Fuzzy Comprehensive Evaluation to the Risk of the Railway Project Contract

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Abstract The railway project construction is full of hided risks. These risks lie in everywhere. The cause of these risks is variable and it will bring up so much destroy when the risk happen. It can improve the bid efficiency and the construction benefit to analyze the bid risk accurately by taking effective method. Fuzzy comprehensive evaluation was put forward to make an evaluation for Risk of the Railway Project Contract based on the fully analyze of the risk in this text. The comprehensive appraisal method nature and quality combine together for Railway Project Contract risk was detailed descript. At the end of the text, the case of China Railway 16™ Group CO, LTD bid for tunnel named Wu-Shao-ling which belongs to the Lan-Wu railway was applied to qualify its scientific and feasibility. This text will offer some reference to the risk management for railway project contractor.

Key words  Railway Project; Contract Risk;; AHP ;Fuzzy Comprehensive Evaluation;

1 Introduction
The appraisal of contract risk should based on the fully distinguish to the risk at first. Analyze the risk level and establish the system of evaluation index according to the link and reason the risks happen. Then set up the appraise models according to the influence degree of the risk and calculate to get the comprehensive appraisal result. At present, there are some methods used in risk appraise. They are investigate and expert (Checklist), Analytic Hierarchy Process(AHP), Fuzzy Set, Statistics, Sensitive Analysis, Monte Carlo Simulation, Controlled Interval and Memory Models (CIM ), Influence Diagram.
[1]

The activity of Bid belongs to inexactitude decision question; great majority of potential risk factor in the railway project is fuzzy, difficult to quantitative calculate. Fuzzy Comprehensive Evaluation is the effective method to deal with uncertain problem. It sets up subjection degrees function and fuzzy subjection degrees matrix using fuzzy set to make comprehensive appraisal to the tested object. So it is feasible to appraise the risk of the railway projects contract using the fuzzy comprehensive evaluation.

2 Analyses of risk factors of railway project contract
The risks of the railway projects contract have the following characteristics: objectivity, universality, contingency, inevitability, diversity and changeability. The appraisal of risk should start with distinguish the risk, seek and analyze the various kinds of uncertain incidents that may exist calmly, objectively [2], starting with such respects as natural conditions, social environment, economic environment, technological condition, etc.

For the construction enterprise, the main risk of the railway projects contract can be summarized as three respects: technological risks, environmental risks and personnel's risk.
2.1 Technological risks

The technological risks\(^3\) are mainly as follows:

1) Scheme design risk: great difficulty of engineering, misjudge of great construction technological question, defective design, pretermission in design, miss account in project amount or the equipment and materials, inefficient optimized construction scheme, large percentage of new technology adopted; too advanced scheme, unqualified technology.

2) Bid risk: Lack true information of owner's instance, capital source, technological of project and construction scene, insufficient estimation to potential rival, attempt to win the bid at a low price and place hope on the claim and follow-up project, over-evaluate one's own strength, underestimate rivals, and refuse to reduction, having pretermission or mistake in bid calculation, unscientific risk fee deciding; blindly using tricks, go for wool and come home shorn overreach oneself, understand to the bid file incompletely, for instance terms of payment, key commercial affair and specifically requirement, key contract term, norm and standard adopted, etc. had responsiveness to bidding documents, failing to fully understand the owner's inclination; the intermediary acts for the risk.

3) Construction risk: inefficient technology management, risk of construction quality, time limit for a project control, project frequent change, inefficient management in goods and materials, disqualification material, insufficient material or not supply in time, type mismatch, supplying delaying or quantity mistake of the equipment, capital collection question, the confused financial administration, performance security being confiscated, damage of the equipment, casualties.

2.2 Environmental risks

The environmental risks are mainly as follows:

1) Political risk: the railway projects, mostly belonging to the country or the government, are susceptible to the adjustment of state laws, regulations, and government policy.

2) Economic risk: railway project construction has relatively long period. Adjustment of the national economic policy, inflation, fluctuate of price, interest rate and exchange rate, will bring the risk to constructing.

