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## Case-based Study Method for Risk Assessment in EPC Project

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**Abstract:** In recent years, with the need of acting on international convention and the development of the enterprises themselves, EPC contract mode gets a wide range of applications. Compared with the traditional contracting mode, contractors take most of risk in EPC projects. It is more important for the contractors to make risk assessment in EPC project. Among some risk assessment methods, such as AHP and fuzzy evaluation method, the data is based on expert review. The results are of subjectivity. In this study a new method and procedure was put forward, in which the data is based on the study of similar or related cases and optimized. This method made the quantitative analysis of risk assessment more accurate and objective. The model was tested by example using 5 case studies with good results. The example showed that this method of quantitative analysis was effective in EPC contract projects risk assessment for contractors, which provided a basis for contractors to make decision.

**Key words:** EPC, case-based study, risk assessment, weighs optimize

### INTRODUCTION

EPC contract mode is now the mainstream mode of international projects in the construction industry. Compared with the traditional contract mode, the contractor of EPC project not only need to complete the construction work of the project but also are responsible for the design and procurement. There is more risks should be undertaken by the contractor in EPC project. Effective evaluation of the risk helps the contractor make proper risk management plan. Among the risk assessment methods, some of data is based on expert review (Green, 2001), such as AHP and fuzzy evaluation method (Benitez *et al.*, 2012). In order to get precise result, MC method (Raftery, 1994) can be used to make a great deal of computer simulation tests and statistical analysis which is complex and difficult to master. In order to make the risk assessment more precise, objective and easy, in this study, a new comprehensive assessment method is put forward which is combined with case-based study and optimize the data through the analysis of experience cases.

### MODEL FOR RISK ASSESSMENT ON CASE STUDY

Form of risk quantification is for the analysis to evaluate the risk, through which the level of risk of the project can be calculated. The application steps of the form are as followed:

- List the Risk variables. Analysis the case and sum up risk variables as indicators of the risk assessment and list in the form
- Determine weights. Ensure the effect of certain risk variable on the overall risk of the project which is the weight of the variables
- Determine the probability of the risk variables. Determine the probability of the each risk factor
- The results of risk evaluation. The weights should be multiply by the probability of the risk variable, thus the results of each risk factor are obtained. The result of the risk evaluation of the project can be got by sum up the results of each risk variable. The calculated risk evaluation is on behalf of the level of risk of the project, the greater the value the greater the risk

As the weight of the risk factor in the form is related to the role and important degree of the risk variables in the evaluation system it is important to determine the weight properly. Usually in the use of the above motioned form, the weight of the variable is identified by experts. Although the experts make decision by their experience, the weights can not be non-subjective. In this study, a feasible method is used to determine the weight factor which is optimized through the study of similar cases. This method is more objectively and easy to make. After study the cases, the mathematical optimization procedure is as following Fig. 1.

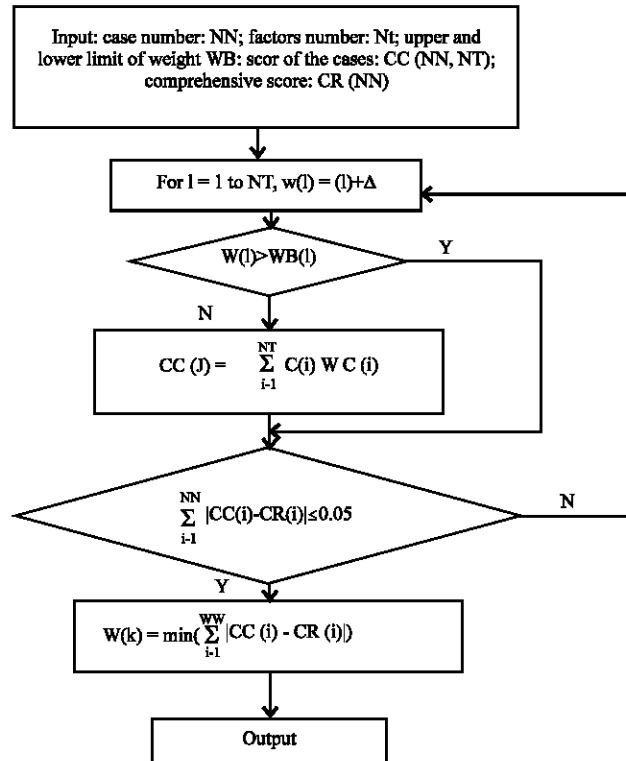


Fig. 1: Optimization procedure

**RISK ASSESSMENT EXAMPLE**

Take the light-rail project in Mecca, Saudi Arabia constructed by CRCPR as an example and use the method proposed above to implement the risk assessment during the bidding stage.

**Case profile:** CRCPR and Urban-Rural Development of Saudi Arabia on February 10, 2009 in the testimony of the leaders of China and Saudi Arabia signed the contract of Mecca light rail. Currently the Mecca light rail project has been almost completed. The project is expected by CRCPR to totally loss 4.153 billion Yuan. The expected loss of 4.153 billion Yuan is just a number on current time while the end result “has not been concluded”. This is the biggest loss of the Chinese construction enterprises in overseas projects so far.

