TOTAL RISK INDEX FOR ASSESSING RISK LEVELS OF OVERSEAS CONSTRUCTION PROJECTS

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ABSTRACT: International construction projects typically manifest difficult, complex, and varied types of risk exposures; because of this, there is a need for accurate evaluation of risk-integrated performances during the timeframe of project execution. Given the financial crisis currently affecting the world economy recession, risk management has become a more crucial part for the success of international project management. However, the majority of risk management approaches, particularly for overseas projects, are focused primarily on simple forms of checklists, formalization of risk variables affecting project performance for a specific phase, or more complicated computational methods that restricting practical utilization in real-world projects; moreover, these methods lack the conceptual basis to broadly visualize the level of risk over all phases of a project. This study suggests an efficient, yet simple risk-integrated total index to successfully assess the risk levels of overseas construction projects. To this end, this paper first investigates the life cycles and key processes of decision-making for a given project and then derives formulas to represent the total risk index (TRI) along the key decision-making processes. In addition, the study examines the relationships between TRI and performance levels based on the analysis of 126 real-world project samples. Validations using the proposed TRI showed a high correlation to project performance, signifying the usefulness of the proposed approach for construction firms when investigating the level of risks and key areas for management focus.

Keywords: Foreign Construction; Risk Management; Total Risk Index

1. INTRODUCTION

International construction projects typically manifest difficult, complex, and varied types of risk exposures; this gives rise to a need for accurate evaluation of risk-integrated performances during the timeframe of project execution. International contractors thus face political, economic, social, and geographical risks; they also face diverse uncertainties internally involved in contracts, financing, sub-contracts, human resources, and the supply of resources and devices. Many studies [1–5] have pointed out the severity of risks in international projects. Whitla et al. [6] consider them "highly volatile, subjecting contractors to financial and geopolitical risks." Given the financial crisis currently affecting the world economy, risk management has become a more crucial part of international project management. According to You and Zi [7], the construction industry is one of industries that are most vulnerable to the current liquidity crisis. For example, as GDP growth of Asian countries decreased during the Asian financial crisis, the growth rate of construction sector also decreased significantly [8]. However, Raftery et al. [9] reported that the Asian construction sector has attained good financial health and made sound management decisions for the long term through effective risk management,

Accordingly, concerns over risks have spawned various studies, attempting to analyze and manage risks in overseas construction projects. Because overseas construction is much vulnerable to various political, economical, social, and cultural factors in a host country, research on risk factors is constantly being conducted in the area of international construction [5, 10–15]. Some studies have focused on the relationship between risk factors and project performance to develop risk-based decision support models [1, 16–19]. In addition, traditional risk management, which typically consists of five steps—identification, analysis, evaluation, response, and monitoring—has been applied as an effective tool for overseas construction projects [3, 20–25]. The majority of risk management approaches, however, is focused primarily on simple forms of checklists, development of risk variables that model the relationship with project performances for a specific phase, or even further complicated computational methods that restrict practical utilization in real-world projects. Although the previous studies on project risk management have contributed to the body of knowledge in this field, the entire spectrum of issues related to international project risks have not yet been fully addressed, leaving room for further research to develop systematic risk management processes covering all stages of a project life cycle. Given the lack of current approaches, this paper suggests practical but yet simple risk index to broadly visualize the level of risk over all phases of a project.

Since each phase of a project requires a unique solution under different exposures to different risk factors, the risk management process should also be tailored to satisfy the specific needs of each phase of the project. In addition, the depth and extent of why and how a decision-maker evaluates relevant risks is quite different for each phase of a project. In this sense, Tah and Carr [26] emphasized the importance of establishing a systematic risk management process for each phase of a construction project. Thus, the objectives of this study are to: 1) carefully review major decision-making processes for international construction projects; 2) derive formulas representing the total risk index (TRI) associated with key decision-making processes; and 3) examine the relationships between TRI and the performance levels of international construction projects.

2. TOTAL RISK INDEX (TRI) SYSTEM

2.1 Factors in Key Decision-Making Processes

As discussed, the majority of previous studies on risk management for international construction projects did not fully consider the linked decision-making process and constraints such as the availability of information in relation to the project lifecycle. Therefore, this study develops a framework for risk evaluation and management using standard metrics over the timeframe of an overseas construction project lifecycle.

