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**Research on the Relationship Quality and  
Relationship Management among Organizations  
in Megaprojects**

Supervisor: Mauro.Mancini

Graduation thesis by  
Rui Shu(id. n. 876169)

## **ABSTRACT**

In practical engineering, megaprojects have a significant impact on the society and the national economy because of huge investment, long construction period and the high degree of complexity. Megaprojects' major stakeholders involve in project construction, including owners, designers, general contractors, suppliers, supervisors and so on. The quality of the relationship between them has a major impact on the construction performance of megaprojects. The existing researches indicate that good relationships between project participants can promote the collaboration among organizations and improve the performance of the project, which can be achieved through the relationship management among organizations. The importance of relationship management has been widely recognized, but there are few researches involved in megaprojects, nor the evaluation of the relationship quality among organizations. There is no fundamental analysis of the need for inter-organizational relationship management, and no one has put forward an implementation process of the relationship management strategies for practical reference.

Based on the existing research, this paper uses the methods of literature research, expert interviews and model research, combined with evolutionary game theory and principal-agent theory to define the related concepts of relationship management among organizations in megaprojects, summarizes and analyzes the relationships Quality dimension among major organizations and the puts forward the relationship quality evaluation system. This paper analyzes the relationship management issues between owners and general contractors through evolutionary game theory, summarizes 12 relationship management strategies and builds the implementation process model.

The concrete meaning of relationship management among organizations in megaprojects is that owners should take the relevant management measures to establish good relationships with the project participants (designers, constructors, suppliers, supervisors, etc.) in order to achieve efficient collaboration and the project goals successfully. The relationship management among organizations can foster mutual trust, speed up the cooperation process and improve project performance. The dimensions of relationship quality among organizations include organizational commitment, common

goal, joint problem solving, information sharing, effective communication and mutual trust. Based on these dimensions, the relationship quality can be subdivided into 18 evaluation indexes. the fuzzy decision method is used to establish the evaluation system of the relationship quality among organizations in megaprojects.

The relationship among organizations in megaprojects is very complicated. Taking the most representative owners and contractors as an example, this paper analyzes relationship management issues using evolutionary game, and draws a conclusion that focusing on short-term interests leads both parties to take opportunistic and profit-taking behaviors and fall into the prisoner's dilemma, The root cause is confrontational relation. Organizational commitment and mutual trust can solve this dilemma, thus highlighting the importance of relationship management among organizations in megaprojects. Through the evolutionary game analysis of the trust, it is concluded that the relationship quality between organizations in megaprojects is closely related to the implementation of relationship management strategies.

The 12 relationship management strategies among organizations in megaprojects correspond to the relationship process of “initiating-developing-evaluating”. In the stage of initiating the relationship, the owners should adopt the strategies of “choose a good partner”, “involve the partners participate in the project early”, “Sign a good contract”. During the development of the relationship stage, the owners should adopt the strategies of “organizational commitment”, “adhere to common goals”, “support and participation of top management”, “strengthen communication”, “jointly solve the problem”, “foster an atmosphere of cooperation among organizations” and “share information and resources”, “trust partners”. In the assessment of the relationship, the owners should take the strategy of “regular monitor the relationship status”.

The research in this paper will enrich the existing organizations theory of megaprojects and help recognize the complexity and essential characteristics of the relationships among organizations in megaprojects of our country and form the key theory of the relationship management among organizations in Chinese context. In practice, this paper establishes a three-stage process model of relationship management among organizations in megaprojects, summarizes 12 relationship management strategies and provides guidance and reference for the project owners.

**Key Words:** megaprojects, relationship quality, relationship management, strategies

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# Chapter 1 Introduction

## 1.1 Background

Megaprojects usually have the technical complexity, long duration, many uncertainties and other characteristics. Over the past two decades, with the development of advanced construction technologies and globalization, the remarkable economic achievements and rapid urbanization have led to rapid increase in the number of megaprojects in China. From 1990 to 2009, over 200 megaprojects with an investment of over 5 billion yuan (about 800 million U.S. dollars) were started in China. In 2013, China also proposed to establish the "Silk Road Economic Belt" with central Asian countries and build the "21st Century Maritime Silk Road" with ASEAN countries, that is "Belt and Road". A large number of ports, airports, nuclear power, high-speed railway and clean energy and other megaprojects have been started which further promoted the vigorous development of China's megaprojects (Brant 2015). Some of these major construction projects have rejuvenated the history of China's construction industry, such as the Three Gorges Dam, the South-to-North Water Diversion Project, the Qinghai-Tibet Railway, the Hong Kong-Zhuhai-Macao Bridge and so on. Compared with the general project, megaprojects are more prone to cost overruns, deferred delivery, safety accidents, environmental pollution, defects in functional quality and ineffective output (Xue and Anbari 2008)

The success of megaprojects cannot be solely achieved by a single subject. It requires the jointly working of a large number of participants. The entire participating units involved in Beijing-Shanghai high-speed railway were seven design institutes, 43 Bureau-level construction units, 28 supervisory units. Every party participating in megaprojects has different resources, advantages and desired demands, which leads to the interdependent and mutually restricted interest needs and complicated stakeholder relations (Van et al. 2008). Indifferent, confrontational relationships among organizations result in project participants only seeking maximum benefits, conflicts and lack of coordination among themselves. The confrontational relationship between project participants is a general problem in the construction industry. This kind of relationship

not only has a negative impact on project performance, but may even lead to project failure (Ng 2002). This is because the project participants are bound by contracts and they behave according to the theory of rational choice (Becker 2013). The formal contract clearly states the rights, obligations and responsibilities (Erik and Laan 2007) All parties tend to protect their rights while minimizing their own responsibilities and obligations thus result in the lack of trust and promises of long-term relationships by senior management among the parties (Chan et al. 2008). The most common phenomenon is contractors bid successfully at very low prices and then make profit through unjustified claims (Rahman and Kumaraswamy 2004)

Complexity is the significant feature of megaprojects, including the complexity of technology, organization and communication, which lead to management complexity. In the course of the megaprojects' life cycle, there are complex situation, multiple organizational levels, huge scales, strong timeliness and the openness. The whole process of decision-making, planning, management and coordination is the combination of the conflicts and interests of multiple involved parties.

There are also complex inter-organizational and intra-organizational relationships and unique "Chinese engineering culture." The relationship between the parties involved in a construction project has long been considered to have a significant impact on project performance (Meng 2012). Relationship management can improve the relationship quality among organizations. The high relationship quality among project organizations enables efficient and harmonious integration of resources and skills. Practical experience shows that the improvement of the relationship quality among project participants is conducive to the improvement of project performance. The role of inter-organizational relationship management more important in megaprojects than that of the general projects due to the long construction period and high degree of uncertainty of megaprojects. relationship management plays an increasingly important role in highly uncertain work. (Tsui and Farh 1997) The good relationship among the organizations helps to overcome the uncertainty in the implementation of megaprojects (Chi et al. 2011). Thus, the quality of the relationship among major engineering organizations have a significant impact on project performance and the relationship management among organizations in megaprojects is extremely important in practice and research.



## 1.2 Research Question

Compared with general projects, megaprojects have huge investment, long duration, high degree of technical difficulty and complexity, great uncertainty, and the risk of project failure is higher. In spite of many risks and uncertainties, a number of very representative and significant megaprojects have still been successfully built in China in recent years, such as the 2010 Shanghai World Expo and the Shanghai Disney Resort.

In the 2010 Shanghai World Expo Park construction project implementation process, all participants have a clear and common goal - to open the park on schedule. Participating parties are highly motivated and cooperate with each other to minimize procedures and speed up the path of customs clearance so as not to cause any further wrangling. The design is modified according to the construction units if it is not perfect. The designers, construction units, supervisors cooperate with each other. The coordination between the various types of work strengthens the formation of an integrated large team, so that organizations can communicate with each other more efficiently and the coordination from top to bottom is strengthened.

Disneyland Hotel is a landmark facility of Shanghai Disney Resort. It adopted delivery model of design-bid-build. The participants of the project include the owners, designer, general contractors and subcontractors, consultants, suppliers, engineering supervision units, cost consulting units, tenders Agencies and many other units. The project has a work flow handbook for the project owner project management team, which has a chapter to specifying the communication work flow between owner and other participants. The project uses the Buzzsaw collaboration platform to centrally manage all kinds of information generated during the project's life cycle so as to facilitate design and construction visualization. At the same time, Box collaborative platform is also used to realize cloud storage, files sharing among members, assigning tasks, leaving comments and so on, and realize information sharing among participants.

The research on the practices of some successful megaprojects found that good quality of the relationship between the project participants facilitates the active collaboration among the organizations to promote the project's success. Some key tactics adopted by the owners in the project management process have stimulated the active cooperation of all parties participating in the project, thus promoting the relationship

quality among organizations involved in the megaprojects. Although the owners do not have the awareness of the relationship management among organizations, the strategies adopted by them are the organizational relationship management strategies. In practice, the relationship management among organizations in megaprojects has not attracted the attention of project participants. Current researches only define the relationship management in general construction projects. There are few concentrating on the relationship management organizations in megaprojects.

This paper focuses on issues of the relationship quality and relationship management among organizations in megaprojects. First of all, it defines the related concepts of relationship management among organizations in megaprojects, laying the foundation for the following research. Relationship management improves project performance by improving the quality of the relationships among the organizations. Relationship quality among organizations is the mediator of relationship management and project success (Williams et al. 2015). The dimension of relationship quality embodies the connotation of relationship management. Therefore, this paper deeply analyzes the dimension of relationship quality among organizations in megaprojects and establishes the assessment system of relationship quality, which is also part of the relationship management process. The relationship among organizations in megaprojects is very complicated. Taking the most representative owners and contractors as an example, this paper analyzes the evolutionary game related to the relationship management among organizations, and the relationship management between the owners and other participants can also learn from it. On the basis of the evolutionary game results, this paper constructs the process model of relationship management among organizations in megaprojects. Combing with the relationship quality dimension, this paper finds out the relationship management strategies among organizations in megaprojects. As a result, this paper enriches existing research on relationship management and provides reference in practice.

## **1.3 Research Meaning**

### **1.3.1 Theoretical Meaning**

In theory, this article enriches the existing research on the field of major engineering organizations, combines the theory of relationship management originated in the field of

relationship marketing and project management theory, and defines the meaning and subject of relationship management among organizations in megaprojects. This paper also builds the evaluation system of the relationship quality among organizations in megaprojects. The relationship management process model was constructed and the relationship management strategies were outlined. This paper also helps further understand the complexity of the relationship among organizations in megaprojects in China, and enrich the existing project management and project management theory.

### **1.3.2 Practical Meaning**

In practice, this paper establishes the three-stage relationship management process model of "initiating relationship-establishing relationship-assessing relationship" and summarizes 12 relationship management strategies. It provides the guidance for clients to conduct relationship management towards designers, construction units and supervision units. Participants of megaprojects can use the relationship quality evaluation system to assess the status of the relationship among organizations and adjust the strategies according to the assessment results in practice. The evolutionary game process of the problems related to relationship management among organizations in megaprojects explains the reasons for confrontational relations among them and also highlights the importance of relationship management. These are conducive to build good relationships and facilitate efficient collaboration among organizations, which help successfully achieve project goals and improve project performance.

## **1.4 Research Content, Methods and Technical Route**

### **1.4.1 Research Content**

This paper focuses on issues of the relationship quality and relationship management among organizations in megaprojects. First of all, it defines the related concepts of relationship management among organizations in megaprojects, laying the foundation for the following research. Relationship management improves project performance by improving the quality of the relationships among the organizations. Relationship quality

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This paper is divided into seven chapters, the main research contents are as follows.

Chapter 1 is the introduction, which mainly introduces the background of this study, clarifies the research questions, and expounds the research significance, research contents and research ideas.

Chapter 2 is the literature review and theoretical basis. The related concepts of relationship management among organizations in megaprojects are defined, such as megaprojects, relationship, relationship quality and relationship management in engineering. Then the paper summarizes the research status of relationship among organizations in megaprojects, relationship quality, the relationship management construction field and relationship between the owners and the contractors.

Chapter 3 is the research foundation and design. Based on the literature review, the outline of the interview is compiled. Seven industry experts with many years' megaprojects experience from the owners, consulting, construction and supervision units were interviewed. Then the concrete meaning, main body, effectiveness of relationship management among organizations in megaprojects are clarified to further select research questions.

Chapter 4 is about the dimension and evaluation system of relationship quality among organizations in megaprojects. The six dimensions of relationship quality among

organizations in megaprojects are "organizational commitment", "common goal", "effective communication", "information sharing", "joint problem solving" and "mutual trust". After deeply analyzing their connotation, the fuzzy decision-making method is used to establish the evaluation system the relationship quality among organizations in megaprojects which is composed of 18 relationship indicators.

Chapter 5 is the evolutionary game of relationship management among organizations in megaprojects - taking the owners and contractors as an example. The relationship among the organizations in megaprojects is very complicated. Taking the most representative owners and contractors as an example, this paper analyzes the relationship-related issues using evolutionary game theory and draws a conclusion that focusing only on short-term interests is the cause of speculative and profit-taking activities and makes the parties fall into Prisoner's Dilemma and lead to the confrontational relationship. Organizational commitment and mutual trust can solve this dilemma, thus highlighting the importance of relationship management among organizations in megaprojects. Through the evolutionary game analysis of trust, it is concluded that the improvement of the relationship quality among organizations in megaprojects requires relationship management.

Chapter 6 is the process and strategies of relationship management among organizations in megaprojects. Combining with the three-stage model of "initiating relationship-establishing relationship-evaluating relationship", 12 relationship management strategies are summarized, which are "selecting good partners", "involving partners to participate in the project early", "signing a good contract", "organizational commitments", "adherence to common goals", "support and participation of top management", "enhancing communication", "joint problems solving", "fostering collaborative atmosphere among organizations", "information and resources sharing", "trust partners", "regularly monitoring relationship status." The paper also establishes a complete relationship management process.

Chapter 7 is the conclusion and outlook. The main conclusions and shortcomings of this paper are summarized, future research directions are pointed out.

## **1.4.2 research method**

Literature research method: through massive and deep reading related thesis and books.

Expert Interview Method: Through semi-structured interviews with experts, this paper forms the definition of the main body of relationship management among organizations in megaprojects. Through asking the experts' opinions on the necessity of relationship management, this paper further enrich the existing theoretical research.

Model Research method: This paper establishes an evolutionary game model. Taking the owners and contractors as an example, this paper analyzes the problems related to the relationship management among organizations in megaprojects, and draws the conclusion that organizational commitment and trust can prevent both parties from falling into prisoner's dilemma. Relationship management is necessary, and the improvement of the relationship quality between organizations requires the implementation of the relationship management strategies.

## 1.4.2 research routine

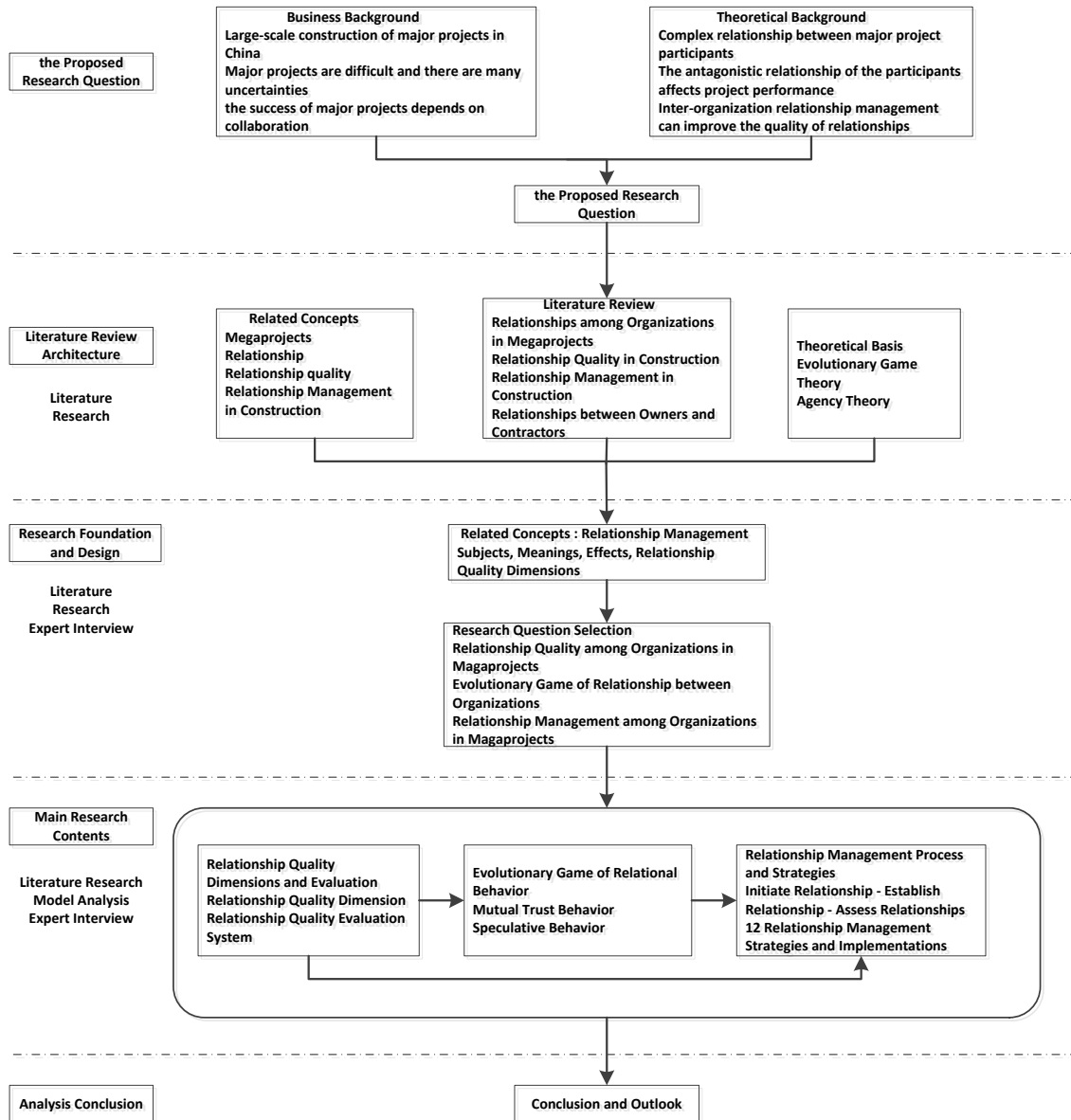


Figure 1 research routine

# **Chapter 2 Literature Review and Theoretical Basis**

## **2.1 Definition of Related Concepts**

### **2.1.1 Related Concepts of Megaprojects**

For the definition of megaprojects, different countries and regions have their own standards in terms of project characteristics and scale. Different scholars and research institutes also have different understandings about it. Therefore, the concept of megaprojects is not uniformly defined. Some scholars and institutions have defined megaprojects from the project investment scale. The Federal Highway Administration has limited the minimum investment for megaprojects to 500 million yuan. Scholars in the Netherlands and Australia have limited the minimum investment for megaprojects to 100 million U.S. dollars and 500 million U.S. dollars respectively (Müller and Turner 2015). Hong Kong's research institutes have defined projects with a total investment of more than HK \$ 1 billion as megaprojects (Hu 2013). The national "Development and Reform Commission" did not define the megaprojects with respect to the investment quotas, but distinguished them according to the examination and approval procedures. Megaprojects need to be approved by the central and provincial governments. Besides the large-scale investment, megaprojects will have a major social, economic and environmental impact on the countries and regions. Compared with general projects, megaprojects have significant differences in terms of complexity, lead time, project goals and stakeholder involvement (Flyvbjerg 2014).

