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Full Length Research Paper

Hierarchical structuring success factors of project stakeholder management in the construction organization

Yongkui Li[1], Yujie Lu[1,2]* and Yi Peng[3]

[1]School of Economics and Management, Tongji University, Shanghai, 200092 China.
[2]Department of Civil and Environmental Engineering, University of Maryland, College Park, MD 20743 USA.
[3]Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong.

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Stakeholder management is essential for project success. Previous studies have explored project stakeholder management process and the success factors while the practice is unsatisfactory. Few have further explored the interrelationships of the success factors, which is obstructive to the in-depth understanding of project stakeholder management. This paper employs interpretative structural modeling (ISM) to develop the hierarchical structure and investigate the interrelationships of these success factors. Moreover, *matrice d'impacts croises-multiplication appliqué a un classemen* (MICMAC) analysis is conducted to identify the dependency and driving power of the success factors. ISM, as well as MICMAC analysis, provides a useful tool for practitioners to understand success factors for stakeholder management in construction. This study discovered that 6 factors among 16 factors have a weak dependent power but a strong driving power while 6 factors have a strong dependent power but a weak driving power. Managing stakeholders with social responsibility, keeping and promoting a good relationship, and communicating with and engaging stakeholder properly and frequently have been found to have the highest dependence on the other factors and have been placed on the top level of the hierarchical structure. The results facilitate the managers to gain an in-depth understanding of project stakeholder management and pay due attention to achieve the success. It can also be generalized to provide good references for investigation of success factors for project stakeholder management in other countries.

Key words: Stakeholder management, project organization, success factors, interpretative structural modeling (ISM), *matrice d'impacts croises-multiplication appliqué a un classemen* (MICMAC) analysis, China.

INTRODUCTION

Stakeholders are individuals or organizations that are either affected by or affect the deliverables or outputs of a specific organization (El-Gohary et al., 2006). Each stakeholder can provide the firms with a kind of critical resources and becomes an important part of the firm (Hill and Jones, 1992). Stakeholder management is the process of appropriately managing stakeholders to support an organization in achieving its strategic objectives by addressing organizations and stakeholders' power, intentions, and values (Savage et al., 1991). Stakeholder management has been widely advanced in business practice and in theory relevant to strategic management, corporate governance, and corporate social responsibility (CSR), since the milestone work 'strategic management: A stakeholder approach' by Freeman (1984) was introduced. As construction project is characterized by the participation of a lot of stakeholders, such as client, stockholders, creditors, managers, employees, suppliers, customers, local communities, and the general public, project stakeholder management is widely appreciated in recent years (Leung et al., 2004).

*Corresponding author. E-mail: lyj0415@gmail.com.

Stakeholder management is essential for project success (Jergeas et al., 2000; Jepsen and Eskerod, 2009; Kuen et al., 2009; Abdullah et al., 2010). It is natural for the stakeholders to attempt to affect the project according to their individual interests (Olander and Landin, 2008). The diversity of interest is prominent especially when limited time and budget is afforded and may bring both problems and uncertainties to project implementation (Karlsen, 2002; Leung et al., 2004). Therefore, project stakeholder management is indispensable to control the negative impacts of stakeholders, maximize the perceived benefits, and achieve the preset mission (El-Gohary et al., 2006; Olander and Landin, 2008). However, project stakeholder management is unsatisfactory through the past years due to the complexity and uncertainty of projects, and less understandings of project stakeholder management itself (Loosemore, 2006).

A number of studies have been conducted to explore how to apply stakeholder management in construction industry. For example, Karlsen (2002) provided a recursive six step process of project stakeholder management, including initial planning, identification, analysis, communication, action, and follow-up. Other scholars put forward similar process model centering on identification, communication and prioritization of stakeholders, although, the detailed steps have some differences (Young, 2006; Bourne and Walker, 2006; Walker et al., 2008). On the other hand, Jepsen and Eskerod (2009) clarified the premises underlying project stakeholder management, which includes making deliberate efforts to exert influence on project stakeholders in order to gain their contributions to the project, allocating limited resources in such a way that they achieve the best possible results, and expending efforts spread across a range of stakeholders than concentrated on a few. Based on this, Yang et al. (2010a) developed a framework for project stakeholder management from the aspect of precondition, information inputs, stakeholder estimation, decision making and sustainable support.

