Analysis of Factors Affecting Project Success in Chinese Context Based on Interpretative Structural Modeling

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Abstract. In the field of engineering management practice in today's China, the theoretical research of project success is still a hot topic. On the basis of literature and Chinese context, the project success factors are summarized for the Chinese construction projects, and the hierarchical structure model of project success factors is constructed by interpretation structural modeling. The results show that the different factors of project success have different effect on project success, but the abilities and experiences of the project owner and project manager are still the most important influencing factors for project success in today's China.

Introduction

In the field of engineering management practice, project success is the ultimate goal of each project. The connotation of project success is not unified yet, its depth and breadth has been changing, but the *iron triangle* (i.e. cost-quality-time) is always at the core [1], its connotation is often extended from the project life cycle, project participants and other aspects to supplement evaluation indicators [2][3]. Therefore, the project success refers to the effectiveness and efficiency of the project and its implementation process, which can be assessed by analyzing the different dimension project performance level including the *iron triangle*, stakeholder satisfaction and so on [4].

Today, China has the largest scale of infrastructure investment in the world, and how to achieve project success has always been an active theory and practice topic in mainland China. Identifying the project success factors and then design reasonable control planning is considered an effective path to realize the project success [5-7].In fact, in different project success factors, their effect on project success may be different, and there may be interaction between each other, which leads to higher complexity of project management decision under the resource constraints. This paper intends to use literature research to determine the project success factors under the Chinese context, and analyzes the relationship among the factors by interpretative structural modeling (ISM), which has some guiding significance for project management decision-making in mainland China.

Determination of Project Success Factors

Literature Analysis of Project Success Factors in Construction Projects

Foreign scholars have studied the project success factors earlier than the Chinese mainland scholars. Since the 1980s, foreign scholars have done a lot of research on this topic. Ashley D. B. et al. found a successful construction project that depended on the experience of the project manager, the stability of the project team, the level of control, planning and other factors [8]. According to the technical paradigm of PMI, Kerzner H. identified six critical success factors for the general project [9]. Pinto J. K. et al. made a pioneering study on the success factors of the construction project, and the ten factors proposed by them [10] were cited by many scholars. Since then, the study of project success factors began to shift to the project implementation process, Jaselskis and Ashley found that increasing the frequency of cost updating, reducing personnel changes and doing constructability research can

promote project performance [11]. After that, scholars began to focus on the systematic study of project success factors in order to construct a theoretical analysis framework, such as Belassi W et al. and Chan P. C.et al., their research has some similarity, and the former divided project success factors into four categories: project factors, project manager and team, project organizational factors, and project external environment [12], the latter divided it into five categories including project factors, project implementer, project management activities, project procedures and project external environment [13].

In the past decade, Chinese scholars began to study the project success factors, and their analysis framework did not break the framework of Western scholars. Wen-zhou WANG et al. conducted a statistical analysis of the literature on the project success factors from 1990 to 2008, and summarized ten factors according to the frequency of the literature [7], which is the most systematic research result of Chinese scholars in this field. In addition, the analysis of a specific factor also began to appear, such as Guang-dong WU et al. analyzed this topic from project team and project conflict [14], which is similar to the study of Pinto J. K. et al [15].

Determination of Project Success Factors in Chinese Context

On the basis of literature review, the framework of project success factors can be summarized four dimensions such as project factors, project management activities and project participants. According to the study above [7], some factors that are not suitable for the Chinese situation are deleted. For example, in the study of Western scholars, end-user participation is considered to be an important factor, but in China's projects, especially in infrastructure projects, end users are difficult to participate in the project implementation process. Based on the above logic, the project success factors in Chinese context are shown in Table 1.

Table 1.　The project success factors in Chinese context

Dimension	Factors/No.	Description/ Literature
Project	Project objectives/F1	The objectives are clear and accepted by the participants, the project is easy to succeed. [3][5][7]
Participant	Project manager/F2	The ability and experience of the project manager, the team and the project sponsor is an important guarantee for project success. [4][5][7][14]
	Project team/F3	
	Project sponsor/F4	
	Participants/F5	Project participants' cooperation to promote project success. [5][7]
	Communication management/F6	Effective communication is the condition for resolving disputes and promoting cooperation. [7][12][13][14]
Activity	Supervision and control/F7	Supervision and control are the basic means of project management
	Plan management/F8	The plan is the core program of project success. [4][11]
	Procurement/F9	Project procurement is key topic of project management.[6]

The ISM model Construction of Project Success Factors

The Construction of Adjacency Matrix

The ISM is a technical method for analyzing the relationship between the constituent elements of the system. According to the basic principle of ISM, it is necessary to determine the relationship between the factors and construct the adjacency matrix at first.