Combining all the definitions, this paper thinks that megaprojects are projects with long duration, high complexity and complex approval process, whose minimum investment is more than 1 billion yuan and have the technical, economic, social and the environmental impact on the regions and countries.



## **2.1.2 Guanxi and Relationship**

### **(1).Guanxi**

In the Chinese context, relationship is called “guanxi (pronounced as kuan-hsi)” that refers to relationships between people based on a common background (Chi et al. 2011). Jacob (1979) defined it as “the existence of direct particularistic ties between two or more individuals”. These ties are usually regarded as major determinants of the strength or closeness of interpersonal relationships (Tsui and Farh, 1997), which lead to categorization of Chinese social relations and variation of their interactions with various categories by contrast to western societies. Tsui and Farh (1997) further stated that ties of familiar person or strangers with common identity contribute to better work outcomes in the frequency of communication, interpersonal trust, favorable evaluations and others through social categorization and identification in the Chinese context. Xin and Pearce (1994) found that the managers in Chinese private firms could acquire the needed sources, personnel, information, and other support through guanxi, which replaced the function of institutional structure.

A recent study by Xiao and Tsui (2007) revealed that a closed relational network in Chinese high-tech firms can bring inter-group trust and mutual benefits. These findings have proven a direct link between guanxi and work outcomes, which are also highly consistent with the finding of similar studies conducted in the US (Tsui, Egan and Xin, 1995). Tsui and Farh (1997) also stated that guanxi would have a stronger effect on work outcomes for tasks with high uncertainty than for those with low uncertainty. Previous demographic studies indicated that individuals are inclined to give more trust and provide more support to those with similar background than with dissimilar background. Kao (1990) stated that personal trust is the most important determinant in selecting staff for high-level positions, where task uncertainty is high, in selecting those for low-level positions with little task uncertainty in Taiwan large firms. Farh (1995) further observed that only persons having closet relationships with firm leaders would obtain the

appointment of high-level positions in Taiwan family firms. The above reviews have fully revealed correlations among guanxi (relationship), task uncertainty and work outcomes.

## (2) Relationship

There are different definitions of relationship. Gummesson (2001) identified 30 tangible relationships, ranging from the micro-scale or nano relationships to the macro-scale of market and mega relationships. Wasserman and Faust say: 'A collection of ties of a specific kind among members of a group is called a relation. For example, the set of formal diplomatic ties maintained by pairs of nations in the world, are ties that define relations.' In this definition ties define the relation, and the ties are not always human or social. Yet ties are also the product of relations, which in part depend upon the tangibility of and scale at which relationships are formed and develop. This is qualified in terms of interaction within a network of relationships.

Relationships are the means by which social and economic value is added to products and services. The view taken in this book is that relations are context specific. Relationships are negotiated in context, mostly socially but frequently the ties are legally binding too. There are different contexts for relationships, which operate at different levels: Business-to-business, organization-to-organization, individual -to individual.

### **2.1.3 Relationship Quality**

Initially the concept of RQ was suggested as an indication of how appropriate a relationship is for particular purposes; Hennig-Thurau and Klee (1997) defined RQ as the “the degree of appropriateness of a relationship to fulfil the end needs of a customer”, however such definitions do not depict the theoretical implication of the concept. Other researchers have tried to identify factors, attributes, and a construct which can explain the concept realistically which is applicable in theory and practice. However there has been disagreements as to what should these factors or attributes be since relationships are human driven ventures and have significant complexities. From very early stages it was

generally agreed on that RQ is “high order construct” (Crosby et al., 1990); implying that it is explained by more than one layer of latent variables or attributes (Hair, 2010). Based on popular literature and mainstream research of marketing and business, Roberts et al. (2003) advocated an attributional definition, and propose that conceptual meanings of constructs are anchored by the properties and/or attributes they possess. So it is widely believed that RQ is attributed as a high order construct made of several distinct though related dimensions or attributes which can deliver an evaluation tool for working relationship status (Jelodar et al. 2015). Attributes such as ethical behaviour, satisfaction, commitment, opportunism, and trust have been considered as RQ attributes or dimensions (Roberts et al., 2003).

The relationship quality among organizations in megaprojects studied in this paper is the direct result of relationship management. The dimensions include organizational commitment, common goal, effective communication, information sharing, joint problem solving and mutual trust, which are the basis for evaluating the relationship quality among organizations in megaprojects.

#### **2.1.4 relationship management in construction**

The concept of relationship management dates back from the field of relationship marketing. It involves analysis, investment in relationships and a clear view of the wider value that can be gained from each relationship and which extends beyond the straightforward features of the product that is exchanged (Gummesson 2001).”

Zou et al. (2014) defined relationship management in the construction industry as “a structured approach of understanding, defining, and supporting a broad spectrum of inter-business activities regarding providing and consuming knowledge and services via networks”. This concept addresses organizational constituencies of relationship management in many various forms, such as customers, suppliers, partners, employees, and among others (Zou et al. 2014). Therefore, a set of comprehensive strategies and

processes should be developed for improving the relationship (partnership) with selected project counterparties to produce superior value in the management of construction projects (Zou et al. 2014). Relationship-based management philosophy has been increasingly supported as a means of fostering mutual trust and improving process partnership among contracting parties in the management of construction projects in the past decade (Smyth and Pryke 2008; Jin and Ling 2005).

In construction field, the focus of relationship management is project performance and owner satisfaction. Through the operation and management of a series of relationships among people, people and organizations, organizations and organizations in the project, the project performance and the owners' satisfaction are improved. Svejvig and Andersen (2015) also noted that projects are often dynamic systems that require agile relationships between the supplier and customer. Davis (2014) and Muller and Jugdev (2012) suggested that these relationships were reciprocal where the customer could influence project success. Serrador and Turner (2015) stated that effective agile project management is based on high levels of interaction, collaboration, responsiveness, and joint problem solving.

The above research shows that the relationship among organizations is very important in project management and it is necessary to study the relationship management among organizations in the construction field.

This paper defines the relationship management in construction field as establishing a good relationship between the two parties based on contract and trust and accomplishing the project goal through efficient collaboration. The relationship management among organizations in megaprojects studied in this paper is that in order to accomplish the project goal, the owners of megaprojects adopt relevant management measures to improve the relationship quality with the project participants (design, construction, suppliers, supervision, etc.) to effectively collaborate with each other.

Compared with the traditional hard management, relationship management includes more

flexible management and improves the performance of the project by improving the relationship quality among the organizations to seek a way to effectively improve the project performance

## **2.2 Literature Review from Domestic and Abroad Research**

### **2.2.1 Relationships among Organizations in Megaprojects**

Megaprojects need to be done by a temporary organization formed by multiple participants in close cooperation. These participants are core stakeholders in major projects, with different abilities, resources and backgrounds. Organizations' capacity and resources have boundaries. For a single organization, it is impossible to accomplish a megaproject by itself. The large number of participants is also one of the salient features of a megaproject. Megaprojects are complex systems whose complexity is due to the large scale of the project as well as the extraordinary interaction between many elements, which are interdependent and interdependent. In the process of these different elements' interactions, there will be a huge amount of information. It requires for frequent participation in communication between major construction projects organizations. This has led to the complexity of the relationships among major organizations in megaprojects.

Baker et al (2002) think the project's complexity and organizational relationship are interdependent. Some scholars also studied the complexity of the organization, mainly related to the complexity of organizational communication, organizational interaction and project complex network. Alojairi et al (2012) Pointed out that the current project management practices of megaprojects overlook the complexity of organizational interaction. Some scholars also study the stakeholders involved in megaprojects. Wang (2014) thinks that the interaction among stakeholders in the project is one of the causes of the project's uncertainty. Megaprojects have many stakeholders. In addition to the general

project owners, designers, contractors, supervisors, suppliers, the government, project management consultant and the public are also the stakeholders. All the stakeholders constitute complex social networks whose interrelationships have a major influence on the achievement of the megaproject goal.

Pauget and Wald (2013) considered that megaprojects have network relevance. It is of great value to consider relationship management, coordination and cooperation among project participants. Pillay and Mafini (2017) believes that the relationship among the construction supply chain organizations is a current problem in the engineering construction field. In practice, the quality of the relationship among the major engineering stakeholders can have an impact on project performance. In addition, the tasks of meagprojects are long-term and highly uncertain. Some studies have shown that relationship management plays a more important role in the task of higher uncertainty than the task of low uncertainty (Tsui and Farh 1997). This shows that the relationship quality and relationship management among organizations in megaprojects is the core issue which can not be ignored.

### **2.2.2 Relationship Quality in Construction Field**

In marketing channel networks and social exchange theory, relationship quality has become a key aspect of the trading activity between organizations. For example, customer relationship management (CRM) has been identified as the fourth most common marketing tool in the field of marketing (Ahearne et al. 2012). The quality of relationship is considered to be a major driver of customer satisfaction in B2B transactions, greatly affecting customer satisfaction and project success. Some scholars also began to study the relationship quality between organizations in the field of project management. Relationship Management in Project Management Focus on client satisfaction and project performance. The research shows that the relationship quality is the antecedent variable of client satisfaction and also the mediating variable of

relationship management and project success.

Some scholars think that the traditional project objectives defined by the "Iron Triangle" should be extended to the client satisfaction and the relationship quality. (Williams 2015) Good relationship quality can promote long-term cooperation and coordination among organizations. This cooperation and coordination is the core of the project implementation process (Hornstein 2015). The relationship quality in a project involves more systematic problem-solving and communication, more long-term vision, trust and benefits. It can assess the relationship status between the project participants. It can also evaluate the effect of the relationship management among the organizations. So relationship quality among organizations in megaprojects needs to be monitored and controlled. In order to realize the value of the relational evaluation system in construction projects, Jelodar and Yiu (2012) redefined the concept of relationship quality because it directly influences the project's success and performance (Meng 2012).

### **2.2.3 Relationship Management in Construction Field**

Due to the importance and complexity of organizational relations in the field of construction engineering, more and more scholars have started to carry out researches on the relationship management among organizations in the construction field. In recent years, Relationship-based management philosophy has been increasingly supported as a means of fostering mutual trust and improving process partnership among contracting parties in the management of construction projects. Currently, the research on relationship management in the field of engineering construction mainly includes the analysis of the impact of relationship management on project performance and innovation, the key success factors of relationship management and the identification of relationship index, as well as the evaluation of the relationship of project participants.

In analysis of relationship management and project performance, Clegg et al. (2011) emphasized that relationship management can enhance the efficiency of working

relationships. Meng (2012) also proposed the idea that relationship management can help improve project performance. Gil et al. (2011) Found that building trust-based relationships is important during the project management implementation phase and contributes to project success. All of the above studies conclude that "relationship management can improve project performance". Ning & Ling (2013) verified the impact of relationship contracts on relationship quality and project outcomes through a study in Singapore and found that the quality of good inter-organizational relationships built by relationship contracts can improve the performance of public projects.

At the same time, many scholars are also devoted to studying key success factors in relationship management. Davis (2014) found that cooperation, collaboration, negotiation and communication are the key factors affecting the success of the project.

Chan et al. (2010) identified 24 critical success factors for construction projects procured by relational contracting based on an extensive review. Specifically, Chan et al. (2004) extracted ten factors from 41 success factors for partnering schemes, a form of relational contracting, through the factor analysis of data obtained from an empirical survey Hong Kong. They are (1) the use of a conflict resolution strategy, (2) a willingness to share resources amongst project parties, (3) a clear definition of responsibilities, (4) a commitment to the win-win attitude, (5) regular monitoring of partnering performance, (6) mutual trust, (7) a willingness to eliminate non-value added activities, (8) early implementation of partnering process, (9) ability to generate innovative ideas, and (10) sub-contractors' involvement.

Smyth (2009) constructed a framework for evaluating the effectiveness of relationship management, advocating that relationship management should be emphasized tactically and even strategically, and that proactive relationship management measures should be taken . Meng (2012) analyzed relationship management from the perspective of construction project supply chain. Construction projects have many stakeholders, involving many participants, and the construction supply chain is also more complex. In



the construction project supply chain, the client is the buyer and the general contractor is the most important supplier. The relationship between them is in the upper reaches of the supply chain. At the same time, the relationship between the general contractor and the professional subcontractor is in the lower reaches of the supply chain.

#### **2.2.4 Relationship between Clients and General Contractors**

The confrontational relationship among project participants is an obvious problem in the construction industry, which not only has a negative impact on project performance, but may lead to project failure (Ng et al. 2002). Clients and contractors are the two most important project participants and their confrontational relationships are most obvious and representative.

Confrontational relationship usually beset with performance problems, such as cost overruns, safety incidents, functional and quality defects, poor environmental performance, and insufficient outcomes (Xue et al., 2008; Le, 2009).

According to the assumption of rational man in economics, there is a conflict of interest between the client and the contractor, which is also the root cause of the confrontational relationship between the two parties. There exist three main explanations for the adverse relationships in prior studies: (1) inappropriate claims for extra payments made by the contractor that wins a contract by providing a extremely low bidding price (Rahman and Kumaraswamy, 2004), (2) lack of trust on contractors or other participants, particularly when engaged in financial issues (Eriksson and Laan, 2007), and (3) lack of commitment to long-term relationship from top management of firms (Chan et al., 2008).

Mohammad (2011) believes that the relationship between clients and contractors needs to be based on mutual trust, consistent goals, mutual commitment, joint problem solving as well as top management support and participation. The confrontational relationship between clients and contractors will lead a small conflict to develop into big disputes, resulting in high costs of arbitration or litigation and undermining the cooperation

between the two parties forming business relations costs. So relationship management between the client and the contractor is important.

### **2.2.5 Summary of Literature Review**

Relationship management can improve the relationship quality between organizations, thereby improving project performance, which is very important in engineering construction. However, due to the characteristics of long duration, high uncertainty and high complexity, megaprojects need to pay more attention to the relationship management among organizations. At present, most researches on relationship management in engineering construction focus on the identification of the key success factors, the impact of relationship management on project performance and satisfaction of the owners. Many scholars have sorted out the key success factors of relationship management. Some scholars also point out that relationship management can improve project performance by promoting good relationship quality among organizations. Some scholars think that relationship management can enhance the satisfaction of clients.

However, there are few studies focus on relationship quality and relationship management among organizations in megaprojects, nor on the analytical and evaluation system of the relationship quality dimension. There is no studies analyzing the problems related to the relationship management from the perspective of evolutionary game.

This paper focuses on the relationship quality and relationship management among organizations in megaprojects. Based on the literature research and expert interviews, the related concepts of major engineering relationship management are further defined, and the meaning of the relationship management, the main effect and the quality of the relationship are determined which are the foundation for the later study. Relationship management among major engineering organizations improves project performance by improving the quality of the relationships among the organizations.

The dimension of relationship quality embodies the connotation of the relationship

management among major engineering organizations. Therefore, this article deeply analyzes the dimension of the relationship quality among organizations in megaprojects and establishes the relationship quality assessment system. The relationship among the major engineering organizations is very complicated, taking the client and contractors for example, this paper carries out the evolutionary game analysis of relationship management between major engineering organizations. The relationship management between the clients and other participants can also be used as reference. In the end, this paper combines the evolutionary game results with the relationship quality dimension to construct the process management model among organizations in megaprojects, sorting out the existing relationship management strategies, enrich existing research on relationship management and provide reference for practice.

## **2.3 Theory Foundation**

### **2.3.1 Evolutionary Game Theory**

Evolutionary game is an important branch in game theory, researching dynamic game of incomplete information. Evolutionary game theory assumes that the players involved in the game are bounded rationality, which is the biggest difference with the classical game theory. Under the condition of evolutionary game theory, participants can not get all the information. They can only make relative dominant decisions under the condition of limited information, take relatively dominant actions, or make unreasonable decisions and adopt action.

In the process of evolutionary game, participants encounter more complicated situations. When the system needs to analyze the problems comprehensively, they usually learn from past successful cases or learn from previous experience. If there is no experience, they may make the appropriate decision and take action simply rely on intuition. This is also in line with Darwin's theory of evolution theory, learning from successful case and

past experience. This process can be achieved through dynamic simulation eventually game equilibrium. Therefore, evolutionary game theory is an extension and innovation of classical game theory.

In the evolutionary game theory, players participating in the game adopt the corresponding game strategies according to their different situations, and their decision-making behavior is in a dynamic process. In this constantly changing process of evolution, the bounded rationality of participants also develops slowly according to a certain trend. The limited rationality of participating in the Gaming Bureau reflects the degree of preference of decision-making in the game.

### **2.3.2 Principal-agent Theory**

The principal-agent theory belongs to a branch of the contract theory, and emerges in response to the problem of the incentive mechanism and information asymmetry in the enterprise. The purpose is to design the contractual relationship between the principal and the agent under the circumstance of incomplete information and conflict of interests between both parties, reduce the agency cost and achieve the ultimate goal of the principal. Therefore, the principal of the principal-agent theory is the incomplete information game, in which the main players involved in the game are principal actors with principal-agent relationship under contractual constraints.

