations) or not. Another task of the risk reviews is to decide about risk measurements and costs or time buffers related to known risks.

4 Final remarks

We will never be able to construct traffic lines without any risk, but we are able to reduce risks, risky activities and risky techniques systematically. The need for standards, for an obligation for systematic risk management and for a holistic risk treatment is evident. The presented approach could be an important step. Further research is necessary to define and develop detailed processes, devices and guidelines. At the same time, changes in organizational culture are necessary in client and in contractor organizations for assuring the transparency we need. Cooperative relationships between client and contractor contribute to a successful joined risk treatment.

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