Study on Dynamic Risk Management Model of High-speed Rail Project Construction Ring East

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Abstract

Risk management of construction site has aroused widespread concern in the construction field, because of city rail transit construction of our country to introduce risk management for a short time, has not yet formed a mature construction site dynamic risk management theory system. At present, China' high-speed railway construction features large over the same period, the introduction of dynamic risk management theory, system analysis of the construction site dynamic risk management implementation method and content, put forward the construction site of the dynamic risk management model, and to the Hainan east ring high-speed rail station construction project for the empirical analysis of the model, this method is to explaining scientific and practical.

Keywords: the dynamic risk management model, project risk, East Ring High-speed Rail

1. Introduction

In recent years, with the integration of urban and rural areas of our country constantly, especially improving regional requirements of transport capacity, objectively promoted the steady development of the domestic rail transit construction. Recently, in the domestic railway construction project management, construction of the meaning of risk management is becoming more and more obvious, and highly valued by all levels of government, project management department and the project participants. The railway construction project risk many factors of uncertainty, and with the engineering projects, the uncertainty of the risk is always changing, and facing a perplexing paradox, which will bring difficulties to achieve project construction management objectives. So the corresponding risk management organization should "keep pace with the times", namely that the risk management organization should reflect the comprehensive, sustained and dynamic management.

2. High speed railway construction site dynamic risk management model

2.1 A dynamic risk management model

The dynamic risk management is the whole process of risk management for long time, throughout the construction of high-speed railway construction preparation stage, construction stage and acceptance stage. Any in the three stages of a stage must be continuously collected information, risk, risk identification, estimation, evaluation, response, monitoring and risk summary, is a dynamic process. Based on the above ideas, we build a dynamic high-speed railway construction project risk management processes, as shown in figure 1.

Dynamic risk management on the construction process of high speed railway mainly includes risk identification, risk analysis, risk assessment and risk management etc. Fig.1process is mainly used to realize the calculation, construction risk analysis of the probability of risk occurrence accident of whole project, and put forward the corresponding control measures and improving the risk management.

(1) Preparation work before construction based on, the expert investigation method, through research and analysis, to identify potential risk in every phase of high speed railway construction process, make clear the reasons of the risk and the potential impact of. According to the risk occurrence probability formula then estimate the probability of project accident.
(2) To evaluate the condition of risk in the project construction, the entropy weight method, the conditions for corresponding risk degree.

(3) In the condition of the corresponding risk degrees, depending on their size and category, put forward the corresponding risk response plan.

