IDENTIFICATION AND CLASSIFICATION OF RISKS IN A NEW MODELLING PROCESS FOR BUILD – OPERATE – TRANSFER PROJECTS

Yiannis Xenidis and Demos Angelides

Department of Civil Engineering, Aristotle University of Thessaloniki, Thessaloniki, 54124, Greece

The Private – Finance –Initiative (PFI) procurement methods provide a framework for countries that lack the adequate own funds to develop major infrastructure projects. The Build-Operate-Transfer (BOT) projects represent a variation of these procurement methods. Success of these projects depends on the project agreement and, especially, the risk management during the whole life cycle. This paper contributes to the risk management of a successful BOT project by introducing a comprehensive new risk inventory and classification scheme of BOT risks. The inventory comprises 86 risks, which are classified based on two criteria, i.e. their nature and the source of their origin. Each one of these criteria comprises several categories, which are explicitly presented and discussed. This classification enables the assignment of risks to the project's life cycle phases, where they may occur, and the mapping of their interrelations; both are the next steps of the development process for a BOT fuzzy-based risk assessment model, which is also presented and discussed in brief. The overall approach facilitates risk assessment and understanding in BOT projects and provides a clear risk framework, which is comprehensible by risk analysts as well as responsive to their demands.

Keywords: BOT projects, Fuzzy theory, Life cycle, Risk.

INTRODUCTION

Build-Operate-Transfer (BOT) procurement method for construction projects is one of the varying schemes for the development of public infrastructure with the partnership of the private and the public sectors. The reasons for a government to adopt the BOT scheme are: (a) lack of funding resources, (b) poorly equipped and organized domestic construction industry, (c) limited experience and expertise of the domestic workforce for certain types of construction projects, and (d) faster completion and operation of the project. All these constraints are successfully lifted under the BOT project development scheme because the project developers (concessionaire) undertake the funding and the technical and commercial risks for the development and operation of the project. The concessionaire retains full control of the project until the end of a predefined time period – called the concession period – when it transfers the project back to the government.

The undertaking by the concessionaire of all the risks associated with the project during the concession period is a major issue of concern for all parties involved, i.e., the contractors, the sponsors, and the government. The success of a BOT project lies in the appropriate initial risk assessment by the potential concessionaire, which provides with the reasoning for a "go or no go" decision. Risk assessment determines

Xenidis, Y and Angelides, D (2005) Identification and classification of risks in a new modelling process for build - operate - transfer projects. *In:* Khosrowshahi, F (Ed.), *21st Annual ARCOM Conference*, 7-9 September 2005, SOAS, University of London. Association of Researchers in Construction Management, Vol. 2, 803-12.

the raising of funds, demanding of guarantees, and investment profitability for the concessionaire, and, eventually, the initiation of the project's development or not.

There are many risk assessment tools and techniques for BOT projects (Dey and Ogunlana 2004). However, they suffer from several limitations that prevent them from being generally applicable to all cases. Examples of these limitations are the focusing of the risk assessment approaches to specific project-types or specific stages of the BOT project development process. The modelling approach developed and highlighted here attempts to overcome these limitations by introducing 86 risks and their interrelations, which are possible to occur in any BOT project case. A new classification scheme for these risks is adopted for the first time, which is based, concurrently, on the nature and the source of origin of these risks. This classification assists the assignment of the risks to the phases of the project's life cycle and the modelling of the interrelations with a fuzzy theory based methodology. The final product is a risk assessment tool that presents general applicability and comprehensibility by risk analysts, and assists the contractor to decide whether to enter or not into a given BOT project.

STATE – OF – THE – ART AND INNOVATION

There have been many efforts to identify, classify and allocate risks, in a universally accepted manner, of BOT projects. For example Ogunlana (1997), Akintoye, et al. (1998), Charoenpornpattana and Minato (1999), Salzmann and Mohamed (1999), Wang, et al. (2000), Kumaraswamy and Zhang (2001), and Thomas, et al. (2003) have suggested a large number of risks associated to BOT projects and several classification approaches for these risks. A comparative study of these efforts indicates that:

(a) There is a consensus among experts on the existence of some risks in this kind of construction projects; however there are also many other risks that are considered as significant from case to case, leaving in this way, the risk inventory incomplete and not applicable to every project case.

