FULLY INTEGRATED WEB-BASED RISK MANAGEMENT SYSTEMS FOR HIGHLY UNCERTAIN GLOBAL PROJECTS

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Abstract: Overseas construction projects are exposed to diverse and complex risks, including political, economical, social, and cultural issues. They tend to have a high possibility of loss/failure compared to domestic projects. For this reason, risk management is getting more important, emphasized, and systemized so as to improve the project performance. Since each phase of a construction project causes different types of risk associated with decision-making process, risk management system for global projects should be tailored to satisfy the specific needs of the particular phase. In this way, various risk management issues that arise through the entire life cycle of the project can be constantly checked and monitored. This study reviews basic decision-making processes in the global construction projects, and presents a framework for risk management of each process of a sequential decision. A fully integrated risk management system is also developed as a decision supporting tool, using key risk factors of each stage of a project.

Keywords: Integrated Risk Management System, International Construction, Risks, Web-based system.

1. INTRODUCTION

Traditionally, risk management was utilized in the area of safety, cost, and time management in construction projects. However, since the 1980's, risk management has been actively executed and has become the key decision supporting tool. Its application area has expanded to include such fields as bid-decision making, feasibility study, marketability study, performance evaluation, and contingency management by reflecting the various factors spanning all phase of the project life-cycle. There now exists the consensus that risk management is the integral part of project management and plays such an important role that its application goes beyond the traditional scope which normally centers on the construction phase (Del Caño and De la Cruz 2002). Accordingly, it is utilized in various decision-making fields related to construction projects.

Particularly, international construction projects are exposed to more diverse and complex risks than what are encountered in domestic projects. Those risks include political, economical, social, and cultural issues. Therefore, international projects tend to have a high possibility of loss compared to domestic projects. This severe environment requires the risk management to be more emphasized and systemized to minimize the impact of various risk variables. Since each phase of a project requires a unique solution under the different exposures of risk factors, the decision-making process should also be tailored to satisfy the specific needs of each phase of the project. In this context, Tah and Carr (2001) emphasized the importance of establishing a systematic risk management process for each phase of a construction project. Thus, the objectives of this study are; 1) to carefully review major decision-making processes for international construction projects, 2) to produce specialized modules for risk management in each stage of construction projects, and finally 3) to develop a fully integrated risk management system that employs the aforementioned decision process modules in a web-based architecture.

2. LITERATURE REVIEW

The studies concerned with international construction projects have been actively performed since the 1980's. Purtell (1982) and Arditi and Gutierrez (1991) drew risk factors that are important for international construction projects and presented methods to manage those risk elements. Efforts were also made to develop methods for addressing specific risk issues. Bing and Tiong (1999) identified risk factors and a management model for international joint venture. Han and Diekmann (2001) presented a model to support bid decisions by structuring various influencing factors on international construction projects. On the other hand, efforts were made to manage risks in the entire cycle of construction projects. Ward and Chapman (1995) suggested major items to be monitored in each stage of an international project. Hastak and Shaked (2000) drew risk factors at country, market, and project level, and presented a model to evaluate those risks. Del Caño and de la Cruz (2002) developed a management model by systematizing risk management process along with the project's characteristics. Although those aforementioned studies regarding project risk management have been contributory to the body of knowledge, the entire aspect of international project risks have not yet been fully addressed, leaving the room for further researches designed to develop systematic risk management processes that cover all the stages of project's life cycle.

Those risk management studies (Ward and Chapman 1995, Hastak and Shaked 2000, del Caño and de la Cruz 2002) followed the traditional risk control strategy (transfer, share, reduction or avoidance). The strategy, which typically consists of five steps: identification, analysis, evaluation, response, and monitoring (see Figure 1), has been perceived as an effective method to identify risks that may occur in the construction projects and to efficiently manage the identified risks. However, the amount of risk-related information collectable on a phase of the project differs from that of another phase. Also, the depth and extent of why and how a decision maker evaluates the relevant risks becomes quite different together with each phase of a project. In this sense, if the characteristics of all phases of the construction project are not considered adequately, it is hard to bring the risk management into its full fruition. Moreover, risk factors of international construction projects are diverse, complex, and interrelated. They are also different from project to project. Therefore, the traditional style of risk management has clear limitation on its applicability to international construction projects where not only management of probable risk factors but also continuous interaction between different decision-making processes is extremely important.

