

The research on the management of project group for flexibility based on Fuzzy Comprehensive Evaluation

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Abstract. Project group is characteristic of dynamic uncertainty and higher complexity, which decides its management methods need to have enough flexibility. Based on the analysis of the flexible influence factors of the project group of management, the paper constructs the project group management flexibility evaluation index system, introduces fuzzy comprehensive evaluation method to the evaluation, and in order to increase its objectivity and feasibility uses the gray correlation analysis method to determine the weights during the process of solving. Finally provides an application example to show that the method is effective and practical.

Introduction

In recent years, the implementation of large-scale and the extra large type engineering projects in the form of project group, multi-projects or a program of combinations has become a trend, such as urban subway project, Shanghai Expo project, Guangzhou Asian Games project, etc. These large projects emerge in the form of project group, which not only makes engineering systems more complicated but also put forward some new challenges in the project management. There are many kinds of definitions regarding the project group in academia, up to a point is that the project group is formed by a number of projects, and these projects not only independent but relevant [1]. Projects among the project group exchange the massive material information and energy and influence mutually between projects, more participants and more intense in conflicts of interest. All these result in a large number of management interface and more complex levels of management increasing the difficulty of program management. These characteristics determine the project management group must have sufficient flexibility, the traditional project management methods for project management on the group appeared to be inadequate. Flexible management is characteristic of dynamic, flexibility, initiative, systematic and efficient.

Currently, as for flexibility academia research has focused on production management, supply chain management, university service management and other areas. A number of analyses concerning the flexibility of production system [2-5] and flexibility of project process management [6] have been carried out. However, fewer literatures are concentrated on the project group. On the basis of previous studies, this paper introduces the flexible management theory, analyses the flexibility influence factors of the project group management, and constructs the flexibility evaluation index system. In the present situation, as for project people's conception is still in a state of gray, belongs to the typical grey system, so this paper takes fuzzy comprehensive evaluation method of the evaluation and introducing the grey relational analysis method to ascertain the index weight, and keep the objectivity of evaluation results and credibility.

Project of flexible management group of evaluation index system

Flexibility of Project group management is the responsiveness in the face of uncertainty, dynamic environment. Through referring to flexible evaluation of research of production system and the project schedule management and other areas, the paper constructs the evaluation index system (as shown in figure 1), including environmental reaction flexible, project group of organizational flexibility, project group of structural flexibility, resource flexibility. It According to consistency of project group organization, it assumes the same owner of the various projects in the project group.

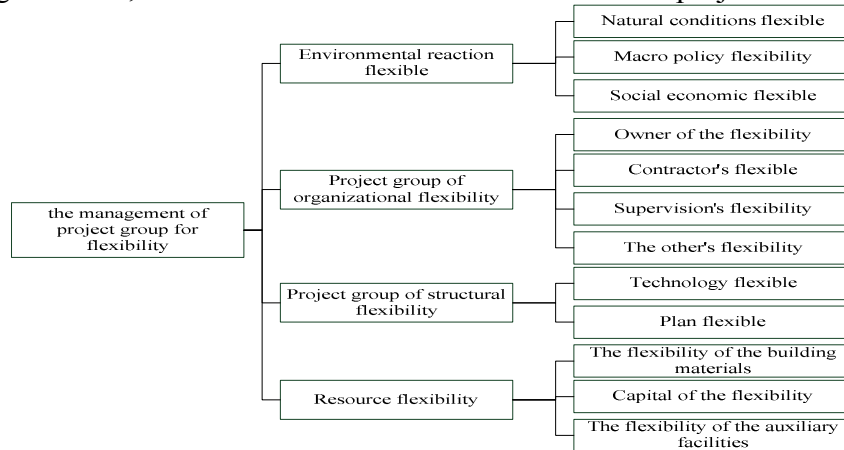


Fig.1 Project group of management of the flexible evaluation index system

Project group of flexible management of the fuzzy comprehensive evaluation method

The fuzzy comprehensive evaluation method. Step 1: make sure the rating set D and membership functions Set evaluation index system $U = \{u_1, u_2, \dots, u_n\} = \{u_i\}$, the rating of the fuzzy level set $D = \{d_1, d_2, \dots, d_m\}$, the general desirable $m = 5 + 2$. In this article, the grade 5 rating set, which $D = \{\text{excellent, good, medium, poor, bad}\}$. According to the flexible management of the project team of the indicators of the specific circumstances of the standards and content, and various levels is decided by the literature material and the experience of managers.

Index layer of C each indicator relative to a certain level of D membership function with trapezoid fuzzy number representation, trapezoidal fuzzy number for (a, b, c, d, e). According to the habits will evaluate will level fuzzy number defined as: excellent (0.9, 1,1,1), good (0.7, 0.8, 0.9, 1), medium (0.5, 0.6, 0.7, 0.8), poor (0.3, 0.4, 0.5, 0.6), bad (0,0,0.3, 0.4). Get fuzzy evaluation matrix M_1 :

$$M_i = \begin{bmatrix} m_{11}, m_{12}, m_{13}, m_{14}, m_{15} \\ m_{21}, m_{22}, m_{23}, m_{24}, m_{25} \\ m_{31}, m_{32}, m_{33}, m_{34}, m_{35} \\ m_{41}, m_{42}, m_{43}, m_{44}, m_{45} \end{bmatrix}$$

Step 2: make sure of the index of set $W = (w_1, w_2, w_3, w_4)$.