The project encountered a lot of difficulties in the implementation process, for example, site inspection is not sufficient resulting in the contractor’s not knowing that Mecca local temperature is high; the geological conditions are complex and the oil is more expensive than water and so on. The Contractor is not familiar with international engineering specifications and standards and does not claim for compensation from the owner when the owner changes the command frequently and the

local residents work does not reach the designated position. Being Lack of awareness of the claim cause cost to increase ceaselessly, gradually accumulating huge losses.

**ANALYSIS AND CALCULATION**

From the project’s ultimate loss results it can be seen that the overall risk level is very high. Let’s use the previously mentioned model for risk evaluation to validate the conclusion.

In order to make out the weight factors of this EPC project, we study the followed five EPC cases which is similar to this project and with the same contractor:

- Afghanistan Jalalabad road rehabilitation projects were contracted by China Railway 14 Bureau group Co., Ltd. During the construction of the project, the contractor encountered some risk but the losses caused by these risks to China Railway 14 Bureau were only a small fraction of the profits, so the overall level of risk in the project was low. The contractor did relatively well in the project risk management

- In Iran hydropower project by the Commonwealth of the AG and Iran SEPASAD, engineering firm joint bid construction company construction of the project was very successful
- Some tenders of the East-West Highway project in Algeria were constructed by the Commonwealth of China CITIC -CRCPR. The contracting company put great importance on the risk management and sent Risk Management commissioners to work in the construction site, to make the risk “knowable, controllable and acceptable”. The project became the country’s largest-invest and most influential national civil engineering construction, became the new historical witness of the China-Africa traditional friendship
- The Hydropower Station Extension Project of one country in Africa emerged various problems shortly after its commencement which cause the time limit of the project was serious lag. This project makes the company suffered the most severe punishment among the punishments from the World Bank Loan Projects that constructed by construction company of China
- A highway project in Africa was constructed by an engineering association. Because of poor risk

management, in the four years of the implementation of the project, China has encountered great difficulties, not only resulting in severe tardy and loss but also affecting the Chinese contractors’ reputation

After comprehensively considering the economic benefit, social benefit and the long-term benefits and other factors, evaluate the comprehensive risk level of the five cases above and list the scores in Table 1.

According to study of this project and five cases, the common risk variables are listed in Table 2 and the probability of risk variables of the five cases are listed in Table 2.

After input the data in Table 1 and 2 into the optimize procedure as showed in Fig 1, the weight can be calculated which is listed in Table 3.

The weight calculated in Table 3 is the weight optimized after the study of cases. Input these weight into the form of risk quantification, the comprehensive result can be get by the followed Table 4.

From the above analysis, we know that the risk level of the project at bid stage is 0.842, converting into percentage system for 15.8 which is even lower than the failure case (case 4) and many individual risk of the

**Table 1: Score of cases**

Case	1	2	3	4	5
Criteria	Good economic benefit and social benefit	Good economic benefit and bring follow project	Good economic, social and political benefit	Heavy deficit and bad reputation	Economy loss
Score	85	80	90	45	50
Level of risk	0.15	0.20	0.10	0.55	0.50

**Table 2: Risk variables and probability of cases**

Risk variable	Case 1	Case 2	Case 3	Case 4	Case 5
Access to market rashly	0.2	0.2	0.2	0.4	0.6
Bid blindly	0.2	0.2	0.2	0.4	0.6
Insufficient site survey	0.2	0.2	0.2	0.6	0.8
Complex geological condition	0.4	0.4	0.4	0.6	0.6
Bad nature condition	0.4	0.4	0.4	0.4	0.6
Lack of design	0.2	0.2	0.2	0.4	0.4
Un-known of social background and custom of site	0.2	0.2	0.4	0.4	0.8
Error bidding	0.2	0.2	0.2	0.6	0.4
Unfamiliar with specifications and standards	0.4	0.2	0.4	0.6	0.6
Total	2.4	2.2	2.2	4.4	5.4

**Table 3: Optimized weight**

Risk variable	Weight (Q)
Access to market rashly	0.13
Bid blindly	0.11
Insufficient site survey	0.12
Complex geological condition	0.11
Bad nature condition	0.11
Lack of design	0.13
Un-known of social background and custom of site	0.09
Error bidding	0.10
Unfamiliar with specifications and standards	0.10
Total	1.00

Table 4: Risk assessment of example

Risk variable	Weight (Q)	Probability of risk variable (P)					Q×P
		(1.0)	(0.8)	(0.6)	(0.4)	(0.2)	
Access to market rashly	0.13			√			0.078
Bid blindly	0.11		√				0.088
Insufficient site survey	0.12	√					0.120
Complex geological condition	0.11		√				0.088
Bad nature condition	0.11		√				0.088
Lack of design	0.13	√					0.130
Un-known of social background and custom of site	0.09	√					0.090
Error bidding	0.10		√				0.080
Unfamiliar with specifications and standards	0.10		√				0.080
Total	1.00						0.842

project became the lethal factor. The CRCPR had not made a good risk evaluation at the beginning of the construction of the project which led to the high overall project risk level. We can see that the calculated result under the above mentioned model and the project ultimately loss results correspond to each other.

**CONCLUSION**

EPC contract project is large in scale, high in cost and long in period. It has the characteristic of high risk. By quantitatively analyzing the contractor’s risk in the foundation of the comprehensive evaluation method and using the experience of case study method to optimize the weights, the risk assessment results are made more objective, more scientific. The model is simple and the expression is more intuitive. This method provides a new train of thought for the contractor’s risk assessment. This method is of certain space for practice in use.

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