Moreover, several studies have investigated the success factors for project stakeholder management. Jergeas et al. (2000) conducted interviews and found that "communication with stakeholders and setting of common goals, objectives and project priorities" can improve the performance of project stakeholder management. Olander and Landin (2008) compared the project stakeholder management of two railway development projects in Sweden and identified five crucial factors for implementing project stakeholder management, namely, "analysis of stakeholder concerns and needs, communication of benefits and negative impacts, evaluations of alternative solutions, project organization and media relations". Jepsen and Eskerod (2009) considered that identification of sufficiently important stakeholders, and warranting information gathering concerning expectations is critical to meet the challenge of project stakeholder management. Comprehensively, Yang et al. (2009, 2010a, b) adopted an approach integrating literature review, interview and questionnaire and found 15 critical success factors for project stakeholder management, which prioritized "managing stakeholders with social responsibilities", "assessing the stakeholders' needs and constraints to the project", and "communicating with stakeholders properly and frequently". It provided a good reference to understand the critical success factors for project stakeholder management.

However, few have further explored the interrelationships of the success factors, which is obstructive to the in-depth understanding of project stakeholder management. Comprehensive understanding of the success factors is essential for management. The identification of success factors for project stakeholder management is only an initial step. Discovering the hierarchy structure and the interrelationships of these success factors is needed to push forward the understanding and facilitate the practitioners to better implement stakeholder management. Therefore, this study aims to provide a hierarchical structural framework of success factors for project stakeholder management by using interpretative structural modeling (ISM) method. Moreover, *matrice d'impacts croises-multiplication appliqué a un classemen* (MICMAC) analysis is conducted to identify the dependency and driving power of the success factors.

RESEARCH METHODOLOGY

ISM is a computer assisted systematic structure model proposed by Warfield (1974). Von Winterfeldt (1980) opined that ISM is a useful tool to formally represent a decision problem by employing matrix and graph theory notions. Kannan et al. (2009) considered ISM as a computer-assisted learning process which enables decision makers to develop a map of the complex relationships among specific elements in a complex system. Based on experts' experience, knowledge as well as computer, ISM is able to divide the complex system into several subsystems, transform the logic structure into stratum steps structure, and construct a multilevel structure model (Xu et al., 2006; Lyer and Sagheer, 2010).

The critical process of ISM mainly has four steps. First, the key problems to solve and the influencing factors of the system should be identified. In mathematical language, a set of specific elements that constitute the system of interest is developed. Secondly, the correlation between every pair of the elements needs to be found out. A matrix called adjacent matrix can be used to characterize the relationships. The number in the adjacent matrix is numerical judgments measuring the strength of the relationship or 0 to 1 judgments about whether a relationship exists or not (Von Winterfeldt, 1980). Thirdly, the reachability matrix should be developed and partitioned to attain the system structure with the help of computer. Reachability matrix is used to indicate whether or not a column element can be "reached" from a row element along a continuous directed path (Watson, 1978). Reachability matrix can be developed from adjacent matrix following specific rules, the detail of which is shown in the latter section. From the reachability matrix, through an iterative process, the relationship between

