DEVELOPING A PROGRAM ORGANIZATION FRAMEWORK FOR THE SUCCESS OF CONSTRUCTION MEGAPROJECTS IN CHINA

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CERTIFICATE OF ORGINALITY

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ABSTRACT

Over the past two decades, a growing number of construction megaprojects have emerged in China because of rapid urbanization and economic development. However, managing these megaprojects not only faces increasing internal complexities as a result of large size, dispensed executions, high technical complexity and numerous participants involved in the megaprojects, but also the external complexities caused by the transition of economic, political, social and cultural contexts in the country. Thus, program management is increasingly being supported as a pragmatic and contextual means of managing megaproject complexities and ensuring megaproject success. This study aims to develop a pragmatic and integrated framework of program organization for construction megaproject success from the client perspective based on the case study of Shanghai Expo construction. A mixed research methodology is adopted in this study, including literature review, interviews, Delphi survey, and fuzzy synthetic evaluation (FSE).

To construct the theoretical background used in this study, the history, definitions, problems, perspectives, developments and directions of construction megaproject research are first presented. Reviewed literature reveals that megaproject organization is an essential subject and a key to megaproject success in megaproject research. The applicability of the program management approach in managing construction megaprojects from the viewpoints of academics and professionals is then examined. Developments and trends in program management research were also reviewed. The review results confirmed the usefulness of the program management approach for clients in constructing high-performing execution organizations and the achievement of megaproject success. An integrated conceptual framework was then formulated based on literature review, and was elaborated by interviewing experts on megaproject practices. The integrated conceptual framework consists of 24 program organizational factors (POFs). A two-round Delphi survey was also conducted to identify principal POFs in managing construction megaprojects. Eleven principal POFs were identified as (1) contextual understanding, (2) program strategy, (3) program leadership, (4) program governance, (5) matrix organizational structure, (6) program management office, (7) use of project breakdown structure/work breakdown

structure, (8) partnership with key stakeholders, (9) technology management, (10) communication management, and (11) team building. The Principal POFs were grouped under three categories: environmental capability, core capacity, and motivational capability.

A program organizational performance index (POPI) is also developed to assess the effect of a client program organization on its corresponding megaproject performance. The FSE model is considered as the most suitable technique for establishing the POPI model. Shanghai Expo construction illustrated the application of the POPI in a particular case study. Fuzzy membership function, a core component in fuzzy theory, assessed the effect of the 11 principal POFs against each of the four selected key performance indicators (KPIs). The four KPIs include time, cost, functionality and quality, and occupational health and safety. A quantitative method is derived from the four KPIs to assess the performance of the established client program organization in the management of a particular megaproject. Performance of the program organization consists of 11 principal POFs can be quantified objectively by the megaproject clients. An FSE model is finally developed using weighted mean method, which aggregates the measured overall performance of the 11 principal POFs against the selection criteria. FSE analysis results indicate that the client program organization contributed significantly to the accomplishment of the four key objectives. The POPI model not only enables clients to tailor the construction of their program organizations for managing a particular megaproject, but is also useful in optimizing the operation of principal POFs within the organizations with regard to megaproject KPIs.

This study is the first attempt to develop an integrated and pragmatic framework of program organization for managing construction megaprojects in China. The framework is developed based on a single case study. However, the findings can provide a better understanding of program management and relevant guidelines in managing construction megaprojects. Findings can also pave the way for future research on construction megaprojects in other countries.

LIST OF RESEARCH PUBLICATIONS

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Eight years ago, I was first involved in the study on program management information system for Shanghai Expo construction. I never thought that I could get so closely involved in construction megaproject practices in China, which has been a key driver of rapid urbanization in the country since the early 1990s. Shanghai Expo construction has become a core theme in my nearly eight years of research and practical experiences in the construction sector.

The beginning of my journey to join, observe, and rethink construction megaproject practices in China, which is mainly based on the Shanghai Expo case, was inspired by Prof. Yun Le, my MPhil supervisor at Tongji University. Under his supervision, I completed my master's thesis, which attempted to develop a pragmatic framework for implementing sustainable construction of the Shanghai Expo construction project, a specific case of a construction megaproject in China. After graduating from Tongji University, I became a professional management consultant at the Shanghai Expo construction project for almost four years, an opportunity that I gained partly through Prof. Le's recommendation. I first became an Assistant Project Manager for the Shanghai Expo Village client, and then became as an Associate Program Manager for the Shanghai Expo construction client, where I witnessed the entire construction process of one of the largest building megaprojects in China since 1949.

Subsequently, in November 2009, I had the opportunity to help Prof. Le respond to an email from Prof. Albert P.C. Chan at the Department of Building and Restate Estate, The Hong Kong Polytechnic University (HKPolyU), in November 2009. I never imagined that Prof. Chan would change my path in life by instilling in me the vision, passion and attitude necessary to contribute to society through research. He provided constant support, unfailing encouragements, valuable guidances, and useful advices throughout my study period. I would like to express my utmost gratitude to him for his guidance and encouragement during the writing of this thesis. Sincere thanks are also extended to Prof. Le, the co-supervisor at HKPolyU, for the guidance, encouragement, and support he provided to me during the period of my master study until my PhD thesis.

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CHAPTER 1: INTRODUCTION

1.1 RESEARCH BACKGROUND

Outstanding economic achievement and fast urbanization has caused construction megaprojects to increase exponentially in China over the past two decades. An investigation conducted by Tongji University (Le, 2009) revealed that 203 construction megaprojects were initiated from 1990 to 2009, each one reaching the cost threshold of RMB 5 billion (almost USD 800 million). These megaprojects included some of super megaprojects in history, such as the Three Gorges Dam, South-to-North Water Diversion Project, and national high-speed rail network. Each megaproject costs over dozens of billions USD. Aside from large-scale investments, multiple challenges in delivery management were faced by majority of these megaprojects such as a mega construction scale, a compressed schedule, hundreds of contractors and designers, and a significant amount of works caused by adopting a design–bid–build approach and construction in parallel mode. To deliver megaprojects on time, most construction megaprojects are divided into several constituent projects and executed separately. However, coordinating and controlling the execution of the delegated constituent projects can pose a great challenge in realizing the overall objectives of a certain megaproject. According to Levitt (2012), construction projects are characterized by decentralized execution. Challenges in Chinese construction megaprojects may also be applicable to other countries and regions.

Program management is increasingly promoted as a key approach to improving megaproject performance through coordinated management of constituent projects within a megaproject (Beehleer, 2009; Rasdorf et al., 2007; Eweje et al., 2012). A megaproject is executed by dividing it into several related constituent projects while sharing common objectives, so executing a construction megaproject is a matter of managing a program (Eweje et al. 2012; Artto et al., 2008; Kim et al., 2009;

Pellegrinelli et al., 2011). Rasdorf et al. (2010) stated that program management can be considered as the application of construction management on megaprojects in numerous ways. Beehleer (2009) emphasized the merits of program management in managing megaprojects by comparing it with two traditional procurement approaches: design–bid–build and design–build. Despite these studies, limited literature is available on the practical application of program management approach in megaproject management.

1.2 RESEARCH PROBLEMS

Program management is accomplished through coordinated management of constituent projects within a megaproject (Beehleer, 2009; Rasdorf et al., 2007; Eweje et al., 2012). However, the lack of clarity and concern in establishing a program management standard for the construction industry may diminish interest in this emerging approach (Milosevic et al., 2007; Artto et al., 2008). Therefore, this study aims to develop a practical model of program organization in managing construction megaprojects based on the case of Shanghai Expo construction. By establishing this model, construction megaproject professionals can collectively establish a baseline for client organizations to manage construction megaprojects throughout the construction lifecycle. Ultimately, the model can improve the performance of construction megaprojects in China and other parts of the world. The program organization model is developed based on a Chinese case. However, the research methodology can be replicated in other countries to produce similar models for international comparisons. Producing similar models would assist in the understanding of managing megaprojects through the program management approach across various countries.

To establish a systematic and pragmatic model, the following research questions are formulated:

(1) What are the elements of the program organization, specifically program organization factors (POFs), established by a client to manage its megaproject?

(2) What are the most significant POFs that can be considered as principal POFs in the program organization for managing its megaproject?

(3) What are the ways to assess the relationships between principal POFs and megaproject performance?

1.3 RESEARCH AIM AND OBJECTIVES

This study aims to develop a systematic and pragmatic program organization model for the client to enhance the performance of construction megaprojects. Specific objectives are enumerated as follows:

(1) To evaluate historical developments in construction megaproject research, which serve as the foundation of this study;
(2) To define and evaluate the applicability of the program management approach in managing construction megaprojects;
(3) To identify the POFs in the management of a megaproject;
(4) To prioritize the POFs and extract the principal ones;
(5) To establish a multi-criteria program organizational performance model (function) to assess the performance level of a construction megaproject.

1.4 RESEARCH METHODOLOGY AND PROCESS

Mixed research methodology is employed in this study, which includes (1) literature review, (2) case study, (3) semi-structured interviews, (4) Delphi survey, (5) questionnaire survey, (6) mean scoring (MS) ranking technique, and (7) fuzzy synthetic evaluation (FSE) analysis. A Delphi questionnaire survey serves as the main tool for field data collection. Mean scoring (MS) ranking and FSE techniques are used to analyze the empirical data. Table 2.1 and Figure 2.1 in Chapter 2 illustrate the details of the research process. Both qualitative and quantitative research methods are employed to establish and assess the program organization model.

1.5 STRUCTURE OF THE THESIS

The structure of the thesis is as follows:

Chapter 1 provides an introduction to the study. This chapter includes the background, problems, objectives, as well as scope and significance of the study. The research approach and structure of this thesis are also outlined.

Chapter 2 describes the research methodology used in this study. Data collection methods using literature review, semi-structured interviews, and Delphi questionnaire surveys are explained. Data analysis methods, such as MS ranking and FSE, are also introduced.

Chapter 3 evaluates the historical development of construction megaprojects and analyses of major problems encountered in megaprojects in China. A critical review of research viewpoints and developments in construction megaproject research between 2000 and 2010 is also provided.

Chapter 4 reviews megaproject-related papers published in selected peer-reviewed construction journals from 2000 to 2010. Papers identified from eight such journals are analyzed in terms of the number of articles published annually, institutional and regional contributions, citations, and categorization of research interests and methodologies. This review helps underpin the conceptual framework of this study.

Chapter 5 defines the program management approach, and distinguishes it from project management and portfolio management. Justifications for adopting the program management approach in managing construction megaprojects are also provided. Evidences from the industry and academic community are enumerated to emphasize the applicability and merits of the program management approach.

Chapter 6 formulates the conceptual framework of program organization to manage construction megaprojects based on the literature review and semi-structured interviews. A consolidated conceptual framework is also presented.

Chapter 7 extracts the principal POFs of the program organization by conducting a Delphi survey of the Shanghai Expo construction case study. Relative importance of the resulting principal POFs is also evaluated.

Chapter 8 develops a program organizational performance index to examine the performance level of a megaproject based on FSE analysis.

Chapter 9 provides a summary of the research findings, highlights the significance and applications of the study, and recommends directions for future research.

1.6 RESEARCH SIGNIFICANCE AND VALUE

The volume of construction megaprojects continues to increase not only in China but also worldwide because of continuous global urbanization over the past decades. The *Economist* (2008) predicted that significant worldwide investments in infrastructure and urban megaprojects would continue to grow from 2008 to 2017. However, megaprojects are commonly beset with underperformance and high control risks in cost overruns, safety incidents, functional and quality defects and poor environmental performance (Flyvbjerg et al., 2003). Increasing research efforts have been devoted to address emerging challenges in megaprojects (Morris & Hough, 1987; Wachs, 1990; Flyvbjerg et al., 2003). Program management is considered as a new approach to improving megaproject performance through the coordinated management of constituent projects within a megaproject (Artto et al., 2008; Kim et al., 2009; Pellegrinelli et al., 2011). However, limited research is available on the application of the program management approach in the construction industry. This study attempts to fill the research gap.

Project management research is moving toward a new paradigm that considers projects, particularly megaprojects, as organizations (Morris et al., 2011). Today, construction megaprojects face multiple challenges in the delivery process, such as organizing the execution, reacting to the context, managing investors and stakeholders, and maintaining control. All works that are required for the successful delivery of a construction megaproject pose a substantial challenge in organization management. This trend has been reinforced by a growing number of studies on construction megaprojects over the past decade (Miller & Lessard, 2000; Flyvbjerg et al., 2003; Winter et al., 2006). Program management is considered as an approach to improving megaproject performance through organizational development (Lehtonen &

Martinsuo, 2008). Therefore, this study focuses on program organization, which is a unique subject in program management practices.

To sum up, this study aims to develop a program organization model to effectively and efficiently manage a megaproject from a client's perspective based on a consolidated theoretical framework. With the development of the program management model, industry professionals can further learn to build program organizations effectively and sustain the efficiency of these organizations toward accomplishing prescribed objectives.

1.7 CHAPTER SUMMARY

This chapter has outlined a framework for conducting this study, namely (1) research background, (2) research problems, (3) research aim and objectives, (4) research methodology and process, (5) structure of the thesis, and (6) research significance and value.

CHAPTER 2: RESEARCH METHODOLOGY

2.1 INTRODUCTION

As an emerging field, the research on program management practices in this study mainly relies on the case study of Shanghai Expo construction, a recently completed construction megaproject. This megaproject is the first example of the successful use of the program management approach in China through an external program management consultant (Bureau of Shanghai Expo Coordination (BSEC) & Shanghai Municipal Urban and Rural Construction and Transportation Commission (SMURCTC), 2010). Prior to the case study, a theoretical framework was developed based on a review of related literature. The theoretical framework was refined by using data from multiple sources, such as interviews, archival documents, and surveys. Qualitative and quantitative methods and tools were both employed in data analysis to ensure research validity. Consequently, the effectivity of the refined conceptual framework was further examined through FSE.

Chapter 2 presents the research objectives, strategies for achieving the objectives, and the research process. Then a comprehensive review of major research methods employed in this study is presented.

2.2 DETERMINATION OF RESEARCH OBJECTIVES AND METHODS

This study aims to develop a program organization model for the effective and efficient management of construction megaprojects. Table 2.1 shows the five specific research objectives and their corresponding research methods.

Table 2.1 Research objectives and corresponding methods

No.	Research objectives	Research methods
1	Defining construction megaprojects and reviewing developments of construction megaproject research	■ Literature review ■ Content analysis
2	Defining program management and evaluating the applicability of this approach to managing construction megaprojects	■ Literature review ■ Content analysis
3	Identifying POFs of the client organization managing a megaproject	■ Literature review ■ Content analysis ■ Structured interview
4	Prioritizing the resulting POFs and extracting the principal POFs	■ Case study ■ Delphi Surveys ■ MS ranking
5	Establishing a multi-criteria program organization model (function)	■ Case study ■ Delphi surveys ■ Questionnaire survey ■ Fuzzy Synthetic Evaluation

2.3 RESEARCH PROCESS

Figure 2.1 presents the research methods and process employed to achieve each research objective. Throughout the research process, a large amount of data, which were collected via literature review, interviews, and surveys, were then analyzed and consolidated. Qualitative and quantitative research methods were both used in the research process.

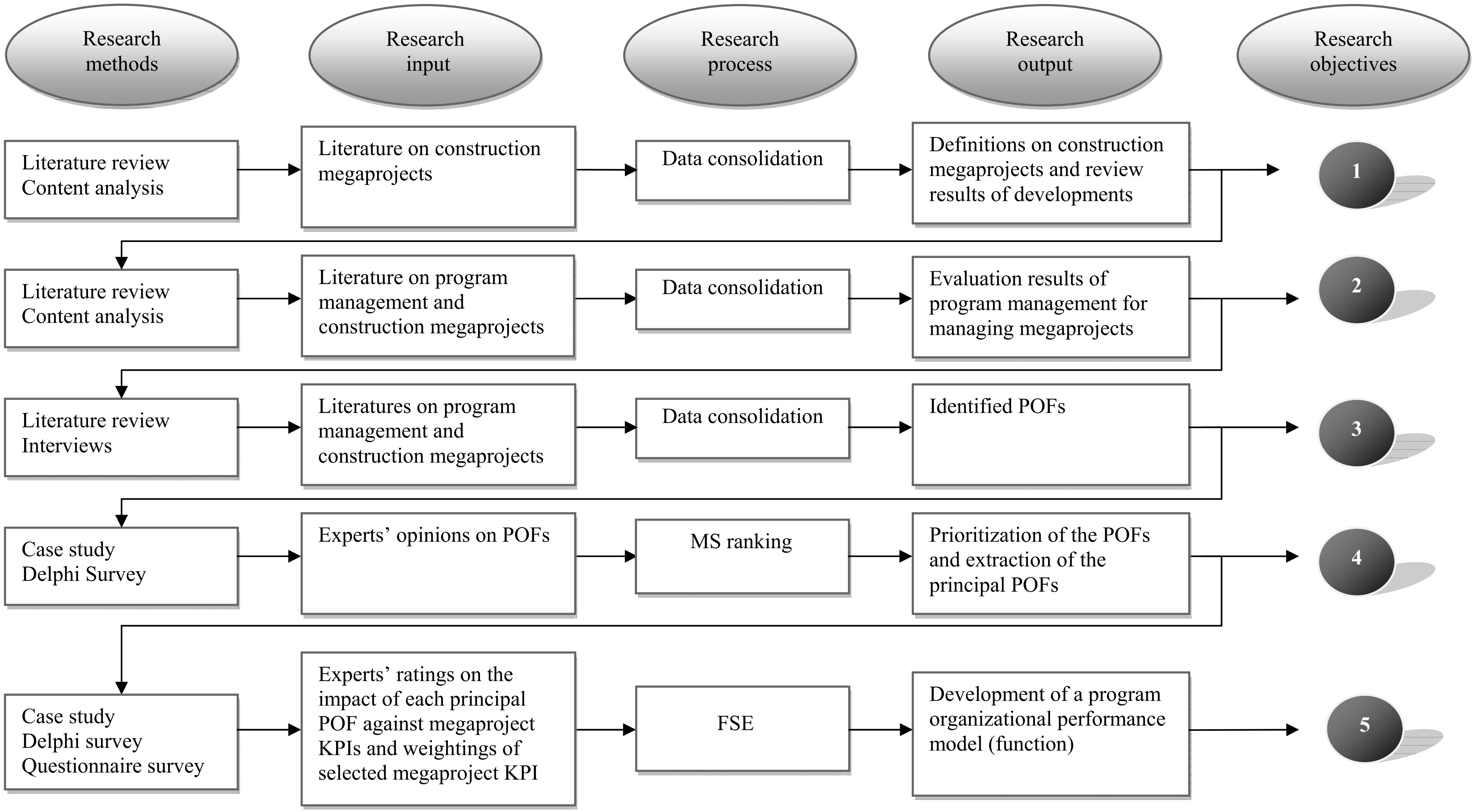


Figure 2.1 The research process

2.4 OVERVIEW OF RESEARCH METHODS

To achieve the prescribed research objectives, a number of research methods are employed in this study, including (1) literature review, (2) case study, (3) interview, (4) Delphi survey, (5) questionnaire survey, (6) MS ranking technique, and (7) FSE. Methods (1) to (5) are the main research methods frequently used in construction engineering management research and in organizational research as well (Fellows & Liu, 2008; Strati, 2000).