The "client" and "agent" originated in the legal field. The classic principal-agent is defined as "an individual or an organization (that is, a principal) entrusting other people or organizations (that is, agents) to engage in some activities that are closely related to the interests of the principal. During the continuance of this contractual relationship. Some decision-making authority is granted to the agent by the principal " (Genfu 2004). Therefore, the legal relationship between principal and agent is a contractual relationship. In which the agent obtains the decision-making power granted by some principal to assist

the principal in achieving the related goal or accomplishing some activities. In accordance with the agreement, the client pays the appropriate remuneration to the agent. In the field of economics, the principal-agent relationship refers to a mutually restrictive and interactive relationship between market participants engaged in economic activities. Different market participants have different degrees of mastery of information, one on the side with relative information superiority is referred to as an agent, and a party on the relative inferiority of information as an agent. In the case of asymmetric information, the economic relations between the two parties in the contract belong to the principal-agent relationship. In construction market, the relationship between owners and designers, contractors, supervisors are principal-agent, of which the most typical and important is the principal-agent relationship between owners and contractor.

In megaprojects, information asymmetry is the status quo of the principal-agent relationship between the owner and the designers, contractors, supervisors, which leads to two kinds of risks: adverse selection and moral hazard. Reverse choice refers to an opportunistic behavior which often occurs before the signing of the contract. because agents have more private information, the client is in a relative disadvantage of information, then the agent is most likely to sign the contract which may damage the interests of the client. Moral hazard refers to a kind of ex post opportunistic behavior, which usually occurs in the contract performance stage.

In this situation, the principal owns more private information and the agent is in a relative disadvantage of information. The agent conducts some opportunistic acts in order to obtain additional income and maximize his own income. The contractor's opportunistic behaviors are unauthorized use of special project funds, resulting in a shortage of funds for the project so that the project cannot be completed on time; shoddy construction materials, cut corners, so that the quality of the project does not meet the requirements, unreasonable claims; using their own information advantages, concealing the facts. All of this will increase the project costs, resulting in investment overspent and out of control,

increasing the investment risk of the owners, causing damage to the interests of agents and ruin the relationship between the two parties.

## **Chapter 3 Research foundation and design**

### **3.1 Research Overview**

The concept of relationship management originates from the field of relationship marketing, including analysis of relationships, investment, and a clear recognition of the broader value of each relationship developed from simple product transactions. Because of the important role of relationship management in the relationship marketing field, many scholars began to study the relationship management in the construction field. The main concerns were the key success factors of relationship management and the impact of relationship management on the satisfaction of owners and project performance. Although some scholars have given the definition of relationship management in the field of engineering construction, there are few studies on the relationship management among organizations in megaprojects at present. This chapter will focus on the meaning, main body of relationship management and relationship quality dimension among organizations in megaprojects. Combined with the literature induction and expert interviews, this paper defines the concept of relationship management among organizations in megaprojects, and further selects out research questions, which will lay the foundation for the next study on the relationship quality and relationship management.

## **3.2 Expert Interview**

### **3.2.1 Background Introduction**

As relationship management is a theoretical concept introduced from the field of relationship marketing, practitioners in major construction fields are not familiar with it and are prone to link it with China's unique "pull relations" and corruption. Therefore, semi-structured expert interviews are needed. we first explain the definition of relationship management to experts, seek the experts' definition of the main body of relationship management in major projects, the necessity of relationship management, the importance of relationship management to project success, some measures and methods for the owners to strengthen the relationship management, the related benefits that the owners obtain, and so on. Based on the interview result, this paper further selects and optimizes the research questions of this research.

There are seven experts interviewed. Two are from the owner. Three are from the consulting unit. One is from the construction unit. One is from the supervision unit. They are practitioners with rich practical experience in the construction industry. They also have many years' experience in major construction projects and have in-depth knowledge of the current status and problems of the major domestic construction projects. The background of interviewed experts is described in Table 3.1. The different backgrounds of the interviews ensure that this interview fully understands the research value and significance of the relationship management organizations in megaprojects from a practical perspective.

Table 3.1 interviewed experts background information

code	unit	position	age	Years experience construction industry	of in	Years experience megaprojects	of in	Involved megaprojects
A	owner	Contract Department manager	41-50	20		10		Hong Kong-Zhuhai -Macao Bridge
B	owner	Project Department manager	31-40	10		10		Pudong International Airport
C	consultancy	Chairman	>50	25		15		Shanghai Disneyland
D	consultancy	General manager	31-40	12		10		Shanghai Disneyland
E	consultancy	Project manager	31-40	7		5		Expo Park
F	construction	Project manager	31-40	15		8		Shanghai Center
G	supervision	General manager	41-50	20		10		Financial Center

### 3.2.2 Interview Arrange

The interviews are Semi-structured. Respondents can speak freely about the interview. All the interviews were recorded in the form of audio recordings and then compiled into words. The further analysis was conducted after interviewees confirming the accuracy.

(1)The necessity and importance of relationship management among organizations in megaprojects

Of the seven respondents, five experts (A, B, C, D, F) made it clear that relationship management was necessary for all parties involved in major construction projects especially for owners. Expert G believed that trust management is necessary. Experts B, D, F, G emphasize the important impact of relationship management on project



performance. Expert E has a neutral attitude towards relationship management.

In the existing literature, many scholars believe that trust is the most important dimension of relationship management. Therefore, trust management proposed by expert G can also be understood as the relationship management, which shows that practitioners in construction field have a certain understanding of the connotation of relationship management. From this we can conclude that 86% of the experts in this interview think that relationship management is necessary in major construction projects. Another expert holds a neutral attitude towards it. This also shows that the status quo of relationship management is not widely accepted in the construction field, which also shows that it is of practical value to study the relationship management among organizations in megaprojects. 57% of experts think that the relationship between major engineering organizations will have a significant impact on project performance, which is consistent with the current research.

(2) The main body of the relationship management among organizations in megaprojects

When it comes to the main body of the relationship management, all the interviewees think that the owners should be the "managers" who take the initiative to manage megaprojects and the other participants are the object of relationship management for the owners. Specifically, the designer and construction units are the owners' most important object of relationship management, which is different from the current literature that most scholars only study the relationship between the owners and the construction unit. In addition, 71% of experts (experts A, B, D, F, G) considered the importance of design units prior to the construction unit. One interviewee (expert C) argued that "design and construction are different and it is difficult to make the comparison". One respondent (expert E) did not clearly distinguish the relative importance of design and construction.

In addition to the most important design and construction units, six respondents (experts A, B, C, D, F, G) mentioned suppliers and supervisors at the same time. Experts D and F thought they are "optional" or "unimportant", and the other four experts (experts A, B, C,

G) consider suppliers and supervisors to be the object of owner relationship management at the same time. Three out of the four experts (Experts A, B, and C) all agreed that suppliers is more important than the supervisors. And only experts G believed that supervisors are more important than suppliers. In addition, Expert E did not talk about suppliers and supervisors. He considered consultants more important, as shown in Table 3.2. In this regard, this paper believes that project management consultants can be broadly defined as "generation owners."

Table 3.2 the object of relationship management

Expert code	designer	Construction unit	supplier	supervisor	count
A	√	√	√	√	4
B	√	√	√	√	4
C	√	√	√	√	4
D	√	√	√	√	4
E	√	√			2
F	√	√	√		3
G	√	√	√		3
Support rate	100%	100%	86%	57%	

### (3) The results of the relationship management

Some interviewees (expert G) think that the management of the relationship between the project owner and other project participants in megaprojects is complementary to the incomplete contractual relationship. The characteristics of the project contract is incomplete, which is particularly prominent in major construction projects. "There are many changes in the long period of project implementation. If participants set the contract terms very carefully and strictly when signing the contract, it would be detrimental for both parties to promote the project. The contract should leave some room for both parties (experts B) ". Good relationship quality among major engineering organizations helps build a good collaborative culture (experts B, D) which helps resolve

conflicting and cultural differences across organizations (expert B), reach the common goal of maximizing benefits. On the basis of equality and cooperation, the participants of major projects are willing to solve problems (experts D) in order to improve their work efficiency so as to improve the project performance.

#### (4) relationship management strategies

According to Chen's (2007) relationship development model, relationship management process in a project is divided into three stages: initiating relationship, establishing relationship, and evaluating relationship. This is in line with the three levels of establishing trust and relationship model studied by Jin & Ling (2005) that is shallow dependence, deep dependence, shallow interdependence), corresponding to the different stages of project construction.

Owners adopt different relationship strategies towards different project participants in different stages. Although all the experts mentioned design units when discussing the relationship management bodies of major engineering organizations, most of the experts discussed the relationship management strategies preferring the construction units. One interviewee (expert D), referring to the owner's management of the relationship with the design unit, said: "Owners should be conscious of minimizing programmatic subversion as little as possible because it is unfavorable to the implementation of the project. Increasing the investment is one thing, sometimes it is devastating blow for the entire team's relationship and enthusiasm. "the relationship management strategies mentioned by experts is shown in Table 3.3.

Table 3.3 relationship management strategies for owners in megaprojects

stages	strategies	experts
Initiate relationship	Reasonably set the tender unit threshold	D
	Increase the prequalification screening process	D
	Preparation of a clear bidding documents	D
	Choose the appropriate contract form	AG
	Establish reasonable contractual objectives	D
	Clear the responsibilities and obligations of both parties	A
	Set reward and punishment incentives	E
Establish relationship	Clearly express intent and enhance communication	DEG
	Establish problem solving mechanism	DF
	Strengthen mutual visits between leaders	BEF
	Condolences to the construction unit	E

While the experts interviewed were primarily directed to the contractor when talking about these strategies, most of the above strategies are still applicable to other objects of relationship management, such as design and supervision units. Although there are some proprietary management strategies for different relationship management objects (such as the need for enhanced change management for the contractor), most of the strategies are generic and effective for design, construction, and supervision units. The relationship management strategies proposed by the interviewed experts are not comprehensive, and existing literature should also be combined to sort out comprehensive relationship management strategies of among organizations in megaprojects.

### **3.3 Related Definitions about Relationship Management among Organizations in Megaprojects**

#### **3.3.1 Main Bodies of Relationship Management among Organizations in Megaprojects**

##### (1) Megaproject stakeholders analysis

The large number of stakeholders is a prominent feature of megaprojects, and they form a complex network of stakeholder relationships. Stakeholders refer to any individuals or groups that plays a key role in the survival of the organization. At present, most domestic megaprojects adopt the procurement model of design-bidding-building. The stakeholders can be divided into three layers. The first layer is the owner-centered internal layer. The owner may be central or local government, other investors or builders whose goal is to successfully complete the project. The second layer is the middle layer of engineering and construction parties, including design units, construction units, suppliers, supervision units and so on. They participate in the construction of the project respectively, and the owners signed a contract with them. They have different interests and their actions directly affect the project objectives and performance. The third layer referred to the stakeholders who are affected by megaprojects such as the surrounding residents, demolished households, the media, the public, etc. External stakeholders often have different interest and demands. Their conflict may hinder the construction of the project.

##### (2) The main bodies of relationship management

The main body of relationship management is the core o stakeholders in of megaprojects. The owners are the active managers in the relationship management process. Stakeholders who signed contract with the owners in the middle layer of the network are the relationship management objects of the owners. There are Design units, construction units, suppliers, supervision units, such as the shaded area in Figure 3.1. In this paper, the

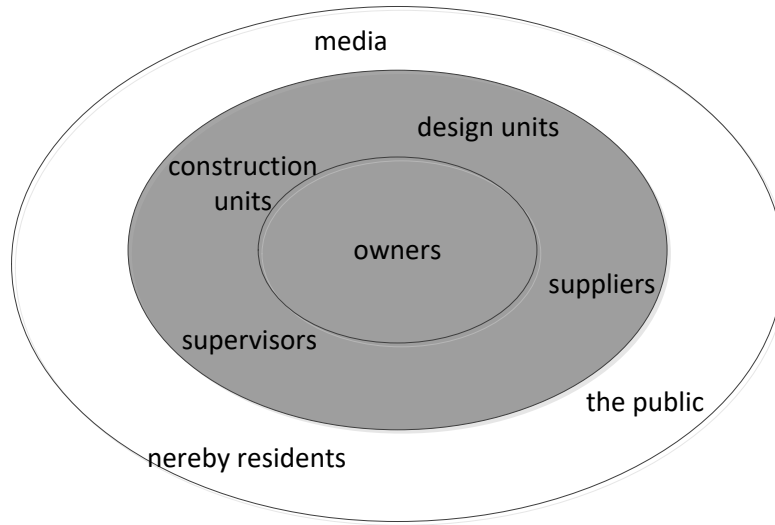


Figure 3.1 the stakeholders in megaprojects

Owner refers to the investment units and the government involved in the construction management of the organization, such as the project headquarters. The contractor specifically refers to the general contract construction units.

From the supply chain perspective, the owner is the end customer in the engineering construction field. The main stakeholders such as design unit, construction unit, supervision unit and supplier involved in the project construction are the general suppliers of construction services or materials. Combining stakeholders and supply chain, the design unit, construction unit and supervision unit is the first-tier suppliers; professional sub-contractor is the second-tier suppliers; materials and equipment suppliers are third-tier suppliers. There may be different types of relationships across different layers throughout the construction supply chain. For example, the relationship between the owner and the general contractor may differ from the relationship between the general contractor and the special contractor. From this we can define the main body of the relationship management among organizations in megaprojects, namely, owners and design units, construction units and supervision units.

### **3.3.2 The Meaning of Relationship Management among Organizations in Megaprojects**

"Management" refers to the process by which managers plan, organize, lead and control the various resources in a given environment in order to achieve certain goals. Based on the results of previous research and expert interviews, this paper defines the relationship management among organizations in megaprojects as follows: In the context of megaprojects, the owners adopt relevant management measures to enhance the relationship with the project participants (design, construction, Suppliers, supervision, etc.) and improve the relationship quality to achieve efficient collaborative process in order to successfully achieve the project objectives.

### **3.3.3 The Dimensions of Relationship Quality**

There are five basic theoretical models in relational marketing to analyze the relationship. The connotation of management : (1) commitment-trust, (2) interdependence, (3) reduction of transaction costs, (4) adherence to relational guidelines, and (5) sharing of resources. According to the results of previous research and expert interviews, this paper argues that the connotation of relationship management among organizations in megaprojects can be expressed in the dimension of relationship quality. They are organizational commitment, common goal, joint problem solving, information sharing, effective communication and mutual trust. Organizational commitment means "it is very important for one organization to consider the ongoing relationship with the other organization during the exchange process, and it needs to try its best to maintain that relationship." (Morgan and Hunt 1994)

A common goal helps to increase the cohesion among the participating parties in megaprojects. Adhere to common goals can converge goals and efforts among different participating parties and ultimately achieve the project goals. The successful achievement

of the megaprojects goals requires project participants to work together, coordinate and solve the problems jointly. Information sharing among project participants helps to facilitate coordination among organizations. Effective communication is an important aspect of relationship management, including a bilateral expectation that both parties will take the initiative to provide useful information to partners (Heide and John 1993). When the two organizations trust each other, they are willing to share confidential information and support the development of the relationship between them (Wong and Sohal 2002)

### **3.3.4 The Effect of Relationship Management among Organizations in Megaprojects**

The relationship management among organizations in megaprojects conducted by owners can foster mutual trust among project participants, speed up the cooperation process and improve project performance during the implementation of megaprojects. Relationship management in megaprojects is a supplement to the incomplete contractual relationship. Good relations between organizations help to establish a harmonious collaborative culture, resolve conflicts and cultural differences across organizations, and help achieve the common goal of maximizing the benefits of the project. On the basis of equality and cooperation, both parties are willing to work together for project solutions, jointly solve problems and improve work efficiency so as to improve project performance and also increase satisfaction between the project owner and project participants.

The philosophy of relationship management is gaining more and more acceptance as a way to foster mutual trust among contracted parties in project management, accelerate the process of cooperation and improve project performance. Clegg et al. (2011) emphasize that one of the obvious advantages of relationship management is the enhancement of the efficiency of working relationships. Meng (2012) also proposed the idea that relationship management can help improve project performance. Gil et al. (2011) found that building a trust-based relationship is important in the project management implementation phase and contributes to project success. Ning & Ling (2013) tested the impact of relationship contracts on relationship quality and project outcomes through a



study in Singapore and found that the quality of good inter-organizational relationships built by relationship contracts can improve the performance of public projects.

Through the combination of practice and theoretical research, this paper concludes that the relationship management among organizations in megaprojects can improve the project performance of major projects.

### **3.4 Research Selection and Research Design**

During the interview, some experts said: "The good relationship quality among organizations helps to establish a harmonious collaborative culture and solve the conflicting and cultural differences across organizations and helping to maximize the benefits of the project." Ning & Ling (2013) found that good relationships quality between organizations can improve the performance of public projects. Good relationships among organizations can overcome fragmentation and facilitate collaboration, which can be a strategic effort to improve project performance. The "assessment relationship" is an important part of the relationship management process. The purpose is to implement the relationship management strategies in a targeted manner by assessing the relationship status so as to achieve the best effect of relationship management. Analyzing the dimension of relationship quality further enriches the connotation of relationship management among organizations, which is also the evaluation criterion of relationship quality. Therefore, the content of Chapter 4 is to define the dimension of relationship quality, and to make an in-depth analysis of its connotation. The evaluation of relationship quality among organizations in megaprojects is established on this basis.

In the megaprojects stakeholder network, the relationship between the owner and the contractor is the most complex and the most representative, and even directly affects the success of the project. While talking about the relationship management object, experts mentioned the design unit. And five experts thought that design unit is more important than the construction unit. but when talking about relationship management strategies,

only one expert mentioned the design unit separately. This shows that in practice, relationship management between the owner and the contractor receives the most attention. Therefore, Chapter 5 takes the owner and the contractor for example to analyze the related problems in the relationship management among organizations from the perspective of evolutionary game, specifically analyzing speculative profit-seeking behavior and trust issue. Other components of the relationship management among organizations in megaprojects can also make the similar evolutionary game.

Good relationships among organizations in megaprojects can overcome fragmentation and facilitate collaboration, which can be seen as a strategic effort to improve project performance. Therefore, good relationship quality between organizations is not the ultimate goal, but the strategic means to achieve the project objectives. This process can be achieved through the relationship management among organizations. Combining expert interviews and literature research, this paper establishes a three-phase model of relationship management, that is "initiating relationship, establishing relationship, evaluating relationship". The owners adopt different relationship management strategies at different stages for the design unit, construction unit and supervision unit. In the expert interviews, the respondents proposed relationship management strategies involves only part of the relationship management, which cannot cover the whole content of the relationship management, nor formed a complete relationship management process. Existing studies have proposed some relationship management strategies, but they do not explain the specific implementation process, nor do they carry out relevant research on megaprojects. Therefore, chapter 6 is to sort out relationship management strategies among organizations in megaprojects. By combining the three-stage model of "initiating relationship, establishing relationship, evaluating relationship", a complete process of relationship management among organizations in megaprojects is established which enriches the theory of major project management and providing reference for practice.