This paper intends to draw major decision-making processes and seeks to identify a unique solution for risk management concerned with international construction projects. Typically, the life-cycle of international construction projects can be divided into four stages: project planning and bid preparation, contracting, construction, and commissioning and operation. Figure 2 summarizes previous risk management studies according to the four project stages.

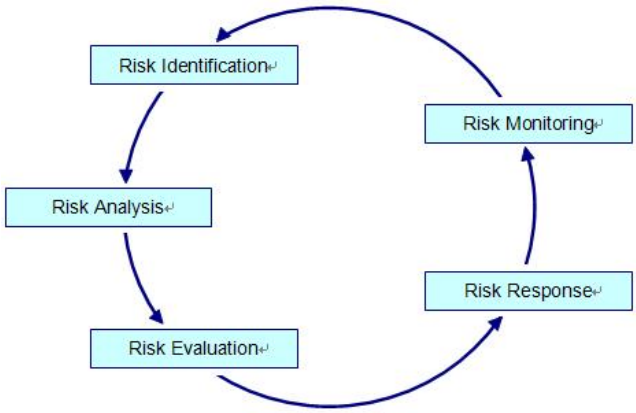


Figure 1. Traditional risk management process

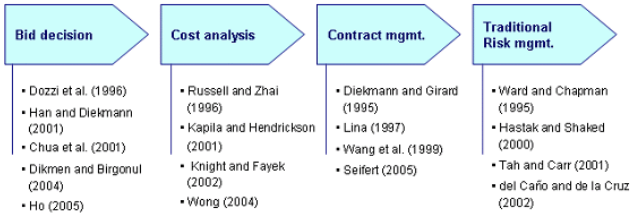


Figure 2. Previous studies on risk management

Apart from risk management at a project level, portfolio studies at a corporate level were also carried out (Han et al. 2004, Gunhan and Arditi 2005), which indicates the increased need of risk management at the level of corporations who are conducting multiple projects in international construction markets. Chan and Tse (2003) emphasized the importance of a thorough pre-project planning especially on the conditions of host countries and clients, bidding processes, and market trends, as well as construction phase risks such as contractors' technical ability and timely resource delivery. These broadened perspectives are the basis for identifying the necessary decision processes that lead to integrated risk management systems.

3. RISK MANAGEMENT PROCESS FOR INTERNATIONAL CONSTRUCTION PROJECTS

Literature reviews and other extensive preliminary investigations produced the general guidelines of risk management for international construction projects. First, there is a need for the development of a model to support bidding decision. Second, in the early stage of bid preparation, an effective tool is required to conceptually analyze the profitability of the project to evaluate the quality of project condition; Third, the more detailed

information available in the phase of construction can be effectively used for the traditional risk management schemes such as the five stages risk control strategy: identification, analysis, evaluation, response, and monitoring; Fourth, procedural guideline is useful to evaluate critical contractual clauses and project-related information and to minimize contractual risks; and finally, a portfolio model to manage various projects at a glance is needed to monitor the trend of corporate-level risks.