2.4.1 Literature Review

Literature review is an essential step in conducting state–of–the–art research and establishing a theoretical foundation for this study. Two rounds of structured literature reviews are used. The first round defines construction megaprojects and evaluates developments in construction megaproject research from 2000 to 2010. The second round examines program management literature and identifies POFs to establish a theoretical framework for the Delphi survey. Both rounds of literature reviews adopt a logical flow of procedures and tools, as proposed by Ke et al. (2009).

2.4.2 Case Study

The case study is an empirical inquiry that investigates a contemporary phenomenon within a real life context. This method is highly useful when the boundaries between phenomenon and context are not evident, and when multiple sources of evidence are used (Yin, 2009). Morris and Hough (1987) stated that the case study can be used in investigating megaproject-related topics because it helps researchers to understand and appreciate various factors that specifically influence megaprojects, such as organizational, managerial, political and other dynamics. Artto et al. (2008) also affirmed the necessity of the case study in program management research. The case study is therefore appropriate for this study. To enhance research quality, multiple sources of evidence, such as interview records, archival documents, and survey feedback, were triangulated to refine a theoretical model for the Shanghai Expo construction case study. Table 2.2 shows a brief background of the Shanghai Expo construction case study.

Table 2.2 Brief background of Shanghai Expo construction

Location	Shanghai downtown
Investors	Shanghai Expo Land Co., Shanghai Expo Co., Shanghai Expo Group Co., and Shanghai Expo Culture Center Co.
Client	Shanghai Expo Construction Headquarters
Consultant (program management)	Department of Construction Management and Real Estate, Tongji University
Construction scale	■ 140 pavilions ■ over 100 supported facility buildings ■ 33-km renewal municipal roads within the Site ■ 1,000,000-m2 greenery and parks
Cost	RMB 16.8 billion (pavilions and supported facility buildings)

Source: BSEC & SMURCTC (2010)

2.4.3 Interviews

The interview is a qualitative research method used to understand the meaning of answers of the interviewees and to describe the meaning of central themes on a particular subject (Kvale, 1996). This method is widely used in the social sciences, including management studies, organizational studies and construction engineering management studies (Fellows & Liu, 2008; Strati, 2000). In construction management research, different forms of interview are widely employed, such as structured interviews (Chan & Yeong, 1995; Chan & Kumaraswamy, 1999; Yeung et al., 2008), semi-structured interviews (Xia et al., 2009; Hung et al., 2011), and unstructured interviews (Laryea & Hughes, 2008). In this study, the semi-structured interview method is used to identify any new POF that is not identified in the literature review. Only experts with hands-on experience in China's construction megaprojects have been invited to participate in the interviews.

2.4.4 Delphi Survey

The Delphi method originated from the United States (US) military industry. This method refers to a structured group communication process that allows a group of individuals as a whole to solve a particularly complex problem (Chan et al., 2001). The Delphi method has been increasingly used to solve complex problems in the construction management field, such as bridge condition evaluation (Saito & Sinha, 1991), procurement system selection (Chan et al., 2001), sustainable construction (Manoliadis et al., 2006), partnering performance model development (Yeung, 2007), and public–private partnership risk allocation and evaluation (Xu et al., 2010). Martino (1973) stated that the Delphi method is suitable for a particular research topic that is too new to have inadequate historical data for the use of other methods. Considering that program management is an emerging field (Pellegrinelli et al., 2011), the Delphi method is believed to be appropriate for this study.

The Delphi survey is typically composed of several rounds of surveys interspersed with group opinions and information feedback in the form of relevant statistical data (Yeung et al., 2007). The method requires careful design and pre-planning to enable meaningful data analyses with advanced statistical techniques.

1) Number of Survey Rounds

The number of rounds of Delphi survey varies between two and seven (Rowe & Wright, 1999; Adnan & Morledge, 2003). This study uses a four-round Delphi survey, which fully considers the research plan feasibility. Through the Delphi survey, time is not waste on panel member interviews but enables researchers to solicit sufficient information from them at the same time.

2) Size of the Expert Panel

One of the key considerations in using the Delphi survey is selecting the expert panel (Stone & Busby, 1996). Ten experts are involved in this study. The selected size satisfies the normal requirement of the Delphi survey, which ranges from 8 to 16 expert panelists (Hallowell & Gambatese, 2010).

3) Selection of Panel Members

Representation of the expert panel is evaluated based on the quality instead of the number of panelists (Powell, 2003). Dawson and Brucker (2001) stated that the knowledge and expertise of each panelist must be in accordance with the research scope of the questionnaire. Experts from the Shanghai Expo megaproject were targeted and invited to participate in the Delphi survey, specifically those who had held senior positions in the client organization of Shanghai Expo construction.

The heterogeneous composition of the expert panel could provide good representation and knowledge base, which were critical in ensuring the validity of the Delphi survey (Hon et al., 2012). Selection of the expert panel also considered the expertise and roles of the panelists in the client organization of the case study.

4) Format of Delphi Survey Rounds

This study adopts a self-administered survey based on four rounds of Delphi questionnaires. Structure of the four-round Delphi survey is enumerated as follows:

Round 1 identifies the POFs in the case study (Appendix F). The questionnaire consists of two parts (Appendix F): Part A contains the personal particulars of the experts, and Part B contains 24 questions to measure the importance of each POF as identified from the literature review and structured interviews (Chapter 7).

Round 2 confirms the relative importance of POFs based on the expert participants' feedback in Round 1 (Appendix G). Eleven principal POFs are then consolidated based on the feedback from the experts.

Round 3 examines the effect of each principal POF on each megaproject KPI in the case study (Appendix H). The questionnaire is developed based on the consolidated feedback of the experts in Rounds 1 and 2 of the Delphi survey.

Round 4 determines the effect of each principal POF on the identified KPIs identified in the case study based on the consolidated feedback in Round 3 (Appendix I).

2.4.5 Questionnaire Survey

The questionnaire is a research instrument commonly used in surveys to measure people's attitudes towards certain subjects (Hoxley, 2007). A questionnaire survey is conducted to obtain the weightings of megaproject KPIs for developing the megaproject performance index to be discussed later on in this thesis. As opposed to program organizations, KPIs are well-established indicators commonly used in both research and practical application. A questionnaire survey is therefore deemed appropriate in this study because such a survey type will not demand a large amount of time from the respondents but enables researchers to solicit sufficient information from them. The questionnaire consists of two parts (Appendix J): Part A contains the personal particulars of the experts, and Part B contains five questions to measure the relative importance of selected megaproject KPIs in the case study.

2.4.6 Mean Score (MS) Ranking

The MS ranking technique extracts key factors based on the ranking of each factor's relative importance. The MS is acquired from a group of experts' scores. The MS ranking technique is commonly used in construction management studies, such as construction time performance (Chan & Kumaraswamy, 1996), partnering performance indicator identification (Yeung, 2007), and risk assessment of public private partnership projects (Xu et al., 2010). This study applies the MS ranking technique to extract underlying principal POFs in the case study. To derive principal POFs, the data obtained from Round 2 Delphi survey is computed and compared through the MS ranking technique. A five-point Likert scale (1 = not important, 2=slightly important, 3=moderately important, 4=important, and 5 = very important) is used to calculate the MS for each POF. Then, the scale determines the relative ranking of the POFs in descending order of importance. Equation (2.1) is used to compute the MS for each POF (Chan & Kumaraswamy, 1996):

$$MS = \frac{\sum (f \times s)}{N}, (1 \leq MS \leq 5) \qquad \text{Equation (2.1)}$$

Where s—a score given to each POF by the respondents, ranging from 1 to 5 (1 = least Important and 5 = most Important).

f—denotes a frequency of each rating (1–5) for each POF.

N—the total number of responses concerning a particular POF.

2.4.7 Fuzzy Synthetic Evaluation (FSE)

FSE is employed in this study to determine the performance level of the program organization in the case study. This method commonly addresses multi-attribute and multi-level problems, such as reservoir water quality analysis (Lu et al., 1999), health risk assessment (Sadiq & Rodriguez, 2004), human resource management (Hsu & Yang, 2004), project risk analysis (Zhao et al., 1997), and contract risk assessment (Chan et al., 2011).

Evaluating the performance of the program organization depends on identifying several significant POFs and on the assessment of these POFs against certain performance criteria. Because principal POFs and their effects on megaproject performance are often multi-layered and fuzzy in nature, which involve subjective judgment of experts, adopting the FSE technique is necessary to develop such a performance evaluation system for the program organization. Table 2.3 compares the FSE method with other modeling techniques. Compared with the regression model and analytic hierarchy process, FSE is particularly appropriate for emerging topics and can better handle complicated and multi-criterion evaluations with a small sample involved. Thus, FSE is chosen and adopted in this study. Before conducting FSE analysis, all POFs and criteria are scrutinized and tested to meet FSE requirements.

Table 2.3 Comparisons of FSE method and other modeling techniques

Methods	Application areas	Advantages	Issues
Regression model	Problems that are related to established theories, that is where there is correlation between input variables and the output variable (Flood & Issa, 2010).	This model can determine a clear-cut mapping from an overstated set of input variables to the output variable, which compensates for the excess of information. (Flood & Issa, 2010)	▪ There is a definite correlation between input variables and the output variables (Flood & Issa, 2010). ▪ This model can deal with a large sample size.
Analytic hierarchy process (AHP)	Problems that are poorly understood, where there are multi-criteria decisions involved.	This model is used to solve multi-criterion complicated decisions.	There is a well-defined hierarchy among input variables (Saaty, 1980).
Fuzzy synthetic evaluation (FSE)	Problems that are poorly understood, where there is limited or no theory quantifying the relationship between input and out variables (Flood & Issa, 2010).	This model is regarded as a refined AHP model powered by fuzzy logic to solve multi-layer and multi-criterion complicated problems (Pang & Bai, 2013).	▪ FSE can deal with a small sample. ▪ It is important to select the appropriate model for the FSE evaluation (Liu, 2009)

2.5 CHAPTER SUMMARY

To achieve the prescribed research objectives, seven research methods have been evaluated and selected to be incorporated into the six-step research process used in this study. These methods include literature review, case study, interview, Delphi survey, questionnaires, MS ranking, and FSE. Justifications and explanations for selecting the research methods were also provided.

CHAPTER 3: REVIEW OF CONSTRUCTION MEGA-PROJECT PRACTICE AND RESEARCH

3.1 INTRODUCTION[1]

The megaproject is a social construct (Altshuler & Luberoff, 2003). In the construction industry, a megaproject correlates to a large-scale and complex construction project. In previous literature, different terms are used to describe megaprojects such as major projects, large projects, complex projects, and great projects (Russka et al., 2009; Dvir & Shenhar, 2011). Megaproject research originated from research initiatives on urban planning issues in urban and transportation infrastructure megaprojects in the US during the 1950s and 1960s (Alshuler, 1965, 1979). Civic and infrastructure megaprojects continued to grow in major developed countries since the 1970s, whereas infrastructure megaprojects in developing countries were just starting to emerge (Merrow, 1988; Flyvbjerg et al., 2003). In the 1980s, the trend of research on large projects emerged but slowed down in the 1990s, as evident on the *Project Management Journal* and *International Journal of Project Management* (Oliomogbe & Smith, 2012).

In the early 2000s, a growing number of studies on construction megaprojects have started to be published. The increase shows that construction megaprojects have become a separate research area, which may be triggered by the rapid infrastructure development and renewal worldwide. Global urban population grew at an annual rate of 2.2% from 1990 to 2008 (World Bank, 2010). Rapid global urbanization has triggered another investment boom in construction megaprojects in the past two decades. Increasing infrastructure demand mainly from developing countries have

[1] Sections 3.1 and 3.2 of this chapter have been partly adapted form a journal paper: HU, Y., Chan, A. P. C., Le, Y., & Jin, R.Z. (2013). From construction megaproject management to complex project management: a bibliographic analysis. *Journal of Management in Engineering*, in press (doi: 10.1061/(ASCE)ME.1943-5479.0000254).

yielded huge investments in urban and infrastructure megaprojects, such as water and sewage, electricity, transportation, and telecommunications. The *Economist* (2008) predicted that major developing countries would invest USD 22 trillion in infrastructure from 2008 to 2017 (Figure 3.1). Meanwhile, numerous infrastructure systems in major developed countries were deteriorating and under renewal (Scott et al., 2011). Infrastructure demands accelerated the growth of construction megaproject research, which also transformed construction megaprojects into a separate area in the construction management field (Flyvbjerg et al., 2003).

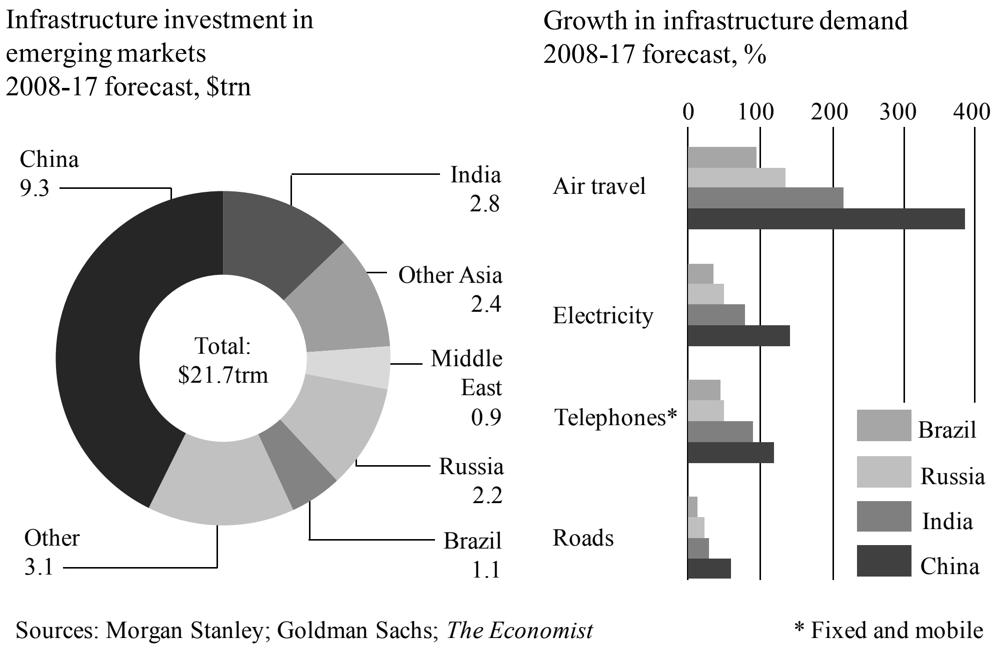


Figure 3.1 Future infrastructure investments in developing countries
(Adapted from *The Economist*, 2008)

This chapter first examines various definitions of megaprojects. Then, problems faced by construction megaprojects in China and in other countries are explored by reviewing previous literature. Developments in megaproject research are also identified based on a critical review of megaproject papers published in nine peer-reviewed construction management journals from 2000 to 2010. Chapter 3 aims to provide a solid theoretical foundation for this study.

3.2 DEFINITION OF CONSTRUCTION MEGAPROJECTS

3.2.1 Viewpoints of Governments and Industries

Most definitions of construction megaprojects are from governmental and industrial directives. One of the most widely accepted definitions was provided by the US Department of Transportation, which uses a USD 1 billion threshold to define a megaproject (Department of Transportation Office of Inspector General, 2001). The US Federal Highway Administration (FHA) later provided a detailed definition of a megaproject:

> "major infrastructure projects that cost more than 1 billion USD, or projects of a significant cost that attract a high level of public attention or political interest because of substantial direct and indirect impacts on the community, environment, and state budgets" (Capka, 2006).

The project cost threshold of USD 1 billion is increasingly considered worldwide as a key criterion in defining a megaproject (Flyvbjerg et al., 2003; van Marrewijk et al., 2008). In European Union countries, the International Project Management Association (IPMA, 2011) designated a cost threshold of EUR 100 million as the basis for defining megaprojects across all industries.