In this paper, through the Delphi method, seven experts analyzed the logical relationship of various factors in Table 1. When comparing the relationship between the two factors (F_i, F_j), if F_i has an effect on F_j, it is expressed by F_i R F_j, and vice versa, expressing by F_i UR F_j. On the basis of factor analysis, we can construct an adjacency matrix A = [a_{ij}], the value of a_{ij} is expressed by the following Eq. 1.

$$a_{ij} = \begin{cases} 1, F_i \ R \ F_j \\ 0, F_i \ UR \ F_j \end{cases} \tag{1}$$

According to the Eq. 1, the adjacency matrix *A* of project success factor is shown in Table 2.

The Calculation and Hierarchical Processing of Reachable Matrix

It is an important step of the ISM method to calculate the reachable matrix by computing the adjacency matrix. The matrix is calculated by Boolean rules, and assuming the letter of *I* is the unit matrix, the calculation process ends when Eq. 2 is valid. When *n = 2*, the calculation ends and the reachable matrix *M* is shown in Table 2.

$$M = (A+I)^{n+1} = (A+I)^{n} \neq \ ... \ (A+I)^2 \neq \ (A+I) \tag{2}$$

Table 2. The adjacency matrix and the reachable matrix

F_i	Adjacency matrix (A)									F_i	Reachable matrix (M)								
	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9		F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9
F_1	1	0	0	0	0	1	1	1	1	F_1	1	0	0	0	1	1	1	1	1
F_2	0	1	1	1	1	1	1	1	1	F_2	1	1	1	1	1	1	1	1	1
F_3	0	0	1	0	1	1	1	1	1	F_3	0	0	1	0	1	1	1	1	1
F_4	1	0	0	1	1	1	1	1	1	F_4	1	0	0	1	1	1	1	1	1
F_5	0	0	0	0	1	1	0	0	0	F_5	0	0	0	0	1	1	1	1	1
F_6	0	0	0	0	1	1	1	1	1	F_6	0	0	0	0	1	1	1	1	1
F_7	0	0	0	0	0	0	1	0	0	F_7	0	0	0	0	0	0	1	0	0
F_8	0	0	0	0	0	0	0	1	1	F_8	0	0	0	0	0	0	0	1	1
F_9	0	0	0	0	0	0	0	0	1	F_9	0	0	0	0	0	0	0	1	1

The Construction of ISM Model

On the basis of the reachable matrix, the most important step of the ISM method is to divide the factors into different hierarchies and construct the structural model by analyzing reachable set ($R(F_i)$), antecedent set ($A(F_i)$) and their intersection set ($R(F_i) \cap A(F_i)$). The results of the calculation and analysis are shown in Table 3.

Table 3. Reachable set, antecedent set and intersection

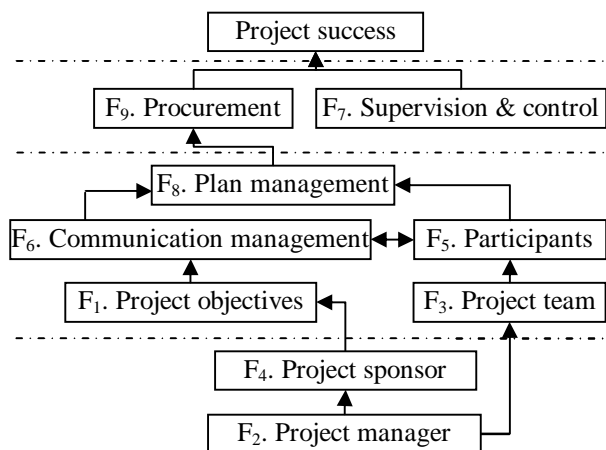| F_i	$R(F_i)$	$A(F_i)$	$R(F_i) \cap A(F_i)$
F_1	1,5,6,7,8,9	1,2,4	1
F_2	1,2,3,4,5,6,7,8,9	2	2
F_3	3,5,6,7,8,9	2,3	3
F_4	1,4,5,6,7,8,9	2,4	4
F_5	5,6,7,8,9	1,2,3,4,5,6	5,6
F_6	5,6,7,8,9	1,2,3,4,5,6	5,6
F_7	7	1,2,3,4,5,6,7	7
F_8	8,9	1,2,3,4,5,6,8	8
F_9	9	1,2,3,4,5,6,8,9	9