(b) There are two prevailing approaches in classifying BOT risks, i.e., either based on criteria of the nature of the risks (e.g. financial) or based on criteria of the timing of potential occurrence in the life cycle. However, there are varying considerations among experts on definitions of both the nature of risks and the phases of the life cycle where these risks may occur.

The abovementioned considerations indicate that there is a lack of a unified approach for BOT risks that prevents from the adoption of a comprehensive risk inventory and a classification scheme that may be applicable in all cases of these projects. The contribution of this paper is the suggestion of a new risk inventory and classification scheme for BOT projects to fill the gap. The significance and innovation in this effort lies to:

(a) The comprehensiveness of the risk inventory, which includes 86 risks, identified and applicable to all types of BOT projects.

(b) The classification of these risks according to two different sets of criteria, i.e., the nature and the sources of origin.

The result of this effort is the generation of a thorough risk framework for BOT projects that is applicable to the whole life cycle and is used for the development of a risk assessment model based on fuzzy theory (not presented here due to space limitations).

THE MODEL DEVELOPMENT PROCESS

Figure 1 presents the development process of the BOT risk assessment model. The development process comprises five processes divided up into two stages. The risk identification, classification and assignment processes are parts of stage 1, while the mapping of risks interrelationships and modelling for risk assessment are parts of stage 2. An intermediate stage is the evaluation/validation of the first stage's results with the help of BOT experts, who responded to a questionnaire designed especially for the purposes of this research. The same questionnaire is used for the assignment of values to the membership functions and the generation of rules of the fuzzy-based risk assessment model.