"Major project" and "major program" are other items frequently used to define large public projects in several countries, such as the US, the United Kingdom (UK), and China. The terms are sometimes interchangeably used with "megaproject" (Haynes, 2002). Even in the US, where the term "megaproject" has originated, the FHA designates "major project" as a separate category and megaproject as its sub-category for the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* that took effect in 2005. Thus, a major project is defined as "a project with a total estimated cost of USD 500 million or more that is receiving financial assistance" (FHA, 2005). South Korea also adopted a similar threshold in defining an urban renewal megaproject (Hyun et al., 2009). In China, major national projects usually involve government-funded projects approved by the National Development and

Reform Commission (NDRC), with a total investment of RMB 5 billion or approximately USD 754 million (National Development and Plan Commission, 2002; NDRC, 2004a). This amount is close to the most popular USD 1 billion megaproject threshold.

Flyvbjerg (2009) estimated that a megaproject cost should be within the range of USD 500 million to USD 1 billion when specific factors, such as scale, economy, and income, are considered. However, this cost threshold can be applied only to major developed countries. Developing countries with gross domestic products (GDPs) that are only a few billions US dollars may experience difficulty in implementing megaprojects. The relationship between the megaproject cost threshold and GDP in various countries are further examined in terms of cost ratios to country GDP (Table 3.1). Most megaproject cost ratios in country GDP are between 0.01% and 0.02%. Therefore, 0.1‰ of a country's GDP is recommended worldwide as a reasonable criterion to replace the definition of megaprojects provided by Flyvbjerg (2009).

Table 3.1 Ratios of megaproject cost threshold in GDP in different countries/regions

Country	Cost threshold[1] (million USD)	GDP[2] (million USD)	Ratio (%)
US	1,000	14,582,400	0.01
EU countries (IPMA)	133	601,817[3]	0.02
China	754	5,878,629	0.01
Hong Kong	26	224,458	0.01
South Korea	500	1,014,483	0.05

Note:
1. Based on the exchange rates on December 30, 2010 retrieved from International Monetary Fund website; USD to HKD exchange rate is HKD 7.8= USD 1.
2. Based on the *Gross Domestic Product 2010 Report* retrieved from the World Bank website (World Bank, 2011).
3. The average GDP of 27 EU membership countries in 2010.

In addition to large-scale investments, construction megaprojects are also characterized by political sensitivity (Locatelli & Mancini, 2010), long delivery span (usually over four years) that includes planning, design and construction (Merrow, 1988; Oliomogbe & Smith, 2012), high complexity (Haynes, 2002; Fiori & Kovaka, 2005), high risks (Flyvbjerg et al., 2003; Fiori & Kovaka, 2005), and a large number of internal and external project stakeholders (Oliomogbe & Smith, 2012). Construction megaprojects are also often subjected to the following effects.

1) Political and Social Effect

The political and social effect refers to the involvement of the government and the public in managing construction megaprojects. Most construction megaprojects are initiated by the government, and also involve a wide range of stakeholders, including investors and industries (Clegg et al., 2002). Locatelli and Mancini (2010) said that the nature of construction megaprojects involved "political sensitivity". Construction megaprojects are also major public concern because of their substantial effects on communities, environment, and economy (Flyvbjerg et al., 2003; Altshular & Luberoff, 2003; Bruzelius et al., 2002).

2) Economic Effect

The economic effect refers to the revenue of a particular megaproject and its contribution to local economic growth. However, numerous post-project evaluations of construction megaprojects, such as the Channel tunnel between France and the UK, the Øresund link between Sweden and Denmark, and the M62 motorway from Liverpool to Leeds (the UK), have indicated that not all megaprojects can make profit and produce a positive effect on regional economic growth (Vickerman, 1987; Matthiesen & Anderson, 1993; Dodgson, 1973). Despite these problems, construction megaprojects remain continuously growing and developing caused by urban growth and renewal worldwide. However, improving the economic revenue of megaprojects and promoting regional economic growth should be further studied.

3) Environmental Effect

The environmental effect of construction megaprojects has two aspects: environmental effect prediction and actual environmental outcome. The first aspect refers to the environmental impact assessment (EIA) used by decision makers, and the second refers to the post-project environmental impact evaluation (PEIE). In recent years EIA issues in construction megaprojects have received growing interest from industrial professionals, scholars, and the public (Dipper et al., 1998; Flyvbjerg et al., 2003), which indicates that environmental issues have an increasingly significant role in megaproject management. Flyvbjerg et al. (2003) also noted that the PEIE issue in megaprojects deserves further research.

Characteristics of construction megaprojects posed an immense great challenge in managing construction megaprojects and triggered a series of problems in the delivery of megaprojects, such as cost overrun, delivery delay, safety incidence, environmental pollution, and technology innovation management (Merrow, 1988; Miller & Lessard, 2000; Flyvbjerg et al., 2003). More research efforts should focus on construction megaprojects.

3.2.2 Viewpoints of Academics

Construction megaprojects exhibit highly complex characteristics and are theoretically considered as complex projects. The management of complex projects originated from complexity theory (Whitty & Maylor, 2009). Complexity theory is a well-known physical theory developed by the Santa Fe Institute in the 1980s to solve complex real-world and cross-disciplinary problems, such as those in astronomy, biology, and economics (Waldrop, 1992; Ziemelis, 2001). The theory has also been applied to project management since the late 1990s (Baccarini, 1996; Williams, 2003). More complex projects are emerging because of the increasing complexity in project scope and environment (Fiori & Kovaka, 2005; Remington & Pollack, 2008). A complex project can also be considered as a complex system formed from numerous components with emergent behavior. One of the most popular frameworks for complex projects is provided by Remington and Pollack (2008). In the framework, project complexity is classified into four categories: structural, technical, directional, and temporal complexity.

A megaproject is a complex project case (Remington & Pollack, 2008). Complex project management theory can also be applied to megaproject research. Fiori and Kovaka (2005) developed a five-criterion framework to define megaprojects, which includes cost, complexity, risk, ideals, and visibility. Case studies of six megaprojects, located in the US, Japan and Taiwan, used this framework, which revealed that construction megaprojects were mainly characterized by huge cost, high complexity, and great uncertainty. Brockmann and Girmscheid (2007) further categorized the complexity of megaprojects into three groups: task, social, and cultural complexity. To define the complexity of megaprojects, Bruijn and Leijten (2008) provided a similar framework by citing technical complexity, social complexity, and complexities from the management of construction megaproject implementation.

A megaproject can also refer to a program that includes two or more projects that require close cooperation (Archibald, 2003). Shehu and Akintoye (2010) noted that a construction megaproject is a typical case in the construction industry. Eweje et al. (2012) had similar ideas and said that oil and gas megaprojects could also be considered as programs. Remington and Pollack (2008) stated that a program could be regarded as a form of a complex project.

3.3 Underperformance in Construction Megaprojects

3.3.1 Cost Overruns and Flawed Cost Management

Cost overrun is the most frequent and serious problem faced by construction megaprojects worldwide (Flyvbjerg et al., 2003). Numerous well-known construction megaprojects have incurred substantial cost overruns mostly because of the lack of relevant experiences. Table 3.2 presents certain cases of well-known megaprojects that encountered cost overruns.

Table 3.2 Construction megaprojects with cost overruns

Megaproject names and locations	Cost overrun (%)
London Olympic games 2012, the UK (Hughes, 2007)	307
Boston's artery/ tunnel project, the US	196
Humber bridge, the UK	175
Vancouver Winter Olympic games, Canada (*The Vancouver Sun*, 2009)	150
Boston–Washington–New York rail, the US	130
Great Belt rail tunnel, Denmark	110
A6 Motorway Chapel–en–le–Firth/ Whaley bypass, the UK	100
Shinknsen Joetsu rail line, Japan	100
Washington metro, USA	85
Channel Tunnel, the UK and France	80
Karlsruhe-Bretten light rail, Germany	80
Øresund access links, Denmark	70
Mexico city metro line, Mexico	60
Paris-Auber-Nanterre rail line, France	60
Tyne and Wear metro, the UK	55
Great Belt link, Denmark	54
Øresund coast–to–coast link, Denmark and Sweden	26

Note: The information without any quotation is adapted from Flyvbjerg et al. (2003).

Cost overrun ratios of the megaprojects in Table 3.2 range from 26% to 307%. Flyvbjerg et al. (2003) emphasized that cost overruns exist in almost all types of construction megaprojects across 20 countries, both developed and developing ones. More evidence of cost overruns can be obtained from a number of large-scale investigations (Table 3.3).

Table 3.3 Five investigations on cost overrun in construction megaprojects

Investigator	Sampled projects	Findings
Aalborg University, Denmark (Flyvbjerg et al., 2003)	258 projects with a total cost of about US 90 billion dollars (1995 prices), including bridges, tunnels, highways, freeways, high-speed rail, urban rail and conventional (inter-urban) rail located in 20 countries on 5 continents	The average cost overrun is 28%.
US Department of Transportation (Pickrell, 1990)	10 US rail transit projects with a total value of US 15.5 billion (1988 prices)	The total capital cost overrun of the projects was 61%, ranging from 10% to 106% for the individual projects.
Auditor–General of Sweden (1994)	15 road and rail projects with a total value of SEK 13 billion (1994 prices)	■ The average cost overrun for 8 road projects was 86%, ranging from 2% to 182%. ■ The average cost overrun for 7 rail projects was 17%, ranging from -14% to 74%.
Transportation and Road Research Laboratory, the UK (Fouracre et al., 1990)	21 metro systems in developing and newly industrialized nations each with a value of USD 22-165 million (1987 prices)	■ The 6 metros overrun above 50%; and 2 of them in the range from 100% to 500%. ■ The other 3 metros overrun in the 20% to 50%. ■ The remaining 4 projects overrun in the range from -10% to 20%.
Han et al. (2009)	Korea Train Express and other six megaprojects in Korea with an investment ranging from USD 0.56 to 5.8 billion	The average final cost at completion increased by 122.4%.

In China, cost information on most megaprojects is not publicly accessible because of the confidentiality requirements imposed by the government or clients. Relevant studies indicate that cost overruns exist in Chinese construction megaprojects such as metros, highways, and bridges; but particularly for those organizations that lack relevant experiences or have a tight schedule (Li, 2002; Wu, 2007; He, 2008). Cost management of construction megaprojects in China also faces flawed management in project financing, cost estimation and planning, as well as payment (Bao & Liu, 2001). In 2004, the State Council noticed the problems in construction projects and therefore required the strengthening of relevant management, particularly for publicly funded projects (NDRC, 2004b).

Over the past decade, cost management in a number of megaprojects has been improved. For example, the cost saving of metro constructions in Shanghai, Guangzhou, and other economically advanced cities has been improved substantially because of technical and management innovations (Li, 2002). More evidences can be obtained from recently completed megaprojects. As one of the largest water infrastructure projects in history, the construction of the Three Gorges Dam megaproject lasted for 17 years (Dai et al., 2006) and faced a major challenge in cost management. An official report stated that the total construction cost of the Three Gorges Dam was about RMB 186 billion, which is lower than the original budget of RMB 204 billion (Lin, 2009). The Three Gorges Dam megaproject is regarded as one of very few examples of megaprojects with proper budget control, which also suggests that China can control megaproject costs within the prescribed budget.

Another interesting event in the megaproject construction in China is the debate on the removal of the retractable roof on the Beijing National Stadium (also known as the Bird's Nest), which was constructed for the 2008 Beijing Olympic Games. To reduce the construction cost, the government decided to cancel the stadium roof required by the client and included in the original design, and the government claimed that removing the stadium roof could save over RMB 500 million from the original budget of RMB 4000 million (Li, 2008). The government’s decision forced a temporary suspension of work for almost five months to amend the design. After the Beijing Olympics, the debate on the Bird’s Nest roof continued. The stadium operator once expressed the intention to add a new roof to the Bird’s Nest because a stadium with a roof can yield more profits from hosting indoor activities (Li, 2008). However, the income from the stadium, which mainly comes from entry tickets and outdoor activities during the summer, is reported to be gradually shrinking (Liu, 2012), and the lack of a roof may limit the use of the stadium for indoor activities. Cost control is essential in managing construction megaprojects. However, cost control may jeopardize other key megaproject objectives, such as profitability, functionality, quality, and safety. Several experts stated that a large number of accidents in recent infrastructure megaprojects, such as in high-speed railways and metros, are possibly caused by an overemphasis on construction cost, which may also reduce resources in safety training and management (He et al., 2008). Therefore, limiting construction cost within the approved budget without compromising other key megaproject objectives can pose a major challenge in managing megaprojects in China.

3.3.2 Delivery Delay

Delivery delay is another main problem in construction megaprojects. The International Program in the Management of Engineering and Construction (IMEC), which investigated the risks of large engineering projects by sampling 60 engineering projects worldwide (including 38 construction megaprojects) in the late 1990s, showed that market risk ranked first and was followed by completion risk in the top three risks for managing large engineering projects (Miller & Lessard, 2000). An earlier investigation of 52 large civilian projects worldwide (Majority of which were in the US) indicated that the average delivery delay of the sampled megaprojects was 17% in a four-year average construction period (Merrow, 1988). Han et al. (2009) stated that the average extension time for five train express lines in Korea was 3.6 years.

More evidence of duration delay in construction megaprojects can be acquired easily from various news and reports on international public sport, exposition venues and other megaprojects, which often experience construction delays. For example, a number of stadiums and facilities for the 2008 Greece Olympic Games venue encountered delays in construction, which promoted Greek authorities to cancel the Aquatics Center's optional roof construction to ensure the timely completion of the stadium before the Olympic inauguration (Times, 2004).

In China, schedule delays in construction megaprojects are not as serious as those in other countries because clients usually set up an extremely compressed time objective and prioritize construction schedule management (Zou et al., 2007). Most construction megaprojects face a similar situation. However, an inappropriate time objective may pose a high risk in managing other objectives, such as cost, quality, and environment. For instance, a high-speed train crash on July 23, 2011 in Wenzhou killed 40 people and injured almost 200 others (Xinhua, 2011). After investigating the cause of accident, the Ministry of Railways required that the construction duration of all railway projects should not be shortened unreasonably (Meng, 2011). The accident also reinforced the fact that most construction megaprojects in China have a tightly compressed duration.

3.3.3 Accidents

Occupational health and safety is an aspect that cannot be neglected in the performance management of construction megaprojects. With the rapid growth of construction megaprojects in China, safety issues have received increasing attention because of the wide-spread effect of such projects. However, official data on safety issues are lacking. Thus, a systematic review of safety incidents (including accidents) related to construction megaprojects was conducted by major Chinese newspapers between 2000 and 2010 using China Core Newspapers Databases (中国重要报纸全文数据库, CCND) via the library website of The Hong Kong Polytechnic University. The database has already collected over 10 million news articles from approximately 500 core newspapers published in Mainland China since 2000. Keywords "construction (施工)" and "accident (事故)" were both used in the subject area of CCND's search engine. Based on the search results, 311 news articles were identified. After further examination of the news articles, the author found 22 accidents in construction megaprojects (Appendix A), which included 21 fatalities and one collapse of a deep foundation accident. As shown in Figures 3.1 and 3.2, the average number of deaths from the 21 fatalities is 4.5. The frequency and number of deaths in the 21 fatalities are reported in Figures 3.2 and 3.3, respectively.

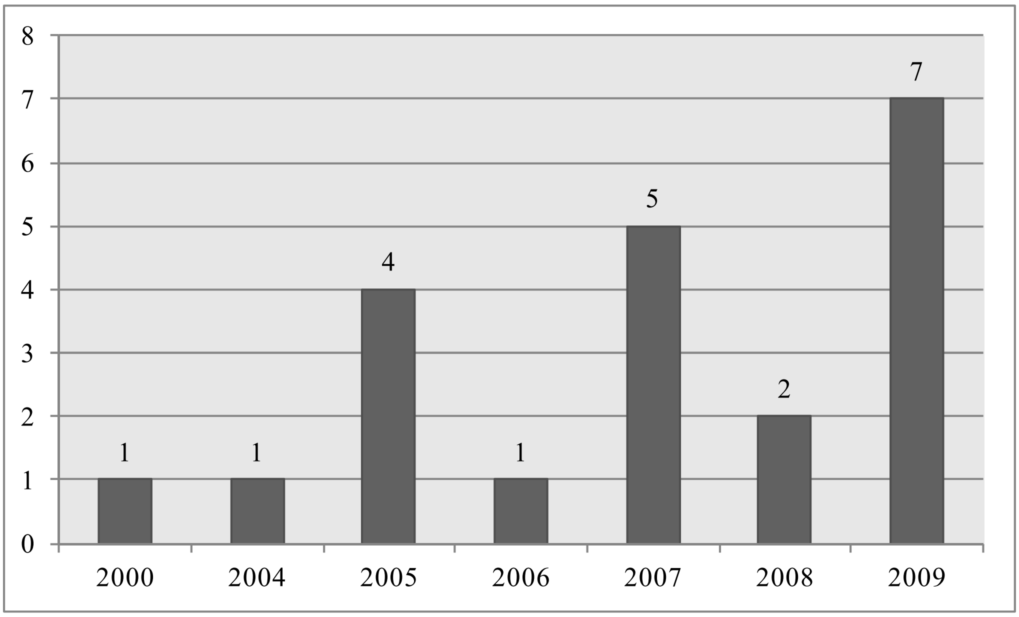


Figure 3.2 Frequency of fatalities in construction megaprojects between 2000 and 2010

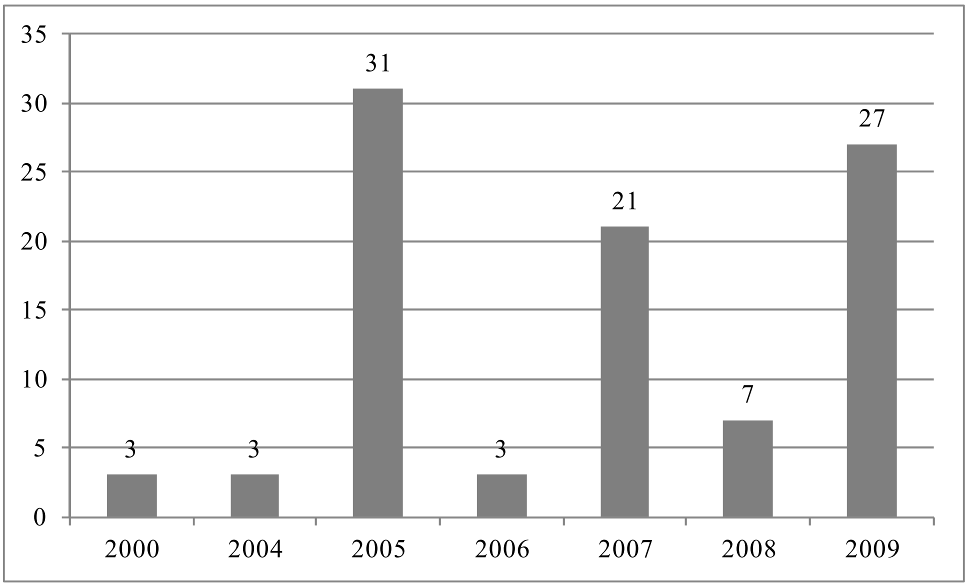


Figure 3.3 Number of Death in construction megaprojects between 2000 and 2010

Majority of the 22 accidents (19 out of 22) are considered as serious accidents or above in terms of the national standard on the four-level categorization of the serious level of accidents (State Council, 2007). The details of categorization of these 22 accidents are shown in Figure 3.4.