This study develops a fully integrated risk management process with various phases and management levels considered (see Figure 3). On the premise that the effect of risk management increases as we focus more on the initial stage of a project (Smith 1999), we classified the life cycle of a project into five stages in the manner that we can put more weight on the pre-construction sides: (1) establishment of project plan, (2) bid preparation period, (3) contracting, (4) construction, and (5) commissioning and operation. To handle different decision-making processes associated with various phases of a project, this study develops decision support models to decide whether to pursue the project, and to estimate overall profitability of the project. These models would assist decision makers in evaluating the advantages and disadvantages of a candidate project in the early stage. An advanced risk checklist is also designed for contracting, construction, and even operation stage. The checklist is superior to other traditional risk checklists in the sense that it can reuse the project information being transferred from the initial stage of the project. It can also quantify risks in a systematic manner such that the causal relationships between risk scenarios can easily be understood and so bid contingency based on the scenarios can be accurately estimated. A portfolio model is also put in place so as to analyze cash flows and the corporate level risks. Altogether, comprehensive risk management over different phases of a project could be conducted. Additionally, guidelines for international project management and contract checkpoints are devised in order to provide basic information and negotiation strategies during the contracting and construction phase.

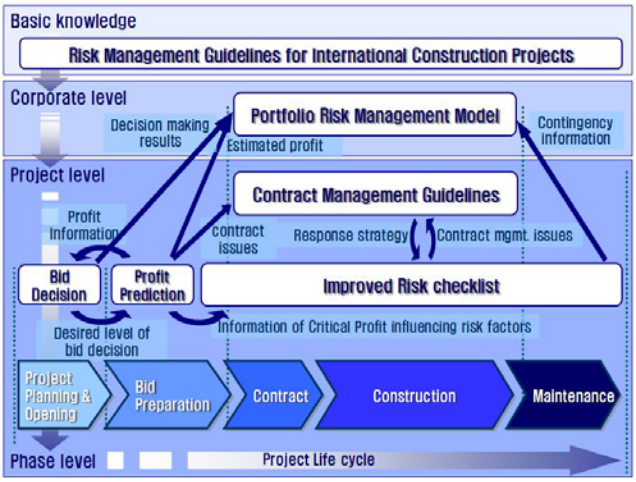


Figure 3. Integrated risk management process

In another aspect, it is essential to develop a risk management model that is subject to available information in its full capacity. Since different phases of a project produce different amount and quality of risk information, this phenomenon should be reflected in the project risk management model. In view of all these, a judgment-based approach focused on broad risk factors should be made at the early stage of a project, and as the project moves ahead, detailed risk items and tools for in-depth analyses are provided by reflecting the features of different levels of risk management, as shown in Figure 4.

In each stage, the consistency of risk management and features of a project should be considered appropriately. For example, a decision model on bidding status is supported through the evaluation of 36 factors under the five categories (such as project characteristics, degree of potential profit, contractor's ability to perform, degree of risk exposure, and level of bid competition), so that overall risk analysis at this stage can be performed using a multi-attribute decision making tool. A statistical profit prediction model is also presented based on 126 real project cases by extending the 36 factors into more detailed 64 risk variables in such five areas as: (1) conditions of host country/client, (2) bid information, (3) characteristics and environment of project contract, (4) organization members and their relationships, and (5) construction and management capabilities of the contractor. As for the checklist that is used in the contracting and construction stage in which more detailed project information can be obtained, it is configured such a way that detailed risk management could be carried out through 201 risk items that are more expanded and structured under the same categories of five areas.

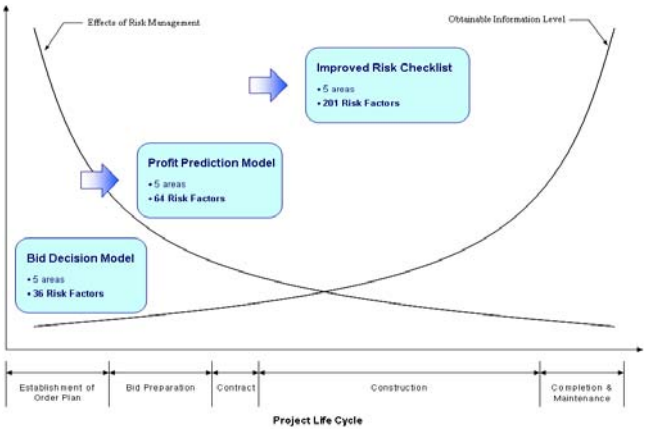


Figure 4. Risk management level through project life cycle

4. Fully Integrated Web-based Risk Management System for International Construction Projects

4.1 Web-based system

For the practical application of the proposed risk management processes, we developed a web-based system

