RISK ASSESSMENT IN CONSTRUCTION INDUSTRY

Goran Cirovic
The College of Civil Engineering and Geodesy, Belgrade, Serbia
cirovic@sezampro.yu

Simo Sudjic
The College of Civil Engineering and Geodesy, Belgrade, Serbia
simosudjich@yahoo.com

Construction industry is a highly risky process mostly because of its long life duration and unique product as a result of construction, and also many different professions are involved in one project. Generally, risks in construction industry should be controlled and reduced during design, procurement and construction phase, and the most important activities are define risk management plan from the very beginning and to assign risks to different project members and to manage their execution. In this paper risks on a project in initial phase will be presented, cost and duration risks and complete contingency for the previously defined budget will be described. Statistical data for one project in design phase will be analyzed and general comments and recommendations will be proposed. Also, general method for calculating risks will be presented.

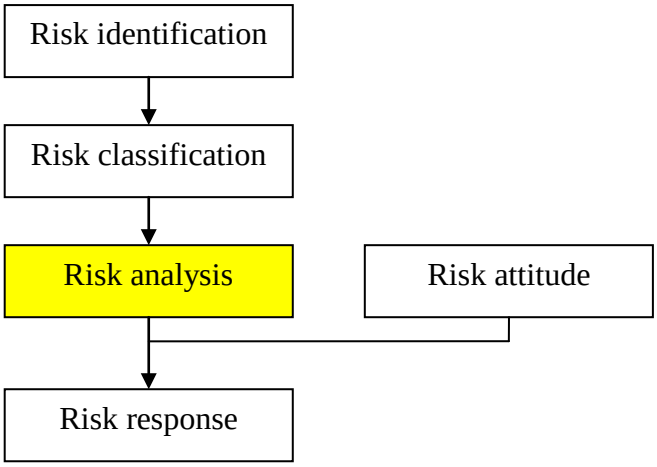
KEYWORDS: construction, risk management, forecasting.

INTRODUCTION

Project management in the construction industry is mostly risk management oriented, and the main goal is to achieve risk control in all project phases. Great and long-lasting construction projects are exposed to many different risks, so the most important is to define risks at the very beginning of the project and to control and reduce them during the project execution. Risk management is a very important segment of project management, and generally the main target on a construction projects is to manage cost and time since quality is very often defined in an agreement. In order to systematize risk overview management it is necessary to carry out risk analysis. Risk Analysis is a systematic approach to understanding these risks and their impact so that the decision makers can account for them in contingency planning, as well as plan for risk mitigation. The project risk can be in many areas, such as traffic estimation, product pricing, host country's fiscal policy or political uncertainty, EHS risk, etc.

RISK ANALYSIS

Risk assessment should be the process which passes through few phases, and during risk generation assessor should overview all risks on the project and their changes. Generally, the risk management framework is [1]:



There are four objectives of doing risk analysis:

- to set the project's funding requirement during Budget or Authorization for Expenditure
- to assess the highest risk items at different project stages so that mitigation can be planned
- to return any excess contingency fund during project execution, so that the fund can be used more profitably in other areas
- to set Stretch Target as a challenge to the Project Team

The most frequent risks on the construction projects are related to:

- land and property
- design
- politics and technique / technology
- infrastructure
- business and commerce
- pre-construction
- site establishment
- procurement
- construction

During the initial phase risks are not completely defined, so it is very difficult to make decision about future project strategy. As an example, one big marina and residential project was in danger with many general risks, and the main risks were identified as in the following table. Also, the in the table is presented description and management action for all identified risks.