### **3.5 Summary of This Chapter**

Based on the literature research, this chapter conducts expert interviews and defines the meaning, subject, boundary and effect of relationship management among organizations in megaprojects. The main participants of megaprojects are the main bodies of relationship management. The owners are managers. Design units, construction units and supervisory units are the objects of relationship management. The project participant who is contracted by the owner and located in the middle layer of the major engineering stakeholder network is the owner's relationship management object. The specific meaning is that the owners adopt relevant management measures to enhance the quality of the relationship with the project participants (design, construction, suppliers, supervisors, etc.) and achieve an efficient and collaborative process in order to successfully achieve the project objectives. The direct result of relationship management is the improvement of the quality of relationships. The dimensions of the relationship quality among organizations include organizational commitment, common goals, joint problem solving, information sharing, effective communication and mutual trust. Relationship management fosters mutual trust among major project participants, accelerates the cooperation process, improves project performance, and improving the satisfaction of owners and project participants at the same time.

On the basis of this, this paper further selects the research questions and define the research content as the relationship management among organizations in megaprojects. Firstly, six dimensions of relationship quality are put forward, and an in-depth analysis is carried out to establish the evaluation system of the relationship quality among organizations in megaprojects by using fuzzy decision-making method. Then, taking the owners and contractors as an example, the relationship among organizations is analyzed through the evolutionary game. Taking the logic of "initiating relationship, establishing relationship, evaluating relationship", the relationship management strategies among organizations in megaprojects are sorted out and applied to the above three processes

respectively to establish the process model of the relationship management among organizations in megaprojects.

# **Chapter 4 The Dimensions and Evaluation of Relationship Quality among Organizations in Megaprojects**

## **4.1 The Dimensions of Relationship Quality Among Organizations in Megaprojects**

The six dimensions of the relationship quality among Organizations in megaprojects are: organizational commitment, common goals, effective communication, joint problem solving, information sharing and mutual trust. The sources of literature on the dimensions of Relationship quality are shown in Table 4.1.

Table 4.1 Relationship Quality Dimensions literature Source

RQ dimensions literature Source	organizational commitment	communication goals	effective communication	joint problem solving	information sharing	mutual trust
Jin & Ling(2005)	√	√	√	√		
Zou et al.(2014)			√			
Chan et al.(2004)		√	√	√	√	√
Chan et al.(2015)	√			√	√	
Chen & Chen(2007)		√	√	√		√
Black et al.(2000)				√		
Ling et al.(1994)		√				√
Rahman&Kumaamy (2002)				√		
Cheng et al.(2000)			√	√	√	
Ling et al.(2013)		√		√	√	
Bemelmans et al(2011).			√		√	
Jin et al.(2007)	√		√	√		
Kog & Loh(2011)		√				√
Chang & Shen(2013)	√			√		
Ibrahim et al.(2014)			√			
Ujene & Edike(2015)			√	√	√	√
Ibrahim CKI et al.(2011)	√		√		√	
Meng(2012)			√			√
Pal et al.(2017)		√	√	√	√	√
Count	5	7	12	12	8	7

### 4.1.1 Organizational commitment

Organizational commitment means "it is very important for one organization to consider the ongoing relationship with the other party during the exchange process, and it needs to do its best to maintain the relationship" (Morgan and Hunt 1994). Commitment in a business relationship means that a business is willing to make short-term sacrifices to maintain its relationship with its partners. Angle and Perry (2014) believes that a higher

level of commitment is tied to the success of the relationship, as more committed organizations will strive to balance short-term issues with long-term goals. In the course of the transaction, the long-term relationship between the two parties needs to be sustained by a certain degree of commitment. From a social normative point of view, promises have played a binding role in the exchange process and can effectively regulate the behaviors and attitudes of the parties promised.

At the organizational level, commitments are divided into two aspects: attitude and behavior (Morgan and Hunt 1994). Attitude commitment based on the premise that a stable partnership will yield favorable results for both parties, and both sides are willing to make active investments or make short-term sacrifices to get favorable expectations. This will reflect the long-term value of maintaining the relationship. Behavioral commitments are commitments that demonstrate the specific actions taken to establish good relationship, such as investment in relations, including input or allocations of manpower, goods and financial resources. Taking the two dimensions of attitude and behavior aspects into consideration, the commitment among organizations in megaprojects can be understood as willingness and concrete action of participating parties in order to establish good relationship and obtain relationship value.

#### **4.1.2 Common Goals**

A common goal helps to increase the cohesion among the participating parties in major projects. Adhering to the common goal can converge different goals and efforts among different participants and eventually achieving the goals of themselves and projects. It is different from the pursuit of one's own interests in traditional practice (Thomas and Thomas,2008). In fact, sticking to common goals is conducive to the realization of their own interests. Businesses also act on the basis of their shared vision to realize their own interests. Each project participant insists on a common goal that will enable them to do their best to achieve the success of major construction projects ( Bennett and Jayes ,

1995).

The participating organizations in megaprojects should exchange their expectations and goals at different stages, clarify the key objectives in different periods and establish common goals. At the same time, it is necessary to check whether its own goals conflict with common goals. If there are conflicts, their own objectives should be amended in time so as to achieve their common goals. The common goal is to maintain the different project participants and form the basis for the development of good relationships among organizations so that each participating party can form a target community or a common goal coalition and promote communication and cooperation among the organizations. The establishment of common goals among different organizations cannot be achieved in a single step. Instead it requires a longer process (Walker et al. 2002). In this process, each project participant needs to carefully consider their own goals while taking the overlap of needs and interests into consideration, and finally establish the common inter-organizational goal through repeated consultations. Because only when the two organizations reach a common commitment to their common goals can their respective interests and best values be realized.

### **4.1.3 Effective Communication**

Communication is the channel through which different individuals or organizations exchange information and ideas. In communication, individuals or organizations communicate information or data to other individuals or organizations. In this way, information and ideas are widely exchanged and disseminated. Broad communication can be understood as "valuable and timely information sharing among enterprises, both formally and informally." Communication with established methods and channels is formal communication. If the ways and channels of information delivery are arbitrary, informal communication is possible. The most common communication is initiated by individuals or organizations as the main body. It refers to the process of reaching an



agreement among people, organizations or within organizations using information as a carrier. Communication consists of seven elements: background, sources of information, recipients, channels, information, barriers to information delivery, and information feedback.

In the field of traditional engineering construction, there are professional information barriers between project participants, and the poor communication makes such barriers more serious. Studies have shown that one of the main reasons for the failure of the partnership in construction projects is the lack of open and effective communication between the participating (Ochieng and Price 2010). Open and effective communication is conducive to the accuracy and timeliness of information transmission, and helps to exchange ideas and concepts so as to reduce misunderstanding among partners and further enhance trust at the same time (Cheng et al. 2010). Effective communication is an important aspect of relationship management, including "a bilateral expectation that both parties will take the initiative to provide useful information to partners" (Heide and John, 1992). Therefore, full and effective communication can promote the information sharing, reduce the negative effects brought by incomplete contracts, create flexibility and reduce or resolve conflicts between parties so as to help all parties to cooperate more effectively. It is also an important factor for the success of the project.

#### **4.1.4 Information Sharing**

Major construction project participants can communicate through face-to-face meetings, telephone calls, faxes, emails and the Internet. In addition to the generally disclosed information in the project, the information includes key information and proprietary information. Information sharing embodies a willingness of project participants to provide valuable information to their partners voluntarily (Morgan and Hunt, 1994). It has been pointed out that the information sharing among project participants is helpful for the coordination among organizations (Min and Roath 2005). In order to achieve

successful cooperation, project participants should maintain frequent, voluntary, active and informal information sharing. Inadequate information sharing or false information can have a seriously negative impact on the cooperation between project participants. Information sharing is one of the key factors in realizing the value of cooperation among organizations (Min and Roath 2005). The quality of information sharing between organizations is also an aspect of measuring the success of partner programs and project performance (Walker et al. 2007).

There are also studies believe that the sharing of information among organizations plays an important role in building trust. Because sharing key information enables different organizations to understand each other's work practices and to formulate conflict resolution mechanisms in a targeted manner. This also shows the mutual trust (Yang et al. 2011). In addition, information sharing can reduce the uncertainty of megaprojects and increase the trust and commitment among organizations (Yang et al., 2011). Resources are scarce and competitive. Usually organizations are not willing to share them with others (Cheng et al., 2000). Due to the different backgrounds, megaproject participants have their own exclusive and complementary resources. The sharing of resources can greatly promote the implementation of megaprojects. Sharing resources is also a measure of relationship quality between the two organizations (Cheng et al. 2000).

#### **4.1.5 Jointly Solve the Problem**

The successful realization of the megaproject goals needs to rely on the project participants to work together to coordinate planning and solve problems jointly. Min et al. (2005) Found that joint efforts among participating organizations to solve problems jointly are very important to successful partnership. Conflicts and problems are inevitable during project implementation. Project participants should consider problem solving as a chance to work together to find the best solution (Cheng et al., 2000). In the process of solving the problem, all participating parties need to have a positive attitude of coping

and collaboration, and to minimize disputes as much as possible. The relationship between the participants also changes as the problem solved. Effective and timely solution to the problem can enhance the relationship between the participating organizations. In addition, problems should be solved promptly so as to prevent the problems from becoming larger and becoming more serious conflicts. Common solutions to problems are: (1) a clear understanding of mutual goals and making decisions together (Chan et al.,2004); (2) joint efforts to solve the problem (Cheng et al., 2000); and (3) joint efforts for continuous improvement.

#### **4.1.6 Mutual Trust**

As a central variable of social exchange theory, trust laid the normative foundation for the development of commercial relations. In the literature on marketing research, trust is seen as "an important concept for understanding contracts and expecting cooperation and planning." (Dwyer et al., 1987) Trust is a long-term harmonious and stable relationship between people or organizations. High degree trust can reduce risk perceptions and increase confidence in relationships. In organizational exchange, trust is seen as an alternative to hierarchical governance and plays an important role ( Aulakh et al., 1996 ). When two organizations trust each other, they are willing to share confidential information and support the development of the relationship between them (Wong and Sohal, 2002).

In social interaction, trust is gradually established through repeated communications and the exchange of interests between the two organizations. After the business relationship is established, the accumulation of trust can facilitate better communication in subsequent stages (Anderson and Narus, 1990). Trust is a complex social phenomenon, which has been divided into different dimensions in previous studies. A large number of studies divide it into two key dimensions: benevolence and credit. Benevolence refers to the partners pursuit of self-interest, as well as the interests of other's wishes and motives

(Ganesan, 1994). Credit refers to the roles and obligations of partners who believe they will keep their promises and fulfill their commitments (Van et al., 2005).

## **4.2 The Interaction of Dimensions of Relationship Quality**

Organizational commitment is a prerequisite for relationship management among organizations in megaprojects. Project participants are aware of the importance of maintaining good relationships with other organizations and are willing to work hard to do so. Organizational commitment helps to balance the short-term and long-term benefits of all project participants and to agree on common goals. After the project participants of megaprojects committed to the inter-organizational relationship, the rest of the relationship quality dimensions can further play their role. The common goal is based on the organizational commitment. Under the constraint and guidance of common goals, the participants in megaprojects are more willing to solve problems jointly, share information, and effectively communicate with each other. At the same time, the above three dimensions will also promote and influence each other. When the relationship quality among organizations develops to a certain stage, the major project participants will start to trust and understand each other.

Trust is a manifestation of the good relationship quality among organizations in megaprojects and trustworthiness partners are also an important factor in relationship management. Organizational trust can greatly facilitate joint problem-solving, information sharing, and effective communication. Organizational commitment and information sharing are fragile, so owners prefer to choose a trustworthy partner to reduce speculation and profitability during megaproject implementation (Roberts and Mpinganjira 2017 ). Trust is at the heart of relationship management among organizations in megaprojects (Sariola and Martinsuo,2016).

Once the relationship between organizations has been established, these dimensions will interact and promote each other. Taking mutual trust as an example, when the

megaproject participants reach a common goal through organizational commitment, each participating organizations will actively solve the problem jointly, effectively communicate and share information. When the relationship quality between the organizations reaches a certain status, they will trust each other. And mutual trust will reversely strengthen and consolidate organizational commitment, common goal, jointly problem solving, effective communication and information sharing. Organizational relationships in major projects are further enhanced by the virtues of the above key influencing factors

### **4.3 Evaluation System of Relationship Quality among Organizations in Megaprojects**

The evaluation of the relationship quality between owners and the partners is an evaluation problem whose goal is affected by many factors. The key of the problem lies in determining the weight distribution of each factor. Usually AHP and value theory of multi-factor are used. However, they have some limitations in practical application. AHP method needs to compare multiple levels, so it is difficult to accurately grasp the relative importance of these factors in practical application, and it is prone to inconsistency, resulting in poor consistency test results. Therefore, the initial comparison value needs to be constantly adjusted. The judgments and conclusions obtained by the fuzzy comprehensive index method are more subjective and less objective and fair. Therefore, this study adopts the method of fuzzy decision-making (NSFDM) to make up for the shortcomings of the above methods and get the ideal evaluation results. Fuzzy decision-making analysis is followed by three steps respectively: decomposition, judgment and synthesis (C.M.Tam et al., 2002).

### **4.3.1 Principles of the evaluation system**

#### (1) Scientific

"Scientific" means that the connotation and concept of the evaluation index of the relationship quality among organizations in megaprojects should be clear, definite and complete. It should include all factors that affect the relationship quality completely and comprehensively. It should be in line with scientific research guidelines.

#### (2) Operability

"Operability" refers to the easy access to the basic information required by the indicator system, including first-hand and second-hand information. It is better that these materials be presented as data in the course of project construction and can be comparable at the same time.

#### (3) overall

"Overall" means that the evaluation system should cover six dimensions of the relationship quality, including organizational commitment, common goals, effective communication, information sharing, joint problem solving, and mutual trust.

#### (4) Hierarchical

"Hierarchical" means that the indicator evaluation system consists of different levels of evaluation indicators. The indicators at the same level are parallel and have some degree of independence, while the indicators at different levels have subordination and inclusion.

#### (5) The main component

A large number of evaluation indicators can fully reflect the relationship quality among organizations in megaprojects, but there are also some drawbacks. Because the larger the number of evaluation indicators, the harder it is to obtain and the higher the cost will be and the more difficult the corresponding calculation will be. Therefore, the indicators in the evaluation system should be ranked from high to low according to the contribution rate and importance, and the least number of principal components that can reflect the nature of the evaluation system should be screened out as far as possible.

### 4.3.2 Determining the Evaluation Index

Through top-down and layer-by-layer decomposition, the relationships quality among organizations in megaprojects is divided into three levels. Each level is broken down into a lower level of evaluation indicators that can reflect its main features, avoiding duplication or omission. The first level is the target level (T), which targets relationships quality among organizations in megaprojects. The second layer is the criteria layer (C), which is expressed in six dimensions: organizational commitment, common goal, joint problem solving, information sharing, effective communication and mutual trust. The third level is the indicator level (H). The six indicators at the next level are decomposed in turn, and the specific evaluation indicators that can reflect the relationships quality among organizations in megaprojects are selected as shown in Table 4.2.

Table 4.2 relationship Evaluation Index

target (T)	criteria (C)	index (I)
Relationship quality	organizational commitment $C_1$	Relationship-specific investment $H_1$
		Focus on the long-term goal $H_2$
		Top Management Support $H_3$
		Win-win attitude $H_4$
	common goal $C_2$	Joint Development of Objectives $H_5$
		Fully understand the goal $H_6$
		Share the Benefits and Risks $H_7$
	joint problem solving $C_3$	Conflict resolution mechanism $H_8$
		Flexibility $H_9$
		Collaborative cooperation $H_{10}$
	information sharing $C_4$	Information Sharing $H_{11}$
		Resources Reciprocity $H_{12}$
	effective communication $C_5$	Smooth communication channels $H_{13}$
		Timely and Accurate Communication $H_{14}$
		Timely feedback $H_{15}$
	Mutual trust $C_6$	Mutual Understanding $H_{16}$
		Mutual recognition and respect $H_{17}$
		Withdrawal and compromise $H_{18}$

Relationship-specific investment: Participants in megaprojects are willing to dedicate specific assets to inter-organizational relationships. The purpose of these asset investments is to enhance the good quality of inter-organizational relationships and not to use them for any other purpose.

Focus on the long-term goal: Compared with rapid gaining of short-term benefits, the participants in megaprojects pay more attention to the long-term goals and benefits and are willing to view the relationship among organizations with a developing perspective.

Top Management Support: The megaproject participants have established good relationships with top-level support organizations and are willing to make strategic efforts to spread the awareness of relationship management from top to bottom.

Win-win attitude: Participants of megaprojects reached a consensus on a win-win attitude, which is also an inter-organizational commitment.

Joint Development of Objectives: Participants of megaprojects participate in the development of common goals together to ensure that the common goals and interests of the organization are consistent.

Fully understand the goal: to make sure that the common goal is correct and reasonable with no bias and ambiguity.

Share the Benefits and Risks: There are fair risk sharing and reasonable revenue sharing mechanisms among the participating organizations in megaprojects.

Conflict resolution mechanism: Participants of megaprojects have an efficient mechanism for resolving conflicts and problems.

Flexibility: Respond flexibly in the face of uncertainty and problems to ensure project goals are achieved.

Collaborative cooperation: megaproject participants work together and have team awareness.

Information Sharing: Participating organizations in megaprojects have achieved information sharing.

Resources Reciprocity: The resources of organizations in megaprojects are complementary to each other and are willing to provide their own resources to other participating organizations.

Smooth communication channels: Conference, telephone, fax, mail, Internet and other



communication channels are open at the same time.

Timely and Accurate Communication: In addition to routine communication, timely communication is required when some unexpected situations occur. At the same time to participants should make their intentions correctly understood by partners to ensure accurate delivery of information.

Timely feedback: response and feedback of communication and access to information between major project participants are timely.

Mutual Understanding: Participants of megaprojects are familiar with the situation of their partners.

Mutual recognition and respect: Participants of megaprojects respect and recognize each other and treat each other equally.

Withdrawal and compromise: In view of the project's overall interests, participants are willing to give appropriate compromise and concession in the handling of some disputes.