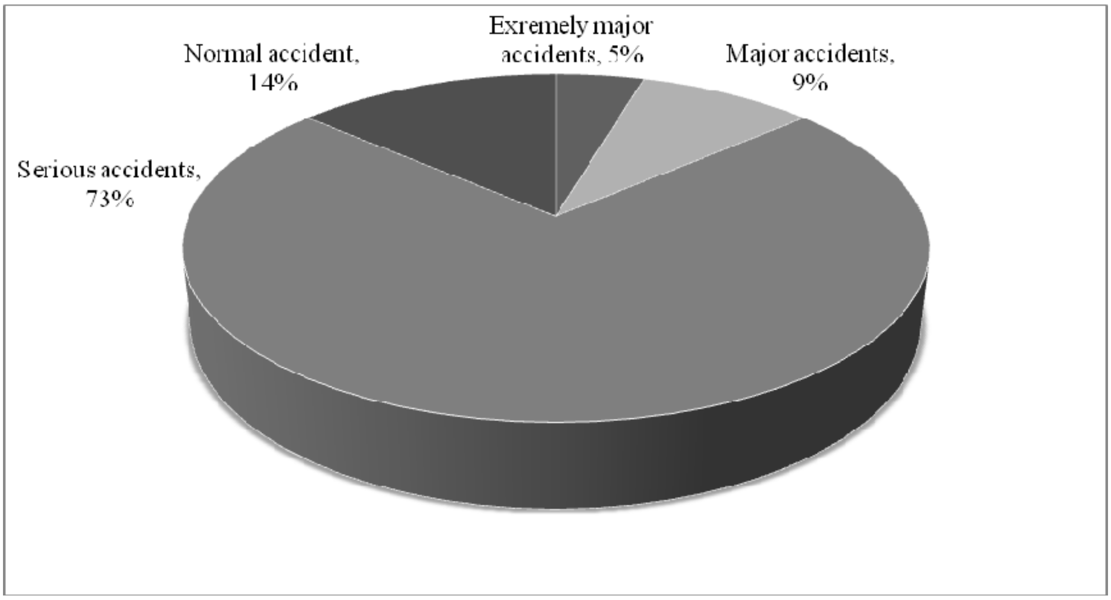


Figure 3.4 Categorization of the serious level of the 22 accidents

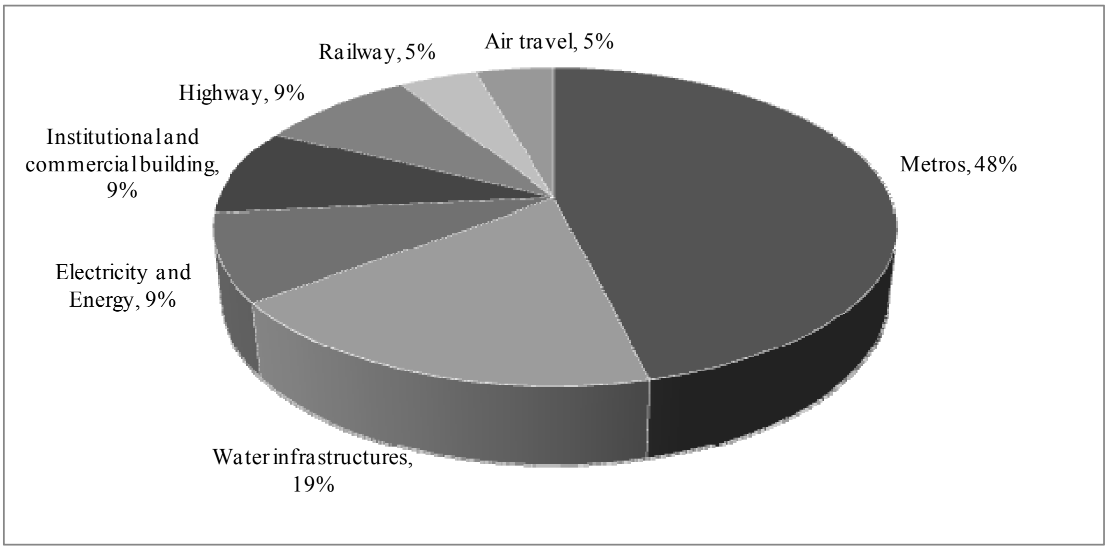


Figure 3.5 Categorization of project types of the 22 accidents

Most of the accidents occurred in construction megaprojects of metros and water infrastructures (67%), which have been characterized by large investments (Figure 3.5).

The identified accidents may not include all accidents happened in construction megaprojects during the target period because of insufficient transparency of information disclosure and limitations of the review method. However, the accidents can show that construction megaprojects in China face a high risk in safety management. Wang Mengshu, an academician at the China Academy of Engineering and formerly a top technical expert in railway construction for the Ministry of Railway and China Railway Tunnel Group Corporation, asserted that the compressed schedule and lack of economic input are the causes of high safety risk in Chinese infrastructure projects (He et al., 2008). Numerous government officials and contractor executives involved in construction megaprojects, such as high-speed railway, metros, and water projects, agreed with this idea (Fan, 2007; Yao, 2009). A study by Zou's et al. (2007) on risk management in construction projects also agreed with Wang's statement that compressed schedule is one of the major causes of safety management risks.

3.3.4 Functionality and Quality Issues

Most construction megaprojects are initiated to deliver long-term operated facilities such as highways, roads, rail networks, and dams. Functionality and quality of these facilities are essential in measuring the performance of construction megaprojects. According to the IMEC study, technical risk (a form of completion risk) ranked second among the major risks of delivering large engineering projects (Miller & Lessard, 2000). Based on case studies of 52 construction megaprojects worldwide in the 1980s, approximately 15% of the studied megaprojects (8 out of 52) suffered from serious technical and quality problems because of using first–of–a–kind technologies or novel systems in construction (Merrow, 1988). In a completed megaproject for the 2010 XIX Commonwealth Games venue construction in New Delhi, India, a string of quality incidents were reported. For instance, a footbridge near Jawaharlal Nehru stadium collapsed on September21, 2010, which resulted in a number of injured laborers; a day later, a part of the stadium roof also collapsed (Betigeri, 2010).

In China, construction megaprojects also face challenges in accomplishing prescribed functionality and quality requirements because of the tight requirements on construction schedule. According to a national investigation by the China Audit office in 2003 that investigated the 27% of the major public-funded projects (528 out of 1965) in urban and civil infrastructure of 28 provinces from 1998 to 2002, almost 37% of the sampled completed projects (119 out of 320) did not operate at design capacity and few were unoperational (Xue et al., 2008). A recent accident in Wenzhou, in which two high-speed trains crashed and killed 35 people, also indicated that more attention should be paid to functionality and quality issues in construction megaprojects (Xinhua, 2011).

3.3.5 Environmental Issues

Environment issues have an increasingly significant function in the performance management of construction megaprojects. Environmental impact assessment (EIA) has become a common practice in decision making for construction megaprojects in numerous countries and regions, including the US, the UK and Germany (Flyvbjerg et al., 2003).

Public environmental concerns have increased in construction and infrastructure megaprojects, particularly urban megaprojects, in China (Li et al., 2012). For instance, the mayor of Guangzhou apologized to local citizens for widespread complaints on environmental pollution, such as dust pollution, noise nuisance, and traffic jams, caused by the Asian Games venue construction (Huang & Yu, 2010). With the growing public concern about environment protection, the Ministry of Construction promulgated "The Guidelines to Green Construction" in 2007 and upgraded these guidelines to a compulsory regulation in 2010 (Ministry of Housing and Urban–Rural Development & General Administration of Quality Supervision, Inspection and Quarantine, 2010). Another well-known event in China's construction megaprojects is the temporary suspension of the Zhuhai–Hong Kong–Macau bridge construction because of the absence of a third-party EIA analysis (Song, 2011). These events reinforce that more attention should be paid to the environmental issues related to managing construction megaprojects.

Environmental concerns also include the use of green materials and technology in construction. The Chinese government is actively pursuing green solutions in the construction industry for sustainable development. Thus, a series of compulsory regulations and technical guidelines were promulgated in the past decade, such as the "Design Standard for Energy Efficiency of Public Buildings" (Ministry of

Construction (MoC), 2005) and the "Evaluation Standard for Green Building" (MoC, 2006). Numerous public-funded megaprojects, such as the Beijing Olympics venue construction (Wu & Liu, 2008) and the Shanghai Expo construction, have actively practiced a green strategy in the design and construction process (United Nations Environmental Programs (UNEP), 2009). Certain megaprojects are not properly practicing a green strategy, but environmental issues should be given due attention.

3.3.6 Overview of Underperformance of Megaprojects in China

Megaprojects in China face similar but slightly different challenges in performance management compared with those in other countries and regions. Major risks in managing key objectives of cost, safety, functionality and quality, as well as environment are equally applicable in China. The lack of official statistics may lead to difficulty in assessing the severity level of cost overruns in megaprojects. However, certain successful cases suggested that project costs can be controlled to an acceptable level if enough attention is paid to the issue. Safety risks, particularly for metro and railway megaprojects, should be considered with higher priority in managing construction megaprojects. Overemphasis on time and cost objectives in these megaprojects may compromise the necessary resources on safety management. Quality and functionality management also deserve further attention because of its close correlation with perceived satisfaction and profitability of the completed megaprojects. In a transition economy, the clients appointed by the government may not have paid sufficient attention to project outcomes, such as profits and functionality. Environmental issues are a common challenge to China and other countries in managing megaprojects. However, the implementation of green strategies in a more effective and efficient manner may serve as a larger challenge for China.

3.4 KEY PERSPECTIVES OF CONSTRUCTION MEGAPROJECT RESEARCH

3.4.1 Performance Optimization

As discussed previously, underperformance is a major problem that besets construction megaprojects. Developing suitable solutions for improving megaproject performance (outcomes) are essential themes in megaproject research. Previous studies mainly focused on problems regarding various phases of a megaproject lifecycle, including decision making, initiation, execution and operation phases. Flyvbjerg et al. (2009) stated that the underperformance of construction megaprojects was based in flawed project planning and decision making. A megaproject suggests that the project is larger than any other in its type (Merrow, 1988). Consequently, the complexity of megaprojects poses an unpredictable challenge in planning and decision making. To optimize the work of decision makers and planners, several studies have been devoted to this area over the past three decades (Ascher, 1979; Wachs 1990; Flyvbjerg et al., 2002 & 2009; Priemus et al., 2008). Another part of the research on megaproject performance management during the execution phase was established by construction management researchers because performance management was essential in construction management during project execution. Various research efforts have been devoted to this area over the past decade, which will be discussed in Section 4.4. Studies on cost management (Eden et al., 2005; Creedy et al., 2010), schedule management (Williams, 2003; Toor & Ogunlana, 2008), and safety management (Chua & Goh, 2005; Rajendran & Gambatese, 2009) can be easily tracked from the literature review. Several studies have been conducted to examine the actual outcome of megaprojects through comparison with predicted objectives (Merrow, 1988; Flyvbjerg et al., 2003; Xue et al., 2008). Flyvbjerg et al. (2003) emphasized the significance of post-project studies or audits after megaproject completion.

3.4.2 Institutional Theory

Research on megaprojects using institution theory occurred in the 1950s and 1960s (Alshuler, 1965). Alshuler (1965) analyzed the political constraint in the planning of urban and transportation development megaprojects in the US. Institutional issues in construction projects (including megaprojects) have received growing research interest since the early 1990s (Engwall, 2003; Flyvbjerg et al., 2006). Engwall (2003) asserted that project success was mainly caused by context-specific circumstances. Flyvbjerg et al. (2006) stated that the government and its agencies might account for flawed planning and decision making for megaprojects or "strategy misinterpretation". Earlier research efforts could be combined with emerging trends to investigate megaprojects based on Institutional Theory. Institutions are "the humanly devised constraints that structure political, economic and social interaction" (North, 1991). Scott (2012) emphasized that institutional analysis could address the fundamental issues of social structure and social change in the construction of global projects, particularly megaprojects that highly depend on global collaboration.

Previous studies focused on two categories, namely, macro institutional context (policies and administration) and micro managerial practices. A study conducted by Altshuler and Luberoff (2003) provided a typical macro analysis of the institutional effects (public policies) on transportation megaprojects in the US urban areas. Other institutional analyses examine the differences among project management practices under different institutional systems and explain the rationale behind these differences. For instance, Mahalingam and Levitt (2007) used institutional theory as a framework for analyzing conflicts in global projects. Chi and Javernick-Will (2011) stated that institutional theory can provide a lens for examining how project arrangements were shaped in different institutional environments.

3.4.3 Complex Project Management

Construction megaprojects exhibit characteristics of high complexity and are theoretically viewed as complex projects. The research on complex project management is rooted in the Complexity Theory (Whitty & Maylor, 2009), a well-known physical theory developed by the Santa Fe Institute in the 1980s for solving complex real-world and cross-disciplinary problems including those in astronomy, biology, and economics (Waldrop, 1992; Ziemelis, 2001). In the late 1990s, complexity theory has been applied to project management (Baccarini, 1996; Williams, 2002). Today, more complex projects are emerging because of increasing complexities in the project scope and environment (Fiori & Kovaka, 2005; Remington & Pollack, 2007). These projects can be considered as complex systems formed from numerous components having an emergent behavior. A megaproject is a typical case of a complex project.

In the past few years, a growing number of research efforts have been devoted to megaproject complexity research. One of the most popular complex project frameworks was presented by Remington and Pollack (2007). Project complexity is divided into four categories: structural complexity, technical complexity, directional complexity and temporal complexity. Brockmann and Girmscheid (2007) categorized the complexity of megaprojects into three groups, namely, task complexity, social complexity and cultural complexity. Bruijn and Leijten (2008) also provided a similar framework consisting of technical complexity, social complexity, and complexities from the execution management of megaprojects in defining the complexity of megaprojects.

3.4.4 Megaprojects as Organizations

Project management is traditionally viewed as “various processes” (Winter & Szczepanek, 2009). Turner and Müller (2003) stated that the evolved definition of a project is a temporary organization, and this definition has been increasingly promoted over the past decade in the project management field (Ruuska & Vartiainen, 2005; Winter & Szczepanek, 2009). Morris et al. (2011) affirmed this research trend by asserting that the focus of project management research has moved toward a new paradigm in which projects are considered as organizations, particularly in megaproject research. This focus has been reinforced by a number of megaproject studies in the past decade (Miller & Lessard, 2000; Flyvbjerg et al., 2003). As early as the 1980s, a small number of researchers have already paid attention to the organizational issues in megaproject management (Morris, 1982; Tatum, 1984). Morris et al. (2011) emphasized that research on project management from the organizational and contextual perspective has played an increasingly crucial role in project management field. In the Oxford Handbook of Project Management by Morris et al. (2011), various perspectives and new directions in current project management studies were incorporated into a unified framework of project organization and context, thereby providing a comprehensive research blueprint.

More indirect evidence can be acquired from the activities of the Engineering Project Organization Society (EPOS), an international academic network based in the US. Established in 2010, the EPOS supports and enhances collaborative research on the application of organizational studies to the engineering domain (EPOS, 2013). The EPOS network has not only received cross-disciplinary supports from the business, construction, and sociology fields across the US, but has also extended its collaborations to the UK, Netherlands, Finland, India, Taiwan, Hong Kong, and Mainland China. The EPOS also promotes communication and collaboration within its network by holding annual conferences and publishing papers regularly[2].

3.4.5 Overview of the Four Key Areas in Megaproject Research

With the four perspectives and theories discussed, megaproject performance optimization has become a solidly established research area. A number of research efforts were reported in the peer-reviewed construction management journals over the past decade, indicating that sound interaction between theory and practices had been established. Research in the perspectives of institution theory and complexity theory has just emerged. However, limited empirical studies have been conducted that applied these theories to megaproject practices. In contrast to these two research perspectives, projects as organizations have attracted more research attention in recent years although it has a relatively short history. Nevertheless, megaproject research conducted from this perspective may have a greater application value because organization is essential to managing megaprojects (Morris et al., 2011).

[2] These observations are made based on the author's involvement of EPOC's 2012 Engineering Project Organization Conference— "Global Collaboration", July 10-12, Rheden, Netherlands.