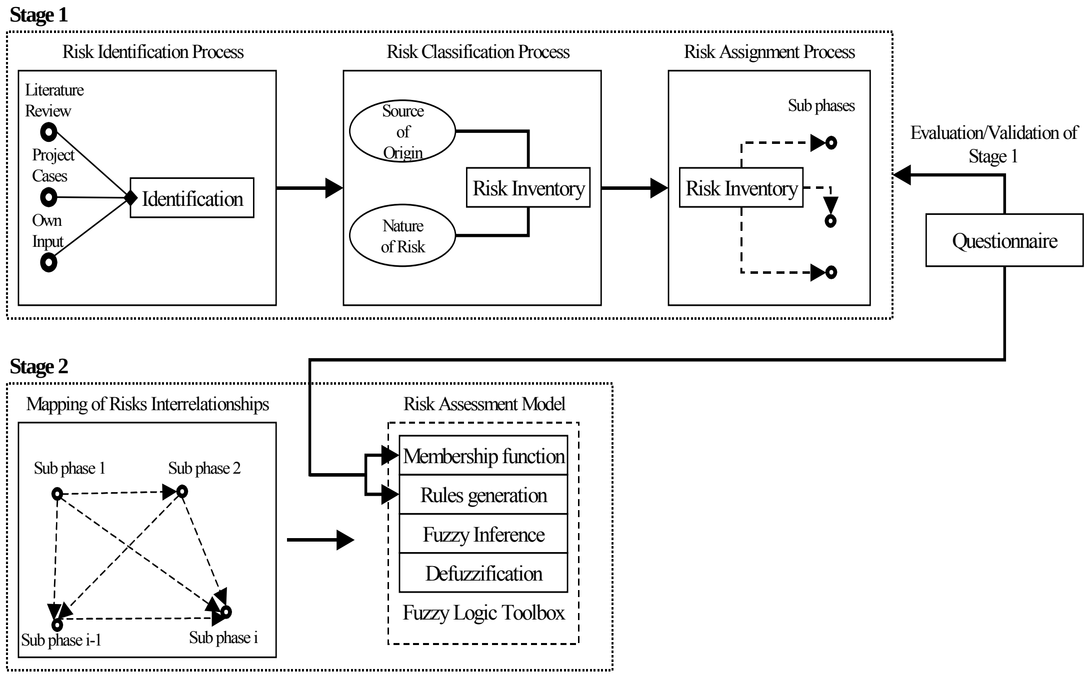

Figure 1. The Development Process of a BOT Risk Assessment Model

The model assesses the overall risk generated by the risks and their interrelationships in the sub-phases (in total 23) of the BOT project's life cycle phases (in total 6). Then the relation between the several sub-phases in the life cycle is considered in order to assess the overall project's risk. Therefore, the life cycle phases and sub-phases constitute the risk propagation path in this risk modelling approach. An important parameter is that the life cycle is considered in relevance to the presence of the concessionaire; this means that the life cycle ranges from the sponsor's preparation to bid to the transfer of the project back to the state.

The process of assigning risks to the sub-phases of the BOT project's life cycle phases is based on the assumption of the time period where a possible occurrence of each risk should be expected. Therefore, there are risks assigned to more than one sub-phase inside the same phase or in more than one phase. The risk assignment process is also validated by the responses of the experts to the questionnaire.

In this paper the focus is on the risk identification and classification processes of the first stage. The details of the rest of the model development process as presented in Figure 1 and briefly described above are omitted due to space limitations.

THE RISK IDENTIFICATION PROCESS

The identification of the risks in the BOT projects was based on:

1. Extensive literature review of: (a) BOT projects, (b) other types of privately financed infrastructure and public private partnership projects (e.g. Build – Own – Operate, Design – Build – Finance – Operate, etc.), and (c) international construction projects. The common features and the great extend of application of similar types of projects compared to the BOT type – and, therefore, the existence of additional information – were the reasons for extending the literature review beyond the case of BOT projects.
2. Review of specific BOT projects regarding: (a) the concession agreement and other related contracts, (b) the organizational structure of the concessionaire during the development and operation of the project, and the relations with the subcontractors, and (c) the occurred risks and their mitigation through specific measures taken during the development and operation of the project.
3. Own analysis based on comparisons and inference from the data and information available.

Risks were perceived as sets of risk constituents. The occurrence of these constituents indicates the occurrence of the corresponding risks as well. Therefore, the identification process included both the risks and their constituents and resulted to a total number of 86 risks and 374 risk constituents rendering the risk inventory as one of the most comprehensive and analytical one for risk analysis in BOT projects.

THE RISK CLASSIFICATION PROCESS

As mentioned above there are many suggestions for classifying risks of BOT projects, which, however, reflect different underlying concepts and conclusions and, therefore, cannot be universally accepted. Apart from the nature and timing of occurrence criteria that are already mentioned, there are many other criteria sets used for risk classification such as the mitigation measures for a risk (Bing and Tiong 1999, Hastak and Shaked 2000) or systemic criteria such as internal, project-specific, and external risks for a construction project (Bing et al. 1999, Aleshin 2001).

A critical observation is that all these approaches focus on a specific aspect of risk, which is used as the criterion for the classification; this criterion would be the nature of the risk or the timing of occurrence or the mitigation measures used, etc. This leaves outside of consideration other aspects that may be of significant importance. The classification approach, adopted for the 86 risks identified here, merges two different criteria for classifying risks: (a) according to the source of origin in the project's context and (b) according to their nature. Therefore, when a risk is introduced as a variable in risk assessment, it bears concurrently more than one facets (i.e., nature and source of origin), thus increasing the accuracy of the assessment. Three main categories were identified, according to the criterion of the risks' nature, namely financial, technical, and legal, and five categories, according to the criterion of source of origin for each risk in the BOT project's framework, namely state-rooted, concessionaire-rooted, market-rooted, contract package-rooted, and miscellaneous. The context of each category is presented hereunder.

