

PRACTICAL APPROACHES TO RISK MANAGEMENT FOR GLOBAL CONTRACTORS

Seung Heon Han¹, Du Yon Kim², and Han Him Kim³

¹ Associate Professor, Department of Civil Engineering, Yonsei University, Seoul, Korea

² Ph. D Student, Department of Civil Engineering, Yonsei University, Seoul, Korea

³ Engineer, Civil Engineering Department, Daelim Industrial Co., Ltd., Seoul, Korea

Correspond to cagedbird@yonsei.ac.kr

ABSTRACT: Global construction projects manifest more risks than do other industries. Often, firms doing business in construction markets find these risks intimidating. To secure corresponding profits, many global contractors attempt to forecast the effects of risks and establish risk management strategies. However, one key problem with present-day risk management methods is that they are basically analytical or mathematical-oriented approaches which are not easy to adopt in real business. Based on preliminary investigations and evaluations of current tools, this research elicits more practical algorithms for risk checklist by constructing risk scenarios over the whole period of project execution. For the application of the algorithms, a “SE/RF” (Source-Event/Regular-Floating) checklist is suggested, which sorts out risk sources and their subsequent events, as well as dividing various risk factors into either regular or floating categories. In addition, the “PIS” (Probability-Impact-Significance) method is introduced, in place of traditional “PI” (Probability-Impact) methods, by adding the additional criterion of “risk significance” to determine the degree of risk exposure in a more realistic way. As a result, we draw the significant finding that the “PIS” method presents a closer evaluation regarding degree of risk exposure as compared to the level of expert judgments than those from traditional methods. Finally, we provide an integrated procedure for international project risk management with all of the research achievements being incorporated.

Key words: international construction projects, risk, significance, PIS method, SE/RF checklist

1. INTRODUCTION

According to *ENR* [1] and *Global insight* [2], the present volume of the world construction market is approximately 4,100 billion dollars. And about 7.1% of that total volume (\$291 billion) consists of potential markets that foreign construction firms can access. As the globalization of the construction markets expands, the opening rate is expected to reach around 15~20%. Consequently, the potential international construction markets will amount to approximately 600 billion dollars. These market changes provide a tremendous opportunity. However, because of the fact that competition in international construction markets is deepening, it is difficult to secure profits from an international construction project. Moreover, global construction project is inherently exposed to unpredictable and complicated risk scenarios.

Therefore it is very important to forecast the effects of these risks beforehand and to establish risk management strategies. Toward this end, this paper develops more practical algorithms for risk checklist elicited by analyzing the causal relationships among the risk factors and by constructing risk scenarios (so called, path-based checklist). Then, it establishes the advanced method for risk rankings through logical leveling by the adoption of more reasonable quantification method.

2. ORGANIZING PATH-BASED CHECKLIST

2.1 Evaluation of Current Risk Checklist

Because of the importance of risks, risk analysis and management has been used to predict and manage the various exposures to the risks inherent in the construction industry. The most common tools are decision trees, influence diagrams, Bayesian networks, Monte Carlo simulation, and sensitivity methods [3, 4, 5]. But most of the present-day risk management methods were too difficult to apply to practical usage. In the practical business world, it is more likely that the simple risk checklist or risk management guideline is useful and performed easily by common users than do the analytic and complicated risk models.

A risk checklist is a basic method for risk management, but it is utilized mostly because of its usefulness in recording and revising the related risks. Although the application procedure of risk checklist is varied depending on firm's workflow, generally it is applied by the following 3 steps [6]. The first step is ‘Identifying risks’, the second step is ‘Quantifying risks’, and the last step is ‘Establishing risk management strategy’. However, current general risk checklist stays in simple level of detail which is just listing the risks so as to limit the quantification and prioritization of interrelated risks. As an example, CII [6] present the example of risk assessment sheet for the risk categories such

as ‘application of tax laws and potential change’ and ‘political instability’. However, the users are easily confused in quantifying these risks in terms of judging likelihood of occurrence and relative impact because this classification entails broad and vague meaning and moreover, these risks often induce the secondary effects to the subsequent risks. As a result, the users have difficulties in estimating their subjective probabilities and impacts directly from their own cognitive perceptions. Also, this risk checklist has problems in establishing risk management strategy. That is, even in the case of selecting main risk by quantification, the targets of management are too comprehensive to set up appropriate and specific response strategies.