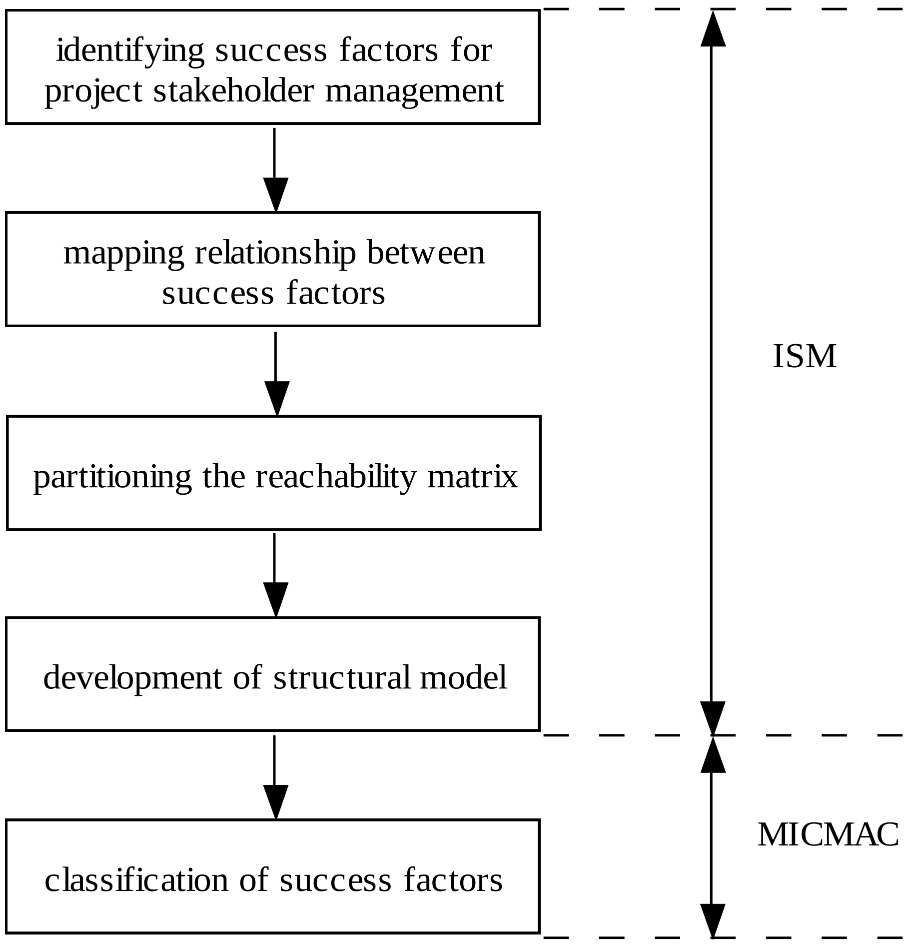

Figure 1. The analytical process of hierarchical structure of success factors for project stakeholder management.

elements is stratified and a hierarchical form which demonstrates the final level of relationship between elements is established (Lyer and Sagheer, 2010). Lastly, the hierarchical diagraph can be converted to a structural model representing the concerned problem. It can be further inspected and modified to help decision makers best understand the system.

ISM has been widely applied in the management field. Generally, it is useful to explore the interrelationship of concerned factors, which provides a foundation for an in-depth understanding of the complex system. The results of ISM would result in structural clarity and help the decision makers to establish a proper prioritized strategy (Lyer and Sagheer, 2010). Specifically, it is considered as a useful tool in systems thinking, which can help capture and exchange individual or group perceptions on complex issues, and reach consensus (Malone, 1975; Sage, 1977; Flood, 1989). As a tool to establish hierarchical structure, it is also useful to analyze the interrelationships of evaluation criteria and further assess and make decision (Watson, 1978; Mandal and Deshmukh, 1994; Kanungo et al., 1999). Moreover, integrating with other methods such as MICMAC, it could be used to identify critical factors and analyze the interrelationships for specific concerns (Ravi et al., 2005; Kannan et al., 2009; Lyer and Sagheer, 2010). Considering the merits of ISM, the paper adopts it to analyze the interrelationship of success factors for project stakeholder management in China. It would deepen the understanding of the interactions between the success factors and facilitate the practitioners to establish a hierarchical order for prioritization and achieve better results of project stakeholder management. Based on the process of ISM introduced above, the analytical process of this paper is illustrated in Figure 1.