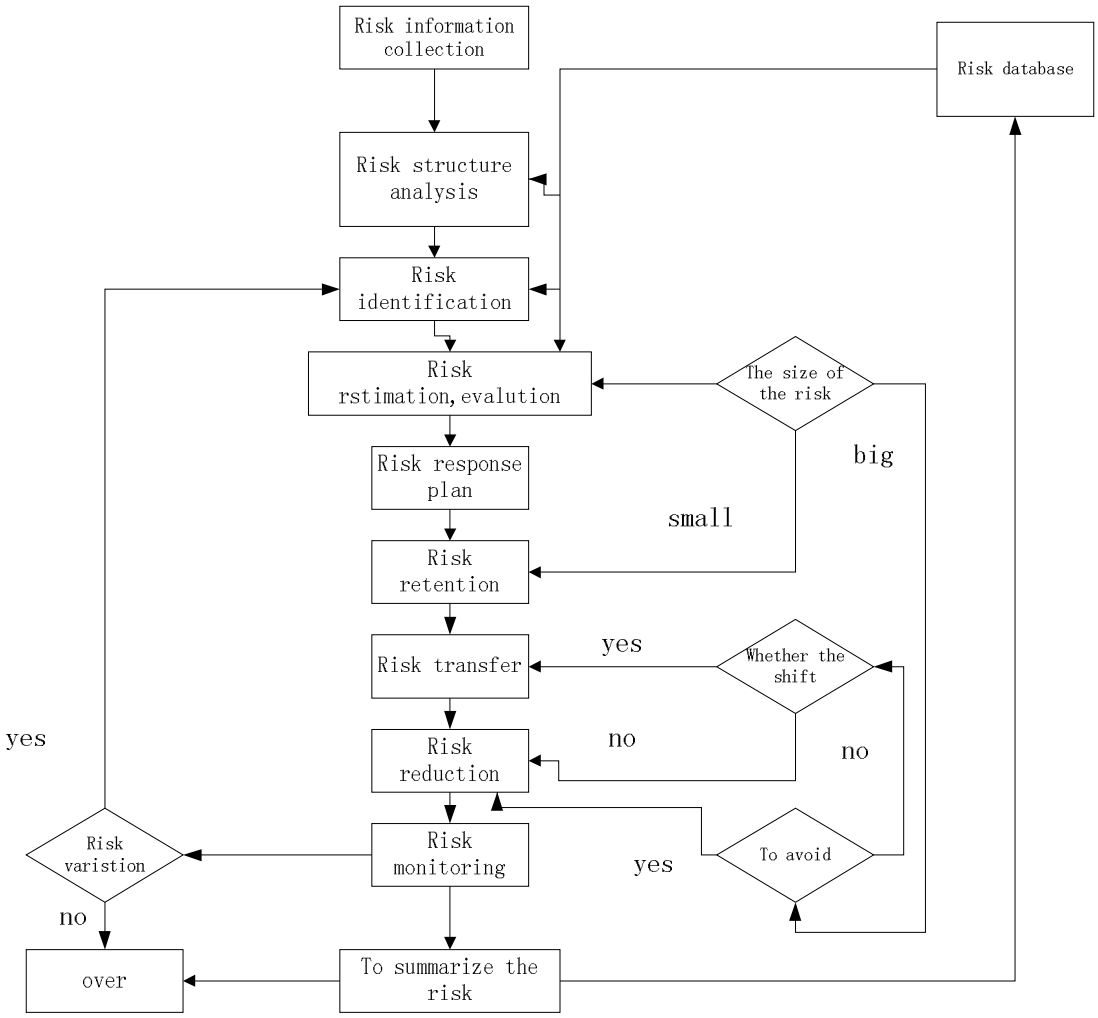

Fig.1 high-speed railway construction project dynamic risk management flow chart

2.2 The risk probability and risk degree calculation

2.2.1 The probability of risk

Top probability event risk calculation formula is:

$$P = 1 - \prod_{i=1}^{n} (1 - P_i) \qquad (1)$$

There, P as the top event probability of risk occurrence probability, P_i as sub event of risk.

2.2.2 The calculation of risk

Considering the complexity of the construction project of high-speed railway, as well as the characteristics of dynamic risk management quantification, clear, in this paper introduce the risk management analysis indexes—risk degree. Q is the risk degree of risk occurrence probability and consequences of loss maximum likelihood estimation, the calculation formula is as follows:

$$Q = 1 - P_f C_f = \mathrm{P_r} + C_r - \mathrm{P_r}\, C_r \qquad (2)$$

In the formula, P as the probability of risk measure; C said the consequences of the loss measure; f risk has not yet occurred; r said the risk. So it has that

$$P_f = 1 - \mathrm{P_r}, C_f = 1 - C_r \quad (3)$$

In order to obtain $\mathrm{P_r}, C_r$, for the reference to the definition of entropy risk measure:

(1) On the basis of risk identification, analysis of the establishment of the risk tree can be set $\mathrm{U}=\{u_1, u_2, \cdots, u_n\}$ by the risk factor and the risk probability and risk of loss together determine the evaluation set $\mathrm{V}=\{v_1, v_2, \cdots, v_{nr}\}$.

(2) Construct the membership matrix R. By experts according to the unified evaluation set V to evaluate the risk factors of each factor in the set U, so as to construct a fuzzy mapping $U \xrightarrow{f} F(V)$, there, $F(V)$ is the fuzzy set V:

$$u_i \to f(u_i) = (r_{i1}, r_{i2}, \cdots, r_{in}) \in F(V) \quad (4)$$

$f(u_i)$ is the membership degree of risk factors on the evaluation set representation u_i. Evaluation of all the risk factors, the membership matrix R can be obtained:

$$R = \begin{vmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \cdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{vmatrix}, \quad (5)$$

set membership matrix with respect U to risk probability and risk loss respectively, R_p and R_c. Then, on the basis of membership to determine risk factors of entropy $e_i = -\frac{1}{\ln m}\sum_{i=1}^{n} r_{ij} \ln r_{ij}$. (6)

Further could get the risk factor weight

$$\lambda_i = \frac{1}{n - \sum_{i=1}^{n} e_i}(1 - e_i). \quad (7)$$

(3) The value respectively r_{ij} of the R_p into type (6)and (7)can be obtained in the weights of various risk factors $\lambda_p = (\lambda_1, \lambda_2, \cdots, \lambda_n)$. According to the expert survey results, we can determine the index set V of corresponding weights for evaluation $A = (\alpha_1, \alpha_2, \cdots, \alpha_m)$. So we can get the probability measure of risk $\mathrm{P_r}$, which is

$$\mathrm{P_r} = \lambda_p R_p A^T. \quad (8)$$

(4) Similarly we can get the consequential loss measure of risk C_r, which is

$$C_r = \lambda_c R_c B^T, \quad (9)$$

in this type λ_c means of the risk factors for weight vector, B is the weight of each index in the evaluation set for V. After get the value $\mathrm{P_r}, C_r$, then type(2)can be get a part of each operating risk, and then judge the corresponding level of risk (see Table 1)probability and risk (see Table 2),to realize the effective management of construction site.