2.2 SE/RF checklist

Because of the limitation of the current risk checklist, it is required to manage risks in various view points, such as cause and its subsequent events, outside and internal factors, occurrence time, phase level, especially in the domain of global construction projects. In this regard, the advanced risk checklist is suggested, which contains following concepts. First, the risk checklist is structured in form of dividing a risk into ‘Source (or cause)’ and ‘Event’. When a risk is drawn by its causality, it is very useful in understanding the relationship among the main risks and related factors through grasping the path of risk series from its source to event. For example, forcemajeur is one of source group, subsequently induce the procedural risk events such as property damages, time delay, work suspension, and cost increase, etc.

Second, the source group of risk is divided into ‘Regular’ and ‘Floating risk’. The ‘Regular risk’ is the type of the risk that can be mitigated or avoided by the preliminary investigation or the experience of the similar projects. In this case, the kind of risks and the occurrence seem almost predetermined by the boundary conditions regardless of project-specific conditions. This category includes uncertainty of law and regulation, degree of corruption of the host county, and firm’s ability to perform. On the other hand, the ‘Floating risk’ is the type of the risk of which occurrence varies depending on the characteristics of a project and its environment. For example, currency exchange risk, internal rate, differing site condition, and material supply condition are in this category. This classification of the risk is worthwhile in a view point of management. Because the ‘Regular risk’ is rather predictable based on the prior information in its existence, probability, and impact, the objectives of management are to reduce the level of the risks. On the contrary, because the occurrence of the ‘Floating risk’ is presumed to be probabilistic, the objectives of management are to raise the accuracy of prediction and minimize the loss by establishing suitable response strategy beforehand.

Third, the risk hierarchy is suggested, which can subdivide all risks into two or three level. The risk hierarchy starts from top-level risk contained the most extensive concept to the lowest level consisted of the independent cause or the single event gradually. Through this hierarchy, it is possible to diversify the risk paths and assign the risk

values against more specific subjects with a consideration of explicit risk contexts.

As stated, the improved risk checklist is structured by causal relationship of risks, regular-floating characteristics of source groups, and series of risk paths. The writers name the risk checklist including these concepts as ‘SE/RF (Source-Event/Regular-Floating) checklist’. Figure 1 shows the main concept of this checklist and figure 2 shows the example of the risk path.

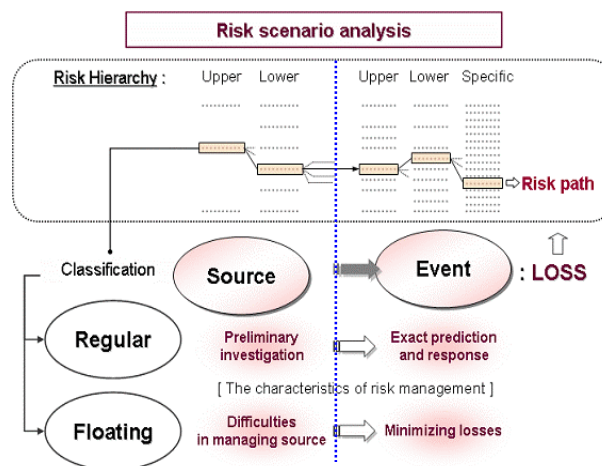


Figure 1. The main concept of the SE/RF checklist

Condition of host country & owner				
Source group		Event group		
Upper	Lower	Upper	Lower	Specific
Owner condition	Insufficient management ability of owner	Inefficient administration	Delayed schedule	...
	Fairness of owner	Ill-disposed attitude of owner	...	...
	.....	Unreasonable requirements of owner	Excessive burden by owner's requirements	Risk path
Condition of host country	Instability of social situation	Delayed permission	...	...
		Delayed custom entry	...	...

Figure 2. The example of the risk path

Because the risks of global construction projects are various and related to the complicated scenarios, the SE/RF checklist can be more useful than do the existing methods. Based on the structural benefits of the SE/RF checklist, the effective and reasonable quantification method is required. The next chapter deals with this issue.

3. RISK QUANTIFICATION

3.1 Existing methods

Risk factors have traditionally been estimated by two criteria, probability and impact [7]. That is, risk with a certain level of impact brings loss with constant probability. In general, the quantification of risks is based on these two attributes. The most typical type of quantification method is the multiplication of impact and probability. This method is

effective in quantifying easily and simply. However, it has a critical defect in that underestimate the risk level because of the characteristics of multiplication. For example, multiplied risk level tends to be a lesser perceived value than those scales of probability and impact. Suppose that the values of probability and impact are 0.9 and 0.85, respectively, the total risk level is generated as 0.77 (0.9 x 0.85).