Reference No	Heading	Description of Risk	Management Action
1.0 General			
1.1	Local market	Projects in the Kotor area create high demand for construction resources	Plan and secure commitment for human and material resources
1.2	Montenegrin legislation	Mis-understanding of Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team
1.3	Montenegrin legislation	Change in Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team
1.4	Montenegrin legislation	Montenegrin approvals take longer than planned	Build in contingencies in master programme ; Keep close to Montenegrin and municipal authorities ; Monitor progress
1.5	Local infrastructure	Local infrastructure cannot support the development	Early contact with local authorities and utility companies ; Allowance in cost plan
1.6	Utility companies	Poor performance by utility companies for infrastructure provision	Agree scope, deliverables and programme with utilities companies
1.7	Utility companies	Change in previously agreed plans by utility companies/municipality	Agree scope, deliverables and programme with utilities companies ; Regular liaison with utility companies/municipal authorities ; Monitor progress
1.8	Local market	Unfamiliarity with Montenegro	Early meetings and regular contact with Montenegrin authorities, utility companies, etc. ; Identify good local partners and maintain regular contact with them ; Identify other International companies active in Montenegro and seek
1.12	Wastewater solution	Currently assuming connection to new regional strategy main sewers, which should be in place by summer 2009	Monitor progress of regional strategy implementation ; Identify contingency plans
1.13	Storm water solution	Existing combined discharges from Tivat cross site. These must be intercepted and not allowed through development to contaminate marina/ bay	Review results of Ehting survey ; Monitor programme for local infrastructure implementation ; Identify contingency plans
1.14	Potable water supplies	New regional supply to be available 2010. Also supply from Herceg Novi is possible solution.	Identify contingency in liaison with local authorities. ; Monitor Regional supply scheme implementation ; Ensure design features incorporate measures to reduce consumption
1.15	Power supplies	Solution will require off-site works – new distribution lines and sub-stations. Possible 3rd party land issues.	Develop robust strategy for power supplies ; Confirm off-site routes and requirements ; Add works to Tivat regional strategy ; Procure via local distribution co as necessary
1.16	Land permit and Building permit	Land Permit and Building Permit applications – possible delay if documentation is not full and complete. Time for approval by Ministry is not	Use local advisors/consultants to define exact scope of information to be produced at each stage

At the planning phase of that project with very strict time frame and very big penalties management decided to proceed risk analysis and to define time and cost contingencies. The result was very interesting:

Cost risk	320,000 Euro	/	Time risk	120 days
	260,000 Euro	/		195 days
	275,000 Euro	/		150 days

As the penalties were 500 Euro per day third combination was optimal. That project was managed with additional specialist, and more consultants during the design phase, so the risk management plan defined at the initial stage helped the project finished successfully.

General risks during design and procurement (tender) stages are how to coordinate design and to estimate cost, as well as to prepare cost plan in a realistic boundaries. Cost and programme is very difficult to estimate. Thus, during the pre-construction phase it is very important to manage all design risks and to organize design according to design brief as well as to minimize budget increase.

After risk elements identification, possible scenarios for all risk elements should be evaluated. The worst case or the most pessimistic scenario and the best case or the most optimistic scenario should be considered as the maximum and minimum impacts of risk elements.

Not all risk elements will impact all cost items. For example, labor productivity will impact only labor cost items and not the material cost items. Also a risk item, if it impacts on several areas, may not impact on them equally. For example, if major equipment scope changes, it will affect the equipment cost significantly, but it will also affect the corresponding bulk material and labor cost by a lesser amount.

For the risk calculation the key factors are the variation from initially defined value (cost or programme) and the probability that the variation can occur. For example, the estimated foundation cost is 1,000,000 £ and the maximum expected variation is 200,000 £, with the probability of 30 %. The expected cost is:

1,000,000 £ + 0,30 x 200,000 £ = 1,060,000 £

The following matrix is an example how to categorize risks according to cost and time variation and probability percentage.

%Probability / (€) Cost / Time	100%	80%	60%	40%	20%
Greater than 3,000,001 max 5,000,000 / Greater than 90 days max 180 days	25	20	15	10	5
Up to 3,000,000 / Up to 90 days	20	16	12	8	4
Up to 1,000,000 / Up to 30 days	15	12	9	6	3
Up to 500,000 / Up to 14 days	10	8	6	4	2
Up to 100,000 / Up to 7 days	5	4	3	2	1

This matrix presents the guideline for assigning the risk categories of importance 1,2,3,4 or 5 and is based on a combination of (€) Cost / Time and Probability Percentage. The color indication presents proposal how to categorize risks as a low (green), middle (orange) and red (high) risk.