with a better access rather than using intranet of a company. It was because each construction site and branch office is located around the world. Table 1 demonstrates the development and user's environment of the fully integrated web-based risk management system. We constructed these system based on the Microsoft ASP.NET platform and MS SQL database. The Microsoft .Net framework is a platform to develop software, and it can be executed regardless of the different operating system. It is suitable for risk management system dealing with internal information of company, because it is superior to existing platform in terms of stability, extendibility, and security. The database includes information from a total of 126 projects and the attributes of each risk variable.

The system architecture is devised for a common user to utilize each model independently in line with the user's requirements and needs for project evaluations. The information in each model can be interconnected so as to share the risk data generated in proceeding stages with the succeeding risk items and the company's portfolio. Figure 5 shows an application procedure of the system. With regard to the project level, individual users utilize a bid decision model, a profit prediction model, and risk checklist in line with each progress stage regarding the registered projects. Through this procedure, continuous monitoring and management of significant risks during the whole cycle of a project becomes possible.

Table 1. The development and use environment of the risk management system

Development environment	User's environment
• Windows 2000 Server	• Minimum resolution : 1024 × 768
• Database: MS SQL 2000	• Internet access
• Framework : Microsoft ASP .Net	

Web Site: http://rms.icak.or.kr

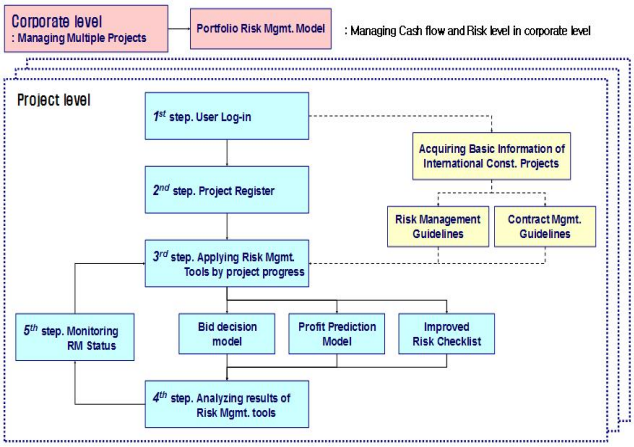
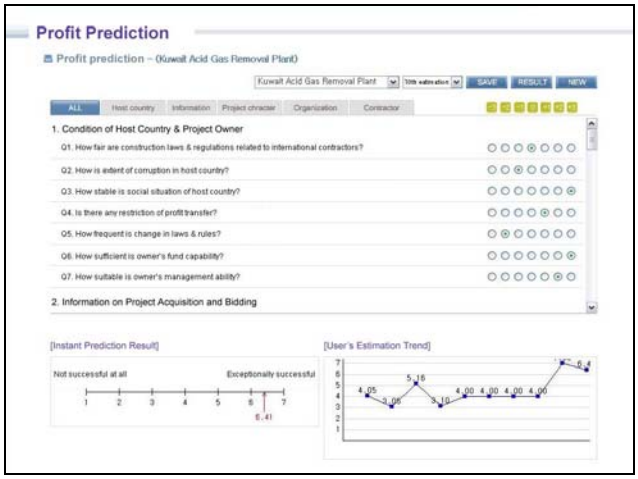
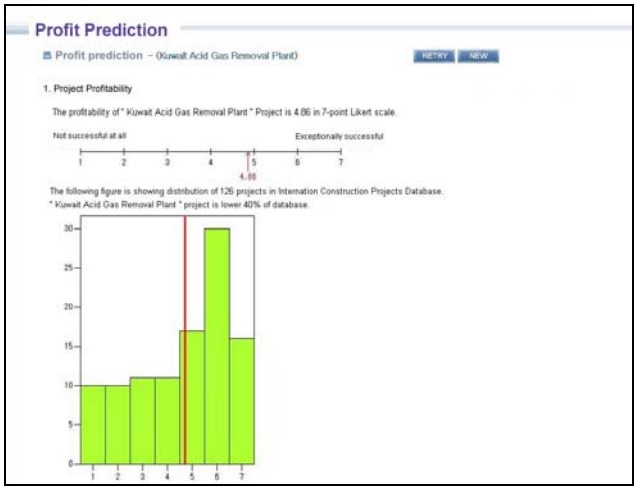