3.5 CHAPTER SUMMARY

A brief review of the megaproject research history and definitions of megaprojects from the viewpoints of governments, industries, and academics have been provided in the first part of this chapter. The 0.01% of the GDP of a country (region) is recommended worldwide as a reasonable criterion to define a construction megaproject. This chapter also analyzed the underperformance related to megaproject practices. Finally, the four academic perspectives used as theoretical foundations for the relevant research were presented.

CHAPTER 4: TRENDS OF MEGAPROJECT RESEARCH IN CONSTRUCTION MANAGEMENT JOURNALS

4.1 INTRODUCTION[3]

The rapid growth of construction megaprojects worldwide has triggered a growing number of published papers in this area since the past two decades, which suggests that construction megaproject management is an emerging area in the construction management field. This chapter aims to review megaproject-related papers published in selected peer-reviewed construction management journals from 2000 to 2010 (inclusive). This chapter also assesses the state and identifies future trends in megaproject research, which helps underpin the conceptual framework of the study. The objective of this study is to answer the following questions:

1) What were the topics covered by megaproject research published in construction management journals from 2000 to 2010?
2) What did the authors from different countries (regions) contribute to megaproject research in the same period?
3) How did the interests, methodologies, and research trends of megaproject-related papers evolve from 2000 to 2010?

[3] The earlier version of this chapter has published in a journal paper: HU, Y., Chan, A. P. C., Le, Y., & Jin, R.Z. (2013). From construction megaproject management to complex project management: a bibliographic analysis. *Journal of Management in Engineering,* doi: 10.1061/(ASCE)ME.1943-5479.0000254.

4.2 REVIEW PROCESS

This study adopts a structured method advocated by Ke et al. (2009) to identify and assess the major outputs of megaproject research published in peer-reviewed journals. The entire review process included three phases.

In Phase 1, comprehensive exploratory desktop searches were conducted through the Web of Science (WoS) and Scopus search engines to identify peer-reviewed journals with the most number of megaproject articles published in the construction management field. Both of the selected engines are the world's largest web sources of peer-reviewed literature covering over 10000 journals. Based on the definitions of construction megaprojects, the common keywords included "megaproject," "mega project," "large project," "major project," and "complex project". They were used in the "title/abstract/keyword" field under the "engineering, environment, energy, and business" sub-area of the search engines. Six journals in the construction management field were identified as having the largest number of published megaproject articles. These journals include the *Journal of Construction Engineering and Management* (JCEM), *Construction Management and Economics* (CME), *Proceeding of the Institution of Civil Engineers-Civil Engineering* (PICE–CE), *Leadership and Management in Engineering* (LME), IJPM, and PMJ. The majority of selected journals were among the top eight journals in the ranking provided by Chau (1997). Two additional journals among the top eight in the same ranking list were added to the list of selected journals, namely, the *Engineering, Construction and Architectural Management* (ECAM) and *Journal of Management in Engineering* (JME). The final list of target journals included eight peer-reviewed construction management journals: IJPM, JCEM, CME, PICE–CE, LME, PMJ, ECAM, and JME.

In Phase 2, a thorough search for megaproject articles in each selected journal was conducted. Two other databases, namely, EBSCO (for PMJ) and Informaworld (for ECAM), were used because Scopus and WoS did not contain a full record of published papers in PMJ and ECAM from 2000 to 2010. A total of 85 articles published from 2000 to 2010 were selected from the eight selected journals.

In Phase 3, quantitative analyses of these 85 articles were conducted to determine their contribution by year, country, author, university/organization, and citation. The scoring method proposed by Howard et al. (1987) was used to assess the contribution value of each author in multi-authored articles. In the scoring method, the credit for each author listed in the same article is calculated based on the order of authorship, as shown in Equation (4.1):

$$Score = \frac{1.5^{n-i}}{\sum_{i=1}^{n} 1.5^{n-i}} \qquad \text{Equation (4.1)}$$

Where n— the number of authors in the article

i —the order of the specific author.

Table 4.1 shows the detailed score matrix for the authors. The scoring method was also adopted by Ke et al. (2008) and Hong et al. (2012).

Table 4.1 Score matrix for multi-author papers

(Adapted from Ke et al. 2009)

Number of authors	Order of specific authors				
	1	2	3	4	5
1	1.00				
2	0.60	0.40			
3	0.47	0.32	0.21		
4	0.42	0.28	0.18	0.12	
5	0.38	0.26	0.17	0.11	0.08

Citations in the journal articles were used as a key index to assess research quality. Both Scopus and WoS did not cover all 85 articles from the eight selected journals, so Google Scholar was selected to report the citation status of each identified journal article. The Google Scholar search engine only provides an indirect citation report, but it has a powerful search function that has a simple and thorough channel used to acquire citation reports. Research topics and research methods were then categorized to identify research developments in the past decade. Relationships between research topics and methods were also examined. Future research directions were also discussed. These analyses cannot provide all research details on megaprojects but can be used to obtain an overall picture of megaproject research from 2000 to 2010. Therefore, analyses are expected to guide and benefit future research.

4.3 DISCUSSIONS OF ANNUAL PRODUCTIVITY AND REGIONAL/INSTITUTIONAL CONTRIBUTIONS

4.3.1 Annual Productivity of Construction Journals based on Megaproject Articles

As shown in Table 4.2, the total number of megaproject articles identified by Scopus was 685 and that by WoS was 200. Scopus had identified more published articles than that WoS because WoS has a more detailed sub-area classification system than Scopus. More specific searches in each of the target journals revealed that among the 4,459 articles published in the eight selected journals, 85 (1.9%) articles addressed megaproject topics or associated issues. The journals had an apparent increasing trend from 3 in 2000 to 12 in 2010. As shown in Table 3, megaproject research emerged as a major area in the construction management field by the turn of the 21st century. The number of megaproject papers (49) published from 2006 to 2010 nearly doubled the number of published papers from 2000 to 2004 (27). Table 3 also shows the consistent growth of interest in megaproject research, which has resulted from the fast growth of megaprojects worldwide.

Table 4.2 Megaproject papers published in the eight journals

	Amount/ Ratio	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Scopus	Megaproject papers	47	52	46	51	55	59	61	78	81	66	89	685
WoS	Megaproject papers	12	17	16	15	15	18	15	22	13	26	31	200
Selected Journals	Total	335	333	348	363	406	432	469	434	438	454	447	4459
	Megaproject papers	3	4	5	7	8	9	7	11	8	11	12	85
	Percentage	0.9%	1.2%	1.4%	1.9%	2.0%	2.1%	1.5%	2.5%	1.8%	2.4%	2.9%	1.9%
IJPM	Total	45	45	68	66	66	69	72	85	85	79	79	759
	Megaproject papers	1	2	2	1	2	1	2	6	2	3	3	25
	Percentage	2.2%	4.4%	2.9%	1.5%	3.0%	1.5%	2.8%	7.1%	2.4%	3.8%	3.8%	3.3%
PMJ	Total	24	22	23	22	20	22	36	31	41	33	40	314
	Megaproject papers	0	1	0	1	0	5	2	2	2	2	3	18
	Percentage	0.0%	4.6%	0.0%	4.6%	0.0%	22.7%	5.6%	6.5%	4.9%	6.1%	7.5%	5.7%
JCEM	Total	62	61	60	80	101	139	132	109	103	132	131	1110
	Megaproject papers	1	1	1	0	2	3	2	1	0	1	2	14
	Percentage	1.6%	1.6%	1.7%	0.0%	2.0%	2.2%	1.5%	0.9%	0.0%	0.8%	1.5%	1.3%
ECAM	Total	37	37	38	36	39	35	36	37	36	33	35	399
	Megaproject papers	0	0	0	2	3	0	0	1	1	3	1	11
	Percentage	0.0%	0.0%	0.0%	5.6%	7.7%	0.0%	0.0%	2.7%	2.8%	9.1%	2.9%	2.8%
CME	Total	87	74	60	72	89	86	105	101	94	90	91	949
	Megaproject papers	1	0	2	0	1	0	0	1	2	0	2	9
	Percentage	1.2%	0.0%	3.3%	0.0%	1.1%	0.0%	0.0%	1.0%	2.1%	0.0%	2.2%	1.0%
LME	Total	--	33	36	27	17	8	12	8	27	19	16	203
	Megaproject papers	--	0	0	1	0	0	1	0	0	0	1	3
	Percentage	--	0.0%	0.0%	3.7%	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	6.3%	1.5%
PICE –CE	Total	37	36	38	37	52	50	52	39	24	44	31	440
	Megaproject papers	0	0	0	2	0	0	0	0	0	2	0	4
	Percentage	0.0%	0.0%	0.0%	5.4%	0.0%	0.0%	0.0%	0.0%	0.0%	4.6%	0.0%	0.9%
JME	Total	43	25	25	23	22	23	24	24	28	24	24	285
	Megaproject papers	0	0	0	0	0	0	0	0	1	0	0	1
	Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.4%

Notes: The total number of papers in the above journals is calculated by excluding articles under the categories of editorial, book review, forum, discussions/closures, letters to editor, article in press, index, foreword, introduction, conference/seminar report, briefing sheet, miscellany, comment, erratum, and announcement.

Table 4.2 indicates the number of published megaproject articles in the eight selected journals from 2000 to 2010. Four journals, namely, IJPM, PMJ, JCEM, and ECAM published the most number of megaproject articles, which are counted as 25, 18, 14 and 11, respectively. The sum of the four journals' megaproject-related articles accounted for 80.0% of all the selected 85 papers. The number of papers published in each of the four journals was more than the average number (10.6) of papers published in the eight selected journals. IJPM published 25 megaproject articles (29.4%), which contributed to the most number of megaproject studies in the past decade. Table 4.2 also reflects that megaproject papers published in PMJ accounted for 5.7% of the total number of papers published in that journal during the study period (Table 4.2). The number from PMJ was higher than in any of the other selected journals. IJPM and ECAM both followed the number of articles in PMJ, with a percentage of 3.3% and 2.8%, respectively. Thus, the four journals can be considered as the most important sources of published papers on megaprojects.

4.3.2 Contributions of Countries/Regions and Universities/ Organizations to Megaproject Research

The number of academic research publications in a country or region may imply the extent of progress in its industrial development and practices (Hong et al., 2012). Analysis of the research contributions of a particular country or region and affiliated institutions can therefore enable to obtain a collective view of the current status of industry development and practices. In this study, the research contributions of each country or region and university (organization) were analyzed by accumulating the score of the contribution of each researcher to megaproject research. The method in computing the score of each researcher's contribution (Section 4.2) was the main tool applied to conduct the analyses. The sum of contribution values of all researchers with identical origins was the final score. The contribution value of one researcher with two origins (i.e. two different countries) was also divided into two equal parts pertaining to the two origins.

Table 4.3 Research origins of the 85 megaproject articles

No.	Country	University/ Organization	Researchers	Papers	Score
1	UK	20	33	23	17.6
2	US	20	26	16	11.1
3	Australia	8	19	11	8.9
4	Canada	9	11	8	5.3
5	Hong Kong	2	10	5	4.8
6	China	8	12	5	3.6
7	Norway	4	9	5	3.3
8	Taiwan	3	6	4	3.3
9	Singapore	1	5	3	2.6
10	Netherland	1	4	3	2.5
11	Sweden	3	5	3	2.3
12	Thailand	1	2	4	2.0
13	Finland	1	6	2	2.0
14	Switzerland	2	7	2	2.0
15	Saudi Arabia	3	3	3	1.9
16	Germany	3	2	2	1.6
17	Bahrain	1	1	1	1.0
18	Belgium	1	3	1	1.0
19	Denmark	1	1	1	1.0
20	India	1	1	1	1.0
21	Italy	1	3	1	1.0
22	Algeria	1	5	1	0.8
23	France	2	3	3	0.8
24	Japan	2	2	1	0.7
25	Israel	2	2	1	0.7
26	Pakistan	1	1	1	0.6
27	Sudan	1	1	1	0.5
28	Portugal	1	1	1	0.3
29	New Zealand	1	1	1	0.3
30	Turkey	1	1	1	0.2
31	Vietnam	1	1	1	0.2
	Total	76	168	85	85.0

As shown in Table 4.3, the originating countries or regions of the identified megaproject articles are outlined with the numbers of universities/organizations and affiliated researchers, the total number of papers published and the score for each origin. The identified 85 papers involved 31 countries and regions, of which 22 were developed countries and regions (including Taiwan) and 9 were developing countries (United Nations Development Program, 2010), which included major construction markets and most emerging construction markets worldwide (Global Construction Perspectives (GCP) & Oxford Economics (OE), 2009). The finding reinforces the observation of Flyvbjerg et al. (2003) that construction megaprojects have become a global phenomenon. Each country/region has an average of 2.7 published papers. The 22 developed countries and regions published 70 papers (82.4%) with a total score of 75.2. A mean value of 3.4 papers (75.2/22) was identified for each developed country, which is higher than the average level. On the contrary, the nine developing countries published only 15 papers (17.6%) with a total score of 9.8 and a mean value of 1.1 papers per country. The main difference between the developed and developing countries (regions) may be caused by a significantly longer tradition of megaproject research in developed countries (regions) than in developing countries. The total score of the developing countries (9.8) is considerably lower than that of developed countries (15.0). Approximately 60% (9/15) of the published papers from developing countries were co-authored with researchers from developed countries. This number shows that some developing countries are trying to establish megaproject research through international collaborations in response to the gradual emergence of their construction megaprojects. Among the eight developing countries that published fewer papers than the average level, India, Turkey, and Vietnam are predicted to be among the top six construction markets to experience the highest growth between 2009 and 2014. They should strengthen their megaproject research. Spain, Russia, South Korea, Brazil and Indonesia were listed among the 15 largest construction markets but some were excluded from the list, as shown in Table 4 (GCP & OE, 2009). These countries have to establish megaproject research in their own research organizations. An imbalance in megaproject research among developed countries and regions was also identified.

Among all countries and regions, the UK, the US, and Australia, had a score of 17.6, 11.1, and 8.9, respectively (Table 4.3). These three countries published the largest number of megaproject articles in the eight journals. Among the 46 published papers by the three countries, 36 were published with their own first authorship, accounting for 78.3% of all megaproject articles. The UK, the US, and Australia are therefore considered as the global centers of megaproject research. The findings can be considered as logical and understandable when the construction market scales of the three countries in the world are examined (GCP & OE, 2009).

Table 4.4 Top ten research institutions publishing megaproject articles
(Based on the original formula)

Ranking	Research institutions	Countries	Researchers	Articles	Scores
1	The University of Hong Kong	Hong Kong	6	4	2.8
2	National University of Singapore	Singapore	5	3	2.6
3	Vrije Universiteit	Netherland	4	3	2.5
4	Asian Institute of Technology	Thailand	2	3	2.0
5	Norwegian University of Science and Technology	Norway	6	3	2.0
6	Helsinki University of Technology	Finland	6	2	2.0
7	Queensland University of Technology	Australia	5	2	2.0
8	University of Reading	UK	3	2	2.0
8	Strathclyde University	UK	3	2	2.0
10	City University of Hong Kong	Hong Kong	4	2	1.8
	Total		44	26	21.8

Table 4.4 presents the top 10 research institutions with the most number of published megaproject papers in the study period. The 10 institutions represent 13.2% of all the involved research institutions. However, the overall contribution score was 25.6% of all published megaproject papers in the target journals from 2000 to 2010. The total number of researchers in the 10 institutions represented 26.2% of all involved researchers. The average number of researchers in the 10 institutions was 4.4 persons, which was twice with that of the researchers by all involved universities and organizations (2.2 persons). As shown in Table 4.4, the University of Hong Kong (with four published articles) ranked first with a score of 2.78 among all identified research institutions. The National University of Singapore ranked second and Vrije Universiteit of the Netherlands ranked third. These universities have played essential roles in megaproject research in their geographical locations and worldwide. However, the contribution of each of the 10 universities remained extremely limited. For

instance, the University of Hong Kong published only four articles and obtained a contribution score of 2.78, which was a small margin compared to other universities.

Table 4.5 Cited times of the eight journals

Journal	Total cited times of relevant papers	Total Number of relevant papers	Times per paper
IJPM	354	25	14.2
PMJ	189	18	10.5
JCEM	140	14	10.0
JME	9	1	9.0
CME	71	9	7.9
ECAM	58	11	5.3
LME	5	3	1.7
PICE–CE	3	4	0.8
Total	829	85	9.8

Controversy exists concerning citations as a measure of research quality (Kostoff, 1998). However, citations have been increasingly adopted as the key indicator for measuring the quality of published papers in the construction management field (Ke et al., 2009; Hong et al., 2012). Therefore, the citations of relevant papers published in the target journals were examined. Table 4.5 shows the citation status of the identified articles from the eight journals. IJPM ranked first with 14.2 citations per article, followed by PMJ and ECAM with 10.5 and 10.0 citations per article respectively. The average number of citations of megaproject papers in each of the three journals was higher than that of the citations from all 85 papers (9.8 citations per paper). The three journals published the most megaproject papers as well as the highest-quality megaproject papers.