### **4.3.3 establish evaluation system**

(1) Establish a judgment matrix

First of all, using three scales (0,0.5,1)to compare the the third level, that is, the index level X in pairs. The specific rules of operation are: 1) if A is more important than B then  $A = 1$  and  $B = 0$ ; 2) if B is more important than A then  $A = 0$  and  $B = 1$ ; 3) if A and B are equally important, then  $A = B = 0.5$ . The three-scale comparison method greatly reduces the comparison grade, simplifies the calculation and reduces the workload, and enables the decision makers make quick and accurate judgment as well as improve Judge the probability of the matrix passing the consistency check which is the key point that distinguishes the NSFDM from the AHP method. Asuming that the comaparison score of factor  $C_l$  and  $C_k$  is  $e_{ij}$ , we can see that the judgment matrix after comparing all the factors is shown in Equation (4.1), and the following three conditions need to be satisfied at the same time.

$$E = (e_{ij})_{n \times n} = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1n} \\ e_{21} & e_{22} & \cdots & e_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ e_{n1} & e_{n2} & \cdots & e_{nn} \end{bmatrix}, e_{ij} \in \{0, 0.5, 1\} \quad (4.1)$$

1) if  $e_{ij} = 1$ , then  $e_{ji} = 0$ ;

2) if  $e_{ij} = 0$ , then  $e_{ji} = 1$ ;

3)  $e_{kk} = 0.5$ .

### (2) Consistency test

The conditions for consistency checking are the three conditions mentioned above:

1) if  $e_{ij} = 1$ , then  $e_{ji} = 0$ ;

2) if  $e_{ij} = 0$ , then  $e_{ji} = 1$ ;

3)  $e_{kk} = 0.5$ .

If the judgment matrix satisfies all three conditions at the same time, then the matrix passes the consistency check. If not, you need to adjust the value of the element in the judgment matrix. Because fuzzy decision-making method obey the rule that the position of the judgment matrix is higher and more reliable than the value of the line in the lower, so the value of the next line should adapt to the value of the previous line when making adjustment

### (3) The importance of sorting and priority rating

After the judgment matrix passes the consistency test, the elements are sorted by descending order according to each row, and the order of importance of the third-level evaluation index can be obtained. In order to clarify the algorithm, a case study is presented here. An expert was asked to judge the importance of the 18 indicators in the third layer and obtaining the judgment matrix as shown in Table 4.3.

Table 4.3 Judgment Matrix of Index

	$H_1$	$H_2$	$H_3$	$H_4$	$H_5$	$H_6$	$H_7$	$H_8$	$H_9$	$H_{10}$	$H_{11}$	$H_{12}$	$H_{13}$	$H_{14}$	$H_{15}$	$H_{16}$	$H_{17}$	$H_{18}$	Sum
$H_1$	0.5	0	0	0	0.5	0.5	0.5	0	1	0	0	0.5	1	1	0.5	0	0.5	0.5	7
$H_2$	0	0.5	0	0	0	0	0	0.5	1	0.5	0	0.5	1	1	0	0	0	0.5	5.5
$H_3$	0	0	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	1	1	1	1	0.5	0	0.5	10.5
$H_4$	0	0	0.5	0.5	1	0	0	0.5	1	0.5	0	0.5	0.5	1	0.5	0.5	0.5	0.5	8
$H_5$	0.5	0	0.5	1	0.5	0.5	0.5	1	1	0.5	0.5	1	1	1	0.5	1	0.5	0.5	12
$H_6$	0.5	0	0.5	0	0.5	0.5	0.5	1	1	0.5	0.5	1	0.5	1	0.5	1	0.5	0	10
$H_7$	0.5	0	0.5	0	0.5	0.5	0.5	0.5	1	0.5	0.5	1	0.5	1	0.5	1	0.5	0.5	10
$H_8$	0	0.5	1	0.5	1	1	0.5	0.5	1	0.5	0	0	0	1	0	0	0	0	7.5
$H_9$	1	1	1	1	1	1	1	1	0.5	0	0	0	0	0.5	0	0	0	0	9
$H_{10}$	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0.5	0.5	1	0	0	0	0	6
$H_{11}$	0	0	0.5	0	0.5	0.5	0.5	0	0	0	0.5	1	1	1	1	1	1	1	9.5
$H_{12}$	0.5	0.5	1	0.5	1	1	1	0	0	0.5	1	0.5	0.5	1	0.5	0	0	0	9.5
$H_{13}$	1	1	1	0.5	1	0.5	0.5	0	0	0.5	1	0.5	0.5	1	0	0	0	0	9
$H_{14}$	1	1	1	1	1	1	1	1	0.5	1	1	1	1	0.5	0	0	0	0	13
$H_{15}$	0.5	0	1	0.5	0.5	0.5	0.5	0	0	0	1	0.5	0	0	0.5	0.5	0.5	0.5	7
$H_{16}$	0	0	0.5	0.5	1	1	1	0	0	0	1	0	0	0	0.5	0.5	0.5	0.5	7
$H_{17}$	0.5	0	0	0.5	0.5	0.5	0.5	0	0	0	1	0	0	0	0.5	0.5	0.5	0.5	5.5
$H_{18}$	0.5	0.5	0.5	0.5	0.5	0	0.5	0	0	0	1	0	0	0	0.5	0.5	0.5	0.5	6

Based on the rankings and the sum of the importance scores for each factor, asking the experts to prioritize the importance of each factor with reference to the semantic operators in Table 4.4.  $a_{ij}$  is the semantic sub-semantic operator points meeting  $a_{ij} \in [0.5, 1]$  (0.5 for the same value, the value of 1 means different).  $b_{ij}$  refers to the semantic operator's priority score, meeting  $b_{ij} \in [0, 1]$ . Semantic points are in accordance with the idea of fuzzy set theory. using formula (4.2) to make the transaction, you can get the priority score, shown Table 4.4.

$$b_{ij} = \frac{1 - a_{ij}}{a_{ij}} \quad (4.2)$$

Table 4.4 Semantic operator related score table related score table

Semantic operator related score table	level	Semantic points $a_{ij}$	Priorities $b_{ij}$
1 exactly the same	1	0.5	1
2 slightly different	2	0.55	0.818
3 a little different	3	0.6	0.667
4 more different	4	0.65	0.538
5 quite different	5	0.7	0.429
6 significantly different	6	0.75	0.333
7 obviously different	7	0.8	0.25
8 very different	8	0.85	0.176
9 Significantly different	9	0.9	0.111
10 Extremely significant difference	10	0.95	0.053
11 absolutely different	11	1	0

(4) Calculating the total score

In the evaluation model of the relationship quality among organizations in mega-projects, the weight vector of each index is derived from the expert's rating, which is the standard of the evaluation system. The people who make the evaluations are those who participated in the construction of major projects. They can be a worker in a front line, a middle manager or a top manager.

From the analysis of the previous step,  $w'_j (j=1,2,\dots,n)$  is the weight of the first evaluation index. Assuming that the score of the first evaluation index is  $s_j$  (the value of the first evaluation index is limited within a range of 5, 10, or 100, etc. In order to accurately evaluate the quality of the relationship between major engineering organizations, it is recommended to adopt a percentile system), Then the total quality of the relationship between major engineering organizations score is  $Z$

$$Z = \sum_{j=1}^n s_j \times w_j \quad (4.5)$$

## 4.4 Summary of This Chapter

The relationship quality of among organizations in megaprojects includes six dimensions: organizational commitment, common goal, joint problem solving, information sharing, effective communication and mutual trust. Organizational commitment means that during the exchange, it is important for one organization to consider that the ongoing relationship between another organization is very important, and it is necessary to do its best to maintain the relationship (Morgan and Hunt, 1994). A common goal helps to increase the cohesion among the organizations in megaprojects. Adhere to common goals can converge of goals and efforts among different participating organizations and ultimately achieve the goals of themselves and the project. The successful implementation of the major construction project objectives requires that all organizations involved in the project should work together to coordinate the planning and solve the problems jointly. Information sharing among project participants helps to facilitate coordination among organizations. Effective communication is an important aspect of relationship management, including a bilateral expectation that both parties will take the initiative to provide useful information to their partners.

When two organizations trust each other, they are willing to share confidential information and support the development of the relationship between them(Wong and Sohal 2002 ). Organizational commitment is the prerequisite for relationship management. Both parties set a common goal based on this, and then start to jointly solve the problem, share information and resources, and begin effectively communication. After the relationship between the two organizations have developed to a certain extent, they start to trust each other. Trust will further promote the role of other dimensions of relationship quality. And mutual trust is the core dimension. Based on the dimension of relationship

quality, this chapter subdivides it into 18 evaluation indexes and establish the relationship quality evaluation system among organizations in megaprojects using fuzzy decision method.

# **Chapter 5 Evolutionary Game Analysis of Relationship Management Organizations in Megaprojects- A Case Study of Owners and Contractors**

## **5.1 Owners and Contractors Opportunistic Profit-making Evolutionary Game Analysis**

Megaprojects have a large number of stakeholders. In the complex social network the stakeholders in the core and middle layers have a far greater impact on the project performance than other outside stakeholders. They are the participants of megaprojects , including owners, design units, construction units, supervision units, suppliers and so on. At present, D-B-B (design-bidding-building) contracting mode is commonly used in megaprojects in China. Owners usually outsource their construction tasks to general construction units. In this paper, contractors refer to general contracting units. Among the many participants in major projects, the relationship between owner and contractor is the most complex and representative.

As the economies in a market environment, owners and contractors are aiming at maximizing their own interests. Therefore, both parties have some degree of blindness in conducting economic transactions. During the construction of megaprojects, both parties may face the act of damaging the interests of their counterparts in order to maximize their own interests. Such acts of contractors are mainly opportunistic acts, which are manifested in the unauthorized appropriation of special construction funds, resulting in project funds shortage and making the project delay. The quality of the project cannot meet the requirements for the proceeds of the project price, Contractors will make unreasonable claims, conceal the facts using their own information superiority. All of those make project investment overruns and, increasing the owners of the investment

risk.

In addition, if the contractor fails to meet the quality requirements in accordance with the stipulated schedule according to the contract, it will also damage the profit of the owner and affect the relationship with the owner. Therefore, this article narrowly defined the opportunistic behavior and other behaviors that are not conducive to the development of the relationship with the owners as the contractor's opportunistic behavior.

And owner's opportunistic behavior is regarded as moral hazard, which is mainly manifested not to pay the contractor's engineering payment in time, disguise the contractor legitimate project proceeds in disguise, forcibly require the contractor to lend money, and propose unreasonable engineering changes.

In the above situation, the owners and contractors have a game relationship.

### **5.1.1 Build the Basic Game Model**

The basic hypothesis of this game model is as follows:

The game process between the owner and the contractor is in the situation of asymmetric information, and both sides are bounded rational. The game model in this case needs repeated games to seek the optimal decision and finally reach an equilibrium state. In megaprojects, the contractor has more engineering experience than the owner. He has direct control of the construction site situation. Although the owner may also have some information that the contractor can not access, such as its own financial risk and actual performance ability. However, from the relative importance and intensity of the information, the contractor is in the position of information superiority to the proprietor and both parties are in the situation of asymmetric information.

Under the limited information provided by the contractor, the owner makes decisions according to his own experience and analysis of current construction conditions. Under such circumstances, the owner has two strategies: whether to conduct moral hazard defaults. Accordingly, the contractor is also in a state of limited rationality at this time.



Under the circumstance of having more sufficient site information of the project owner and information superiority of the contract completion status, there are two kinds of strategies or behaviors: whether to conduct speculation and profit-making.

Based on the above assumptions, the basic components of the model are:

(1) Participants: Owners and contractors, both sides are limited rational, they of their own interests to maximum;

(2) Information: The contractor has the information superiority to the owner, both sides are in the information asymmetry state;

(3) Strategy: the owner chooses whether to conduct speculation and profit-making, and the contractor chooses whether to conduct speculation and profit-making;

(4) Revenue of both parties: The profit of the owner and the contractor is the utility function in the game model. there are four situations, the specific analysis is shown below;

(5) Equilibrium: the final state of evolutionary game model.

In this game model, the owner's strategy (or action) can be: whether to take speculative or profit-taking behavior, the contractor can choose the strategy (or action) as follows: whether to take speculative or profit-taking behavior, both parties are not interfered by each other, nor do they know each other's strategy beforehand. They make decisions under the condition of being independent from each other. They are in the situation of non-cooperation, incomplete information and static game.

Under normal circumstances, the normal return of the owner is  $S_1$ , indicating the normal return of the contractor. The probability that owners take speculative and profit-seeking behavior is  $q(q \in [0,1])$ , and the probability that owners do not take the opportunistic behavior is  $1-q$ .

The additional revenue obtained by the Owner through the speculative and profit-making activities is  $u_1$ . Accordingly, the contractor suffered losses as a result of the

opportunistic behavior of the owners is  $u_1$ . The probability of the contractor adopting the speculative and opportunistic behavior is expressed as  $p(p \in [0,1])$ . The probability of not using the opportunistic and opportunistic behavior for the contractor is  $1-p$ . The contractor's additional benefit obtained through the speculative and profit-seeking behavior is expressed as  $u_2$  .shown in Table 5.1. among them .  
 $S_1 > 0, S_2 > 0, u_1 > 0, u_2 > 0$

Table 5.1 the symbolic description of Game evolution model

symbolic	symbolic description
$S_1$	The normal income of the owners under normal conditions
$S_2$	The general contractor's normal revenue
$q$	The probability of the owner taking speculative and profit-taking behavior
$1-q$	The probability of the owners do not take the risk of opportunistic behavior
$p$	Probability of contractor taking opportunistic and profit-taking behavior
$1-p$	Probability of the contractor not taking speculative and profit-taking behavior
$u_1$	Owners take speculative and profit-making extra benefits
$u_2$	Contractor to take opportunistic profit-making extra benefits

In this evolutionary game model, the contractor and owner's strategy matrix is shown in Table 5.2, where the owner's strategy / action is on the right and the contractor's strategy/action is on the right.

Table 5.2 Evolutionary Game Strategy of Owners and Contractors in Megaprojects

		contractor	
		Take speculative and profit-making behavior	Do not take speculative and profit-making behavior
owner	Take speculative and profit-making behavior	(Take speculative and profit-making behavior, Take speculative and profit-making behavior)	(Take speculative and profit-making behavior, Do not take speculative and profit-making behavior)
	Do not take speculative and profit-making behavior	(Do not take speculative and profit-making behavior, Take speculative and profit-making behavior)	(Do not take speculative and profit-making behavior, Do not take speculative and profit-making behavior)

In the strategy combination (taking speculative and profit-taking behavior, taking opportunistic and profit-taking behavior), the additional gain that the owner obtains is  $u_1$ . that the loss of interest is expressed as  $u_2$ . The total revenue obtained by the owner is  $S_1 + u_1 - u_2$ . The extra income obtained by the contractor is  $u_2$ . The loss of interest is  $u_1$ . The total revenue received by the contractor is expressed as  $S_2 - u_1 + u_2$ .

In the strategy combination (taking speculative and profit-taking behavior not taking speculative and profit-taking behavior), the owner gains extra income is  $u_1$ . The total profit obtained by the owner is expressed as  $S_1 + u_1$ . The loss of profits suffered by the contractor is  $u_1$ . At this point the contractor obtain the total revenue  $S_2 - u_1$ .

In the strategy combination (not taking speculative and profit-taking behavior, taking speculative and profit-taking behavior), the contractor obtains the extra income  $u_2$ , and the total revenue is  $S_2 + u_2$ . The loss of profit for the owner is  $u_2$ . And Owner receive the total revenue of  $S_1 - u_2$ .

In the strategy mix (not taking speculative and profit-taking behavior, not taking speculative and profit-taking behavior), both the owners and contractors did not take the speculative and profit-taking behavior and the total return of both was normal return under the general ideal. The normal return of the owner is  $S_1$ , and the normal return of the contractor is  $S_2$ .

From the above analysis, the revenue matrix of the evolutionary game model under the general state constructed by the contractor and the owner is shown in Table 5.3

Table 5.3 Evolutionary Game Revenue Matrix of Owners and Contractors in Megaprojects

		contractor	
		Taking speculative and profit-making behavior (p)	Not take speculative and profit-making behavior (1-p)
owner	Taking speculative and profit-making behavior (q)	$S_1 + u_1 - u_2, S_2 - u_1 + u_2$	$S_1 + u_1, S_2 - u_1$
	Not Take speculative and profit-making behavior (1-q)	$S_1 - u_2, S_2 + u_2$	$S_1, S_2$

According to the above Revenue matrix, it can be concluded that the expected utility function that the owner chooses to take a speculative and profit-taking behavior is

$$E_{y1} = p(S_1 + u_1 - u_2) + (1-p)(S_1 + u_1) = S_1 + u_1 - pS_2 \quad (5.1)$$

The expected utility function that the owner chooses not to take speculative and profit-taking behavior is expressed as

$$E_{y2} = p(S_1 - u_2) + (1-p)S_1 = S_1 - pS_2 \quad (5.2)$$

Therefore, the expected utility function that the owner can choose to adopt the hybrid strategy in the general state can be expressed as

$$\bar{E}_y = qE_{y1} + (1-q)E_{y2} = S_1 + qu_1 - pu_2 \quad (5.3)$$

Similarly, the expected utility function that the contractor chooses to take opportunistic and profit-taking behavior can be expressed as

$$E_{c1} = q(S - u_1 + u_2) + (1-q)(S_2 + u_2) = S_2 - qu_1 + u_2 \quad (5.4)$$

The expected utility function that contractor chooses not to take the speculative and profit-making behavior is

$$E_{c2} = q(S_2 - u_1) + (1-q)S_2 = S_2 - qu_1 \quad (5.5)$$

Therefore, the expected utility function that the contractor can choose to adopt the hybrid strategy in the general state can be expressed as

$$\bar{E}_c = pE_{c1} + (1-p)E_{c2} = S_2 - qu_1 + pu_2 \quad (5.6)$$

Based on the above analysis, the change rate of the probability for owners choose to take opportunistic profit-making behavior is

$$\frac{dq}{dt} = q(E_{y1} - \bar{E}) = q(1-q)u_1 \quad (5.7)$$

From (5.4) and (5.6), it can be concluded that the probability of the contractor choosing to take the opportunistic and profit-seeking behavior changes at a rate of

$$\frac{dp}{dt} = p(E_{c1} - \bar{E}_c) = p(1-p)u_2 \quad (5.8)$$

The Jacob matrix for this evolutionary game model can be derived from the above formula, that is

$$J = \begin{pmatrix} (1-2q)u_1 & 0 \\ 0 & (1-2p)u_2 \end{pmatrix} \quad (5.9)$$

The determinant  $\det J$  and trace  $\text{tr}J$  of this Jacobian matrix are further determined as follows

$$\det J = (1-2q)u_1(1-2p)u_2 = (1-2p)(1-2q)u_1u_2 \quad (5.10)$$

$$\text{tr}J = (1-2q)u_1 + (1-2p)u_2 \quad (5.11)$$

Let Equations (5.7) and (5.8) be equal to 0, and the equilibrium point of this evolutionary game model can be solved as (0,0), (1,1), (0,1) and (1,0) respectively. Taking the values of these four equilibrium points into Equations (5.10) and (5.11) respectively, the positive and negative values of the above-mentioned Jacob matrix determinant  $\det J$  and trace  $\text{tr}J$  can be obtained. The local evolution strategy of evolutionary game model should meet  $\det J > 0, \text{tr}J < 0$ , which is the Evolutionarily Stable Strategy point. This condition is also the equilibrium state of evolutionary game model.

