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Top 10 Key Risk Factors of GZA Project Implementation Are Analyzed with Interpretative Structural Model

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Abstract

The top 10 risk factors of GZA project implementation are analyzed with interpretative structural model. There is scientific decision-making, policy supporting, design quality, supervisory mechanism, drawing accuracy, costing, budget control, organization structure, personnel quality, democratic participation, and its interpretative structural model is established. The result illustrates that the relationship among the top 10 risk factors of GZA project implementation is like a pagoda: the root risks are risk of scientific decision-making and risk of drawing accuracy, and risk of organization structure is on the top floor. Those three risks are the most critical factors which affect GZA project implementation's success or failure. The study attempts to facilitate designing of the specific strategy to avoid risk in order to enhance the success rate of GZA project implementation.

Keywords

GZA Project, Key Risk Factors, Interpretative Structural Model (ISM)

1. Introduction

Due to the characteristics and mode of operation of government investment projects, there are a lot of problems in the government project. Risk management of government investment project has attracted the close attention from society. We urgently need to study risk factors from theory to practice in the process of government investment projects in order to prevent and control risks.

GZA project is a super large infrastructure project built by Guangdong Province, Hang Kong and Macao with the first cooperation. J.P. Wan and G.W. Pan identified the risk factors of three levels in GZA project implementation process with literature survey and expert investigation and evaluated those risk factors with analytic

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hierarchy process, and the top 10 key risk factors are as follows: scientific decision-making, policy supporting, design quality, supervisory mechanism, drawing accuracy, costing, budget control, organization structure, personnel quality, democratic participation [1]. This paper studies the hierarchy relationship among the top 10 risk factors of GZA project implementation with Interpretative Structural Model (ISM), and tries to find the root risk and the influence relationship among risk factors, so as to provide better risk management.

This paper is organized as follows: introduction and literature review are in the first section, then the hierarchical structure relationship among the top 10 risk factors of GZA project implementation is analyzed with ISM in order to find the root risk factors and their influence relationship. Finally they are conclusion, acknowledgements and references.

2. Literature Review

2.1. Project Risk Management

Since the mid-1980s, various foreign risk management theories were applied to project management, especially the large civil engineering projects with the continuous development of our economy. For example, the Shanghai subway project in the implementation process was successfully applied in project risk management method [2]. Z.Y. Zhao, Y.S. Liu, H.C. Yang introduced the fault tree analysis method of the engineering reliability theory to the risk management of construction projects. The diagram deductive method was proposed to create the project risk fault tree. The project risk made identification and the risk factor quantification was approached. The minimal cut set method for detecting project's weakness was provided. Based on the binary system and the probability theory, the project successful degree was calculated and the minimizing of the costs to reduce the project sick was studied [3]. P. Guo, P.G. Shi proposed the grey clustering theory which could be used to obtain the index grey statistics and structure the project risk fuzzy subjection matrix and establish the comprehensive risk evaluation method of combing grey evaluation with fuzzy evaluation [4]. Reasonable risk allocation (RA) was attributed to project success among the core participants of project. H. Zhao, Y. L. Yin on the basis of literature review, nine influencing factors are proposed. Then, the hierarchical structure model of influencing factors of reasonable risk allocation (RA) is constructed based on ISM. Finally, the hierarchical relationship of RA influencing factors is obtained and further analyzed the RA strategies selection of project owner. The result provides the theoretical basis for identifying influencing factors of RA and allocating project risks reasonably [5].

2.2. Interpretative Structural Model

Interpretative Structural Model is proposed by Professor Warfield in America to analyze the problem of complex social economic system [6]. It is mainly applied to qualitative analysis, translates the vague idea into an intuitive hierarchical relationship structural model with participants' practical experience and computer technology, so as to solve the complex problem. B. Cheng use of Delphi method to identify entrepreneures to build evaluation capacity factor matrix, then, the capacity factor, combined with the characteristics of entrepreneures, to build entrepreneurial capacity factor to explain the structure of the model (ISM), the capacity factor of entrepreneures the intrinsic relationship between, in order to cultivate the capacity of entrepreneures to the core provides the relevant recommendations [7]. J.P. Wan and J.J. Hou focus on the key risks of SAP Business One implementation, the interpretative structural modeling approach is used to study the relationship between these factors and establish a seven-level hierarchical structure. The study illustrates that the structure is olive-like, in which the risk of data import is on the top, and the risk of senior managers is on the bottom. They are the most important risk factors [8]. J.P. Wan, Y.H. Cao, J.J. Hou establish the comprehensive risk management system based on the software project features of H Corp., the causal relationships among risk factors are discovered, and corresponding risk structure model is built with ISM. Five original risk factors are found, including requirements analysis risk, project communication risk, schedule risk, risk of system design, and risk of project cooperation [9]. J.P. Wan, Y.H. Zhu, L.Y. Liang intend to study the success factors of mobile Internet with grounded theory and it is the result that 17 success factors are identified. Then the following top 10 key success factors are found out through the questionnaire: the user traffic and scale, product and service innovation, keen market environmental sense, the user experience and business model innovation, core technology, the development of mobile terminals, e-commerce and online payment services, customized services and applications of cloud computing and big data. Finally, ISM is applied to analyze the relationship among the key success factors

and the root key success factors of mobile Internet were figured out [10].