Table 4.6 Top ten journal articles ranked by the citation (from Google Scholar)

Ranking	Author information	Year	Journal	Vol.(Issue)	Times
1	Von Branconi and Loch	2004	IJPM	22 (2)	46
2	Thorpe and Mead	2001	JCEM	127 (5)	44
3	Lampel	2001	IJPM	19 (8)	34
4	Berggren et al.	2001	PMJ	32 (3)	32
4	Flyvbjerg	2006	PMJ	37 (3)	32
6	Crawford et al.	2006	IJPM	24 (8)	31
6	Miller and Hobbs	2005	PMJ	36 (3)	31
8	Ivory and Alderman	2005	PMJ	36 (3)	29
9	Williams	2003	IJPM	21 (1)	28
10	Molenaar	2005	JCEM	131 (3)	23
10	Nguyen et al.	2004	ECAM	11 (6)	23

Table 4.6 lists the top 10 articles ranked by citation. Most of the papers were published in IJPM, PMJ, JCEM and ECAM, which reinforced the fact that these journals published the most number of megaproject papers as well as the most significant and influential articles. The paper by van Marrewijk et al. (2008) entitled “Managing public–private megaprojects: Paradoxes, complexity, and project design” ranked seventh with a citation of 30 times in the list of IJPM’s most cited papers provided by Scopus (retrieved on March 11, 2013). The analyses may not fully reflect the citation status of recent journal articles, but megaproject research can be construed to be a major area in the construction management field.

4.4 Categories of Research Interests in Megaproject Research

Construction management publications have witnessed an increasing trend in megaproject research with topics covering a wide scope from theoretical development to practical application. According to Themistocleous and Wearne (2000), the major areas of megaproject research involve nine topics (Table 4.7).

Table 4.7 Major research interests of the 85 megaproject papers

Topics	00	01	02	03	04	05	06	07	08	09	10	Total
Organization and stakeholder management	1	1	1	1	1	3	1	4	2	2	0	17 (20.0%)
Project planning and procurement	1	1	2	1	3	0	1	1	2	1	4	17 (20.0%)
Cost and schedule management	1	1	1	1	1	2	3	1	1	1	1	14 (16.4%)
Construction and site management	0	0	1	1	0	2	0	0	1	4	1	10 (11.7%)
Risks analysis and management	0	0	0	1	2	1	1	1	1	0	1	8(9.4%)
IT innovation and utilization	0	1	0	2	0	0	0	2	0	0	2	7(8.2%)
Leadership and professional development	0	0	0	0	0	0	1	1	0	2	1	5(5.8%)
Complex project management	0	0	0	0	0	1	0	0	1	1	1	4(4.7%)
Project monitoring and control	0	0	0	0	1	0	0	1	0	0	1	3(3.5%)

Organization and stakeholder management ranked first among the nine topics with 17 involved papers. Morris et al. (2011) stressed the importance of the new paradigm of viewing projects as organizations in the project management field, which marks the principal shift of focus in project management studies. Table 4.7 shows the relevant papers concentrating on integrating activities and stakeholders across different organizational and disciplinary domains to improve megaproject performance, including stakeholder management (Awakul & Ogunlana, 2002; Leung et al., 2004; Helm & Remington, 2005; Ruuska et al., 2009), project partnership (Cathcart, 2003; Anderson Jr. et al., 2006; Alderman & Ivory, 2007; van Marrewijk et al., 2008), communication management (Murtoaro & Kujala, 2007; Tai et al., 2009), team management (Dzeng & Wen, 2005; van Marrewijk, 2007), organizational governance and integration (Berggren et al., 2001; Klakegg et al., 2008; Miller & Hobbs, 2005), as well as organizational learning and innovation (Lê & Brønn, 2007; Winch, 2000).

Project planning and procurement also received the highest ranking with 17 involved papers, which is essential for clients in ensuring megaproject success. Relevant papers were mainly concerned with defining project scope, breaking down a megaproject into several manageable packages, and outsourcing to contractors the work packages, including objective and scope management (Ahmad et al., 2003; Nguyen et al., 2004; Beheiry et al., 2006; Zhai et al., 2009; Toor & Ogunlana, 2010), decision management (Kumaraswamy et al., 2004; Jergeas, 2008; Genadio & Singh, 2010; Williams & Samset, 2010), procurement methods (such as design–build, engineering procurement construction and build–operate–transfer) (Tam, 2000; Lampel, 2001; Kumaraswamy & Morris, 2002; Ling & Lau, 2002; Algarni et al., 2007), and contract management (von Branconi & Loch, 2004; Badenfelt, 2008; Rose & Manley, 2010). Table 4.7 shows that the relevant studies have nearly gone through the whole study period and received increased interest.

The number of papers on cost and schedule management ranked third out of the 85 megaproject papers. Flyvbjerg et al. (2003) stated that cost overruns and time delays are the main risks faced by construction megaprojects. Thus, this topic has received significant attention in the past decade. Research interest in this aspect was grouped into the following categories: cost overrun analysis (Eden et al., 2005; Creedy et al., 2010), delay analysis (Williams, 2003; Toor & Ogunlana, 2008), optimization and modeling (Wang & Demsetz 2000; Hardie, 2001; Liu & Rahbar, 2004; Vanhoucke et al., 2005; Touran & Lopez, 2006; Bonnal et al., 2006; Yang, 2007; Zammori et al., 2009), and performance management (Walker & Shen, 2002; Yang et al., 2006).

Construction and site management ranked fourth among all megaproject papers with 10 relevant papers. The interest in this area mainly included safety management (Chua & Goh, 2005; Rajendran & Gambatese, 2009), labor and construction productivity (Elhakeem & Hegazy, 2005; Aziz, 2008; Helen et al., 2010), quality and material management (Ibn-Homaid, 2002; Keeling, 2003), and construction technology and management (Attar et al., 2009; Chakraborty, 2009; Hassanain, 2009). These studies addressed practical issues in megaproject construction and are indispensable to the execution management of construction megaprojects.

Risk analysis and management took the fifth place with eight involved papers. This topic has been advocated as a critical aspect in managing megaprojects (Miller &

Lessard, 2000; Flyvbjerg et al., 2003; Fiori & Kovaka, 2005). Specific topics of the identified papers included risk identification (Santoso et al., 2003; Busby & Hughes, 2004; de Camprieu et al., 2007; Krane et al., 2010), risk measurement (Molenaar, 2005; Sun et al., 2008), and risk control methods (Schexnayder et al., 2004; Flyvbjerg, 2006). Table 4.7 shows that research interest in this area has increased since 2003.

Information technology (IT) is an essential aspect of managing megaprojects. Harty et al. (2007) emphasized the rising trend of using IT in construction. In this study, seven papers were identified to be relevant in IT. The papers mainly involved IT application issues in different phases and aspects of megaproject management, including design management (Harty & Whyte, 2010; Whyte & Lobo, 2010), communication management (Thorpe & Mead, 2001; Underwood & Watson, 2003; Rowlinson, 2007), and workflow and process management (Badir et al., 2003; Boersma et al., 2007).

With the development of megaproject management as a new profession, leadership and professional development has received increasing attention since 2006. Relevant papers concentrated on two specific topics, namely, capability assessment (Yasin et al., 2009; Müller & Turner, 2010) and professional development (Crawford et al., 2006; Toor & Ogunlana, 2009; Frank et al., 2007). These issues are expected to receive more research attention in the future because of rapidly increasing megaproject practices.

Complex project management has been increasingly advocated as the main theory for megaproject research since the mid-2000s. A growing number of scholars stressed the significance of applying the theory to megaproject research, which not only contributes to the establishment of a knowledge body for megaprojects (Ivory & Alderman, 2005; Saynisch, 2010), but also improves the capability of professionals who manage megaprojects (Thomas & Mengel, 2008; Whitty & Maylor, 2009).

Central monitoring and control has an essential function in project management research. However, central monitoring and control has received limited research concern over the past decade. Only three papers on this topic were identified: Brady and Davies (2010), Edum-Fotwe et al. (2004), and Jaafari (2007).

4.5 Categories of Research Methods in Megaproject Research

Table 4.8 Categories of research methods of the 85 megaproject articles

Topics	Number	Types of research methods		
		Qualitative	Quantitative	Mixed
Organization and stakeholder management	17	14	3	0
Project planning and procurement	17	11	4	2
Cost and schedule management	14	4	8	2
Construction and site management	10	4	6	0
Risks analysis and management	8	3	4	1
IT innovation and utilization	7	3	3	1
Leadership and professional development	5	1	4	0
Complex project management	4	4	0	0
Project monitoring and control	3	2	0	1
Total	85	46	32	7

Table 4.8 shows the relationships among the eight research topics and the methods of the 85 articles in the eight selected journals within the study period. Qualitative methods (including mixed methods) were generally employed at a high frequency (62.4 %) in the relevant studies, which indicated megaprojects represented an intermediate research area (Edmondson & Mcmanus, 2007).

Table 4.8 further shows the results of the detailed examinations of the research methods used in each topic. Quantitative methods (including mixed methods) were used at a high frequency employing as the main research methods (60.0% to 80.0%) in each of the five topics, namely, cost and schedule management, construction and site management, risk analysis and management, IT innovation and utilization and leadership and professional development. The topics are initially mature or already mature in megaproject research (Edmondson & Mcmanus, 2007). Numerous optimization models and tools were developed and used to resolve real-life problems based on the topics. The main quantitative methods and models employed in the studies consisted of the following:

- Empirical survey (e.g., Müller & Turner, 2010; Santoso et al., 2003; Yasin et al., 2009),
- Delphi survey (Dzeng & Wen, 2005; Sun et al., 2008),
- Correlation analysis (Helen et al., 2010),
- Regression analysis (Creedy et al., 2010),
- Fuzzy analysis (Zammori et al., 2009; Dzeng & Wem, 2005),
- Particle swarm optimization (Yang, 2007),
- Markov analysis (Hardie, 2001),
- Integer programming analysis (Rajendran & Gambatese, 2009),
- Loss causation analysis (Chua & Goh, 2005),
- Nomograph theory (Elhakeem & Hegazy, 2005),
- Maximal flow theory (Liu & Rahbar, 2004),
- Social network analysis (Thorpe & Mead, 2001),
- Monte Carlo simulation analysis (Touran & Lopez, 2006), and
- Networks under correlated uncertainty simulation model (Wang & Demsetz, 2000).

Among the four remaining topics, namely, organization and stakeholder management, project planning and procurement, project monitoring and control, and complex project management, a high ratio of qualitative methods (including mixed methods) as main research methods (76.5% to 100.0%) was observed in each of these topics (Table 4.8). The four remaining topics are nascent research areas (Edmonson & Mcmanus, 2007). A triangulation of multiple qualitative methods, such as interviews, case studies and content analyses, were frequently used in the studies to explore the theories behind real cases (e.g. von Branconi & Loch, 2004; Murtoaro & Kujala, 2007; Thomas & Mengel, 2008; Ruuska et al., 2009; Toor & Ogunlana, 2010; Brady & Davies, 2010).

4.6 Assessing Megaproject Research in a Project Complexity Framework

As shown in Figure 4.1, a dual-dimension framework was proposed to assess previous megaproject studies and identify future research directions.

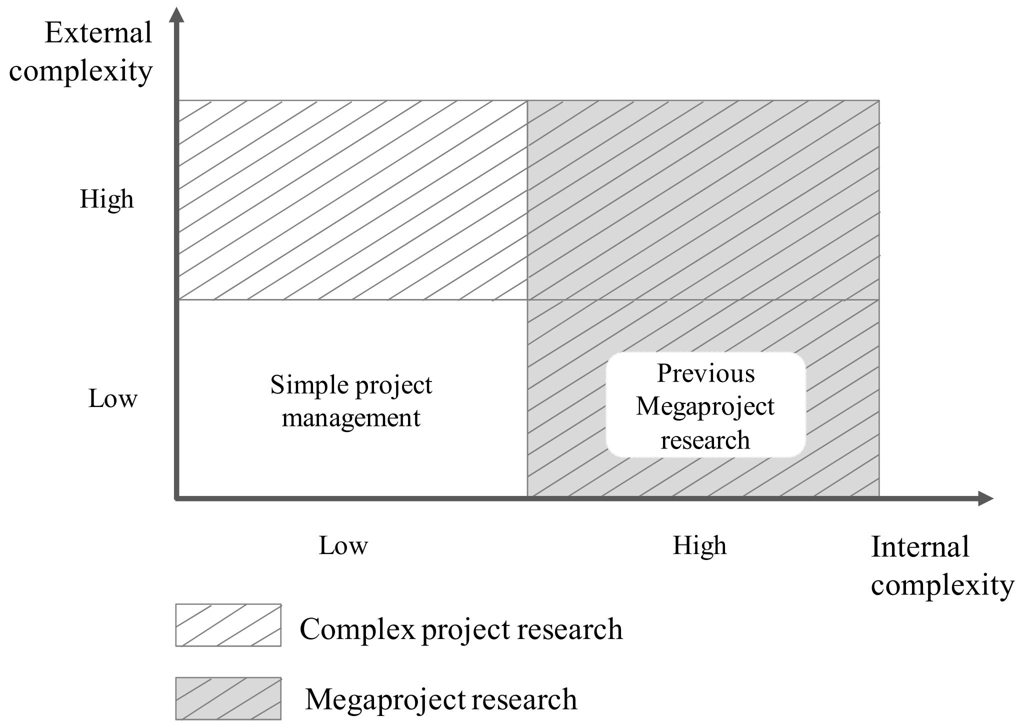


Figure 4.1 Project complexity framework for positioning megaproject research

Rapid emergence of construction projects worldwide has significantly improved in the built environment. However, the execution of megaprojects has pushed the limits of scope, experience and technology (Fiori & Kovaka, 2005). Megaprojects are typically characterized by high internal complexity, such as task complexity (Brockmann & Girmscheid, 2007), structural complexity (Remington & Pollack, 2008), directional complexity (Remington & Pollack, 2008), technical complexity, and organizational complexity (Baccarini, 1996). Most previous megaproject studies have focused on the internal complexity issues (Figure 4.1). Numerous studies have been conducted on relevant topics, such as construction and site management, cost and schedule management, risks analysis and management, IT innovation and utilization, as well as leadership and professional development. However, frequent use of qualitative methods (including mixed methods) in the three additional topics, namely, organization and stakeholder management, project planning and procurement, and project monitoring and control, indicates the possible lack of a main theory. This lack reinforces the argument of Pellegrinelli et al. (2011) that a significant research opportunity exists in megaproject organization. A growing number of researchers suggest that complex project management serves as the theoretical foundation of megaproject research, particularly in these nascent topics (Ivory & Alderman, 2005; Whitty & Maylor, 2009; Thomas & Mengel, 2008).

Construction megaprojects should also deal with the complexity from contextual uncertainty, that is, external complexity. Construction projects operate in an uncertain context because of widespread economic fluctuation (Shehu & Akintoye, 2010). In major developing countries, such as China, India, and Russia, which are new investors in megaprojects, megaproject management faces an even higher uncertainty from social and cultural transitions. This contextual uncertainty has significantly increased the external complexity of managing megaprojects which includes temporal complexity (Remington & Pollack, 2008), as well as social complexity and cultural complexity (Brockmann & Girmscheid, 2007). External complexity has an effect on relevant topics, such as organization and stakeholder management, project planning and procurement, project monitoring and control, as well as risk analysis and management. External complexity has been discussed by Miller and Hobbs (2005), de Camprieu et al. (2007), and Klakegg et al. (2008), but the issue deserves more attention in future megaproject research. Miller and Hobbs (2005) proposed that megaprojects could reconcile the uncertainty through positive interaction with the institutional environment. Mahalingam and Levitt (2007) stated that institutional theory could help practitioners classify the issues from institutions they encounter, determine the causes behind the problems, and judge with relatively ease factors in solving each problem. Only recently institutional analysis has been increasingly advocated as the main tool in examining the contextual effect on the management of megaprojects (e.g., Grigg, 2005; Mahalingam & Levitt, 2007; Chi & Javernick-Will, 2011). For example, Chi and Javernick-Will (2011) used institutional analysis to examine project management arrangements in high-speed rail projects between Taiwan and China. Mahalingam and Levitt (2007) also used this method to analyze the source of conflicts in metro railway projects in India. Remington and Pollack (2008) enumerated several methods of research on the external uncertainty of megaprojects, such as mapping complexity, system anatomy, and multi-methodology in parallel. Most of relevant studies mentioned were conducted either in developed countries or as a collaboration between developed and developing countries. Major developing countries that are new investors in megaprojects but lack a research tradition should consider research collaborations with developed countries to establish megaproject research for their own benefits. Several collaborative studies have been completed but remain insufficient.

4.7 Chapter Summary

This chapter has systematically reviewed relevant articles published between 2000 and 2010 to assess and identify trends in megaproject research. Eighty five relevant papers were identified from eight peer-reviewed construction management journals, and the papers were analyzed in terms of the number of articles published annually, institutional and regional contributions, citations, and categorization of research interests and methodologies. Analysis results indicated that developed countries, such as the UK, the US, and Australia, have enjoyed significant advantages in megaproject research because of their longer traditions. Megaproject research in developing countries, such as Russia, India, Turkey, and Vietnam, remains weak or insufficient. These results revealed that numerous theory-based findings were also reported in five sub-areas, namely, construction and site management, cost and schedule management, risk analysis and management, IT innovation and utilization, and leadership and professional development. The sub-areas of organization and stakeholder management, project planning and procurement, and project monitoring and control remain promising domains for future research, particularly in developing countries that have yet to establish a research tradition. Incorporating the complexity theory and institutional theory as the theoretical foundation of these sub-areas can further develop megaproject research through strengthened global collaboration in the future.

CHAPTER 5: APPLICATION OF PROGRAM MANAGEMENT FOR THE SUCCESS OF CONSTRUCTION MEGAPROJECTS

5.1 INTRODUCTION

After entering the 21st Century, program management has not only become a new profession with increased attention from industries (IPMA, 2006; Rasdorf et al., 2010), but has also received greater attention from the academic community. In the construction industry, program management has been increasingly advocated as a pragmatic means of improving megaproject performance through coordinated management of constituent projects with a megaproject.

This chapter first presents the definition of program management. Then, the merits of program management in managing construction megaprojects from different viewpoints are addressed. Finally, a brief review of the developments in program management studies in the past decade is presented.