As a substitute, a new quantification method has been developed [8, 6]. In this method, as shown in figure 3, impact and probability of risk factors are two axes of the coordinates, and the level of risk can be calculated by the distance from the origin, as shown in equation (1).

$$l = \sqrt{P^2 + I^2}, \quad l_{max} = \sqrt{2} \quad (1)$$

where, l =distance from the origin; l_{max} =maximum distance; P =Probability of risk; I =Impact of risk

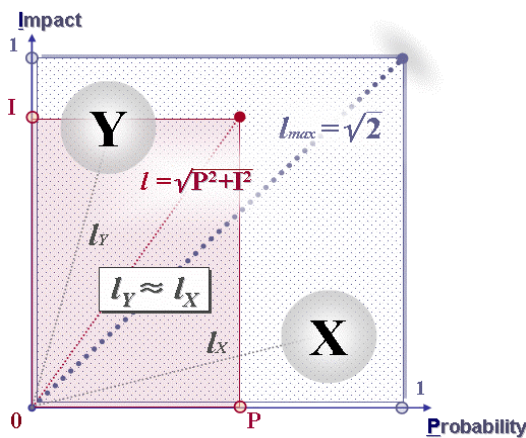


Figure 3. Risk quantification by the PI method

As presented, the risk quantification methods through probability and impact (PI methods) are easy to understand and convenient to use. However, because they limit the attributes of risk to just probability and impact, these types of methods have limitations in considering other main points which are necessary for quantifying risk levels. For example, as shown in figure 1, the point 'X' is high probability-low impact risk, and the point 'Y' is low probability-high impact risk. In this case, actually, risk 'Y' is recognized as more important and likely than 'X' because of its noteworthy impact size. But, in using the PI method, the risk levels of 'X' and 'Y' are calculated as the same value ($l_x=l_y$) by not reflecting the recognition of this difference. Consequently, it can be noted that the risk priority derived from the PI method is less reasonable. Therefore a new method which can also consider appropriately other attributes, in addition to probability and impact, is suggested.

3.2 PIS method

Because of the limitation of the PI method, an additional measurement standard is needed to quantify risk more rationally. From this point of view, many researches have

suggested new quantifying criteria [6, 9, etc.]. As a result of critical reflection of these researches, attributes of risk other than probability and impact can be included in the category of 'significance.' The significance of risk can be defined by the degree that the practical expert feels risk intuitively. Therefore, significance can be influenced easily by the estimator's personal experience or thoughts. Table 1 shows the sub criteria of 'significance,' which are regrouped from previous literature surveys.

Table 1. Criteria of risk quantification

Criteria of risk quantification	Sub-criteria and contents
Probability	Probability that risk happens : 0~1.0 or 0~100%
Impact	Degree of actual loss by risk : in proportion to financial loss
Significance	I. General recognition about risk
	II. Difficulty of gaining information and management
	III. Degree of indirect or potential loss
	IV. Relation with project profitability
	V. Attitude about risk

By considering the significance, various attributes of risk can be reflected in risk quantification or management priorities. In this paper, this quantification method including significance with probability and impact is called the PIS method, in contrast to the existing PI method. Figure 4 shows the concept of the PIS method.

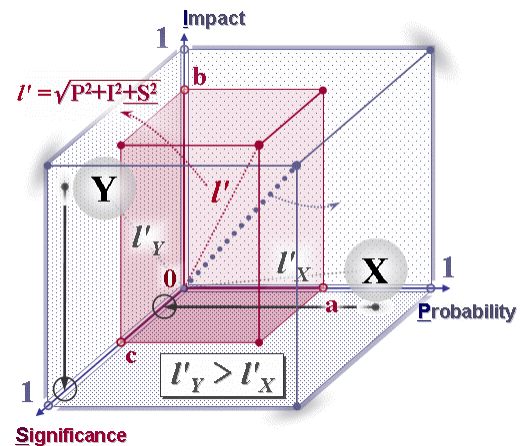


Figure 4. The concept of the PIS method

As compared in quantifying risk from probability and impact, a significance axis is added to the existing second-dimensional coordinates, expanding them to the third dimension. In three-dimensional coordinates consisting of probability, impact and significance, the risk level is computed by the distance from the origin, as shown in equation (2).

$$l' = \sqrt{P^2 + I^2 + S^2}, \quad l'_{\max} = \sqrt{3} \quad (2)$$

where, l' =distance from the origin in three-dimensional coordinates; l'_{\max} =maximum distance; S =Significance of risk