Step 3: primary fuzzy comprehensive evaluation

$$U_i = W_i * M_i \quad (i = 1, 2, 3, 4). \tag{1}$$

Get level fuzzy comprehensive evaluation set U

$$U = \begin{bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \end{bmatrix} = \begin{bmatrix} U_{11}, U_{12}, U_{13}, U_{14}, U_{15} \\ U_{21}, U_{22}, U_{23}, U_{24}, U_{25} \\ U_{31}, U_{32}, U_{33}, U_{34}, U_{35} \\ U_{41}, U_{42}, U_{43}, U_{44}, U_{45} \end{bmatrix}$$

Step 4:the secondary fuzzy comprehensive evaluation. According to the weight W and level set comprehensive evaluation set U, use formula:

$$P = W * U. \tag{2}$$

Get secondary fuzzy comprehensive evaluation set $P = (p_1, p_2, p_3, p_4, p_5)$.

Step 5: determining the evaluation results. The weighted average method, to the rating set $D = (d_1, d_2, d_3, d_4, d_5)$, and each lever d_j pre-ordained a numerical t_j , with the power of b_j reweighted estimators weighted average method take for constant t :

$$t = \frac{\sum_{j=1}^m (p_j)^k * t_j}{\sum_{j=1}^m (p_j)^k} \tag{3}$$

In this type, according to specific problems index k and decide, generally desirable $k = 1$ or 2 , is a constant t ask in advance of the provisions with numerical t_j , confirm the final evaluation level.

Sure indexes weights. To rule layer in B , take $U = \{ u_1, u_2... u_n \}$ as an example, by using the gray correlation analysis method to determine the weight of each index algorithm.

(1) Through the experts investigation, with m experts to assign a value to the index weight, respectively, said the first j a r_{ij} experts to give the weights of the B_i index.

(2) To select a frame of reference r_{i0} , a r_{i0} be m to experts are maximum weight, the r_1, r_2, r_3, r_4 to compare the sequence. R_i ($i = 1, 2, 3, 4$) with r_0 element in the i the correlation coefficient by the following formula can work out:

$$L(j) = \frac{\min_i \min_j |r_{i0} - r_{ij}| + a \max_i \max_j |r_{i0} - r_{ij}|}{|r_{i0} - r_{ij}| + a \max_s \max_t |r_{i0} - r_{ij}|} \quad (i=1,2,3,4; j=1,2,...,m) \tag{4}$$

In this type, a is distinguish coefficient of correlation function, is to improve the difference between significant, reduce extreme value to the influence of the calculation, usually take $a = 0.5$. Compared r_i to r_0 , and its relational sequence defined as h_i , among them

$$h_i = \frac{1}{m} \sum_{j=1}^m L(j) \tag{5}$$

H do to normalized processing, draw of the index of set $W = (w_1, w_2, w_3, ... w_4) = (r_1 / (\sum r_i), r_2 / (\sum r_i), r_3 / (\sum r_i), r_4 / (\sum r_i))$, namely rule layer of B index B_1, B_2, B_3, B_4 respectively, the weight of w_1, w_2, w_3, w_4 .

The case analysis

Jiangsu city metro project is an important part of the network in the province, the provincial government gave high attention. In metro project group, different line is independent of the projects but essential to urban subway project system, for specific functions and intricate relationship. To solve the problems in the management of project group of conflict effectively, optimize the management system, adopt fuzzy comprehensive evaluation method to identify the flexibility insufficient place, then optimize the whole system of the project group management.

Through the five experts investigation, a index weight can be gotten, such as table 1 questionnaire.

Table 1 Project group of flexible management evaluation index system

	Rule layer B	weight C	Comments set				
			Excellent	Good	Medium	Poor	bad
Target Layer B ₀	B1	C11	0	0.5	0.4	0.1	0
		C12	0	0.8	0.2	0	0
		C13	0	0.7	0.3	0	0
	B2	C21	0	0.8	0.1	0.1	0
		C22	0	0.6	0.4	0	0
		C23	0	0.6	0.2	0.2	0
		C24	0	0.7	0.3	0	0
	B3	C31	0	0	0.4	0.6	0
		C32	0	0	0.7	0.3	0
	B4	C41	0	0.5	0.5	0	0
		C42	0	0.6	0.3	0.1	0
		C43	0.2	0.8	0	0	0

According to the index survey, the grey correlation analysis of value method to calculate the index weight. Generation into type 4, 5 type can project group of flexible management index weight and the results is followed as table 2.