As shown in Figure 1, international construction projects are generally partitioned into 5 phases: project planning and bid opening, bid preparation, contract, construction, and maintenance and operation [27]. In the early phases, the projects selection, go/no-go decision, and markup decision constitute key decision processes. Therefore, in the early days of project implementation, it is necessary to evaluate relevant risks with involving comparatively less information and then link key decisions with the results of such an evaluation. However, available information increases as a project progresses, the focus of risk management is likely to shift from a holistic level to a project-specific dimension such as responses to individual risks. As Figure 1 shows, this study divides risk management into three general phases. Since risk management is more effective at the beginning of the project lifecycle, the initial phase includes two stages; phases following the initiation of construction are merged into a single process.

Accordingly, it is necessary to identify related risk factors for each of the 3 phases constituting the project lifecycle. This study builds upon our earlier works [19, 28]—in reference to the risk factors that were identified with experts' interviews and extensive literature studies in association with each phase of Figure 2. First, 36 risk factors under five categories (project characteristics, degree of potential profit, contractor's ability to perform, degree of risk exposure, and level of bid competition) were identified in relation to the project planning and bid opening phase. For the risk factors of the markup decision phase, 64 risk variables were identified under five areas: (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. Since the phase of project execution requires more specific risks to be managed accordingly, the risk factors were further expanded into 201 variables under the same five categories.

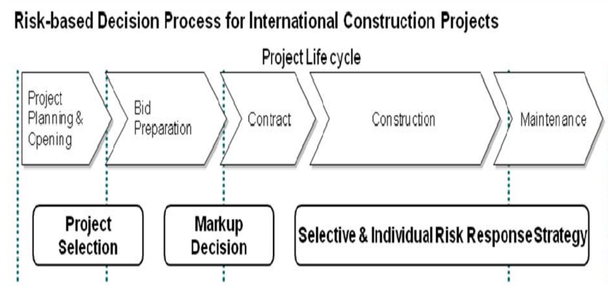

Figure 1. Project Lifecycle and Key Decision Process

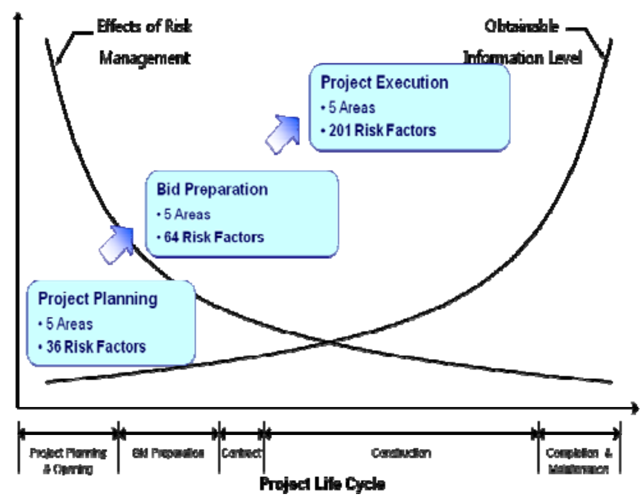

Figure 2. Phased Risk Factors [28]

2.2 Conceptual Framework for TRI

The risk index regime for each phase is developed on the basis of the three phases and risk factors identified above. Traditionally, it is customary to utilize the probability and intensity of impact to quantify risks [27, 29]. However, in the early stages of projects, it is difficult to evaluate probability or intensity of individual risks; hence, assessing impacts of major risks or projecting level of overall risks accrued can be a more viable target for risk management at this stage [28, 30]. Furthermore, even in the project execution stage where the focus of risk management is quantifying individual risks, current techniques simply relying on probability and impact intensity limit our evaluation in distinguishing more significant risks from common ones, because level of risks is actually affected by more than frequency and impact of consequence. It necessitates an improvement in the current approach [31, 32]. Therefore, this study proposes a quantification approach factoring the characteristics of each phase to overcome the limitations of conventional risk quantification techniques and develop a risk index regime enabling holistic risk projection along the entire project lifecycle; this regime is named as the Total Risk Index (TRI). Table 1 shows a summary of TRI and the quantification formulas for each phase.