### 5.1.2 Stability Analysis of Evolutionary Game

Taking the four equilibrium points (0,0), (1,1), (0,1), (1,0) into Equations(5.10) and (5.11)

respectively, we can get the  $\det J$  and  $\text{tr}J$  positive and negative values, as shown in Table 5.4:

Table 5.4 Game Model Evolution Analysis Table

equilibrium points	$\det J$	$\text{tr}J$
(0,0)	$u_1u_2$	$u_1 + u_2$
(1,1)	$u_1u_2$	$-u_1 - u_2$
(0,1)	$-u_1u_2$	$-u_1 + u_2$
(1,0)	$-u_1u_2$	$u_1 - u_2$

In equilibrium point (0, 0),  $\det J > 0, \text{tr}J > 0$ , it is unstable. In equilibrium point (1, 1),  $\det J > 0, \text{tr}J < 0$ , it is ESS (Evolutionarily Stable Strategy) stable point. In equilibrium points (0, 1) and (1, 0),  $\det J > 0$  and  $\text{tr}J$  is uncertain, which are the saddle points. The evolution path is shown in Figure 5.1

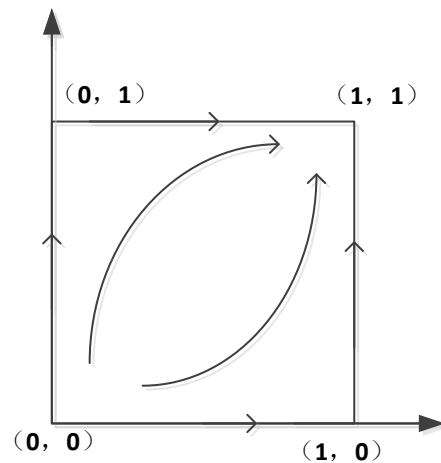


Figure 5.1 General state of evolution path map

In general state, if we consider the immediate short-term interests, from the perspective of the owners, the owners choose to take opportunistic and profit-taking behaviors to obtain additional benefits regardless of the contractors' behaviors. Therefore, the

dominant strategy of the owners is to take speculative behavior. Similarly, from the perspective of the contractor, the contractors choose to take opportunistic and profit-taking behaviors to obtain additional benefits regardless of the owners' behaviors. Therefore, the dominant strategy of the contractors is to take speculative behavior. In this way, owners and contractors are trapped in the typical prisoners' dilemma of game theory under general conditions. The final steady state of the evolutionary game model is that both the owner and the contractor take the opportunistic actions, falling in prisoners' dilemma. This is also the reason for the antagonistic relationship between owners and contractors.

### **5.1.3 Analysis of the Evolutionary Game Result**

In megaprojects, the fundamental reason why owners and contractors fall into the prisoner's dilemma is that both sides only pay attention to immediate short-term interests while ignoring long-term returns. Therefore, they will only make opportunistic and profit-taking acts that harm the bilateral relations and adversely affect the success of the project. The issue of "organizational commitment" and "mutual trust" in the relationship management among organizations in megaprojects can solve this problem. Organizational commitment in megaprojects refers to short-term concessions and sacrifices made by project participants who are willing to maintain good relations with other organizations. High levels of organizational commitment is related to the good relationship quality between organizations. Owners and contractors will work hard to balance their short-term and long-term goals without worrying about their opportunistic and profit-taking behavior under the organizational commitment.

Under the promises of the organization, the owners and contractors of mega projects will reach a win-win attitude and realize that the success of the project is of great benefit to both parties. Both parties, to some extent, will have the awareness of the community of interests and are willing to do their best to achieve the success of the project. And they

are willing to establish good relationships with organizations. Mutual trust can also have the same effect. The evolutionary game process of speculation and profit-seeking behavior between owner and design unit and supervision unit is similar. From this we can see that relationship management among organizations in megaprojects can avoid speculative and profit-taking behavior of project participants, among which organizational commitment and mutual trust play a key role.

## **5.2 Trust Evolution Game between Owners and Contractors in Megaprojects**

In the process of relationship management among organizations in megaprojects, "mutual trust" is a measure of whether good relationships between organizations are established. Trust is also an important dimension of relationship quality among organizations in megaprojects. Organizational trust can greatly facilitate joint problem-solving, sharing of information and resources and effective communication. Organizational commitment and information sharing are fragile, so promising owners choose a trusted partner to reduce speculative and profit-making behavior during megaproject implementation. Trust is the key dimension of relationship management. The evolution of trust between owners and contractors is an important part of the relationship management.

Most of the past researches analyzed trust by establishing the static game model. However, the construction of major projects is a dynamic process. The situations in which both parties are located are constantly changing, and the strategies of both parties will also change. Therefore, this study adopts the idea of evolutionary game to analyze the game process between owners and contractors on whether to take mutual trust from the perspective of dynamic learning, and to explore the attitude and choice of mutual trust between the two parties.



## 5.2.1 Build the Basic Game Model

In order to simplify the evolutionary game model, it is assumed that the owners and contractors will receive the same benefits under the same conditions and the probability of the two parties choose whether to trust each other or not is the same. In this way, the game analysis is liberated from the cumbersome and complicated mathematical solving process. The research focuses on the principle analysis of evolutionary game, and the equilibrium state of final game solution of evolutionary game model is consistent with the actual situation

Based on the above assumptions, the basic components of the model are:

- (1) Participants: Owners and contractors of megaprojects. Both of them are limited rational and pursue the maximization of their respective interests;
- (2) Strategy: Owners choose whether to trust the contractors, Contractors choose whether to trust the owners;
- (3) Revenue: the owners and contractors of the proceeds is the game model of the proceeds. There are four cases, the specific analysis is shown below;
- (4) Equilibrium: the final state of evolutionary game model.

In this evolutionary game model, the contractor and owner's strategy matrix is shown in Table 5.5, where the owner's strategy / action is on the left and the contractor's strategy / action on the right.

Table 5.5 Strategies of Evolutionary game on trust between owners and contractors

		contractor	
		Trust the owner	Not trust the owner
owner	Trust the contractor	(Trust the contractor, Trust the owner)	(Trust the contractor, Not trust the owner)
	Not trust the contractor	(Not trust the contractor, Trust the owner)	(Not trust the contractor, Not trust the owner)

In strategy combination (trust the contractor, trust the owner), both the owner and the

contractor receive the additional benefits of mutual trust, which is expressed as  $I_1$ . In strategy combination (trust the contractor, not trust the owner), the contractor gains more benefit and the owner suffers more than the condition when there is mutual trust . At this point the owner obtains the revenue of  $I_2$ , and the contractor obtains the benefit of  $I_3$ . In strategy combination (not trust the contractor, trust the owner), the returns received by owners and contractors are just the opposite of the strategy combination (trust the contractor, not trust the owner).

That is, the owners unilaterally gain more than the two parties trust each other, and the contractor suffered more loss either. At this point the owner of the obtained the benefit of  $I_3$  , the contractor to obtain the benefits of  $I_2$  . In strategy combination (not trust the contractor, not trust the owner), both parties suffer a certain loss due to the lack of trust, but this loss is smaller than unilateral trust, so the return at this time is more than that of unilateral trust Slightly larger. At this time their income is the same, that is  $I_4$  , seeing Table 5.6.

Table 5.6 the game of trust between Owners and contractors symbol

symbol	Symbol Description
$I_1$	The revenue when owners and contractors trust each other
$I_2$	The revenue when One trusts the counterpart but the counterpart doesn't trust itself
$I_3$	The revenue when One doesn't trust the counterpart but the counterpart trusts itself
$I_4$	The revenue when owners and contractors don't trust each other
s	The probability of owners and contractors choose to trust each other
1-s	The probability of owners and contractors choose not to trust each other

In the construction process of megaproject , if both parties do not trust each other, owners and contractors will pay less loss. One party will gain more benefit when ie doesn't trust the other while the other party trust it. At this time the counterpart's interests will suffer a great loss. Because trust also contains certain degree of risk,which can be understood as the damage and vulnerability of trust. Trust is affected by the uncertainty.

Based on the above analysis, assuming  $I_3 > I_1 > I_4 > I_2$ . The probability that owners and contractors choose to trust each other is expressed as  $s(s \in [0,1])$ , and the probability of choosing not to trust each other is  $1-s$ .

From the above analysis, in the megaprojects, the revenue matrix of the evolutionary game model under the general state constructed by the contractor and the owner is shown in Table 5.7.

Table 5.7 The earning matrix of owners and contractors evolutionary game on trust

		contractors	
		Trust owners $(s)$	Not trust owners $(1-s)$
owners	Trust contractors $(s)$	$I_1, I_1$	$I_2, I_3$
	Not trust contractors $(1-s)$	$I_3, I_2$	$I_4, I_4$

## 5.2.2 Game Analysis Under Missing Trust

According to the above income matrix, it can be concluded that the expected utility function owners or contractors choose to trust each other is

$$E_1 = sI_1 + (1-s)I_2 \quad (5.12)$$

The expected utility function that owners or contractors choose not to trust each other can be expressed as

$$E_2 = sI_3 + (1-s)I_4 \quad (5.13)$$

Therefore, the expected utility function of the owner or contractor can be obtained from the above two formulas as

$$\bar{E} = sE_1 + (1-s)E_2 = s^2I_1 + s(1-s)I_2 + s(1-s)I_3 + (1-s)^2I_4 \quad (5.14)$$

Based on the above analysis, the change rate of the probability that the owners or

contractors choose to trust each other is

$$\frac{ds}{dt} = s(E_1 - \bar{E}) = s(1-s)[s(I_1 - I_3) + (1-s)(I_2 - I_4)] \quad (5.15)$$

The rate of change represented by this differential equation refers to the rate of change of probability of the owner or contractor choosing to trust each other.

Letting  $\frac{ds}{dt} = F(s)$ , Then getting this differential equation derivation on both sides, we can get

$$\frac{ds^2}{dt} = F'(s) = (1-s)[s(I_1 - I_3) + (1-s)(I_2 - I_4)] - s[s(I_1 - I_3) + (1-s)(I_2 - I_4)] + s(1-s)(I_1 - I_3 - I_2 + I_4) \quad (5.16)$$

letting  $F(s) = 0$ , we can get  $s_1 = 0, s_2 = 1, s_3 = \frac{I_4 - I_2}{I_4 - I_2 + I_1 - I_3}$ ,

According to the assumption  $I_3 > I_1 > I_4 > I_2$ , we can get  $I_4 - I_2 > 0, I_1 - I_3 < 0$ , so,  $I_4 - I_2 + I_1 - I_3 < I_4 - I_2$ .

The following discussions are in different situations.

(1) when  $I_4 - I_2 + I_1 - I_3 > 0, s_3 = \frac{I_4 - I_2}{I_4 - I_2 + I_1 - I_3} > 1$ , there is no meaning, because it doesn't meet the requirement that  $s \in [0,1]$ .

(2) when  $I_4 - I_2 + I_1 - I_3 < 0, s_3 = \frac{I_4 - I_2}{I_4 - I_2 + I_1 - I_3} < 0$ , there is no meaning, because it doesn't meet the requirement that  $s \in [0,1]$ .

(3) When  $I_4 - I_2 + I_1 - I_3 = 0, s_3$  is not existing. Therefore, based on the analysis of the above three cases, it can be concluded that it is impossible to obtain a stable solution to the above differential equation. Stable solutions can only be  $s_1$  or  $s_2$ . substituting  $s_1$  and  $s_2$  into the above second-order reciprocal equation, we can get the stability of the

differential equation  $F'(s_1) = I_2 - I_4 < 0, F'(s_2) = I_3 - I_1 > 0$ , which is the stable solution of this evolutionary game model. From this simplified evolutionary game model, it can be concluded that both owners and contractors choose to adopt a strategy of not trusting each other in the absence of trust. The four equilibrium solutions of the evolutionary game model are (0,0), (0, 1), (1,0), (1,1), and the final ESS (Evolutionarily Stable Strategy) is (0,0). The specific evolution path is shown in Figure 5.2.

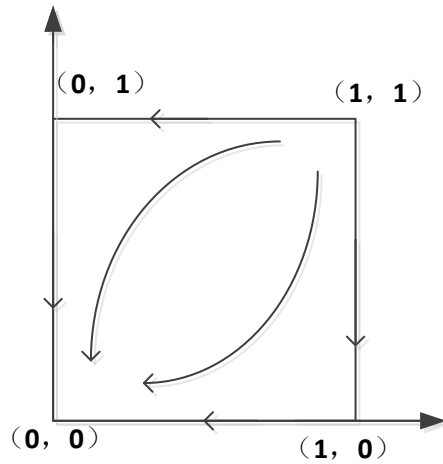


Figure 5.2 Trust evolution between owner and contractor under missing trust

### 5.2.3 Game Analysis under the Condition of Sound Trust Mechanism

When owners and contractors in megaprojects have established good relationships, the two sides begin to trust each other, and if the owners or contractors at this time take the strategy of not trusting each other, then he will have to pay a high cost. At this point, both sides choose to gain mutual and their revenue is the largest of all strategy set. In this case,  $I_1 > I_2 > I_4 > I_3$ , according to the same analytical ideas, differential equation is obtained.

$$\frac{ds}{dt} = s(E_1 - \bar{E}) = s(1-s)[s(I_1 - I_3) + (1-s)(I_2 - I_4)] \quad (5.17)$$

Letting  $F(s) = 0$ , we can get  $s_1 = 0, s_2 = 1, s_3 = \frac{I_2 - I_4}{I_2 - I_4 + I_3 - I_1}$ ,

According to the assumption,  $I_1 > I_2 > I_4 > I_3$ , so  $I_2 - I_4 > 0, I_3 - I_1 < 0$ , so we can get  $I_2 - I_4 + I_3 - I_1 < I_2 - I_4$ .

The following discussions are in different situations.

(1) when  $I_2 - I_4 + I_3 - I_1 > 0$ ,  $s_3 = \frac{I_2 - I_4}{I_2 - I_4 + I_3 - I_1} > 1$ , there is no meaning, because it doesn't meet the requirement that  $s \in [0, 1]$ .

(2) when  $I_2 - I_4 + I_3 - I_1 < 0$ ,  $s_3 = \frac{I_2 - I_4}{I_2 - I_4 + I_3 - I_1} < 0$ , there is no meaning, because it doesn't meet the requirement that  $s \in [0, 1]$ .

(3) When  $I_2 - I_4 + I_3 - I_1 = 0$ ,  $s_3$  is not present. Therefore, based on the analysis of the above three cases, it can be concluded that it is impossible to obtain a stable solution to the above differential equation. Stable solutions can only be  $s_1$  or  $s_2$ . Substituting  $s_1$  and  $s_2$  into the above second-order reciprocal equation respectively, we can get  $s_2 = 1$  is the stability of the differential equation, which is the stable solution of this evolutionary game model. From this simplified evolutionary game model, it can be concluded that owners and contractors will choose to adopt a strategy of trusting each other in the presence of trust. The four equilibrium points of the evolutionary game model are (0,0), (0,1), (1,0), (1,1), and the ESS (Evolutionarily Stable Strategy) is (1, 1). The specific evolution path is shown in Figure 5.3.

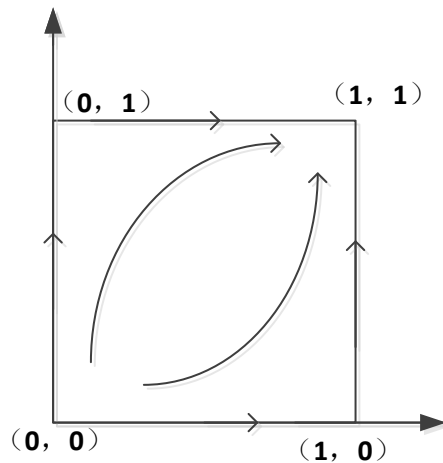


Figure 5.3 Trust evolution of owners and contractors in the presence of trust

The above analysis shows that when the owners and contractors have established good relationships, the two sides begin to trust each other and the state of mutual trust at this time is stable. Under such circumstances, if one of them choose to mistrust another in one game, then he will gain less than trusting each other. At this time, he also suffers more costs. Therefore, when the two parties have a good foundation of trust, the final equilibrium state of the evolutionary game model is mutual trust and the state is stable.

#### 5.2.4 Analysis of Trust Evolution Game Results

Based on the above analysis, we can know that during the construction of mega projects, when the relationship quality between the owner and the contractor is still at a low level, the value of trust between the two parties is not high. In this case, the final result of evolution game between them is not trusting each other. When the relationship quality between the owner and the contractor is still at a high level, the value of trust between the two parties is very high. In this case, the final equilibrium state of evolutionary game between the owner and the contractor is trusting each other and the state is stable. In the process of megaproject construction, both the owner and the contractor need to invest some tangible and intangible resources to ensure the implementation of the project. These resources include land, capital, equipment, technology, professionals, management experience, etc. In general, the more resources invested in a project, the more emphasis

the project will be on both parties and the greater the likelihood of a successful project. But this also needs to bear the associated risk. Because of the uncertainty about the attitude of both parties involved in trust, it can be concluded that the quality of the relationship between the owner and the contractor is closely related to the mutual trust, which can be achieved through the implementation of the relationship management strategies.