3. Building the Top 10 Risk Factors Interpretative Structure Model of GZA Project Implementation

3.1. Establishing the Interpretative Structural Model Group

ISM work program can be divided into the following steps: 1) implement the ISM group, including technical experts, coordinators and participants; 2) set the key issues; 3) select the factors have influence on the key issues of the system; 4) list the correlation of the factors; 5) establish the adjacency matrix and accessible matrix, according to the correlation; 6) breakdown the accessible matrix and build the structure model; 7) establish the interpretative structure model based on the structure model [5].

8 experts who engaged in the field of government investment projects, including management experts, government leaders, and managers of design firms, construction companies, supervision companies and consulting firms, are invited to join the ISM group, these experts have rich experiments in government investment project implementation, and are willing to provide sincere help.

The discussion and communication in ISM group were going with e-mail. Setting the general problem of modeling is whether factor A affect factor B, we distributed the problems to each members of ISM group in the form of the questionnaire, after collecting and collating the questionnaire, we gave feedback to each member, let them modify the conclusion. It was repeated until all the ISM group members on the formation of a consensus opinion.

3.2. Discussion about the Relationship among the Top 10 Risk Factors of GZA Project Implementation

The ISM group had unified views on the result of the discussion and formed the causal relationship between risk factors after analysis of multiple iterations through iterative analysis repeatedly. In order to express conveniently and uniformly, "X" in the cell is used to illustrate the row factor and the column factor influence each other, "V" means the row factor has influence to the column factor, while "A" has the opposite meaning, and the cell in space means there is no relationship between row factor and column factor (**Table 1**).

According to the results above, an adjacent matrix can be built. For the top 10 risk factors of e-business $K_i\ (i=1,2,\cdots,10)$, "1" means K_i is influential to K_j, otherwise, "0" is used. So the relationship in **Table 1** can be expressed as the adjacency Matrix (1) as follows:

Table 1. The relationship among the top 10 risk factors of GZA project implementation.

		K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}
K_1	scientific decision-making										
K_2	policy supporting	V									
K_3	design quality	V									
K_4	supervisory mechanism	V	V								
K_5	drawing accuracy	V		A							
K_6	costing		V	V		V					
K_7	budget control	V	V	V	V	V	V				
K_8	organization structure	V	V	V	V	V	V	V			
K_9	personnel quality	V	V		V			A	A		
K_{10}	democratic participation	V	V		V				A		

$$A = \begin{array}{c} \\ K_1 \\ K_2 \\ K_3 \\ K_4 \\ K_5 \\ K_6 \\ K_7 \\ K_8 \\ K_9 \\ K_{10} \end{array} \begin{array}{c} \begin{array}{cccccccccc} K_1 & K_2 & K_3 & K_4 & K_5 & K_6 & K_7 & K_8 & K_9 & K_{10} \end{array} \\ \begin{pmatrix} 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \end{array} \tag{1}$$

According to the formula $(A+I)^{k-1} \neq (A+I)^k = (A+I)^{k+1} = R$ (I is referred to the unit matrix), the reachable Matrix (2) is acquired as follows with the ISM WIN 1.1 software:

$$R = \begin{array}{c} \\ K_1 \\ K_2 \\ K_3 \\ K_4 \\ K_5 \\ K_6 \\ K_7 \\ K_8 \\ K_9 \\ K_{10} \end{array} \begin{array}{c} \begin{array}{cccccccccc} K_1 & K_2 & K_3 & K_4 & K_5 & K_6 & K_7 & K_8 & K_9 & K_{10} \end{array} \\ \begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \end{pmatrix} \end{array} \tag{2}$$

The set for each factor K_i is obtained with the reachable matrix R:

$$P(K_i) = \{K_j m_{ij} = 1\} \tag{3}$$

$$Q(R_i) = \{K_j m_{ji} = 1\} \tag{4}$$

$$P(K_i) \cap Q(K_i) = T(K_i) \tag{5}$$

$P(K_i)$ is called to reachable set, namely the set of all the reachable factors from factor $K_i \cdot Q(K_i)$, called advanced set, refers to the set of all the factors can reach $K_i \cdot Q(R_i)$ means the universal set, which is the set of all the factors both belong to the reachable set and the advanced set (**Table 2**).

The relationship description of the top 10 risk factors above is not intuitive enough. To express the relationship more clearly, the hierarchy is further analyzed (**Table 3**).