Figure 5. Application procedures of the system

For example, in the case of profit prediction model, the database includes a total of 126 projects information and the attributes of each risk variable, i.e. performance level and criticality in achieving the specified profitability. A real system based on these concepts is shown in Figure 6. As shown in Figure 6a, the users can handle a prediction model more easily by just inputting their basic project information and the expected severity of each risk variable through the web-based system. Based on user's input information, internal mathematical algorithms (multiple regression model) calculate the factor scores and then present the predicted regression result on the profit level of the possible candidate project. Moreover, in addition to the provision of predicted profit level, it can compare its outcome with the reference group from the existing database that takes on similar characteristic in terms of project types, regional locations, and contract types. By doing so, the users can evaluate the candidate future project in comparison with the specific distribution of similar completed projects (See Fig. 6b). It can also provide the sensitivity analysis suggesting which risk variables are critically affecting the profit performance.



a. Input screen



b. Estimation result

Figure 6. System snapshot – Profit Prediction Model

4.2 Experts feedback

To demonstrate actual utilization of the developed system, a questionnaire survey targeting the experts of international construction projects was carried out. The questionnaire consisted of two parts: multiple choice questions on the risk management system and open questions in which respondents can describe freely their personal opinions on the quality of a system. Evaluation of the developed risk management system was conducted through 7 point Likert scale (1: very low - 7: very high) concerning four items: completeness of the system, adequacy of applied model in each stage of a project, suitability of the system structure, and applicability in real cases. As a result of the questionnaire survey targeting 10 international construction experts both from global companies and the academia, the evaluation of overall system received a high score of 5.23 as shown in Table 2. Looking into the detailed items, the suitability of the system structure gained the highest score at 5.50, followed by completeness of the system, and adequacy of applied model in each stage at 5.40, respectively.

Table 2. Degree of utilization

Experts	Utilization items				Total score	SD
	Completeness of system	Adequacy of applied model	Suitability of the system structure	Applicability in real cases		
# 1	5	5	4	3	4.25	0.96
# 2	5	5	5	5	5.00	0.00
# 3	6	5	6	6	5.75	0.50
# 4	4	6	6	3	4.75	1.50
# 5	6	6	7	5	6.00	0.82
# 6	6	5	6	6	5.75	0.50
# 7	5	6	5	4	5.00	0.82
# 8	6	5	4	4	4.75	0.96
# 9	5	5	5	5	5.00	0.00
# 10	6	6	7	5	6.00	0.82
Mean	5.40	5.40	5.50	4.60	5.23	0.42
SD	0.70	0.52	1.08	1.07	0.84	0.28

5. CONCLUSION

This study derived key decision making processes through a literature review and experts feedbacks so as to establish an integrated risk management model, which addresses the life cycle of international construction projects. Based on the results, individual models suitable for each stage of international construction projects, and an integrated risk management process were presented. In addition, a Web-based system was developed based on the proposed concept, which enabled users to perform continuous risk management for each stage of decision processes. The study results can be utilized as a means for decision making of an individual project as well as multiple-projects through utilization of the portfolio module at the corporate level.

Until now, more than 200 contractors have been registered to developed risk management system and currently in use for managing more than 50 international construction projects by playing a beneficial role as a scientific and rational risk management model. The procedural future studies will concentrate on complementing the requirements of real cases and updating the model with getting more data from the registered projects. Also, continuous improvement of each model is required through the evaluation of more real case applications.

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