In the project planning and bid preparation phases, users are allowed to intuitively evaluate each risk so as to reduce the higher burden of data input using a more pragmatic perspective. First, weights among the five risk groups are determined through the well-known analytic hierarchy process (AHP). Individual risk factors under each group are further assessed by estimating the weight and exposure level per each risk. In this process, weights are subjectively evaluated by users with the simple multi-attribute rating technique (SMART). A weight estimation regime using AHP and SMART is easy for users to utilize and understand intuitively. With this evaluation, TRI is gauged on a scale of 0 to 100 in accordance with the formulas in Rows 1 and 2 of Table 1. The higher the TRI value is, the more severe the overall risk is.

As for the project execution phase, it is essential to utilize information on each risk in more details so as to respond to individual risks. In an effort to supplement conventional risk evaluation techniques that rely on probability and intensity, this study adopts the significance concept defined in our previous research [28]. The significance concept is intended to indicate the importance of individual risks perceived intuitively by experts in addition to probability and impact; it encapsulates the other dimension of each risk including; general perception on the severity of risk, level of difficulties in acquiring relevant information, level of difficulties in controlling the risk exposure, degree of indirect, additional, or secondary damages, level of influence that affect the firm's profit, and attitude toward the extent of risk exposures and range of responsibility [28]. To ensure consistency with the preceding phase, TRI is calculated as the distance from origin by squaring and summing up the probability, importance, and significance on a scale of 0 to 100, as shown in Table 1.

3. TRI AND PROJECT PERFORMANCE

In the total risk index system, it is crucial to ensure that the evaluation of risk level is carried out in tandem with the decision-making process in each phase. Many critics of previous risk studies have pointed out the lack of consideration in connecting risk quantification with decision-making processes in practical terms [33, 34]. Therefore, to utilize TRI more effectively, it is necessary to investigate how the risk level in each phase is related to project performance. To that end, this study analyzed the correlation between TRI and project performance using real data on 126 projects collected in our previous study [19].

The data on 126 projects included the level of each risk and project performance delivered by Korean construction contractors internationally. The project performance was collected and measured in terms of profitability, cost variation, and schedule performance. TRI was calculated using the formulas in Table 1 for each project case in reference to the risk level assessment. Correlation analysis and analysis of variance (ANOVA) tests were performed on such data to test if the TRI score for each phase is varied with reference to project performance. As Table 2 shows, the correlation analysis indicated that TRI had a negative correlation with profitability and a positive correlation with cost variation and project duration, which statistically validates the assumption that a higher TRI level is likely to result in lower profitability, cost overrun, and schedule slippage. However, the schedule performance showed relatively a smaller correlation with the TRI score in the project execution phase. It perhaps explains that level of risk is more related to cost side than time dimension, as time delay is rather affected by many excusable causes incurred by owner’s needs. The ANOVA test also indicated that the mean of the TRI scores for each project performance showed a significant difference at the 95% confidence interval (Figure 3).

Table 1. Total Risk Index System

Phase	Purpose	Assessment Method	Target Risk	Total Risk Index
Project Planning	• Project selection • Go/No-go decision	• Weighting : AHP, SMART • 1 to 5 scale	• 5 Groups • 36 Risks	$TRI_{pl} = \left[\sum_{j=1}^{5}\sum_{i=1}^{36}(GW_j \times RW_i \times LR_i)\right] \times \frac{100}{s_p}$ where, GW_j = weight of risk group j (j = 1,…, 5): AHP RW_i = weight of risk i (i = 1,…, 36): SMART LR_i = level of risk i (1 to s_p scale) s_p = risk assessment scale in project planning phase
Bid Preparation	• In-depth analysis of profitability • Markup decision	• Weighting : AHP, SMART • 1 to 5 scale	• 5 Groups • 64 Risks	$TRI_{bid} = \left[\sum_{j=1}^{5}\sum_{i=1}^{64}(GW_j \times RW_i \times LR_i)\right] \times \frac{100}{s_b}$ where, GW_j = weight of risk group j (j = 1,…, 5): AHP RW_i = weight of risk i (i = 1,…, 64): SMART LR_i = level of risk i (1 to s_p scale) s_b = risk assessment scale in bid preparation phase
Project Execution	• Assessment of detailed risk factors’ influences • Selective and individual risk response strategy	• Weighting : P, I, S • 1 to 5 scale	• 5 Groups • 201 Risks	$TRI_{exe} = \frac{\sum_{i=1}^{201}\sqrt{(PR_i \times \frac{1}{s_e})^2 (IR_i \times \frac{1}{s_e})^2 + (SR_i \times \frac{1}{s_e})^2}}{201} \times \frac{100}{\sqrt{3}}$ where, PR_i = Probability of risk i (i = 1,…, 201) IR_i = Importance of risk i (i = 1,…, 201) SR_i = Significance of risk i (i = 1,…, 201)