### **5.3 Summary of This Chapter**

The relationships among organizations in megaprojects are complex and the relationship between owners and contractors is most representative and receives the most attention. This chapter takes the owners and contractors as an example to analyze the evolutionary game related issues to the relationship management, that is the opportunistic profit-making behavior and the mutual trust between the two parties. If both parties only consider immediate short-term interests, the dominant strategy of balanced game is that both parties take speculative and profit-taking actions. The two sides fall into the typical prisoner's dilemma, resulting in confrontational relationships.

This is because owners and contractors only focus on short-term benefits. The "organizational commitment" and "mutual trust" in relationship management among organizations in megaprojects can solve this dilemma. which is very important. The quality of the relationship between the owner and the contractor is closely related to the mutual trust between the two parties. Mutual trust is based on the good quality of the relationship between the two parties, which can be achieved through the implementation of a relationship management strategies among organizations in megaprojects.



# **Chapter 6 The Process and Strategies of Relationship Management among Organizations in Megaprojects**

## **6.1 The Process of Relationship Management**

Good relationships between people need to operate and maintain so the relationship between organizations also need a series of relationship management strategies to enhance. Therefore, it is very necessary for the owner to manage the relationship between the organizations in megaprojects. For the owners, the relationship management between the core participating parties can be achieved through some strategies. so that there are good relationships among the organizations involved in the megaprojects. The cooperation is also more efficient and the project performance can be greatly improved.

According to the relationship development model of Chen (2007), the relationship management in a project is divided into three stages: initiating relationship, developing relationship, and evaluating relationship. This is in line with the three stages of trust and relationship model proposed by Jin and Ling (2005) (shallow dependence, deep dependence, shallow interdependence), corresponding to different stages of project construction. The division criteria between initiating and developing relationship is whether the contract is signed. There is no strict division between developing and evaluating relationship. It is generally believed that when the mutual trust between organizations begins, the good relationships are established. The relationship evaluation does not necessarily have to be used after the development relationship. The evaluation and the development of the relationship can be carried out simultaneously. The owners take corresponding relationship management strategies according to the evaluation result of the relationship. According to "the relationship between the level of demand," the relationship between different organizations can be divided into five levels, in accordance with the different degrees of shallow to deep. They are pan-level, interest level, friend

level, confidante level and brother level. As the implementation of the megaprojects, the relationships between owners and partners are also changing. Owners at different stages need to adopt different relationship management strategies to their partners. From the perspective of long-term interests, the higher the level of relationships among organizations, the better the quality of the relationship. When the relationship between the owner and the partner reaches a certain level, the owner should adopt the corresponding relationship management strategies to make the relationships developing into a higher level.

### **6.1.1 Initiating the Relationship**

Initiating the relationship refers to the owner and organizations in megaprojects treat the contract as a link to clarify the intention of the parties to establish a good relationship. At this stage, the owner should select the overall strength of the partner during the bidding phase. In addition to ensuring that partners have the strength to successfully accomplish megaproject objectives, the owners should also consider whether the partners have the potential to establish good relationships with them. After carefully identifying the partners, the owner should take the initiative to express his willingness to establish a good relationship with the partners.

Establishing a good relationship with the owners is conducive to the cooperation among organizations. Therefore, the participating organizations will generally respond positively. When both parties express their willingness to establish good relationships with each other at the same time, the owners can implement the following relationship management strategies. When initiating the relationship, the owner signs a good contract with the major construction party to further respond to the owners' relationship management. A fair, objective and reasonable contract reflects the intention of the owner to cooperate sincerely and also inspires the participating organizations actively.

By involving the participating organizations in megaprojects early, the owners give them sufficient time to overcome the difficulties that may arise in the implementation of the

project and this is conducive to the success of the project. For the construction units, they can not only grasp more advanced construction technology, but also have more tough experience, which help enhance their overall strength. At this stage, the level of relationships between the owners and the megaproject participants will go from the pan-level to the level of interests level and there will be a tendency toward the friend level.

### **6.1.2 Developing Relationship**

Developing Relationships means that participating organizations will gradually form a good relationship during the process of interaction by adopting a series of countermeasures. This is the most important stage in the relationship management process among organizations in megaprojects. During this stage, owners need to take a series of relationship management strategies to further develop the relationships among organizations. Organizational commitment and the setting common goals contribute to a consensus among organizations on the establishment of good relations of cooperation. Through top management support and participation, senior management emphasizes the awareness of cooperation and relationship building from the top to the bottom and helps to establish a comprehensive sense of cooperation among organizations.

Appropriately empowering staff and increasing flexibility to deal with issues help to reduce disputes. Owners should strengthen communication with their partners to ensure smooth communication channels such as formal meetings, telephone calls, faxes, emails and the Internet. At the same time, owners should clearly express their intentions, so partners can easily understand and ensure smooth communication channels conducive to information transmission and sharing. Appointing employees with strong interpersonal skills, paying attention to certain communication skills also achieve good results. For some difficulties in the project construction, the participating organizations should work together to make full use of the complementary resources and different background. Owners can also carry out some activities for front-line workers, such as basketball and

football, as well as soliciting the partners on holidays.

The partners have the information superiority to the owners. The owners have the resources superiority to the partners. The major engineering organizations can realize the mutual benefit and sharing resources and information and jointly promote the implementation of the project. At the same time, owners should trust their partners. Trust and understanding will also promote the effective implementation of other relationship management strategies at this stage and achieve a virtuous circle of common promotion and synergy between relationship management strategies. In the establishment of the relationship stage, the owners can adjust the above relationship management strategies in terms of sequence, frequency and intensity according to the actual situation, so that the relationship among organizations can be developed from the interest level to the level of friends or higher.

### **6.1.3 Evaluating the Relationship**

Through the "developing relationship" efforts, the relationship between owners and partners has developed to a friend level. There are mutual trust and understanding. The organizations have established the working model of cooperation. There are already win-win attitudes and mutual respect and understanding at this time. Due to the complexity and uncertainty of megaprojects, the relationships among organizations are dynamic. Owners should also pay attention to monitoring the organizational relationships, and make adjustment about strategies to deal with unexpected situations. The relationship quality evaluation system was used to figure out the satisfaction of front-line workers and middle-level managers through field visits. Based on the project objectives such as quality, progress and cost, the comprehensive evaluation the effect of relationship management can be done.

## **6.2 Relationship Management Strategies and Relationship Quality among Organizations in Megaprojects**

The relationship management strategies sorted out in this chapter is suitable for design unit, the construction unit and the supervision unit. The main purpose for the owners to conduct relationship management towards the above parties is to strengthen cooperation among organizations and establish good interorganizational relationships so as to accomplish the project objectives and improve project performance. Unless particularly specified, "partners" in this article refers to the relationship management objects (design units, construction units and supervision units). The relationship management strategies for megaproject owners are: ① choosing a good partner, ② involving partners in the project early, ③ signing a good contract, ④ organizational commitment, ⑤ adhere to common goals, ⑥ support and participation top management, ⑦ strengthening communication, ⑧ solving the problem jointly, ⑨ cultivating a collaborative atmosphere among organizations, ⑩ sharing resources and information, ⑪ trusting partners, and ⑫ regularly monitoring the status of relationships. The literature sources of the strategies are shown in Table 6.1.

Table 6.1 the literature resource of RM strategies

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Jin and Ling(2005)	√	√	√	√	√	√	√	√	√			√
Zou et al.(2014)						√	√					
Chan et al.(2004)			√		√	√	√	√		√	√	√
Chan et al.(2015)				√				√		√		√
Chen and Chen(2007)					√		√	√			√	
Black et al.(2000)			√			√		√				
Ling et al.(2006)			√		√						√	
Rahman and Kumaraswamy(2002)			√					√				
Cheng et al.(2000)	√					√	√	√		√		
Ling et al.(2013)			√		√			√	√	√		
Bemelmans et al.(2011)						√	√			√		√
Jin et al.(2007)		√	√	√		√	√	√				
Kog and Loh(2011)	√				√						√	
Chang and Shen(2013)				√				√				√
Ibrahim et al.(2014)						√	√					
Ujene and Edike(2015)			√			√	√	√		√	√	
Ibrahim CKI et al.(2011)				√		√	√			√		
Meng(2013)			√				√		√		√	
Pal et al.(2015)	√				√		√	√		√	√	√
count	4	2	9	5	7	10	12	12	3	8	7	6

In the relationship management three-phase model among organizations in megaprojects, developing relationship is the most important phase. During this phase, the owner adopts the organizational commitment, adhere to common goals, support and participation top management, strengthening communication, solving the problem jointly, cultivating a collaborative atmosphere among organizations, sharing resources and information, trusting partners . These relationship management strategies also affect the quality of the relationship among organizations in megaprojects.

## **6.3 Owners' Relationship Management Strategies and Processes**

### **6.3.1 Relationship Management Strategies**

#### (1) Choosing a good partner

Choosing the right partner is the first step in relationship management. Before the bidding, prequalification is used to initially narrow the scope of selection and raise bid requirement appropriately. Bidding documents should be clear, unambiguous and clear. Choosing a partner should consider the following factors: relevant construction practice experience, strength of the project service team, company background and reputation, post-evaluation and feedback of the serviced owner and quotation. The construction industry has always attached great importance to construction practice experience. And it can reflect the construction units competence. The project service team directly participates in the design, construction and consulting process of the project. Its strength, especially the chief architect and project manager, has a direct impact on the success or failure of the project.

The company provides support and guarantee for the project team. The project team is under the leadership and management of the company. Powerful company has many resources. Good reputation in the industry is also the external performance of its strength. The post-assessment and feedback of the serviced owner reflects the service level of the partner. The satisfaction of the owner is also a measure of the project's performance. As an important part of the business quotations, quotations naturally have to be valued. In addition to the above factors, whether the partners have a good relationship and cooperation records should also be considered. Relationship management is not yet popular in the Chinese construction industry. Many practitioners regard it as a new thing. If partners have relevant relationship and cooperation experience, it will inevitably

improve the efficiency of relationship management between major engineering organizations and further promote the improvement of relationships. Partners need strong relationship and cooperation capabilities. The relationship cooperation ability mainly includes cultural compatibility, learning ability, information acquisition and processing efficiency.

## (2) Involving partners in the project early

The life cycle of a megaproject can generally be divided into four phases: decision-design-construction-operation. The design unit, construction unit, and supervision unit participate in the project at different time. At present, China's construction industry generally adopts a "design-bidding-building (DBB)" procurement model. The separation of design and construction may pose a risk of construction drawback. This will not only affect the progress of the project, but may also result in changes and claims. The designer may not be able to implement a design scheme because he or she does not understand the actual situation in construction. As a result, the construction unit cannot meet the design requirements during the actual construction.

Involving partners to participate in the project early, mainly refers to the construction unit involved in the project at the design stage. By doing so, the contractor can fully communicate with the designer which can improve the project's constructability. On the other hand, if the designer does have higher requirements beyond the current construction level, by involving the construction unit in the project early give it enough time to overcome the relevant technical problems and conduct constructability research. Not only can it Embodying the designer's concept, but helps to improve the construction process and level, ensure the quality of the project, increase the value of the project, and promote the healthy development of the construction industry. Involving the supervision unit in the project early to make it aware of construction difficulties and key points, so that it is prepared to facilitate the implementation of key management projects to ensure project quality.



Owners should do a good job of coordinating and communicating among them to ensure smooth communication between design and construction units, so that all participants form a collaborative atmosphere and avoid conflicts. This is true for both owners and design units. The implementation of BIM (Building Information Modeling) technology enables partners to get involved in the project early.

It should be noted that since China's current project bidding system does not allow the construction when design is not finished, megaprojects are generally government investment projects and must take the form of open tendering, which sets the obstacles for the relationship management strategy of “involving partners participate in the project early. The cultivation of the relationships between major engineering organizations is a long-term process. Based on this, this paper believes that it is necessary to break the existing model and develop new types of contract-granting relations, such as the project general contracting model, combing design and construction to maximize project performance.

### (3) Signing a good contract

A good contract is the guarantee and foundation for the owner's relationship management. The basic criteria for a good contract are fair, objective, and reasonable. The owners have absolute power in the implementation of the megaprojects, and the design, construction and supervision units are in a relatively passive situation. In order to successfully win the bid, the above-mentioned participants may sometimes sign contractual clauses which is unfair. They may make up for the benefits in other ways which may harm the project. The construction unit performed most clearly at this point. They may win the bidding in the low price and make high price claims. construction units and supervision units seeking rent. A fair and objective contract is a reflection of the owners' willingness to establish a good relationship with their partners. Establishing a common goal will also promote the relationship between the owner and the partner, such as improving project performance, achieving excellent city or provincial excellence, and so on. The clauses of the contract

should clearly divide the responsibilities and obligations of both parties. There should be no ambiguous and unclear terms. Both parties must comply with their own rights and responsibilities.

Owners can also establish appropriate incentives and punishment for partners to identify the bottom line and encourage them to contribute to improving project performance. The owners should also share the benefits and losses with the partners and reduce their risks. In addition, some irreparable terms should be retained to deal with the uncertainty of the contract. It is impossible for a detailed contract to take all the actual situations into account. The complexity and uncertainty of major projects require more flexible space. If the contract terms are too cumbersome and complex, it is not conducive to building mutual trust with partners. Based on fair, objective and reasonable contracts, major project organizations establish common goals, have clear division of responsibilities and rights, and establish rewards and penalties. Contracts have certain flexibility with terms that can be changed depend on both sides. A good relationship will facilitate the advancement of the project.

#### (4) Organizational commitment

Organizational commitment refers to “in the process of exchange, one organization considers that the continuing relationship with another organization is very important, and therefore he needs to do his best to maintain this relationship ( Morgan and Hunt 1994). Commitment in business relations means that a company is willing to make short-term sacrifices in order to maintain its relationship with its partners (Anderson and Weitz, 1992). After initiating the relationship, the owner and design unit, construction unit, and supervision unit should have organizational commitments. Owners and partners who have long-term commitments will work hard to balance their short-term tasks and long-term goals. They do not have to worry that the other party will engage in speculative activities and achieve their own and common goals. Major project organizations have reached a win-win situation. They are aware that the success of the project will be of

great benefit to the project participants. The project participants will have a sense of interest community to a certain extent and are willing to do things which is good for success of the project contributes. They are also more willing to establish a good relationship among organizations.

(5) Adhere to common goals

Major construction project participants should exchange their expectations and goals at different stages, clarify key objectives in different periods, and establish common goals. When there is a conflict between the target and the common goal, it is necessary to make adjustment in time so as to achieve the adherence to the common goal. The common goal is to maintain the participation of different project participants. It is also the basis for the development of good relationships among organizations. All the participating party forms a target community or a common goal alliance to promote communication and cooperation among organizations. The establishment of common goals between different organizations cannot be accomplished overnight and requires a long process. In this process, the participants of the project need to carefully consider their respective goals carefully. At the same time, taking into account the overlap between their needs and interests through repeated consultations. Only when the organizations agree on a common goal, can their respective interests and best values be realized.

(6) Top management support and participation

In organizational theory, there are generally three levels of management: the grassroots, the middle, and the high levels. Grassroots managers are also front-line managers, mainly managing non-management personnel who are engaged in product production or providing services on the front line. The middle managers mainly manage the grassroots managers. Similarly, the senior management manages the middle managers, and has the responsibilities of cross-functional departments. Senior managers coordinate the resources and tasks of various departments and ensure the realization of the overall goals of the organization. In the context of traditional Chinese culture, management power is

concentrated at the top, and senior managers have strong decision and execution rights. The promotion of relationship management requires the support and participation of senior management.

There are two kinds of reforms: bottom-up and top-down approaches. Relationship management is a new concept that has not yet been widely practiced in China. It is easier to achieve success by adopting the top-down approach. The characteristics of the construction industry are also more suitable for top-down reforms. The owners must reach a consensus with the top management of the partners, and then the top management emphasizes the sense of cooperation from top to bottom. Management personnel from all levels should emphasize the concept of relationship management at the meeting and conduct it in practice. This can enable employees at all levels to gradually embrace the concept of relationship management. At the same time, employees should be given appropriate powers, leaving them with a certain amount of space for self-determination, which can reduce unnecessary levels of information transfer and improve the efficiency of event handling.

#### (7) Strengthen communication

Good communication is very important in relationship management among organizations in megaprojects. Active communication initiated by the owner is an important way to maintain and improve the relationship among organizations. Because of different culture and background, owners and their partners will have their own preferred industry terminology, commonly known as “jargon”. This may cause communication obstacles, which is not conducive to the transmission of information, and it can lead to the estrangement and misunderstanding between the owners and partners, resulting in an antagonistic relationship. Effective communication can reduce suspicions, avoid disputes, and eliminate cultural barriers. It is the basis for maintaining good relationships and establishing mutual trust. In previous projects, the owners and project participants mainly communicated by the contract language. This is far from enough for large projects with

large amounts of information. It will limit the owners from establishing a good relationship with major project participants.

Communication skills can help the communication process in relationship management. If employees have good communication skills, they will ensure the accuracy of information transmission and improve the overall communication efficiency of the organization. In addition, the strong coordination ability of the staff can also ensure the effectiveness of the communication between the two parties. This also helps to create an open and inclusive atmosphere among the teams. The communication of senior managers can promote consensus between the parties, increase mutual trust and understanding, and promote the development of relationships. Effective communication between employees of each organization is conducive to the exchange of technology and thus facilitates the sharing of information. An effective communication channel between owners and partners should be established to ensure the smooth flow of information among organizations.

In addition to the contract, face-to-face meetings, telephone, fax, mail, and the Internet can also be used for effective communication. Full and effective communication enables the sharing of information on project technology and knowledge among organizations. Organizations can exert their cooperative efforts to create acceptable expectations. The communication between the owner and major project participants is measured from three dimensions: the quality of communication, the degree of information sharing, and the degree of interaction and participation in planning and objectives. The quality of communication includes the effectiveness, timeliness, and accuracy of information communication.

#### (8) Jointly solving the problem

Although a lot of work was done to improve the relationship among organizations, conflicts and problems are inevitable during the implementation of the project. It is necessary for the owners and partners to reach a consensus on a joint solution to the

problem. Setting up a regular meeting and informal work meetings to discuss the solution to the problem with the partners is a good method. Owners can also preside over the design coordination meeting to ensure the smooth communication between the design unit and the construction unit and eliminate the gap between them. Establishing a risk warning mechanism to identify potential problems and resolve the problems in time to help project teams improve their ability to resist risks is also a good method.