In figure 2, the levels of risk ‘X’ and ‘Y’ have the same value. In figure 3, however, by reflecting the significance, a reasonable estimation of risk levels can be computed ($l'_y > l'_x$). Through the PIS method, the limitation of the existing PI method can be overcome and supplemented. Because the PIS method measures various attributes of risk, the management priority of those risks can be subdivided in more detail. Moreover, by using the PIS method, additional benefits can be expected: (1) A risk with high significance means that it has more influence on the profits of a project and has more possibility of incurring damage. So a risk with high significance must be recognized as a main target of risk management; (2) Because practical experts judge the significance of risk from their personal experience and the environment of the project, the significance of the risk itself is a fundamental ground for risk priority; (3) Unlike probability or impact, significance of a specific risk can be gauged from its own characteristic value. Therefore, when practical experts judge the significance of risk, the standard significance values of each risk can help inexperienced or novice users to estimate it easily and minimize errors.

4. EVALUATION OF PIS METHOD

For evaluation of the PIS method, typical quantification method is analyzed and compared with it. The main object of this assessment is to find the best quantification method that corresponds well to the judgment of experts.

4.1 Survey

The targets of the survey are experts who have experiences in international construction for more than 10 years. Nine copies of the survey questionnaire are collected in total. The objects and contents of questionnaire are shown in table 2.

Table 2. The objects and contents of the survey

Process	Request	Collecting data
1 st .	Intuitional risk assessment	Intuitional assessment results
2 nd .	Sub-criteria of significance and impact assessment	Significance and impact assessment results
3 rd .	Probability assessment	The results of PI and PIS methods

The survey was conducted in 3 separate processes at intervals of a week. The purpose of the intervals between each process was to prevent the transfer effects of a previous survey result to the next one. For the simultaneous recognition of risk priorities, the number of risk factors was limited to 4~8 items. We asked them to rank the risks based

on the specific information of the project configurations. Considering that the respondents are experts, the results of the first survey are considered trustworthy as to risk priority. Therefore, the accuracy of the priority drawn from the second and third surveys is evaluated by degree of correspondence to the results of the intuition-based first survey. Through the survey processes, the results of the 2 quantification methods, such as PI and PIS methods are compared to the experts’ judgment. Table 3 shows the analyzed results of the survey from the 9 experts.

Table 3. The results of the Experts survey

Project # (experts)	Corresponding rate with intuitional judgment of experts	
	PI method	PIS method
01	98.0	95.7
02	96.4	96.4
03	87.0	87.0
04	86.1	94.7
05	99.4	96.1
06	100.0	100.0
07	93.2	93.2
08	88.9	93.5
09	86.6	87.4
Mean	92.8	93.8
Standard deviation	5.8	4.2

As a result of the two quantification methods, most of the corresponding rates with intuition-based judgment were recorded at around 93%. The PIS method (93.8%) rated slightly higher than the PI method (92.8%) on the average. Although there is no statistic difference between each quantification method in mean value, when considering the standard deviation together, the PIS method shows more stable corresponding rate, which means it gives more reliable and accurate results than is the case of the PI method.

In other words, even in the case of experts groups who are well trained in prioritizing risks regardless of different quantification methods, the estimation of the results of the PI method can vary according to the personal ability and experience of the experts, and their information about the project. On the other hand, the PIS method can minimize the variation of the results and also can guarantee the reliability of the results. But, the size of the sample was too small to validate the reliability of the results statistically.

4.2 Experts' interviews

Because the analysis on mean and standard deviation is still not sufficient to prove the superiority of the PIS method, a feedback interview was performed to supplement the survey results. At first, the respondents were questioned as to which factors they consider in deciding risk priority. The result shows that the past experience of the respondents is a great influence on their estimation of risk level. That is to say, the concept of risk significance is used to prioritize risks. Therefore, significance is one of the key issues in identifying the main objectives of risk management.

On the other hand, most of the experts answered that they identify and estimate risks by collecting and studying the contract conditions and information about a project and its surrounded environment. It shows that they try to supplement their experience-based knowledge of the risk significance by estimating the probability and impact of the project risks. Although there were some differences in considering significances, probabilities and impacts among experts, they all agreed that no criteria should be ignored.

Therefore, considering the results of the survey and the interview, the PIS method is the most reasonable method to estimate risks. Moreover, the PIS method can be effective in the estimations of inexperience or novice groups. Because the PIS method is closer to the way of experts' cognitive thinking, it can be a guideline to support judgment for risk estimation.