Table 2. Correlation Analysis Result

Pearson Correlation	TRI Score		
	Project Planning	Bid Preparation	Project Execution
Profitability	–0.614	–0.657	–0.512
Cost Variation	0.434	0.463	0.362
Schedule Performance	0.312	0.291	0.160

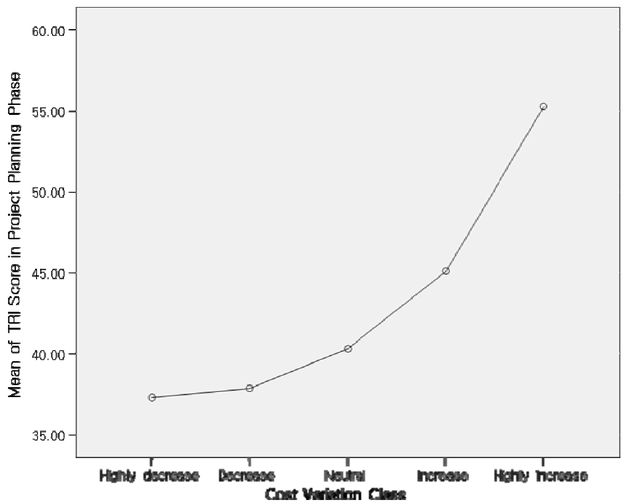

Figure 3. Plot of Means: TRI versus Cost Variation

The TRI versus profitability guideline for utilizing the TRI score is proposed in relation to such analyses (see Table 3). The mean of the TRI scores and the lower and upper bounds at the 95% confidence interval are defined for prompt decision-making process; the distribution of project performance is suggested to provide TRI evaluation as readily available inputs for decision-making processes. For example, if the TRI score is found to be 60 in TRI evaluation during project planning phase, such a project is likely to be bad with showing a probable profitability being under '- 9%' on average.

Table 3. TRI-Profitability Guideline for Project Planning

Profitability (%)		TRI Score	95% Confidence Interval for Mean	
Class	Mean (%)	Mean	Lower Bound	Upper Bound
1: Not successful at all	–9.571	56.237	50.914	61.561
2	–7.667	49.155	42.309	55.999
3	–4.517	46.905	43.245	50.565
4: Neutral	0.063	43.602	39.062	48.143
5	6.685	42.692	38.571	46.813
6	10.345	37.959	35.828	40.090
7: Very Successful	15.420	32.431	28.420	36.442

4. CONCLUSIONS

The critical importance of risk management has been highlighted all the more in overseas construction projects by the current global economic crisis, as the international construction market has many risk factors vulnerable to changes in the global economy. Conventional risk management approaches do not consider the characteristics of different phases in international construction projects, posing limitations on utilizing the risk evaluation results and failing to provide a consistent guideline. The TRI system developed in this study is significant in that it provides a risk evaluation regime that takes into account the characteristics of different project phases for key decision-making processes in overseas construction projects. Furthermore, 126 project data sets were analyzed to validate the correlation of the TRI score with project performance and to ensure effective utilization of the TRI system. Users are allowed to estimate the TRI score with a simple and efficient risk evaluation process in each project phase, and TRI score estimated as such is interfaced to project performance to help decision-making processes.

However, the TRI system needs to be further refined, as risk factors utilized by the system are oriented more toward the cost dimensions of project performance—such as project profitability or cost variation—instead of schedule performance. In addition, subsequent studies need to focus on methodologies to ensure objectivity in the risk evaluation process and examine how to relate the TRI score in each project phase to project performance in more depth.

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