ANALYSES AND RESULTS

Identification of success factors for project stakeholder management

Literature review and expert interview were conducted to identify the success factors for project stakeholder management. As Yang et al. (2009; 2010a, b) have conducted a comprehensive study to identify the success factors for project stakeholder management, the identified 15 factors were adopted for analysis. Moreover, the expert interview suggested that flexible project organization is needed to cope with the complexity and uncertainties of construction in China, which is echoed with the existing research (Olander and Landin, 2008).

Table 1. The adjacent matrix for success factors for stakeholder management.

Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
F2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F3	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
F4	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
F5	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
F6	0	0	0	0	1	0	0	1	1	1	1	0	1	0	1	0
F7	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
F8	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
F9	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0
F10	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
F11	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
F12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F13	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1
F14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
F15	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
F16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Therefore, the success factors used for further analysis are listed as: F1-flexible project organization, F2-managing stakeholders with social responsibilities, F3-formulating a clear statement of project mission, F4-properly identifying stakeholders, F5-understanding of stakeholder interest area, F6-exploring stakeholder needs to projects, F7-assessing stakeholder behavior, F8-accurately predicting the influence of stakeholders, F9-assessing attributes (power, urgency, and proximity) of stakeholders, F10-analyzing conflicts and coalitions among stakeholders, F11-effectively resolving conflicts between stakeholders, F12-keeping and promoting a good relationship, F13-formulating appropriate strategies for the management of stakeholders, F14-predicting stakeholder reactions to implementation of the strategies, F15-analyzing the changes in stakeholder influences and relationships, and F16-communicating with and engaging stakeholders properly and frequently.

Olander and Landin (2008) and Yang et al. (2009, 2010a, b) gives details of the 16 success factors.

Mapping relationship between identified success factors

A 16×16 adjacent matrix is used to capture the relationship between every two success factors. In this study, 0-1 is used to judge whether there is a relationship or not between two factors. Suppose the adjacent matrix $A=[a_{ij}]$, and the element a_{ij} is defined as:

$$a_{ij} = \begin{cases} 1, & F_i R F_j \\ 0, & F_i \bar{R} F \end{cases}$$ (Formula 1)

where R indicates that F_i is directly related to F_j, and $\bar{R}$ indicates that F_i is not directly related to F_j.

Pairwise comparisons of the identified 16 success factors were conducted to attain the value of adjacent matrix *A*. Experts were invited to fill the matrix based on their experience and knowledge. Although, difference of opinions occurred at the first round of interview, Delphi was employed to reach consensus of the value of matrix finally. As a result of this step, the adjacent matrix is shown in Table 1.

Partitioning the reachability matrix

Reachability matrix is used to imply whether or not a column element can be "reached" from a row element along a continuous directed path (Watson, 1978). According to the existing research, the reachability matrix can be attained through adding the adjacent matrix *A* and unit matrix *I* together, and applying the power operation for the sum of *A* and *I* (Ai and Zhang, 2009). Suppose $A_1 = A + I$, $A_2 = (A+I)^2$, ..., $A_i = (A+I)^i$, A_r is defined as the reachability matrix *R* if it satisfies the condition that formula (2) implies:

$$A_1 \neq A_2 \neq A_3, ..., A_{r-1} \neq A_r = A_{r+1} = A_{r+2}$$ (Formula 2)

It is kindly reminded that the power operation here adopts Boolean algebra operation rules as shown in formula (3):

$$\begin{cases} 0+0=0, \quad 0+1=1, \quad 1+1=1 \\ 0\times 0=0, \quad 0\times 1=0, \quad 1\times 1=1 \end{cases}$$ (Formula 3)

Table 2. The reachability matrix for success factors for stakeholder management.

Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	Driving power
F1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3
F2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F3	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	13
F4	0	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1	11
F5	0	1	0	0	1	0	0	1	0	1	1	1	1	1	1	1	10
F6	0	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1	12
F7	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	10
F8	0	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	9
F9	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	10
F10	0	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	9
F11	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3
F12	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
F13	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	4
F14	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	5
F15	0	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	9
F16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
Dependence power	1	12	1	1	3	2	2	9	3	9	10	15	11	10	9	15	

By applying the criterion in this study, the reachability matrix *R* is gained through four times of power operation, which is shown in Table 2.

The reachability set and antecedent set can be reached by partitioning the reachability matrix as shown in Table 2. The reachability set for a particular factor composes of the factor itself and the other factors, which the particular factor has an impact on (Kannan et al., 2009). It can be found from entry 1 in different cells of the horizontal row to the particular factor in the reachability matrix (Lyer and Sagheer, 2010). The antecedent set for a particular factor consists of the factor itself and the other variables, which have an impact on the particular factor (Kannan et al., 2009). It can be selected from the entry 1 in different cells of the column corresponding to the particular factor in the reachability matrix (Lyer and Sagheer, 2010). Following the criteria, the reachability set and antecedent set for all the factors can be identified.

For any factor, if the intersection of the reachability set and antecedent set is the same as the reachability set, the factor is selected and assigned a particular level corresponding to the number of iterations. In this study, the first iteration produced the results as shown in Table 3. From Table 3, it is found that the intersection set for factors F2, F12, and F16 is the same as the reachability set. As a result, factors F2, F12, and F16 are selected out and placed at level I.

Development of structural model

The iterative process is continued with the remaining factors until all the factors are selected out and placed at corresponding levels. The result of the hierarchy level is shown in Table 4.

In order to provide a visual form of the hierarchical structure, the identified level in Table 4 integrated with the reachability matrix in Table 2 is used to develop a diagraph. The diagraph is beneficial to understand the contextual relationship between each of the success factors and their hierarchies, as derived by modeling (Lyer and Sagheer, 2010). The factors appearing at level I are placed at the top of the hierarchy. Herein, the factors appearing at level II are positioned below the top level. By repeating this process, the factors can be placed at different levels of the hierarchical structure. The interrelationship between various factors can be obtained by the corresponding entries in the reachability matrix in Table 2. For example, for factor F1 (flexible project organization), the entries corresponding to factors F12 and F16 are 1 and for all the other elements, the entry is 0. In other words, factor F1 leads to F12 and F16, while there is no relationship between F1 and other remaining element. Through a similar way, the interrelationships between the success factors are identified and shown as directional arrows reflecting the direction of the relationship. By following these steps and removing the transitivity as described in ISM methodology, the diagraph of the hierarchical structure is presented in Figure 2.

Figure 2 shows that formulating a clear statement of project mission (F3) is fundamental for the success of project stakeholder management as it forms the base of the ISM hierarchy. It is echoed with the fact that project mission provides the orientation and objective for which project stakeholder management chases. Managing

Table 3. The first iteration of identifying reachability set and antecedent set.

Factor (F_i)	Reachability set $R(F_i)$	Antecedent set $A(F_i)$	Intersection $R(F_i) \cap A(F_i)$	Level
F1	1, 12,16	1	1	
F2	2	2,3,4,5,6,7,8,9,10,13,14,15	2	I
F3	2,3,5,6,8,9,10,11,12,13,14,15,16	3	3	
F4	2,4,7,8,10,11,12,13,14,15,16	4	4	
F5	2,5,8,10,11,12,13,14,15,16	3,5,6	5	
F6	2,5,6,8,9,10,11,12,13,14,15,16	3,6	6	
F7	2,7,8,10,11,12,13,14,15,16	4,7	7	
F8	2,8,10,11,12,13,14,15,16	3,4,5,6,7,8,9,10,15	8,10,15	
F9	2,8,9,10,11,12,13,14,15,16	3,6,9	9	
F10	2,8,10,11,12,13,14,15,16	3,4,5,6,7,8,9,10,15	8,10,15	
F11	11,12,16	3,4,5,6,7,8,9,10,11, 15	11	
F12	12,16	1,3,4,5,6,7,8,9,10,11,12,13,14, 15,16	12,16	I
F13	2,12,13,16	1,3,4,5,6,7,8,9,10,13,14,15	13	
F14	2,12,13,14,16	1,3,4,5,6,7,8,9,10,14,15	14	
F15	2,8,10,11,12,13,14,15,16	1,3,4,5,6,7,8,9,10,15	8,10,15	
F16	12,16	1,3,4,5,6,7,8,9,10,11,12,13,14, 15,16	12,16	I