5.2 DEFINITION OF PROGRAM MANAGEMENT

5.2.1 Definition of Program Management in Construction

The word “program(me)” originated from the “project” concept, and the item has been used interchangeably with project management (PMI, 2000). Archibald (2003) first distinguished a program from projects and defined a program as “a long-term undertaking that includes two or more projects and requires close cooperation”. This definition seems to be an evolved construct of a large project based on managerial philosophy. A number of definitions have been advocated by different researchers and institutions. Table 5.1 reviews various definitions of program management.

Table 5.1 Definitions of Program Management

Authors	Definition
Office of Government Commerce (2003)	The coordinated organization, direction and implementation of a portfolio of projects and activities that together achieve outcomes and realize benefits that are of strategic importance.
Reiss et al.(2006)	The orchestration of organizational change.
Turner (2009)	A program is a group of projects which contribute to a common, higher order objective. The parent organization has a change objective which may require contributions from several different areas, or several different types of projects for its achievement.

The Project Management Institute (PMI) in the US and IPMA in Sweden are both well-known project management research institutions in the world. Both institutions have developed their own definitions of program management.

PMI (2006) defined program management as follows:

> "A program is a group of related projects managed in a coordinated way to obtain benefit and control not available from managing them individually. Program management is the centralized coordinated management of a program to achieve the program's strategic benefits and objectives."

IPMA (2006) defined program management in the fresh standard of "ICB–IPMA Competency Baselines (Version 3.0)" as follows:

> "A program is set up to achieve a strategic goal. A program consists of a set of related projects and required organizational changes to reach a strategic goal and to achieve the defined business benefits."

The two definitions reflect that management works with a program can be divided into two parts: (1) management tasks within constituent projects with definite objectives that the traditional project management approach can apply to, and (2) coordination **activities** across constituent projects to realize the common program objectives (Figure 5.1). The second part mainly refers to program management.

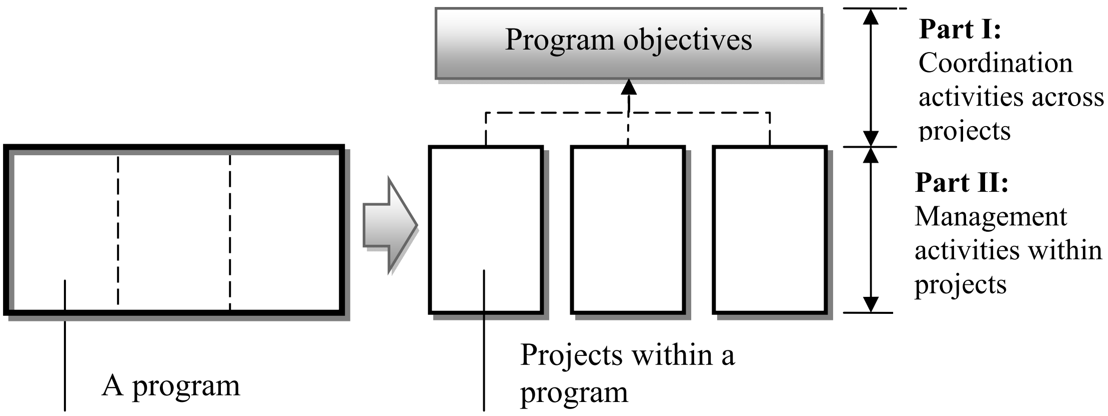


Figure 5.1 Management works within a program

In the construction industry, a program refers to a large and complex construction project that is divided into multiple units and executed in a dispersed manner. For example, Shanghai Expo construction includes approximately 200 pavilions, supporting buildings and infrastructures. Thus, the construction works of these buildings and infrastructures were divided by the client into 10 projects and were executed by different project management teams (PMTs). Aside from the management tasks performed by the 10 PMTs, the client should also have a separate team to coordinate and integrate all works performed by the PMTs. Coordination and integration tasks are termed as program management in this study. In numerous megaprojects, such as dams, railways, and highways, the clients face a similar situation in delivering a megaproject as a whole although the constituent units (projects) of each megaproject are executed dispersedly. Program management in this study mainly refers to coordination activities intended to achieve the overall objectives, such as functionality and quality, time, and cost.

5.2.2 Project, Program, and Portfolio Management

Project, program, and portfolio management are three related but different concepts commonly used in the project management field. To clearly define "program management," the main differences among these concepts should be compared. These issues also attract attention from numerous research institutions and scholars.

According to PMI (2006), IPMA (2006), and Reiss et al. (2006), several common characteristics and differences among project, program and portfolio management are included in Table 5.2.

Table 5.2 Comparisons of project, program, and program management concepts
(Partly adapted from PMI (2006))

	Project	Program	Portfolio
Success measures	Budget, on time, and products delivered to specification	Returned On Investment (ROI), new capabilities, and benefit delivery.	Aggregate performance of portfolio components.
Management objective	A single project	A group of related projects	A combination of programs and projects/programs
Attitude toward change	Negative	Positive	Sensitive
Focus of leadership style	Task delivery and directive in order to meet the success criteria.	Managing relationships and conflict resolution; and facilitates the political aspects of the stakeholder management	Adding value to portfolio decision making
Source of business benefits	Out of a project	Within a program	Out of a portfolio
Time, and cost works	Strict plan and high control	Rough plan and less control	High monitoring in terms of strategic targets in the portfolio

To sum up, program management can be regarded as an evolved version of project management in dealing with larger and more complicated projects such as megaprojects. Program management aims to break down a large project into smaller manageable units (e.g. a project or work), and control the progress of related projects so that a successful control at the program level can be attained (Remington & Pollack, 2008). The core of program management includes two issues: (1) breaking down a large project into manageable units, and (2) controlling all of the broken down units at the program level.

Meanwhile, portfolio management refers to several unrelated projects that may have business benefit at the corporate level (PMI, 2006). These constituent projects do not require inter-project coordination and control compared with program management.

5.3 Application of Program Management for the Success of Construction Megaprojects

With the rapid emergence of construction megaprojects worldwide in the past decade, program management has been advocated by academics and professionals as a pragmatic approach to managing megaprojects. Viewpoints from different sectors of the construction industry prove that the program management approach is appropriate in managing a construction megaproject that is divided into several projects and executed dispersedly.

5.3.1 Viewpoints of Academics

Evaristo and van Fenema (1999) enumerated three forms of the geographical distribution of a program: (1) collocated program, where a number of projects are executed in parallel and in a single geographical location; (2) a number of traditional projects, where projects are located at different places; and (3) a number of distributed projects, where each project consists of several sites either at overlapping locations or at discrete locations. The three forms can be termed as different types of construction megaprojects, such as skyscrapers, dams, railway networks, and so on.

Burke (2003) defined programs management as “the management of large capital projects”. In most cases, the term “large capital projects” is used interchangeably with “construction megaprojects”.

Artto et al. (2008) stated that program management is rooted in large project practices. Because a megaproject is an extreme example of a large project, the program management approach can also be applied to megaproject practices.

Kim et al. (2009) stated that construction megaprojects can be treated as programs, and reported the developments and practices of the intelligent program management information system for managing urban renewal megaprojects in Korea.

Rasdorf et al. (2010) defined program management as the application of construction management to extremely large projects in numerous aspects, and noted that program managers can handle teams to deliver large projects.

Pellegrinelli et al. (2011) stated that the challenges of managing a megaproject are highly similar to those of managing a program.

According to Eweje et al. (2012), a megaproject is a case of a program because it comprises a set of multiple, but related projects with common strategic and business objectives, which are usually executed individually but generate benefits that are unavailable from managing them individually. Oil and gas megaprojects are examples in which management can apply the program management approach.

More indirect evidence of program management as appropriate in managing megaprojects can also be acquired from recent research in numerous universities worldwide. In the UK, Oxford University set up the Center for Major Program Management (CMPM) at the Saïd Business School in partnership with British Telecom (BT) in 2008. As stated on the CMPM website (2013), the term "major program" mainly referred to large-scale stimulus spending on transport, information communication technology, health, and so on. The majority of programs were construction megaprojects. Recently, the UK government, in partnership with BT CMPM, announced that GBP 6.2 millions would invested in a leadership academy for senior megaproject leaders (Simons, 2012). A similar definition of viewing megaprojects as programs was provided by the International Center for Program

Management at Cranfield School of Management.

As the preceding review proves, the trend for managing construction megaprojects by adopting the program management approach has been increasingly supported by the academic community over the past few years.

5.3.2 Viewpoints of Practitioners

Beehleer (2009) stressed the advantages of employing an external program manager for megaprojects through comparisons with two other procurement approaches, design–bid–build and design–build, from the perspective of a client. Some of these advantages are listed as follows:

(1) Comprehensiveness and continuity of services for the client with staff or a third party overseeing the entire process from project planning to project closeout.
(2) Control of the design and construction processes throughout the project by offering the client timely cost and schedule information to facilitate informed decisions on cash flow and the exposure of accurate information to executives, regulators and the public.
(3) Reduce temporary employment of additional staff for specific project-related functions by writing the requirement of temporary resource adjustment into the contract.
(4) Current knowledge of design and construction resources, material suppliers, and best practices in previous megaproject practices.
(5) Stage-based bid packages for engineering, materials and contracting based on project requirements.
(6) Penalties or incentives for the works of program manager in maintaining schedule and budget.

A survey across the construction industry on employing an external program manager has been conducted in the US by FMI Corporation, a construction consulting company, and the Construction Management Association of America to examine the market demand for program management services (Rasdorf et al., 2010). Survey results have revealed that program management has been widely accepted by public and private clients as a key approach to megaproject management. These results also indicate that most clients intend to manage large projects by employing an external program manager.

With the success of the program management approach in the Shanghai Expo megaproject, numerous construction consulting companies in China have begun to provide program management services to clients who need to manage megaprojects (SKCPM, 2011; SPM 2011). A large number of clients have tried this new service to manage their investment megaprojects, such as Shanghai Aircraft Manufacture Base and Ping-an International Finance Center in Shenzhen.

5.4 Review in Program Management Studies

Program management has become a concept distinct from project management since 2003. Several studies have focused on this area over the past decade (Artto et al., 2008). Pellegrinelli et al. (2011) stated that program management is an emerging area of research and practice. Recent developments in program management research have been reported by Lycett et al. (2004), Artto et al. (2008), and Pellegrinelli et al. (2011). Discussions on developments and future directions in program management research are presented in the following sections based on the works of the afore-mentioned researchers and the literature reported in Section 6.2.

5.4.1 Developments in Program Management Research

1) Definitions of Program Management

The difference in definitions between project management and program management remain unclear (Milosevic et al., 2007). Lycett et al. (2004) stated that a program should not be treated as a scale-up project. Thus, numerous research efforts have been devoted to distinguish program management from project and portfolio management in terms of characteristics, scope and differences (Lycett et al., 2004; Morris, 2009). According to Pellegrinelli et al. (2011), knowledge in the project management field is well established, whereas knowledge in program management continues to change based on megaproject practices, theories and techniques in other fields.

2) Program Management Frameworks

Pellegrinelli et al. (2011) stated that program management from a research perspective is "a framework to coordinate, communicate, align, manage, and control activities to achieve a desired synergy, benefits, outcome, or vision". Numerous program management frameworks, such as the Standard for Program Management by PMI (2006), the Management of Successful Programs (MSP) Framework by the Office of Government Commerce (OGC) (2003), the competency framework for program success by Pellegrinelle et al. (2002), and the program management framework by Partington et al. (2005), have been reported in the past decade. However, none of these frameworks has received considerable support from the construction industry (Rasdorf et al., 2010). Artto et al. (2008) revealed that these frameworks seldom considered the background of a specific industry. The definition of program management lacks clarity, so formulating a conceptual framework for program management is critical for future research and practices. Such a conceptual framework can not only guide future research directions, but also serve as references for professionals. Numerous scholars have investigated the validity of program management frameworks. For instance, Pellegrelli et al. (2007) examined the degree of implementing the OGC's MSP framework into practices and found that current practices do not comply with the MSP framework. Therefore, these issues deserve further investigation to establish the knowledge body on program management.

3) Program Management Practices

Similar to project management, program management is also a social construct. Artto et al. (2008) stated that program management is rooted in large project practices. Pellegrinelli et al. (2011) emphasized the significance of program management practices in research and stated that aside from being involved in a debate on definitions and frameworks, research on program practices is indispensable to understand the essence of program management. Various research efforts have also been devoted to this area. Burren et al. (2010) analyzed the benefits and obstacles of program management practices based on a case study of development projects in the Amsterdam Metropolitan Area. Pellegrinelli et al. (2007) examined the contextual impact on program practices in the UK. These research efforts have contributed substantially to the establishment and refinement of the general knowledge body on program management.

5.4.2 Research Directions: Program Organizational Capability Development

Organizational theory has been advocated gradually as a new paradigm in program management research (Artto et al., 2008; Pellegrinelli et al., 2011). Among the diversified regime of organizational theories, organizational capability (competence) theory has been widely advocated as a main theoretical foundation in previous project and program management studies (Pellegrinelli et al. 2011; Ghapanchia & Aurumb, 2012). Organizational capability is defined as the creation and exercise of an organization's reliable capacity to accomplish an undertaking through its intended action (Dosi et al., 2000). Firms can gain and sustain competence by developing organizational capabilities such as technological, coordination, strategic, and knowledge-based capabilities (Schienstock, 2009). Similarly, programs have to develop and maintain such organizational capabilities to accomplish their prescribed objectives. Empirical studies also revealed that organizational capabilities were highly correlated with projects success (Sofian, 2003; Ghapanchia & Aurumb, 2012). Thus, the areas concerned with these issues remain a promising domain for future research.

Strategic management is one of the key directions of program management research (Pellegrinelli et al. 2011) because programs today are executed as long-term undertakings that operate in a dynamic and changing context. Teece et al. (1997) stated that organizations could address the needs of strategic management by renewing dynamic capabilities. Wang and Ahmed (2007) further categorized these capabilities into adaptive, absorptive and innovative. Ghapanchia and Aurumb (2007) analyzed the impact of project dynamic capabilities on project performance based on case studies of open–source software projects. However, these program management frameworks seldom reflect the requirements of the construction industry (Rasdorf et al., 2010). Therefore, research on this sub-area also deserves further investigation.

Being in a newly recognized managerial profession, program managers face huge difficulties in developing and sustaining leadership and competence in program practices (Pellegrinelli et al., 2011). Numerous industrial associations, such as the IPMA and Association for project management (APM) in the UK have been heavily engaged in program leadership and competence issues in the past decade. For example, IPMA's Competency Baselines and APM's Body of Knowledge (2006) have contributed to developments in this area. These issues have also been investigated by Engwall (2003), Crawford (2005), Pellegrinelli et al. (2007), and Partington et al. (2005). Leadership and personal competences are also sources of organizational capability (Dave & Lake, 1991). As driven by practice, this area is expected to continue developing further.

To sum up, organizational capability theory can serve as a main theoretical foundation for program management research (Pellegrinelli et al., 2011). Thus, developing a unified framework for program organization in terms of organizational capability theory can provide better direction for future research.

5.5 CHAPTER SUMMARY

A brief history and definition of program management have been presented in this chapter. The applicability of program management to megaprojects is analyzed both from academic and industrial perspectives. Analysis results validated the application of program management approach in managing construction megaprojects. Finally, developments and directions of program management studies over the past decade have been reviewed to provide an overall depiction of program management.

CHAPTER 6: FORMULATION OF A CONCEPTUAL MODEL OF PROGRAM ORGANI-ZATION FOR MANAGING A CONSTRUC-TION MEGAPROJECT

6.1 INTRODUCTION[4]

Rasdorf et al. (2010) expressed the need to develop a program management standard for managing megaprojects. Lycett et al. (2004) and Rasdorf et al. (2010) emphasized that program organization is a crucial elements of any program that typically takes the form of an integrated client organization with an external program manager being employed to manage a megaproject.

Numerous researchers defined program management as a framework to guide and improve program practices (Pellegrinelli et al. 2011; Shehu & Akintoye, 2009). A conceptual framework of program organization is formulated based on the literature review before the case study to ensure that the program organization model is grounded in a theoretical foundation of previous studies.

This chapter aims to develop a conceptual framework of program organization. First, the review process is introduced. A conceptual model of construction program management comprising 22 POFs is presented based on the identified literature. Finally, the model is validated through interviews conducted in the case study.

6.2 REVIEW PROCESS

[4] The earlier version of this chapter has been published in a working paper: HU, Y., Chan, A. P. C. & Le, Y. (2012, July). Conceptual framework of program organization for managing construction megaprojects – Chinese client's perspective. *Working Paper Proceedings of the Engineering Project Organization Conference,* Rheden, Netherlands.

A structured literature review similar to those reported in Chapter 4 on relevant papers in published peer-reviewed construction management journals between 2000 and 2010 was conducted to develop a conceptual framework of program organization. A list of nine journals similar to those mentioned in Section 4.2 was formulated. This journal list was validated through both WoS and Scopus. The list included the journals with the most number of relevant papers published. In the validation process, common keywords, such as "program management", "program control", "programme control", "program controlling", "programme controlling", "program organization", "programme organization", "program coordination", "programme coordination", "program manager", and "programme manager", were used in the "title/abstract/keyword" field of search engines under the "architecture/business/ construction/engineering" sub-area. Most of the journals are also included in the journal-ranking list provided by Chau's (1997) in the construction management field. Second, relevant articles in the nine journals were searched using Scopus and WoS in February 2011. Search results in the nine selected journals are presented in Table 6.1 (Appendix C).