Table 2 Index Weight Questionnaire

	Expert 1			Expert 2			Expert 3			Expert 4			Expert 5		
B1	0.16	C11	0.080	0.13	C11	0.065	0.15	C11	0.075	0.20	C11	0.100	0.22	C11	0.110
		C12	0.040		C12	0.033		C12	0.038		C12	0.050		C12	0.055
		C13	0.040		C13	0.032		C13	0.037		C13	0.050		C13	0.055
B2	0.35	C21	0.140	0.40	C21	0.160	0.36	C21	0.144	0.35	C21	0.140	0.34	C21	0.136
		C22	0.105		C22	0.120		C22	0.108		C22	0.105		C22	0.102
		C23	0.070		C23	0.080		C23	0.072		C23	0.070		C23	0.068
		C24	0.035		C24	0.040		C24	0.036		C24	0.035		C24	0.034
B3	0.25	C31	0.083	0.22	C31	0.073	0.20	C31	0.067	0.15	C31	0.050	0.27	C31	0.090
		C32	0.167		C32	0.147		C32	0.133		C32	0.100		C32	0.180
B4	0.24	C41	0.080	0.25	C41	0.083	0.29	C41	0.097	0.30	C41	0.100	0.17	C41	0.057
		C42	0.120		C42	0.125		C42	0.145		C42	0.150		C42	0.085
		C43	0.040		C43	0.042		C43	0.048		C43	0.050		C43	0.028

Through the experts investigation, statistics the experts to the evaluation index, the opinion that flexible evaluation index to evaluate the level of degrees, the following table 3 shows:

Table 3 Project group of flexible management index weight list

Target layer	Rule layer B	weight W	Index layer C	weight W _i
	Environmental reaction flexible B ₁	0.2469	0.2469	Natural conditions flexible C ₁₁
Macro policy flexibility C ₁₂				0.3553
Social economic flexible C ₁₃				0.3553
Project group of organizational flexibility B ₂	0.2534	0.2534	Owner of the flexibility C ₂₁	0.2039
			Contractor's flexible C ₂₂	0.2263
			Supervision's flexibility C ₂₃	0.2590
			The other's flexibility C ₂₄	0.3108
Project group of structural flexibility B ₃	0.2451	0.2451	Technology flexible C ₃₁	0.6358
			Plan flexible C ₃₂	0.3642
Resource flexibility B ₄	0.2546	0.2546	The flexibility of the building materials C ₄₁	0.3289
			Capital of the flexibility C ₄₂	0.2983
			The flexibility of the auxiliary facilities C ₄₃	0.3728

According to the degree of table, a fuzzy evaluation matrix, generation into the type 2 primary fuzzy comprehensive evaluation, and into the type 3 for secondary fuzzy comprehensive evaluation, the calculation process as follows: (for example, B0 to B1, B2, B3, B4 calculation process omitted)

$$\begin{aligned}
 B1=W_1*R_1 &= [0.2894, 0.3553, 0.3553] * \begin{bmatrix} 0, & 0.5, & 0.4, & 0.1, & 0 \\ 0, & 0.8, & 0.2, & 0, & 0 \\ 0, & 0.7, & 0.0, & 0, & 0 \end{bmatrix} \\
 &= [0, 0.6777, 0.2934, 0.0289, 0]
 \end{aligned}$$

For multi-grade fuzzy comprehensive evaluation, available in the table 4 and table 5, the results as follows:

Table 4 Level fuzzy comprehensive evaluation

Rule layer	Comments set				
	Excellent	Good	Medium	Poor	bad
B ₁	0	0.6777	0.2934	0.0289	0
B ₂	0	0.6669	0.2559	0.0722	0
B ₃	0	0	0.5092	0.4908	0
B ₄	0.0745	0.6417	0.2540	0.0298	0

Table 5 Secondary fuzzy comprehensive evaluation

Target Layer	Comments set				
	Excellent	Good	Medium	Poor	bad
B ₀	0.0190	0.4997	0.3267	0.1533	0

Use type 5, make $K = 1, t_j = 1,2,3,4,5$, then:

$$t = \frac{0.0190 * 5 + 0.4997 * 4 + 0.3267 * 3 + 0.1533 * 2 + 0 * 1}{0.0190 + 0.4997 + 0.3267 + 0.1533 + 0} = 3.3863$$

$t = 3.7106$, the corresponding comments level is good, illustrates the subway project group of flexible management in good condition. Through primary fuzzy comprehensive evaluation result, it is not good enough to adjust the risk in the management system of the project structure, and is good at dealing with the environment, the project group of organizations and resources on reaction ability of change, the managers can take appropriate measures to optimize the project group of construction technology and management plan, and adjust management focus.

Conclusions

Flexibility is a kind of organization capacity to respond to the state of internal and external environment uncertain, benefit to the management goal realization, flexible evaluation involves many factors, the process is relatively complex fuzzy system. Project group is dynamics, uncertainty and complexity, the introduction of the flexibility management is reasonable.

This article constructs fuzzy comprehensive evaluation method conbind with the grey correlation analysis method, not only keeps the evaluation multi-level, but also keeps the final evaluation result to be more objective and feasible, it provides an effective and practical method to strengthen the project group of flexible management.

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