Table 4. The hierarchy level of success factors for stakeholder management.

Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
Level	II	I	VII	VI	V	VI	V	IV	V	IV	II	I	II	III	IV	I

stakeholders with social responsibility (F2), keeping and promoting a good relationship (F12), and communicating with and engaging stakeholders properly and frequently (F16) are the critical factors that the success of project stakeholder management depends on. These factors have appeared at the top of the hierarchical structure. This happens to partly echo with the research done by Yang et al. (2010a). Moreover, Figure 2 provides the interrelationships between success factors and connected impact path for further inspection. The details of the full ISM model for the success factors are shown in Figure 2.

DISCUSSION

After attaining the hierarchical structure, which graphically and qualitatively demonstrates the relationships between success factors, it is necessary to further investigate the degree of relationship between the various success factors. MICMAC analysis is a good method to investigate the degree of relationship by analyzing the dependence power and driver power of each factor (Mandal and Deshmukh, 1994). Based on the reachability matrix shown in Table 2, dependence power of each factor is the sum of 1s in the corresponding column. Parallel, the driving power of each factor is attained by summing 1s in the relevant row. The result of driving power and dependence power in this study is tabulated in the last column and row of Table 2. The result can also be plotted as point in a coordinate system with dependence power as the horizontal coordinate, and driving power as the vertical coordinate. According to the result, MICMAC could categorize the factors into autonomous, dependent, linkage and clusters.

The autonomous cluster consists of factors that have a weak driving power and a weak dependence power. These factors are relatively disconnected from other success factors. The dependent cluster constitutes factors which have a weak driving power but a strong dependence power. The linkage cluster includes factors that have a strong driving power and a strong dependence power. These factors are usually unstable as any change will have an effect on others and also a feedback on themselves. The independent cluster represents the factors that have a strong driving power but a weak dependence power (Kannan et al., 2009; Lyer and Sagheer, 2010). Based on the results in Table 2, the success factors for project stakeholder management were classified into four groups as shown in Figure 3.

In this study, more than half factors (9 out of 16) have a strong driving power, the driving power of which are over