3.3. Building the Hierarchical Interpretative Structural Model of Risk Factors of GZA Project Implementation

According to the hierarchy of the top 10 risk factors of GZA project implementation, the ISM model of the top 10 risk factors of GZA project implementation is established (**Figure 1**).

This model consists of 6 levels, indicating that affecting relationship between the risk factors. We can illustrate in **Figure 1**: 1) The risk of organization structure directly determines whether GZA project implementation successes or fails, which is the direct cause; 2) The risk of scientific decision-making and risk of drawing accuracy affect the GZA project from the beginning, which are the root cause; 3) Every hierarchy risk factors distributes in different stages of GZA project implementation, the relationship of risk factors is interactive.

Table 2. The reachable set, advanced set and universal set of the top 10 risk factors of GZA project.

K_i	$P(K_i)$	$Q(R_i)$	$T(R_i)$
K_1	1, 2, 3, 4, 6, 7, 8, 9, 10	1	1
K_2	2, 4, 6, 7, 8, 9, 10	1, 2	2
K_3	3, 6, 7, 8	1, 3, 5	3
K_4	4, 7, 8, 9, 10	1, 2, 4	4
K_5	3, 5, 6, 7, 8	5	5
K_6	6, 7, 8	1, 2, 3, 5, 6	6
K_7	7, 8	1, 2, 3, 4, 5, 6, 7, 9	7
K_8	8	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	8
K_9	7, 8, 9	1, 2, 4, 9	9
K_{10}	8, 10	1, 2, 4, 10	10

Table 3. The hierarchy process of the top 10 risk factors of GZA project.

K_i	$P(K_i)$	$Q(R_i)$	$T(R_i)$
	Stage 1 = $\{K_1, K_5\}$		
K_2	2, 4, 6, 7, 8, 9, 10	2	2
K_3	3, 6, 7, 8	3	3
K_4	4, 7, 8, 9, 10	2, 4	4
K_6	6, 7, 8	2, 3, 6	6
K_7	7, 8	2, 3, 4, 6, 7, 9	7
K_8	8	2, 3, 4, 6, 7, 8, 9, 10	8
K_9	7, 8, 9	2, 4, 9	9
K_{10}	8, 10	2, 4, 10	10
	Stage 2 = $\{K_2, K_3\}$		
K_4	4, 7, 8, 9, 10	4	4
K_6	6, 7, 8	6	6
K_7	7, 8	4, 6, 7, 9	7
K_8	8	4, 6, 7, 8, 9, 10	8
K_9	7, 8, 9	4, 9	9
K_{10}	8, 10	4, 10	10
	Stage 3 =$\{K_4, K_6\}$		
K_7	7, 8	7, 9	7
K_8	8	7, 8, 9, 10	8
K_9	7, 8, 9	9	9
K_{10}	8, 10	10	10
	Stage 4 =$\{K_9, K_{10}\}$		
K_7	7, 8	7	7
K_8	8	7, 8	8
	Stage 5 = $\{K_7\}$		
K_8	8	8	8
	Stage 6 = $\{K_8\}$		

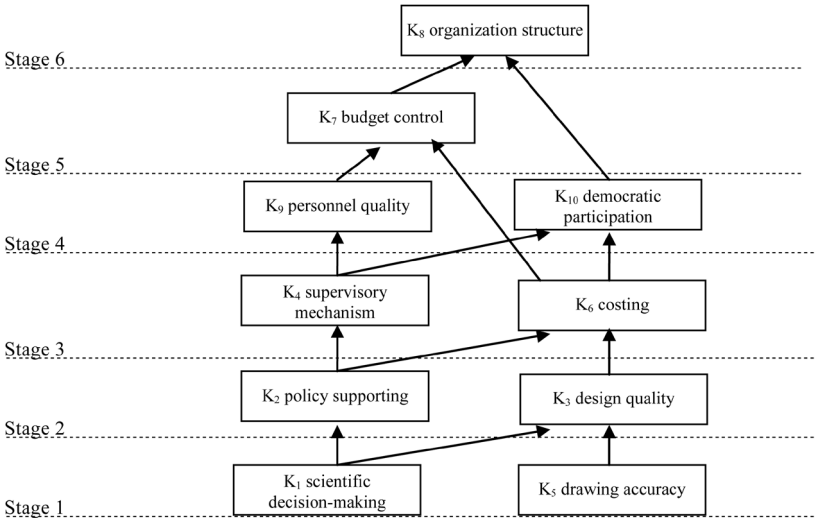

Figure 1. The hierarchical structure model of the top 10 risk factors of GZA project.

4. Conclusion

The key risk factor of interpretative structural model to analyze the top 10 risk factors of GZA project implementation was established. The result illustrated that the relationship among the risk factors of GZA project implementation is the complex network of relationships which is like a pagoda: the root risks are risk of scientific decision-making and risk of drawing accuracy, and risk of organization structure is on the top floor. Those three risks are the most critical factors which affect GZA project implementation's success or failure. We hope that the research will be enlightenment for GZA project implementation.

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