3) Natural risk: the project of the railway constructs outdoors, natural conditions have tremendous influence on constructing, such as the unfavorable climatic conditions (continuous rain fall or frost), force majeure (thunder and lightning, earthquake, flood, hurricane, etc.), the bad condition of hydrology and geology.

2.3 Personnel's risks

Personnel's risks\(^4\) are mainly as follows:

1) The risk of owner and supervise engineer: owner's solvency and means of payment, Owner’s bad credit, lack the sincerity of honouring an agreement, low working efficiency of owner, intention to create obstacles and arrears with the project fund, owner intervenes the project arbitrarily, no guarantee to raise funds, inequity of the supervise engineer, supervise engineer intend to create obstacles.

2) Subcontractor’s risk: the subcontractor has bad qualification, communication and low labor productivity. They can't guarantee the time limit for a project and quality.

3) Supplier’s risk: the material of railway project constructs is mostly local. Material supplier's bad consciousness of honouring an agreement, bad quality supply, no guarantee for delivery will cause such risks as holding up work for lack of material or doing poorly done work over again. The railway project construct has relatively high expectations for project equipment. There are risks of order, and deliver of corollary equipment.

4) Project organizing risk: unfavorable project organizing, inexperience project manager, weak worker, confusion of personnel management, etc.

3 Confirm the relative weight of risk factor with AHP

Through the analysis of railway projects contract risk factors, we can find out that the risk factors influence contract is intricate. We construct out three layers structure with AHP to weigh the important degree and confirm the relative weight of every factor.
1) Construct out three layers structure of the risk factors
Goal layer: U- the contract risk of railway projects;
Criterion layer (Ui): U1- technological risk; U2- environmental risk; U3- personnel's risk;
Sub criterion layer (Uij): U11- conceptual design risk; U12 - bid risk; U13- construct risk; U21- political
risk; U22- economic risk; U23- natural risk; U31- the risk of owner and supervise engineer; U32-
subcontractor's risk; U33- supplier's risk; U34- project organizing risk;
2) Construct the judging matrix
After setting up appraise model of railway contract risk factors, the experienced technical staff and
expert give relatively mark to every risk factor according to the graduation method as form 1to 9,
showed in table 1, and draw the risk judging matrix A = (a_{ij}) n*n.
3) Calculate the biggest characteristic root (λ)
and corresponding eigenvector (w) of A
with root low in AHP. wi is the approximate
value of eigenvector , that is the score of relative
importance of the risk factors.
4) Consistency inspection\(^{[5]}\) to judging matrix
Calculate the consistency index of the deviation:

<table>
<thead>
<tr>
<th>Relative importance</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The same importance</td>
</tr>
<tr>
<td>3</td>
<td>i is slight important than j</td>
</tr>
<tr>
<td>5</td>
<td>i is important than j</td>
</tr>
<tr>
<td>7</td>
<td>i is obvious important than j</td>
</tr>
<tr>
<td>9</td>
<td>i is absolute important than j</td>
</tr>
<tr>
<td>Reciprocal</td>
<td>The result of j to i is the reciprocal of i to j</td>
</tr>
</tbody>
</table>

4 Appraise with the fuzzy comprehensive evaluation
The level and size of the risk is a fuzzy concept, so we can use the fuzzy mathematics to do quantitative research. That is to appraise the risk with the fuzzy comprehensive evaluation according to relative weight of every risk factor determined by AHP.
1) Build the fuzzy appraise muster
muster of the railway projects contract risk factors: \( U = \{ U_1, U_2, U_3 \} \)
muster of risk factors appraise : V= \{ v_1, v_2, v_3, v_4 \} , describing the risk {very big, relatively big, relatively small, small }
2) Set up the sujection matrix\(^{[6]}\)
Make the criterion of the comments grade to every risk index, experts give a mark to every risk factor contrasting the criterion of risk grade, then form the sujection vector which means the criterion layers of every risk factor Ui belong to the muster of risk factor appraise, the sujection matrix is \( R_i = (r_{i1}, r_{i2},...r_{ij}) \), Among them, \( r_{ij} = \frac{V_j}{N} \), j=1...4, N is the total of the experts; Vij is the number of experts who think the index Ui belongs to the grade r_j
According to the compositor result, we can get the weight vector of every risk factor included in criterion layer \( W = (w_1, w_2, w_3) \), so
\[
B = W \circ R = (W_1, W_2, W_3) \circ \begin{bmatrix} b_{11} & b_{12} & \ldots & b_{14} \\ b_{21} & b_{22} & \ldots & b_{24} \\ b_{31} & b_{32} & \ldots & b_{34} \end{bmatrix} = (b_1, b_2, \ldots, b_4)
\]
B is the goal layer, that is the subjection vector of railway project contract risk (U) to the muster of risk factor appraise, it shows the extent the project risk is big, relatively big, relatively small, small. If
\[
b_j = \max\{b_1, b_2, ..., b_m\}
\]
so we can draw the conclusion \( V_j \).