Table1: Construction risk degree and the risk grade

Degree of risk	The risk grade	Construction state
$Q > 0.75$	High risk	To stop construction, take the risk response measures
$0.35 \le Q \le 0.75$	Medium risk	Strengthen monitoring and analysis, adopt measures to control the risk of developing
$Q \le 0.35$	Risk	The normal construction

Table2: The probability of risk and risk classification

status	v_1	v_2	v_3	v_4	v_5
Risk probability description	impossible	infrequence	occasionally	possible	frequently
Risk of loss description	Does not affect the basic engineering	A small amount of economic loss, no casualties	Large economic loss	There are significant economic losses, have more casualties	Great economic losses, social influence

Notes: $p < 0.01\%$, means impossible; $0.01\% \le p < 0.1\%$,means infrequence; $0.1\% \le p < 1\%$,means possible; $1\% \le p < 10\%$,means possible; $p \ge 10\%$,frequently. P is the probability of risk.

3. The empirical analysis

3.1 The general situation of Hainan East Ring high-speed rail project

Hainan East Ring Road in Hainan province is located in the east coast, north of Hainan Province, the provincial capital of Haikou city, south to the famous tropical coastal tourist resort city of Sanya, is line length of 308.112kilometers.The line with the Hainan West Ring Road, Yuehai Railway ferry, Haikou Meilan International Airport, Sanya Phoenix International Airport, work together to build a city of Eastern Hainan Province, tourism economic zone and island tourism comprehensive transportation system. Taking into account the building construction is one of the key point of the whole project, the dynamic risk management of the construction phase as an example, to illustrate the application of the dynamic risk management model of the construction of the railway in the project of.

3.2 Risk calculation

(1) Calculated values of $\mathrm{P_r}$. Put the value r_{ij} of R_p (see Table 3) through the type (5), calculated the conditions of various risk factors of entropy: $(e_1, e_2, \cdots, e_6)=(0.795,0.640,0.758,0.590,0.558,0.766)$ (10)

and put the value of e_i through the type(6), get the operating conditions of each risk factor weight is :

$\lambda_p = (\lambda_1, \lambda_2, \cdots, \lambda_6) = (0.09, 0.165, 0.110, 0.187, 0.202, 0.148)$. (11)

For the evaluation standard, experts give the weight is:

$A = (\alpha_1, \alpha_2, \cdots, \alpha_5)=(1/25, 3/25, 5/25, 7/25, 9/25)$ (12)

Substituting the obtained value (6), probability measure to the risk for the:

$\mathrm{P_r} = \lambda_p R_p A^T = 0.213$ (13)

(2) Calculated values of C_r .Similarly, through the r_{ij} of R_c (see Table 4)in the value into a type(6) and (7)can be obtained by risk

measure: $C_r = \lambda_c R_c B^T = (0.151, 0.195, 0.09, 0.154, 0.115, 0.154) R_c (1/25, 3/25, 5/25, 7/25, 9/25) = 0.210$

so we can get the risk degree is :

$Q = 1 - P_f C_f = \mathrm{P_r} + C_r - \mathrm{P_r} C_r = 0.378$. (14)

Refer to table1, we know that the operating conditions in the moderate risk status, so we needs to take corresponding measures to control the development of the risk. At the same time to judge the condition has been moderate risk rating conditions, in addition to strengthening the construction management, the monitoring data to the design time, when necessary, can change the construction design. Membership to determine the risk factors in the model selection and the corresponding to the evaluation set, is obtained by the statistical data and expert experience, with a certain degree of subjectivity, it still needs further improvement.

Table 3: The probability of risk occurrence membership matrix R_p

	v_1	v_2	v_3	v_4	v_5
u_1	0	0	0.5	0.6	0.1
u_2	0	0	0.3	0.3	O
u_3	0	0	0.3	0.4	O
u_4	0.1	0.2	0.5	0.2	O
u_5	0	0.3	0.6	0.2	O
u_6	0	0.2	0.3	0.4	0.1

Table 4: loss of membership matrix R_c

	v_1	v_2	v_3	v_4	v_5
u_1	0	0.2	0.2	0.6	0
u_2	0	0.3	0.4	0.3	0.1
u_3	0	0.2	0.3	0.4	0
u_4	0.1	0.2	0.6	0.1	0
u_5	0.1	0.2	0.5	0.2	0
u_6	0	0.1	0.3	0.5	0.1

4. Conclusion

In this paper, on the basis of research results about the system of risk management of railway construction project on the analysis, proposed a dynamic risk management process, systematic and dynamic, put forward the model of dynamic risk management of construction site construction project. The model reflects the dynamic risk management process of continuity and risk management activity, make the risk management is conductive to reflect the risk information, is conductive to timely response risk, conductive to the realization of the goal of construction project. This paper just analyzes the dynamic risk management model, there are many limitations, such as the relationship between the systematic construction project risk analysis and evaluation, risk factor is how the risk factors affecting project status how, after the stage, still needs further study.

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