Fig. 1 The ISM of project success factors

For all factors (F_i), their common set $T = \{F_i \in N | \ R(F_i) \cap A(F_i) = A(F_i)\} = \{2\} \neq \ \Phi$, it means that there is only one connected domain among all factors in this paper. According to the rule of $R(F_i) \cap A(F_i) = R(F_i)$, the highest level ($L_1$) can be determined, and then, L_2, L_3, …. L_n can be defined according to the same rules after removing the factors in L_1. Obviously, in this paper, $L_1 = \{7, 9\}$, $L_2 = \{8\}$, $L_3 = \{5, 6\}$, $L_4 = \{1, 3\}$, $L_5 = \{4\}$, $L_6 = \{2\}$, where the factors in L_3 can reach each other, so the

level of L_3 is a strongly connected block. According to the drawing principle of ISM, the ISM model can be constructed by connecting the factors with unidirectional arrows, where the factors in the strongly connected block are connected by double arrows. The ISM model of project success factors in this paper is shown in Fig. 1.

The Hierarchical Analysis of Project Success Factors

According to the model shown in Fig. 1, the hierarchical structure of project success factors can be roughly summarized as three levels. The first level is a set of direct factors including the factors of L_1, the second level is a set of indirect factors including the factors of L_2, L_3, and L_4, and the third level includes a series of factors in L_5 and L_6. The mechanism of different factors affecting project success and its related project implementation strategies can be summarized as follows.

Direct Factors Analysis. As shown in Fig. 1, the factors of the level of L_1 including the procurement and supervision & control are at the first level, which means that these two factors have a direct effect on project success. In theory, the procurement management of project is a core activity in the implementation process of the construction project. The efficiency of project procurement has a key role in the efficiency of project funds, which directly determines the project performance in business dimension. On the other hand, the supervision and control of project is a common means of project management, and its effectiveness has a fundamental role in the project implementation process, whish directly determine whether the project can be successful. For engineering management practice, it means that the project owner should strengthen the project procurement management and design effective procedures of project supervision and control in order to achieve project success.

Indirect Factors Analysis. In this paper, the factors in the level of L_2, L_3 and L_4 are considered the indirect factors, which mean that these the impact of these factors on the project success is achieved through other means, but their effect can still be ignored. As shown in Fig. 1, for realizing project success, all participants should strength plan management, communication management and promote the collaborative work of project participants, and for the project owner, defining a clear project objective and hiring an efficient project management team may be more meaningful.

Fundamental Factors Analysis. As shown in Fig. 1, the abilities and experience of project manager and project sponsor have a fundamental effect on project success. These two factors have a systemic effect on the project success by influencing other factors, which means that the ability of both transaction parties directly determines the efficiency of project management activities and has a fundamental role on project success in today's China. Therefore, improving the ability and experience of both transaction parties has a prominent significance for project management practice in China.

Conclusions

In today's China, the theoretical research of project success is a hot issue due to the existence of a large number of practical projects. This paper analyzes the domestic and foreign research results on the project success factors, summarizes several influencing factors of the project success in Chinese context, and discusses their mutual relations by the ISM model. The study found that there were interactions between different project success factors, which have different impact degrees on project success, and particularly worth mentioning is that the ability and experience of project sponsors and project managers remains the most important factors for promoting project success in today's China.

At the practical level, the results of this study have some particular value to the project owners or sponsors. At first, the efficiency of project activities such as procurement and project supervision & control should be focused on, and a reasonable approach may be developing the strategies of good planning management. And then, the good relationship governance should be constructed and maintained by the project owner, which can directly improve the efficiency of the collaborative working and communication for all project participants. In addition, a clear project objectives and efficient project team have direct positive impact. Finally, the fundamental work for the project owner is hiring a good project manager, which has a systematic impact on the work performance of project

team and the communication and collaboration of all project participants, and can also promotes the owners to improve project management capacity and define a clear and reasonable project goal (s).

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