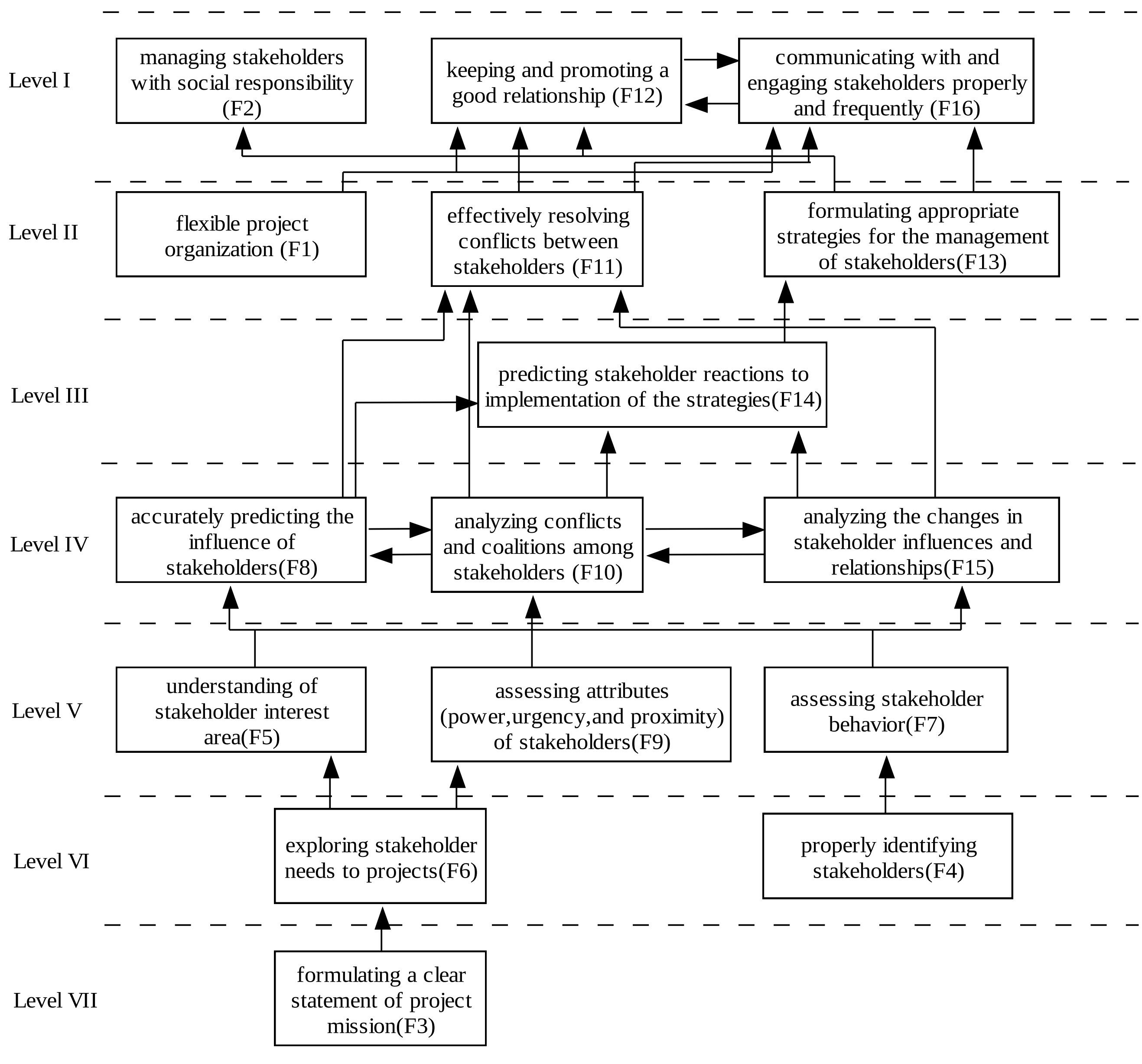

Figure 2. The hierarchical structure of success factors for project stakeholder management.

8, while more than half factors (9 out of 16) have a strong dependence power, the dependence power of which are over 8. Specifically, flexible project organization (F1) is the only factor in autonomous cluster. It implies that flexible project organization could contribute to the success of project stakeholder management but it needs other measures rather than project stakeholder management to realize this. On the other hand, accurately predicting the influence of stakeholders (F8), analyzing conflicts and coalitions among stakeholders (F10), analyzing the changes in stakeholder influences and relationships (F15) are in the linkage cluster. These factors are usually sensitive and unstable. Good attention should be paid to ensure the quality of the three factors when conducting project stakeholder management. There are six factors falling in the dependent cluster, among which, managing stakeholders with social responsibility (F2), keeping and promoting a good relationship (F12), and communicating with and engaging stakeholders properly and frequently (F16) are placed on the top of hierarchical structure. Thus, it can be prioritized to achieve the success of project stakeholder management. Finally, formulating a clear statement of project mission (F3), properly identifying stakeholders (F4), understanding of stakeholder interest area (F5), exploring stakeholder needs to projects (F6), assessing stakeholder behavior (F7), assessing attributes (power, urgency, and proximity) of stakeholders (F9) have a strong driving power and a weak dependence power as perceived by the experts. These factors are fundamental to conduct project stakeholder management and therefore should not be ignored.