RISK CALCULATION AND OVERVIEW

Risk register is a document which should be updated regularly and it is one of the key documents on the project. All risks and all risks management actions for risk reducement or control should be described in the document. For all the risks a response could be to accept, reduce, transfer or avoid them. It is very important to propose management action based on current situation on the project. Every risk should be assigned to the specific owner and close out date for every risk should be defined.

Since the cost and duration and cost of the project are in an interrelation and the changes of cost very often cause changes in duration or vice versa, the risk calculation is mostly related to the cost and duration.

Cost of Risk Occurrence (€K) Raw Information			Duration of Risk Occurrence (Weeks) Raw Information				Cost of Risk Occurrence (€K) With Probability Factor					
Min Likely	Most Likely	Max Likely	Min Likely	Most Likely	Max Likely	Probability of Occurrence (%)	Min Likely	Most Likely	Max Likely	Expected Exposure to Risk	Category of Risk A, B or C	Risk Response

				Cost Rating	Duration Rating	Highest Rating
Risk Ref	Risk Title	Description of Risk	Management Action	0 - 5	0 - 5	
1.0 General						
1.1	Local market	Projects in the Kotor area create high demand for construction resources	Plan and secure commitment for human and material resources	3	4	4
1.3	Montenegrin legislation	Change in Montenegrin legislation	Translate legislation into English ; Local consultants to provide interpretation to whole team	3	3	3
1.5	Local infrastructure	Local infrastructure cannot support the development	Early contact with local authorities and utility companies ; Allowance in cost plan	5	4	5
1.6	Utility companies	Poor performance by utility companies for infrastructure provision	TC to be provided from utility companies after full submission of required capacities from the Client	2	4	4
1.12	Wastewater solution	Currently assuming connection to new regional strategy main sewers, which should be in place by summer 2009.	Monitor progress of regional strategy implementation ; Identify contingency plans	1	1	1
1.13	Storm water solution	Existing combined discharges from Tivat cross site. These must be intercepted and not allowed through development to contaminate marina/ bay	Review results of Ehting survey ; Monitor programme for local infrastructure implementation ; Identify contingency plans	1	1	1
1.14	Potable water supplies	New regional supply to be available 2010. Also supply from Budva is possible solution.	Client instruction is to considerate water supply from Budva. Regulary check the progress of that project.	3	4	4
1.15	Power supplies	Solution will require off-site works – new distribution lines and sub-stations which may have possible 3rd party land issues.	Coordinate with electrical utility company, and together with them find best solution to speed up the process.	1	4	4
1.16	Land permit and Building permit	Land Permit and Building Permit applications – possible delay if documentation is not full and complete. Time for approval by Ministry is not predictable	Use local advisors/consultants to define exact scope of information to be produced at each stage	5	4	5