Owner should establish conflict resolution mechanisms with the partners jointly. If the problems come out, there is a mature process to resolve them. The owners and partners will do their best to solve the problems. The conflict refers to a disharmonious state among organizations. The reason for this dissonance is generally caused by the inconsistency of behavior due to different interest needs and cognitive perspectives. For conflicts between owners and major project participants, cooperation, compromise, indifference, and coercive measures can be used in a comprehensive manner so that the partners can jointly solve problems.

#### (9) Fostering collaboration between organizations

Collaboration between organizations does not mean recruiting team members to concentrate on working in one place, but emphasizes the need for efficient collaboration and collaborative decision-making among organizations. The collaborative atmosphere between the owners and partners can be established by organizing team building activities, fostering a learning atmosphere. Organizing team building activities can improve employees' self-identity and sense of team belonging. It is a way for grass-root employees to understand organizational culture. Holding cross-organizational associations, such as basketball and football, can not only eliminate the barriers between organizations, enhance the team's cohesiveness, but also enrich their leisure life.

Learning can change attitudes, eliminate barriers to cooperation, and create competitive advantages. This is particularly important for construction companies. The level of cultural knowledge of construction workers is generally low, and they lack in spiritual life.

Advocating mutual learning can improve the overall knowledge of employees. At the organizational level, the design, construction and supervision units have a lot of experience worthy of the owners to learn. Once the collaborative atmosphere between the owners and partners is established, relationship management will be more natural and efficient.

#### (10) Sharing information and resources

Resources are scarce and competitive, and an organization usually does not share resources with other organizations (Cheng et al., 2000). Resources are divided into tangible resources and intangible resources, including land, capital, equipment, personnel, technology, management experience, and so on. In the implementation of the project, information is a very important resource. In addition, resources also include knowledge, professional skills and assets. The completion of a project is the result of integration of resources owned by owners, design units, construction units, project management consultants, and other project stakeholders. The owners and the above partners have different resources due to different professional backgrounds. If properly integrated and managed, such professional complementarity can enhance the competitive advantages of major engineering organizations and the strength of project construction and maximizing project benefits. Information sharing is also a dimension of the relationship quality among organizations in megaprojects.

BIM (Building Information Modeling) technology can effectively achieve information sharing between owners and partners. BIM technology is an integrated management. By establishing a parameterized model, the owner can timely and comprehensively grasp the project's various information. The partners insert, update and modify information in the implementation process of the project in time. The owner realizes the real-time control of the project information by viewing the parameterized model. For example, when a certain construction process on the construction site has changed, the construction unit will modify the corresponding information on the parameterized model in time, and the owner

will be able to query and monitor the accurate project information in real time. BIM 5D collaborative management is the latest technology to achieve information sharing between the owner and the construction unit. The construction project accurate and real-time construction progress information, as well as the project detailed contract price can accurately control the cost and progress of the project. Enables real-time sharing of information between owners and partners

#### (11) Trusting Partners

Trusting partners includes believing, understanding and respecting partners. This is the best state of relationship management pursuit. When the organizations begin to trust each other, it means that the relationship management of the owners has achieved remarkable results. Owners' trust in partners includes three dimensions: contract level, competence level, and emotional level. Trust at the contract level is basically established when “signing a good contract”. The competence level of trust is established when “choosing good partners”, while the emotional level of trust requires a series of relationship management measures to achieve. Owners and partners believe their counterparts will fulfill their responsibilities and obligations in an exchange relationship (Pruit, 2013). Mutual trust can reduce stress and improve adaptability, which is very important for breaking the boundaries of the relationship (Williamson, 2008). The two parties can consider each other’s difficulties and are willing to make concessions and compromises on some non-principal issues. Both parties can help each other. The owners can tolerate minor mistakes caused by objective factors. And partners are willing to help the owners such as taking on some extra work requirements.

#### (12) Regularly monitoring the status of the relationship

The relationship quality among organizations in megaprojects is the measure of partnership success. Relationship management among organizations in megaprojects is a dynamic process. The relationship between owners and partners will be affected by many factors and will also be accompanied by the progress of the project and the relationship



management of the owners. The high degree of complexity and uncertainty of megaprojects makes it more difficult for owners to manage relationships with partners to some degree. Therefore, owners must have a sense of monitoring the relationship quality among organizations in megaprojects when they begin to conduct relationship management.

Through the monitoring of relationship quality, owners can control relationship investment, assess the management effectiveness, adjust management strategies, improve the dynamic management process of relationship quality, and ensure the healthy development of relationships among organizations in megaprojects. The relationship quality among organizations in megaprojects will affect the project performance. And it can be indirectly assessed from the actual quality, progress, and cost completion of the project implementation process. However, there are certain limitations in this perspective. The owner can use the relationship quality evaluation system in Chapter 4 to know the relationship status among organizations. Owners should also conduct on-site visits to check the progress of the project, so as to more comprehensively and accurately grasp the relationship quality among organizations and ensure the implementation of relationship management.

### **6.3.2 Implementation of Relationship Management Strategies**

The above 12 relationship management strategies should be implemented in accordance with the project progress and the relationship quality among organizations in megaprojects. The initiation phase of the relationship corresponds to bidding and contract signing. At this stage, the owner needs to carefully select a good partner. After confirming the cooperation relationship with major project participants, owners can involve the partners participating in the project in advance. Megaprojects are often technically complex, with many construction problems to be overcome, and require high level of construction technology. The construction unit and the supervision unit involved early in

the project and cooperated with the design unit to improve the constructability of the design diagram so as to ensure the progress and quality goals of the project.

Signing a good contract can avoid a large number of unreasonable claims, which helps to control costs and increase owners' satisfaction. In the development of relationship stage, organizational commitment, adhering to common goals, top management support and participation are prerequisites for developing relationship between the owner and the partner. On this basis, the owner should strengthen communication with partners and establish a conflict resolution mechanism approved by both parties. Through a number of friendship and sympathy activities, collaborative atmosphere will be fostered among the organizations. then the owners can adopt the strategies of sharing resources, and actively trusting partners to establish a good relationship with partners. In the phase of relationship evaluation, the owner periodically evaluates the relationship quality to ensure that the relationship status is working well and ultimately improves project performance.

See Figure 6.2.

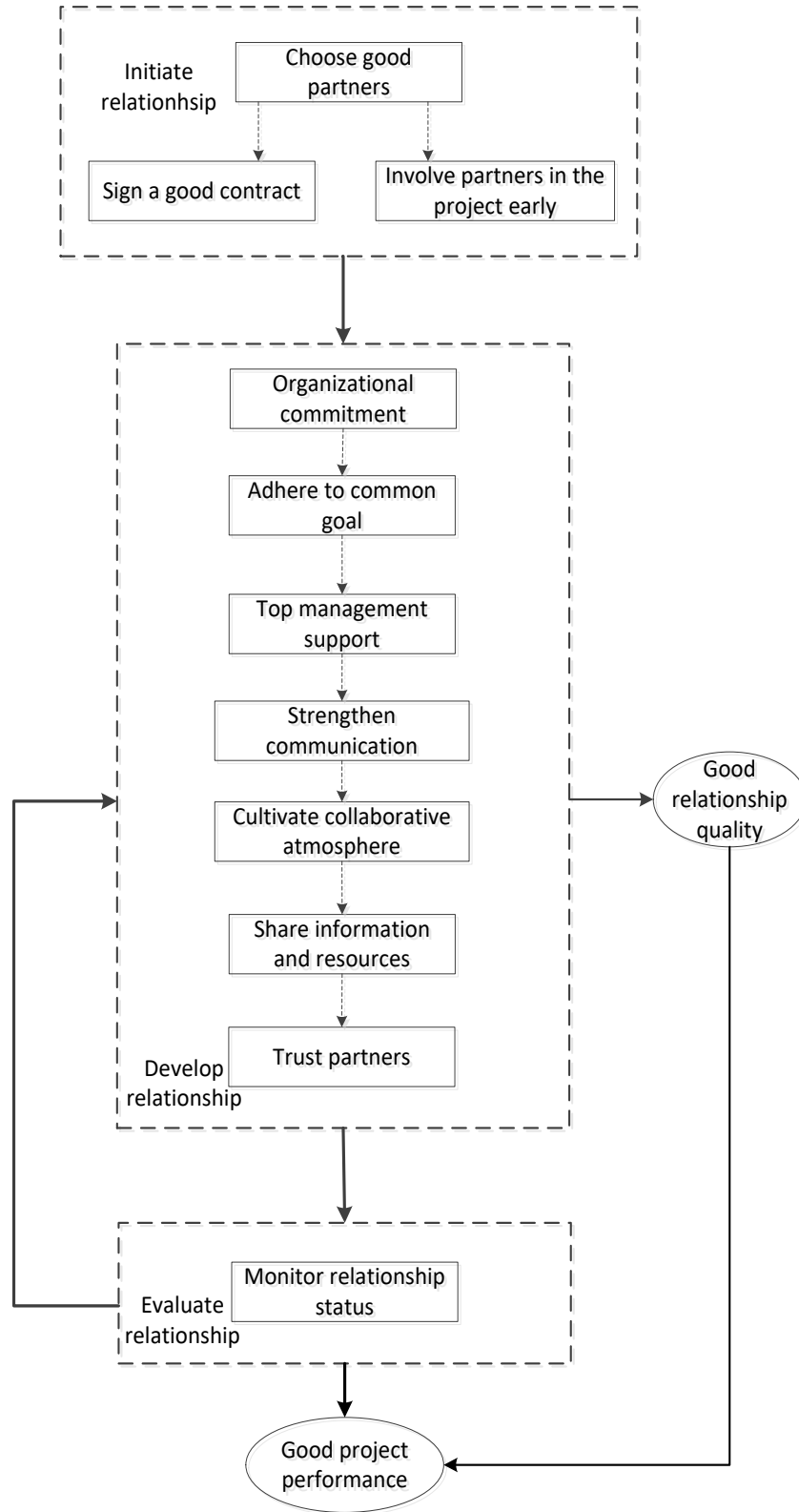


Figure 6.2 relationship management implementation

## 6.4 Summary of This Chapter

This chapter first establishes a three-phase process model for relationship management, that is initiating relationship, developing relationship, and evaluating relationship. Then summarized 12 relationship management strategies, which provides a management process reference model for the owners to conduct relationship management for the design, construction and supervision units. In the initiating relationship phase, the owners should adopt a relationship management strategy of “choosing a good partner”, “involving partners participate in the project early” and “signing a good contract”. When choosing a partner, owners should consider the following factors: related engineering practice experience, the strength of the project service team, the company's background and reputation, post-assessment and feedback from the serviced owner and quotation.

Involving partners to participate in the project early mainly refers to the construction unit involved in the project at the design stage. By doing so, the designer can fully communicate with the contractors and can improve the project's constructability. The basic criteria for a good contract are fair, objective, and reasonable. During the developing relationship stage, the owners should adopt the relationship management strategies of “organizational commitment”, “adhering to a common goal”, “top management support and participation”, “enhancing communication”, “jointly solving problems”, “cultivating collaborative atmosphere among organizations”, and “sharing information and sources”. "trusting partners". The relationship management promotion requires the support and participation of senior management. Effective communication can reduce suspicion, avoid disputes, and eliminate cultural barriers.

Jointly solving problems helps resolve conflicts and promote project implementation. Cultivating a collaborative atmosphere among organizations facilitates cooperation. Sharing information and resources facilitates the improvement of relationships between organizations. Trusting partners includes believing, understanding and respecting partners. This is the best state of relationship management pursuit. In the evaluation phase, the

owners should adopt a relationship management strategy of “regularly monitoring the status of the relationship”, Including the establishment of the evaluation system, paying close attention to the progress of major projects, cost, quality goals. Owners should also value frontline workers and management feedback and make adjustment in time.

# Chapter 7 Conclusions and Prospects

## 7.1 Main conclusions

This article focused on research issues related to the relationship quality and relationship management among organizations in megaprojects. Combining literature research and expert interviews, this paper further defined the related concepts of relationship management among organizations in megaprojects, determined the specific meaning, management subject, effect and relationship quality dimension, and laid the foundation for subsequent research. Relationship management among organizations in megaprojects improves project performance by improving the relationships quality among organizations. The dimension of relationship quality embodies the connotation of relationship management. Therefore, this paper deeply analyzes the dimensions of relationship quality among organizations in megaprojects and establishes a relationship quality assessment system.

The relationships among organizations are complicated. Taking the most representative owners and contractors for example, this paper analyzed the issues related to relationship management among organizations in megaprojects through evolutionary game. The relationship management between owners and other participating parties can also be used for reference. Finally, this paper combined the evolutionary game results with the relationship quality dimension to construct a process model of relationship management among organizations, sort out relationship management strategies, enrich existing relationship management research, and provide references for practice.

(1) Related Concepts of Relationship Management among organizations in megaprojects  
Expert interviews were conducted on the basis of literature research to define the meanings, subjects, boundaries and management effectiveness of relationship management. The major participants of megaprojects are the subjects of relationship

management, including owners, design units, construction units, and supervision units. The specific meaning is that the owners adopt relevant management measures to enhance the quality of the relationship with the project participants (design, construction, suppliers, supervisors, etc.) and achieve an efficient and collaborative process in order to successfully achieve the project objectives. The direct result of relationship management is the improvement of relationship quality. The dimensions relationship quality among organizations in megaprojects include organizational commitment, common goals, joint problem solving, information sharing, effective communication and mutual trust. Relationship management can foster the mutual trust of major project participants, accelerate the process of cooperation and improve project performance, and at the same time increase the satisfaction of owners and project participants.

#### (2) the Dimension and Evaluation of Relationship Quality

The relationship quality of among organizations in megaprojects includes six dimensions: organizational commitment, common goal, joint problem solving, information sharing, effective communication and mutual trust. Organizational commitment means that during the exchange, it is important for one organization to consider that the ongoing relationship between another organization is very important, and it is necessary to do its best to maintain the relationship (Morgan and Hunt, 1994). A common goal helps to increase the cohesion among the organizations in megaprojects. Adhere to common goals can converge of goals and efforts among different participating organizations and ultimately achieve the goals of themselves and the project. The successful implementation of the major construction project objectives requires that all organizations involved in the project should work together to coordinate the planning and solve the problems jointly. Information sharing among project participants helps to facilitate coordination among organizations. Effective communication is an important aspect of relationship management, including a bilateral expectation that both parties will take the initiative to provide useful information to their partners.

When two organizations trust each other, they are willing to share confidential information and support the development of the relationship between them(Wong and Sohal 2002). Organizational commitment is the prerequisite for relationship management. Both parties set a common goal based on this, and then start to jointly solve the problem, share information and resources, and begin effectively communication. After the relationship between the two organizations have developed to a certain extent, they start to trust each other. Trust will further promote the role of other dimensions of relationship quality. And mutual trust is the core dimension. Based on the dimension of relationship quality, this chapter subdivides it into 18 evaluation indexes and establish the relationship quality evaluation system among organizations in megaprojects using fuzzy decision method.

### (3) Evolutionary Game Analysis of Relationship Management

The relationships among organizations in megaprojects are complex and the relationship between owners and contractors is most representative and receives the most attention. This chapter takes the owners and contractors as an example to analyze the evolutionary game related issues to the relationship management, that is the opportunistic profit-making behavior and the mutual trust between the two parties. If both parties only consider immediate short-term interests, the dominant strategy of balanced game is that both parties take speculative and profit-taking actions. The two sides fall into the typical prisoner's dilemma, resulting in confrontational relationships. This is because owners and contractors only focus on short-term benefits. The "organizational commitment" and "mutual trust" in relationship management among organizations in megaprojects can solve this dilemma. which is very important. The quality of the relationship between the owner and the contractor is closely related to the mutual trust between the two parties. Mutual trust is based on the good quality of the relationship between the two parties, which can be achieved through the implementation of a relationship management strategies among organizations in megaprojects.



#### (4) Relationship Management Process and Strategies

This paper first establishes a three-phase process model for relationship management, that is initiating relationship, developing relationship, and evaluating relationship. Then summarized 12 relationship management strategies, which provides a management process reference model for the owners to conduct relationship management for the design, construction and supervision units. In the initiating relationship phase, the owners should adopt a relationship management strategy of “choosing a good partner”, “involving partners participate in the project early” and “signing a good contract”. When choosing a partner, owners should consider the following factors: related engineering practice experience, the strength of the project service team, the company's background and reputation, post-assessment and feedback from the serviced owner and quotation.

Involving partners to participate in the project early mainly refers to the construction unit involved in the project at the design stage. By doing so, the designer can fully communicate with the contractors and can improve the project's constructability. The basic criteria for a good contract are fair, objective, and reasonable. During the developing relationship stage, the owners should adopt the relationship management strategies of “organizational commitment”, “adhering to a common goal”, “top management support and participation”, “enhancing communication”, “jointly solving problems”, “cultivating collaborative atmosphere among organizations”, and “sharing information and sources”. “trusting partners”. The relationship management promotion requires the support and participation of senior management. Effective communication can reduce suspicion, avoid disputes, and eliminate cultural barriers.

Jointly solving problems helps resolve conflicts and promote project implementation. Cultivating a collaborative atmosphere among organizations facilitates cooperation. Sharing information and resources facilitates the improvement of relationships between organizations. Trusting partners includes believing, understanding and respecting partners. This is the best state of relationship management pursuit. In the evaluation phase, the

owners should adopt a relationship management strategy of “regularly monitoring the status of the relationship”, Including the establishment of the evaluation system, paying close attention to the progress of major projects, cost, quality goals. Owners should also value frontline workers and management feedback and make adjustment in time.

## **7.2 Research Insufficiency and Prospect**

Seven experts were interviewed in the expert interview. The number of experts was small, which may lead to subjective biases in the interview results. The experts interviewed came from the owners and consultants, design institutes, construction units, and supervision units. There were no experts from the suppliers, which also led to insufficient attention to the suppliers. The experts interviewed are all from the field of engineering practice. The research should also conduct interviews with research experts in related fields such as university professors. They have rich research experience in the field of engineering management and can theoretically provide a more comprehensive view for this research.

This paper summarized relationship management strategies through literature analysis methods and expert interview which are qualitative. The results of this qualitative analysis are subject. In future research, questionnaires and other methods can be used to quantitatively analyze the issues related to relationship management among organizations in megaprojects.

BIM technology has been widely used in the field of construction practice in recent years. It can realize the timely communication between the design unit and the construction unit. BIM 5D collaborative management is the latest technology to achieve information sharing between the owner and the contractor. This enables the sharing of information between the owner and the contractor to be truly realized. Future research can combine relationship management with BIM to explore more efficient management processes

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