Financial Risks
A financial risk is related to a project's failure due to a financial or economic cause. A cause of this nature is related to the funding of the project and the commercial, competition, loan, and demand issues, etc. (e.g. cost overruns, taxation, imposition of restrictions, etc.).

Technical Risks
A technical risk is related to a project's failure due to a technical cause. Failure is considered as a shortfall in succeeding to meet the project's requirements. Technical cause is anything associated with the process of the project's development and operation. Therefore, the category of technical risks comprises all the aspects that may endanger project's success (e.g. material and equipment failure, deviations from designs and schedule, limited expertise of labour and personnel, etc.) and are related to the BOT project's evolution in terms of properties and implementation processes.

Legal Risks
A legal risk is related to a project's failure due to deficiencies in the legal and institutional framework. The institutional framework comprises: (a) organizational issues of both the country where the project is established and the concessionaire and (b) political issues. Organizational and political issues are introduced as different categories in other risk classification approaches. However, in terms of context, there is a significant overlap between legal, organizational, and political issues. This is due to the fact that any policy or organizational structure is realized through legal tools (e.g. laws, contracts, regulations, etc.). The realization of a policy or the establishment of any organizational structure is based – in the end – on the adopted legal, contractual, and regulatory system. Therefore, legal risks may be considered as a broad category that can include institutional risks as well.

State-rooted Risks
The entity of the state is a very critical parameter in the development of a BOT project and a significant source of risks. A state-rooted risk is related to a project's failure due to actions or omissions by governmental and public agencies.

Concessionaire-rooted Risks
The entity of the concessionaire is the most important factor for the development of a BOT project and a significant source of risks. A concessionaire-rooted risk is related to a project's failure due to issues that are in control of the concessionaire and the rest entities involved in the project excluding the state.

Market-rooted Risks
The environment wherein the BOT project will operate is another important parameter. A BOT project represents an investment for all the stakeholders involved; as an investment it is affected by the characteristics (e.g., the structure and maturity) of the construction industry market but also the overall market as well. A market-rooted risk is related to a project's failure due to issues that are related to the market wherein the project is developed.

Contract package-rooted Risks

The contract package of a BOT project is a complex and large framework of agreements and other legal documents that govern the development and operation of a BOT project. This complexity and possible inadequacies in the structuring of the contract package may be a very good reason for the generation of risks. Therefore, a contract package-rooted risk is related to a project's failure due to deficiencies or misinterpretations of the project's contract package.

Miscellaneous Risks

There are some risks that may originate from a context that either involves more than one of the abovementioned sources of origin (e.g. prolonged negotiation period) or none of them (e.g. force majeure). Therefore a miscellaneous risk is related to a project's failure for reasons, which are beyond the context of all the above groups.

Presentation of risk classification and discussion

Tables 1, 2, and 3 present the classification of the identified risks as discussed so far.

Table 1. The financial risks in a BOT project and their sources of origin

No.	**Financial Risks**	**Source of Origin**				
		State	Con/naire	Market	Contract	Misc.
1	Unfavourable economy in the host country	X				
2	Import/export restrictions	X				
3	Rate of return restrictions	X				
4	Taxation risk	X				
5	Lack of creditworthiness		X			
6	Inability of debt service		X			
7	Bankruptcy risk		X			
8	Unfavourable economy of the country of the main stakeholders		X			
9	High bidding costs		X			
10	High design costs		X			
11	High construction costs		X			
12	Errors in forecasting the demand		X			
13	Wrong estimation of trade-offs between different phases in the project's life cycle		X			
14	Risks regarding pricing of the product		X			
15	Cost overruns		X			
16	Complex financial structure of BOT projects		X			
17	Lack of cooperation to new initiatives		X			
18	Insufficient performance during operation		X			
19	Lack of guarantees		X			
20	Financing risk		X			
21	Loan risk		X			
22	Fall of demand			X		
23	Competition risk			X		
24	Fluctuation of the inflation rate			X		
25	Currency risk			X		
26	Unfavourable international economy			X		