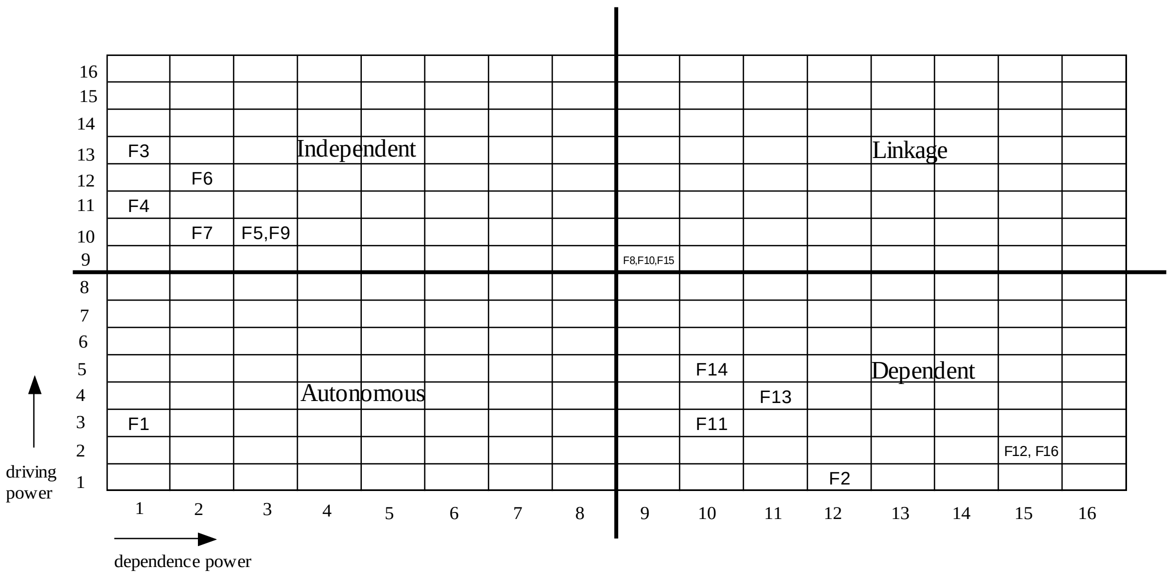

Figure 3. The classification of the success factors for project stakeholder management.

Conclusion

The existing research focuses on how to apply stakeholder management in construction industry while efforts have been given to identify critical success factors. However, few have investigated the interrelationship between success factors, which blocks the in-depth understanding of success of project stakeholder management. The study pushes forward the research by investigating the hierarchical structure and interrelationships of the factors. ISM and MICMAC analysis were adopted to develop the hierarchical structure and explore the degree of relationships between factors.

The ISM model and following MICMAC analysis identified the hierarchical structure and degree of interrelationship between success factors for project stakeholder management. MICMAC analysis implies that there are 6 factors in the independent cluster, which is fundamental to conduct project stakeholder management, which should not be ignored. Moreover, there are 6 factors in the dependent cluster, which have strong dependence on the independent cluster and linkage cluster. These factors are critical for the success of project stakeholder management. Meanwhile, the hierarchical structure obtained from ISM also shows that the independent factors are placed on the top level. Herein, these factors need to be prioritized to achieve success when conducting project stakeholder management. The findings can help the practitioners gain an in-depth understanding of success factors for project stakeholder management, and take proper strategy to achieve success. Although, the findings are based on the Chinese case study, it is beneficial for investigating the hierarchical structure and interrelationship between success factors for stakeholder management in other countries.

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