5 instance analyses

Set the China Railway 16™ Group CO, LTD bid for tunnel named Wu-Shao-ling, about 3000 meters long, the bottleneck to the construction of second line of Lan-Wu railway which belongs to the Lan-Wu railway as the example. The project of Wu-Shao-ling tunnel provides an opportunity for Engineering Bureau to improve engineering technology and establish brand. So many Engineering Bureau and tunnel office will submit a tender.

According to the analysis result of risk factor, construct the judging matrix to calculate the relative importance weight of the index, and then put the weight into the fuzzy model to get the fuzzy appraisal result, showed in table 2.

**Table 2 appraisal of contract risk of the project of Wu-Shao-ling tunnel**

<table>
<thead>
<tr>
<th>Weight of index</th>
<th>Second class fuzzy appraisal</th>
<th>First class fuzzy appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological risk (0.44)</td>
<td>0.18</td>
<td>Big</td>
</tr>
<tr>
<td>Environmental risk (0.39)</td>
<td>0.18</td>
<td>Relatively big</td>
</tr>
<tr>
<td>Personnel's risk (0.17)</td>
<td>0.27</td>
<td>Relatively small</td>
</tr>
<tr>
<td>Design risk (0.58)</td>
<td>0.16</td>
<td>Small</td>
</tr>
<tr>
<td>Bid risk (0.31)</td>
<td>0.33</td>
<td>Small</td>
</tr>
<tr>
<td>Construction risk (0.11)</td>
<td>0.06</td>
<td>Small</td>
</tr>
<tr>
<td>Political risk (0.16)</td>
<td>0.2</td>
<td>Big</td>
</tr>
<tr>
<td>Economic risk (0.30)</td>
<td>0.3</td>
<td>Relatively big</td>
</tr>
<tr>
<td>Natural risk (0.54)</td>
<td>0.6</td>
<td>Relatively small</td>
</tr>
</tbody>
</table>

The fuzzy comprehensive evaluation result calculated is: \( B = (0.20, 0.36, 0.32, 0.12) \). According to the principle of biggest subjection, 0.36 is the biggest, and its corresponding appraisal is "big" risk. We find the second largest subjection is 0.32; it is very close to 0.36, its corresponding risk is "relatively small". That is to say there are greater risks for the Railway Bureau 16 Corporation (Group) submitting a tender for the project of Wu-Shao-ling tunnel. But if control capably, it is still favorable to...
contract. Make considering to comprehensive various fields factor, submitting a tender is the suggestion.

5 Conclusions

In the railway projects contract, the risks exist objectively, and are of great uncertainty. Risk factors, which are difficult to be calculated will be quantitative settle with fuzzy mathematics tool. The method have already overcome the shortcoming of the tradition optimized method which solves the problem quantitatively, and it is also remedy the deficiency of experience estimate to solve the complicated problem. The efficiency and accuracy of decision has been improved greatly. So it is scientific and rational applying Fuzzy Comprehensive Evaluation to the appraisal of railway projects contract risk. The main difficulty of this method faces in practical application is collection and management of expert’s opinion.

Acknowledgement
This text has got the subsidy of doctor's fund project of Hebei scientific and technological office: Study on theory and application of the equal risk management (No:05547009D-3 )

References