Table 2. The technical risks in a BOT project and their sources of origin

No.	**Technical Risks**	**Source of Origin**				
		State	Con/naire	Market	Contract	Misc.
1	Non-beneficial procurement arrangements	X				

2	Delays regarding land acquisition	X				
3	Inadequate access to the project location	X				
4	Delays in other projects servicing the project in hand	X				
5	Delays to obtain design approvals in time	X				
6	Insufficient time for bid preparation	X				
7	Set of unrealistic goals	X				
8	Lack of reliable data for the preparation of bids	X				
9	Defects (or absence) of feasibility studies		X			
10	Defects of the design		X			
11	Application of innovative and unfamiliar technology		X			
12	Application of innovative and unfamiliar processes		X			
13	Equipment failure		X			
14	Construction schedule overrun		X			
15	Failure to meet the contract specifications		X			
16	Construction personnel safety risk		X			
17	Risks due to work in congested areas and overcrowding		X			
18	Inadequate project organization structure		X			
19	Incompetence of the project management team		X			
20	Failure to put together personnel from different nationalities		X			
21	Lack of coordination between subcontractors		X			
22	Deterioration of quality standards in operation and maintenance		X			
23	Environmental risk					X
24	Supply risk			X		
25	Lack of appropriate domestic partners			X		
26	Lack of skilled workforce and personnel			X		
27	Prolonged negotiation period prior to project initiation					X
28	Risks due to natural hazards					X

Table 3. The legal risks in a BOT project and their sources of origin

No.	**Legal Risks**	**Source of Origin**				
		State	Con/naire	Market	Contract	Misc.
1	Prejudiced and unfair process of awarding the project	X				
2	Host-country's interference in choosing sub-contractors	X				
3	Overprotective control/supervision by the host government	X				
4	Disapproval of guarantees by the government	X				
5	Unfavourable changes of host country's policy	X				
6	Change of host country's fiscal regime	X				

7	Change of host country's consideration of the project's scope	X			
8	Expropriation/Nationalization of the project	X			
9	Lack of political support by the government	X			
10	Lack of political stability	X			
11	Non-cooperation between different public agencies	X			
12	Actions or omissions of the public authorities that prevent the project to be completed	X			
13	Delays in calculating compensation	X			
14	Unsteady legal and regulatory framework	X			
15	Poor legislation	X			
16	Non-enforcement of the legislation	X			
17	Lack of a stable project agreement			X	
18	Varying focus for the project by parties involved			X	
19	Vague and inconsistent clauses and specifications and inaccurate phrasing			X	
20	Non-accordance between all contracts in the BOT Framework			X	
21	Language barrier for the contract			X	
22	Breach of contract provisions			X	
23	Revision of the contract clauses			X	
24	Relatively unknown status of the stakeholders		X		
25	Unanticipated change of the concessionaire scheme		X		
26	Lack of confidentiality and trust in the concession company		X		
27	Public opposition if environmental or social impacts are questionable				X
28	Risk of early termination				X
29	Force majeure				X
30	Public disorder/Riots				X
31	Terrorism				X
32	War				X

The innovative classification, based concurrently on two sets of criteria, i.e. nature of risks and the sources of origin, facilitates a better understanding of risks in a BOT project. This classification is significant for two reasons. First, it structures risks both in the project's framework (i.e., sources of origin) as well as in terms of individual entities (i.e. nature) regardless the project's context. This presentation assists the risk analysts' understanding of the risk profile of a BOT project. Second, it facilitates the modelling – in particular the mapping of interactions – at the second stage of the modelling process towards a BOT risk assessment tool.

The classification in three groups in terms of nature, i.e. financial, technical, and legal, although it could be considered as "very general", it involves the three basic terms that are most broadly accepted and used by the analysts and researchers to characterize a risk.