5. PROCEDURE FOR SE/RF CHECKLIST

Through the structure of the SE/RF checklist and the PIS method, the reasonable procedure of risk management for global construction projects can be integrated. The procedure of prioritizing risks by SE/RF checklist is shown in figure 5. As the first step, the estimated probabilities, impacts, and significances about each risk path (or scenario) are used to discriminating the grade of risk level (A, B, C, D, and E) based on the PIS quantification method. The top-ranked risks involved in A or B group are primarily fell into the main management targets. Because the SE/RF checklist contains the hierarchy of the risk exposures, the estimation of the attributes of each risk is easier than existing methods. Moreover, the concept of risk path helps to understand the relationship among risk variables and estimate risk attributes. After registering critical top-ranked risks, the next step focuses on setting up the risk response plans to mitigate these critical risk exposures. In addition, this checklist is equipped with monitoring and feedback system through assigning responsibilities to each registered risk and by evaluating the risk response plans on how much they are effectively implemented.

In order to examine the quality of the SE/RF checklist, experts' opinions were explored through the interviews. The evaluation of the SE/RF checklist was conducted in four points of view such as completeness, appropriateness, effectiveness, and usefulness. Each item was measured by 7 points Likert scale (1: very poor to 7: very good), and total 10 experts engaged in global construction projects responded to the interview. Table 4 shows the results of the experts' interviews.

Causality Information	Source		Event			Path	Evaluations			
	Upper	Lower	Upper	Lower	Specific		Probability	Impact	Significance	Risk level
Regular	R.S.U1	R.S.L1	EU1	EL1		01				
			EU2	EL2		02				
			EU3	EL3		03				
		R.S.L2	EU1	EL1		04				
			EU2	EL2		05				
			EU2			06				
	R.S.U2		EU1		ES1	07				
			EU2		ES2	08				
			EU2			09				
		EU3	EL1		10					
			EL2		11					
					12					
...		
Floating	F.S.U1	F.S.L1	EU1			51				
			EU2			52				
			EU3			53				
		F.S.L2	EU1	EL1		54				
			EU2	EL2		55				
			EU2			56				
	F.S.U2		EU1			57				
			EU2			58				
			EU1			59				
		F.S.L1	EU2	BM1	EL1		60			
				EL2		61				
			EU2	BM2	EL1	62	0.24	4	4	B
	F.S.U3	F.S.L2	EU1	BM1			63			
				BM2			64			
			EU1			65				
		F.S.L3	EU2	BM1			66			
				BM2			67			
			EU2			68				
...		

Figure 5. The basic form of the SE/RF checklist

Table 4. The evaluation results of the SE/RF checklist

Interview questionnaires	Mean	Standard deviation
Completeness of the SE/RF checklist	5.20	0.789
Appropriateness of the SE/RF checklist	4.80	0.789
Effectiveness of the structure of the checklist	5.20	1.033
Usefulness of the SE/RF checklist	4.20	1.229

As shown in table 4, the completeness and effectiveness of the SE/RF checklist were appeared to be highest (5.20). Though the SE/RF checklist achieved around 5 points on the average, the experts provided with several important suggestions. They all agreed to the effectiveness of the risk path and source-event relation. However, about the RF (regular-floating) format of the checklist, they showed some negative opinions. That is mainly because the classification between regular and floating groups can be easily distorted by the characteristics and circumstances of projects, and moreover, it is too difficult and complex to formalize the checklist in this framework. Whereas the RF format is effective in establishing the management strategy, rather, the classification by the construction phase is suggested more useful in practical usage.

6. LESSON LEARNED AND CONCLUSION

All construction projects are possible candidates for losses due to the risks inherent in the process of the project. Because of these circumstances among global construction projects, risk management by scientific method becomes a key success factor. This study suggests the SE/RF checklist and the PIS method as advanced risk management tools attempting for more reasonable prioritizing and quantification. The important findings are summarized as; (1) the overall evaluation results proved the value of the

SE/RF checklist; (2) the concept of risk significance is adopted to supplement the existing quantification method of probability and impact; (3) because the PIS method can consider the probability, impact and significance of risk all together, it is verified as more suitable risk quantification method; (4) through the PIS method, common users can easily estimate risk priority and level, especially for novice and inexperience users.

However, although respondents to the survey were experts, the sample used was too small to validate the reliability of the results statistically. Therefore, the influence of significance in risk quantification will be a main focus of future researches. Also, a risk management strategy using the PIS method needs to be developed.

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