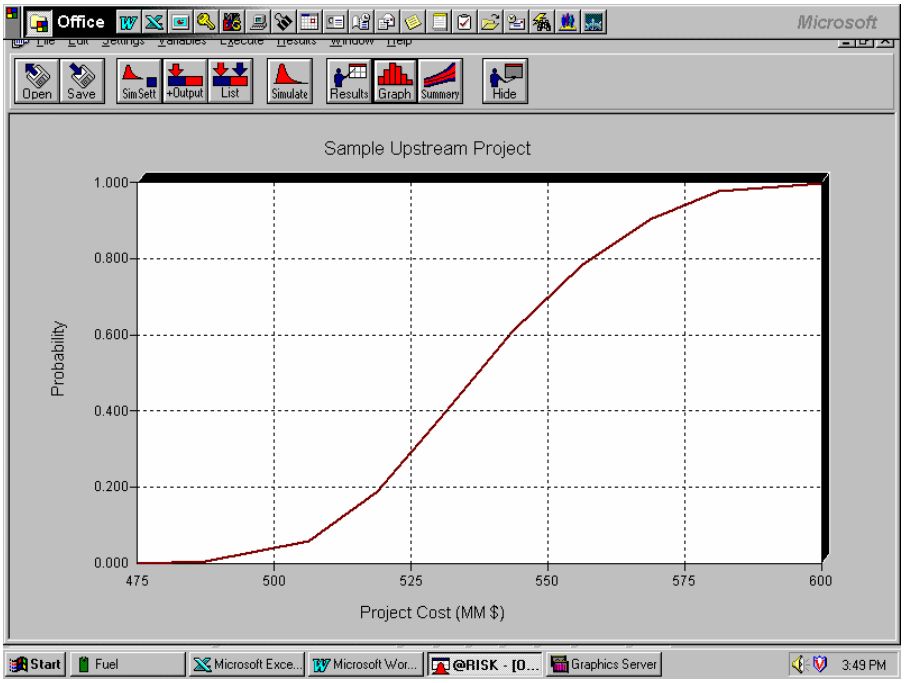
Cost Risk			Duration Risk			Probability Rating	Probability %	Risk Rating Number	Factored Risk Cost	Factored Risk Duration
Min €	Max €	Ave. Cost	Min days	Max days	Ave. Duration	0 - 5				
500,001	1,000,000	750,001	31	90	60.5	1	20%	4	150,000.10	12.10
500,001	1,000,000	750,001	15	30	22.5	1	20%	3	150,000.10	4.50
3,000,001	5,000,000	4,000,001	31	90	60.5	4	80%	20	3,200,000.40	48.40
100,001	500,000	300,001	31	90	60.5	2	40%	8	120,000.20	24.20
0	100,000	50,000	0	7	3.5	1	20%	1		
0	100,000	50,000	0	7	3.5	1	20%	1	10,000.00	0.70
500,001	1,000,000	750,001	31	90	60.5	2	40%	8	300,000.20	24.20
0	100,000	50,000	31	90	60.5	4	80%	16	40,000.00	48.40
3,000,001	5,000,000	4,000,001	31	90	60.5	4	80%	20	3,200,000.40	48.40

The tables above show a real example of risk calculating at a great construction project. It is very important to describe the risk and management action in order to keep it on an acceptable level or possibly to eliminate it. This method is applied to determine the impact of risk on costs and project duration in the range 1 - 5, where each value presents our assessment how much a certain risk can affect cost increase and project delay. Besides these values, the assessor should also determine the probability of risk occurrence during the project completion. Through a calculation determined in advance factual costs and time risks are obtained.

This calculation functions based on the principle of fuzzy logic as it should be taken into account that it is difficult to determine how much a certain risk can affect the project, so the values are kept within specific limits. It is very important to determine how much all the risks can increase the project value and duration, however, it should be taken into consideration that many risks are overlapped, so that through this calculation a great reserve or contingency is very frequently obtained.

The following diagram presents the curve that actually shows the probability in which range the project costs can vary. Considering that costs are generally estimated as a fixed value, by this approach the probability of completing the project for this value would be added to the value. For example, it can be seen from this graph that the project can be completed for $ 550 million with the probability of 68%.

These values have been gained in such a way that some items from the bill of quantities were given the value with definite probability, and thus these cost values of a complete project have been gained from the analyzed project.



CONCLUSION

The principal objective of risk analysis and calculation is to offer the decision maker more variants of cost and project duration, perceiving the probability to complete the project within this range. It is also essential to forecast reserves, with which the risk from budget exceeding is reduced. The decision maker makes the decision with what risk level the project will be completed based on the data at his disposal. During the project completion all these values must be controlled and corrective actions must be proposed.

REFERENCES:

Flanagan R., Norman G., "Risk Management and Construction", Blackwell Science, 2003.

Ivković B., Popović Ž., (2005). "Construction Project management", Građevinska knjiga, Beograd (in Serbian)

Brook M., (2008) "Estimating and tendering for construction work", Oxford : Butterworth-Heinemann

Hinze J.W., (2004) "Construction Planning and Scheduling", Pearson Prentice Hall

Jamadi O.A., Almishari S., "Risk assessment in construction", Journal Construction Engineering Management, Vol 129, No 1, 2003, p. 492-500

Edwards L., (2008) "Practical risk management in the construction industry"

Koller G.R., (2007) "Risk assessment and decision making in business and industry"