An observation of the risks and their classification reveals that:

- The most predominant risk sources are the state (29 risks in total) and the concessionaire (31 risks in total). This implies that both entities are equally playing the most significant role to the risk profile of a BOT project and should be treated with the same concern and attention.

- The state-rooted risks are mostly of legal nature (16 out of 29 in total), while the concessionaire-rooted risks are equally of technical and financial nature (15 and 16 respectively). This is rather expected since the concessionaire controls the project and the state is responsible for the legal and regulatory framework for the development of the project.
- The three different categories of risks nature are almost equal in terms of number of risks per group (28 technical, 26 financial, 32 legal). This implies that all three aspects of a BOT project are equally critical for its success and there should be no special care for one of these aspects against the others.

CONCLUSIONS

BOT projects are well known types of the public private partnership scheme for construction projects, which, however, present a great variety regarding identification and classification of risks. A comprehensive approach for both processes is presented in detail as a part of a briefly discussed development process of a BOT risk assessment model. This approach includes 86 risks classified in 8 categories according to nature and source of origin criteria. The classification approach has the unique feature of simultaneous consideration of both groups of criteria allowing in this way a better understanding, by risk analysts, of BOT risks.

The identification and classification of risks was evaluated and validated by the use of a questionnaire distributed and answered by experts in the field of BOT projects. The same questionnaire validated also the assignment of risks to the life cycle phases and allowed the initiation of the second stage of the modelling process. This stage includes the mapping of the interrelations between the identified risks in the BOT project and their inclusion into a fuzzy based risk assessment model. The risks assignment to the life cycle phases and the processes in stage 2 could not be presented here due to space limitations; nevertheless, the risk inventory and the classification scheme provide, already, a comprehensive tool for risk analysts that deal with BOT projects.

REFERENCES

Akintoye, A, Taylor, C and Fitzgerald, E (1998) Risk analysis and management of private finance initiative projects. *Journal of Engineering, Construction and Architectural Management*, **5**(1), 34-49.

Aleshin, A (2001) Risk management of international projects in Russia. *International Journal of Project Management*, **19**(4): 207-22.

Bing, L and Tiong, R L K (1999) Risk management model for international construction joint ventures. *Journal of Construction Engineering and Management*, **125**(5), 377-84.

Bing, L, Tiong, R L K, Fan, W W and Chew, D A (1999) Risk management in international construction joint ventures. *Journal of Construction Engineering and Management*, **125**(4), 277-84.

Charoenpornpattana, S and Minato, T (1999) Privatization-induced risks: State-owned transportation enterprises in Thailand. *In:* Ogunlana, S O (Ed.), *Profitable Partnering in Construction Procurement*, London, E. & F.N., 429-39.

Dey, P K and Ogunlana, S O (2004) Selection and application of risk management tools and techniques for build – operate – transfer projects. *Industrial Management & Data Systems*, **104**, 334-46.

Hastak, M, Shaked A (2000) ICRAM-1: Model for international construction risk assessment *Journal of Management in Engineering*, **16**(1), 59-79.

Kumaraswamy, K M and Zhang, X Q (2001) Governmental role in BOT-led infrastructure development. *International Journal of Project Management*, **19**(4), 195-205.

Ogunlana, S O (1997) Build - operate - transfer procurement traps: Examples from transportation projects in Thailand. *In:* Davidson, C H and Meguid, T A (Eds.), *Procurement - A Key to Innovation*, 1997, Montreal, 585-94.

Salzmann, A and Mohamed, S (1999) Risk identification frameworks for international BOOT projects. *In:* Ogunlana, S O (Ed.), *Profitable Partnering in Construction Procurement*, London, E. & F.N., 475-85.

Thomas, A V, Kalidindi, S N and Ananthanarayanan, K (2003) Risk perception analysis of BOT road project participants in India. *Construction Management and Economics*, **21**, 393-407.

Wang, S Q, Tiong R L K, Ting, S K and Ashley, D (2000) Evaluation and management of political risks in China's BOT projects. *Journal of Construction Engineering and Management*, **126**, 242-50.