Table 6.1 Search results in the nine selected journals

No.	Journal Title	Code	Total
1	International Journal of Project Management	IJPM	26
2	Project Management Journal	PMJ	6
3	Leadership and Management in Engineering	LME	1
4	Journal of Construction Engineering and Management	JCEM	2
5	Journal of Asian Architecture and Building Engineering	JAABE	2
6	Construction Management and Economics	CME	0
7	Engineering, Construction and Architectural Management	ECAM	0
8	Journal of Management in Engineering	JME	0
9	Proceedings of Institution of Civil Engineers–Civil Engineering	PICE–CE	0
	Total		37

6.3 Formulation of a Conceptual Model of Program Organization

A conceptual framework consisting of 22 POFs was formulated after reviewing the 37 identified papers. The POFs were the contextual, regulative, structural, normative, technical and cultural–cognitive elements at multiple levels of the program organization established by a client to manage its construction megaproject. The review scope also included the 87 megaproject papers published in the same period as mentioned in Section 4.2. These papers were included because research on program management is rooted in megaproject practices (Artto et al., 2008). Only the POFs identified from the 87 megaproject papers that were consistent with the program management literature were deemed appropriate for incorporation into the conceptual model of program organization. POFs were identified according to two criteria. First, the identified POFs should be consistent with the evidence on the Shanghai Expo construction. Second, the items defining each POF should be clearly and easily understandable to industry professionals. The selection of criteria was based on author's involvement in the Shanghai Expo construction for almost three years. Finally, 22 POFs were identified. These POFs are shown in Table 6.2.

Table 6.2 Categories of POFs by previous studies

Categories/ POFs Previous Studies	Environmental capability		Core capacity																Motivational capability			
	Contextual understanding	Program strategy	Program leadership	Scope management	Program governance	Matrix organizational structure	Program management office	Competent staff	Use of PBS/WBS tools	Standardized process management	Partnership with key stakeholders	Risk management	schedule management	Cost management	Function & quality management	Knowledge management	Program Control information system	Contingency management	Program culture	Communication management	Team building	Program incentives
Artto et al. (2008)					√		√															
Brady & Davies (2010)																		√				
Buuren et al. (2010)			√		√						√											
Crawford & Nahmias (2010)			√	√	√					√	√	√		√	√				√	√	√	
Davies et al. (2009)										√								√				
Dvir & Shenhar (2011)			√	√							√					√			√			
Gray (2001)	√																					
Geraldi et al. (2010)								√										√				
Greiman (2010)											√											
Kim et al. (2009)				√													√					
Ko & Paek (2008)						√	√			√											√	
Kumar & Hsiao (2007)			√																			
Lehtonen & Martinsuo (2008)					√																	
Lycett et al. (2004)				√	√	√							√			√			√	√		
Maylor et al. (2006)		√		√	√					√										√		
Modig (2007)						√																
Molenaar (2005)												√		√								

Table 6.2 (Continued)

Categories/ POFs	Environmental capability		Core capacity																Motivational capability			
Previous Studies	Contextual understanding	Program strategy	Program leadership	Scope management	Program governance	Matrix organizational structure	Program management office	Competent staff	Use of PBS/WBS tools	Standardized process management	Partnership with key stakeholders	Risk management	schedule management	Cost management	Function & quality management	Knowledge management	Program Control information system	Contingency management	Program culture	Communication management	Team building	Program incentives
Nguyen et al. (2004)			√	√	√			√						√		√	√			√		√
Nieminen & Lehtonen (2008)					√					√												
O'Laery & Williams (2008)																	√					
OGC (2003)				√							√	√			√		√	√				
Partington et al. (2005)	√			√	√	√						√	√	√								
Pellegrinelli/ Pellegrinelli et al. (2002, 2007 & 2009)	√		√	√	√	√	√			√	√	√		√	√				√	√	√	
PMI (2006)				√	√				√	√	√	√	√	√	√		√			√	√	
Rasdorf et al. (2010)		√	√																			
Reiss et al. (2006)	√	√		√	√		√			√	√	√		√	√	√				√		
Remer & Martin (2009)			√																			
Schexnayder et al. (2004)												√										
Shehu & Akintoye (2009 & 2010)			√		√		√	√	√	√		√		√						√	√	
Thirty/ Thiry & Deguire (2002 & 2007)					√											√						
Tang et al. (2008)																						√
Wellman (2007)			√			√														√		
Total	**4**	**3**	**10**	**11**	**14**	**6**	**5**	**3**	**2**	**9**	**8**	**9**	**3**	**8**	**5**	**5**	**5**	**4**	**4**	**9**	**5**	**2**

The International Development Research Center (IDRC) and the Inter-American Development Bank (IADB) (2002) provided a three-aspect framework of development project organization. This framework categorized project organizational factors into three groups: environment, capacity and motivation. Correspondingly, the program organization established by a client to manage its construction megaproject should develop environmental capability, core capacity, and motivational capability. Thus, a three-dimensional categorization framework of the 24 POFs has been established by refining the framework of IDRC and IADB (2002) in terms of organizational capability theory. The 24 POFs include two environmental factors, 16 capability factors, and four motivational factors. Figure 6.1 presents the program organization framework for managing a construction megaproject from the perspective of a client.

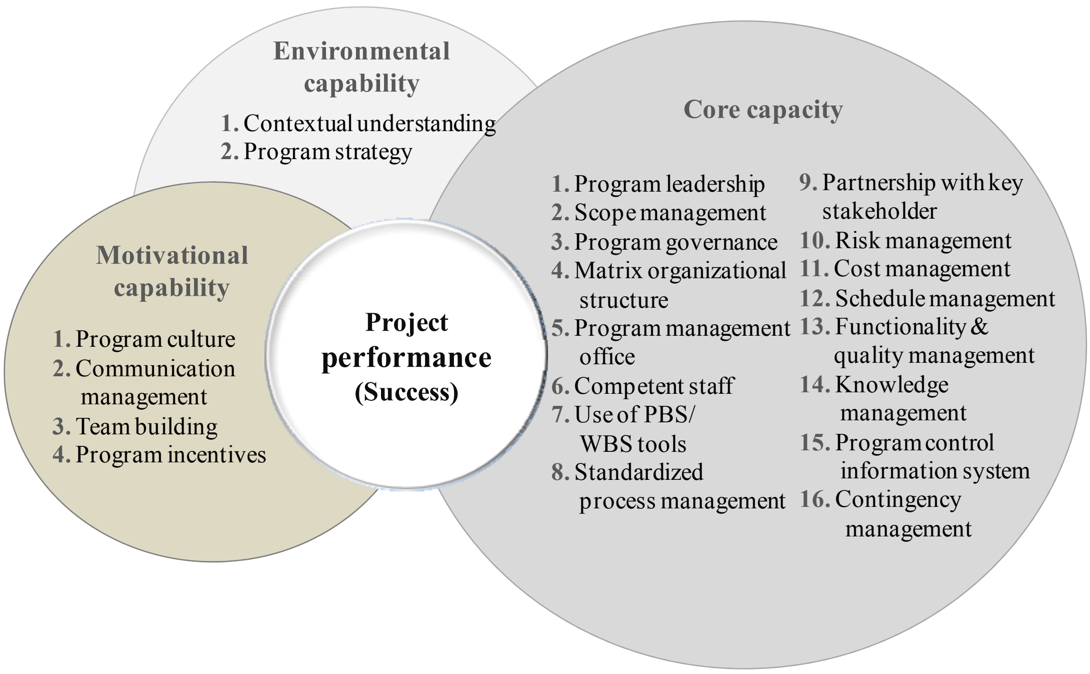


Figure 6.1 The program organization framework for managing construction megaprojects

6.3.1 Environmental Capability

1) Contextual Understanding

Program context is defined as the environment within which a program operates

(Reiss et al., 2006; Gray, 2001). The environment typically refers to the administrative, technological, economic, socio-cultural and historical factors (Lusthaus et al., 1995; Engwall, 2003). Although the environmental impact on complex organizations has been highly recognized since the 1960s (Thompson, 1967; Galbraith, 1973; Granovetter, 1985; Scott & Meyer, 1994), the environmental impact on project management has been recognized only since the late 1980s (Pinto & Covin, 1989; Shenhar & Divor, 1996). The significance of this issue in program management has been recognized over the past few years (Partington et al., 2005; Pellegrinelli et al., 2007; Chi & Javernick-Will, 2011). Engwall (2003) emphasized that the environment can significantly influence the structure, processes and behavior in a project organization. Thus, contextual understanding is essential to design a program organization for a megaproject. Moreover, the program organization managing a megaproject should sustain such an understanding throughout the megaproject lifecycle because adjustments to organizational structure, processes and behaviors should be made timely when environmental changes occur during development of megaprojects (Gil et al., 2008).

2) Program Strategy

The management of a program has to address strategic management issues because it usually involves an almost five-year (even longer) execution plan. Morris and Hough (1987) emphasized the significance of strategic management in managing megaprojects (major projects) by stating that megaproject success should address strategic management issues, such as objectives, technical management, political concerns, schedule and financial affairs and project implementation. Artto et al. (2008) highlighted the role of project strategy from the contextual perspective and noted that project strategy could ensure the success of a project in its environment. In managing megaprojects, clients should develop organizational capability by adopting a strategy to coordinate interfaces with other stakeholder organizations within the megaproject consortium and to control the execution works performed by the consortium effectively and efficiently. Such a strategy can be regarded as a configuration strategy through which elements of the strategy–making process, the content of the strategy, and the structure of the organization and its context can be clustered into the formation (transformation) process of a temporary client organization to deliver megaprojects (Mintzberg et al., 2009). Rasdorf et al. (2010) observed an increasing trend of clients employing external program managers (consultants). Thus, integrated organizations with strong capability can be established to manage construction megaprojects. Clients can obtain improved efficiencies in the technical and management aspects of each constituent project within the program (megaproject) and integrate key stakeholders involved in the construction process by employing external program managers who have relevant experiences in managing similar megaprojects.

6.3.2 Core Capacity

1) Program Leadership

Yukl (2010) defined leadership as “a process whereby intentional influence is exerted over other people to guide, structure and facilitate activities and relationships in an organization.” Reiss et al. (2006) defined program leadership as “the good leadership and clear direction setting at all levels within a program organization.” This issue is essential in constructing a high-performing program organization. Clients managing megaprojects should lead changes in the temporary program organization (the client organization) and sustain its effectiveness and efficiency to achieve the prescribed objectives. Thus, program leadership is the key to accomplish these tasks. The significance of leadership in program management has received increasing attention in recent years (Pellegrinelli et al., 2007; Remer & Martin, 2009; Shehu & Akintoye, 2010; Dvir & Shenhar, 2011). A number of project management associations, such as the International Centre for Complex Project Management (ICCPM) and IPMA, have also been heavily engaged in this field by publishing several relevant standards over the last decade (IPMA, 2006; ICCPM, 2008). However, Rasdorf et al. (2010) pointed out that a lack of consideration of the construction industry background exists in current program management standards.

2) Scope Management

Scope management refers to the identification, measurement, and achievement of the expected benefits that a program is intended to deliver (PMI, 2006). The relevant tasks also include timely adjustment of program scope during program execution. Lycett et al. (2004) stated that program existed to create value by improving the management of project isolation. Partington et al. (2005) advocated that scope management was essential in program management. However, the current difficulty in program management is the lack of a systematic method that can change stakeholder benefits into workable measures (Shehu & Akintoye, 2009). Dvir and Shenhar (2011) noted that defining the scope of a program would be a time-consuming work. Nowadays, construction project are moving towards a more complex regime of objectives (Swan & Khalfan, 2007). Thus, developing workable measures for managing program benefits may be even more challenging.

3) Program Governance

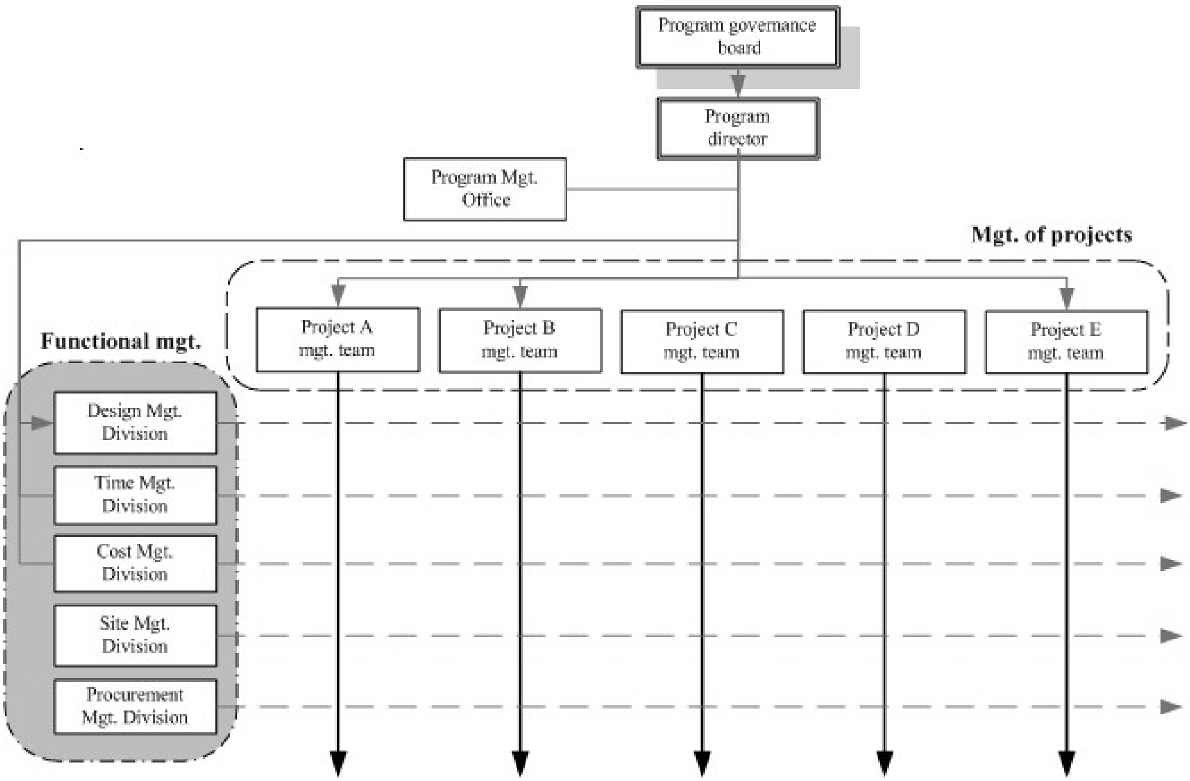
Program governance refers to a decision board that can sustain the external resource input and ensure program progress in accordance with the requirements of prescribed objectives (Nguyen et al. 2004; Reiss et al. 2006). The program governance board may include investors, senior government officials, operators, and other major external stakeholders. Several scholars affirmed the significance of program governance in constructing an effective program organization (Partington et al., 2005; Flyvbjerg et al., 2003; Artto et al., 2008). Shehu and Akintoye (2010) noted that the program governance board had a key function in sustaining ample resources for program execution. Buuren et al. (2010) stressed four merits of program governance that could not be achieved by traditional project management (Table 6.3). Program governance can also serve as a mechanism to coordinate with key external stakeholders by incorporating representatives from investors, operators, sponsors, industry partners, communities, and the public.

Table 6.3 Merits of program governance
(Buuren et al. 2010)

No.	Merits
1	Interdepartmental integration among government.
2	Multi-level governance integration.
3	Increasing coherence between projects.
4	Speeding-up decision-making.

4) Matrix Organizational Structure

Matrix organizational structure refers to an organizational form in which staff should report to the departmental head and project leaders. This factor is one of the characteristics of program organization (OGC, 2003). The matrix organizational structure includes the roles and responsibilities of program organization as well as their clear-cut relationships with project breakdown structure and major benefits of stakeholders (Reiss et al., 2006). The research trend of viewing megaprojects as organizations has been increasingly advocated in recent years as mentioned in Section 3.4.4. In the early 1980s, Morris (1982) emphasized the significance of applying matrix organizational structure to manage megaprojects based on case studies of the Apollo program, the Tans–Alaskan Pipeline construction and Acrominas manufacturer. Tatum and Fawcett (1986) proposed five organizational alternatives for managing large projects: strong functional organization，functional organization with area coordination, functional organization with area management, area management with craft discipline staff, and autonomous area organization. All of the five alternatives are forms of matrix organizational structure. The focus of megaprojects as organization has been reinforced recently by Miller and Lessard (2000) and Flyvbjerg et al. (2003). Lycett et al. (2004) pointed out that proper attention should be given to program roles and responsibilities in designing program organizations for megaprojects.



Note: "Mgt."-management

Figure 6.2 Form of the matrix organizational structure

5) Program Management Office (PMO)

PMO refers to a collection of functions that serve for program decisions (Reiss et al., 2006). Thompson (1967) emphasized the necessity of establishing a centralized coordination unit in a complex organization, particularly in an uncertain environment. Ven et al. (1976) further analyzed the internal constraints of this group coordination mode by comparing it with impersonal and personal coordination modes. According to Ven et al. (1976), the establishment of PMO can address increasing task uncertainty and facilitate mutual adjustments in workflow interdependence through horizontal communication between project managers and functional heads. Previous studies revealed two functions of PMO in program organizations: coordinating the relationships between projects and cross-functional working (Shehu & Akintoye, 2010; Artto et al., 2008) and dealing with different information needs (Reiss et al., 2006). Reiss et al. (2006) provided detailed explanations of the information dealing function of PMOs (Table 6.4).

Table 6.4 PMO's information dealing function (Reiss et al., 2006)

No.	Function details
1	Deal with information from, and feedback to the program decision level
2	Make instructions from program to its projects and feedback from them
3	Deal with other information needs between the program and relevant operational functions

6) Competent Staff

Competent staff refers to the qualified staff employed in the program organization. Shehu and Akintoye (2010) stated that the lack of qualified staff was a major obstacle in constructing high-performing program organizations. Geraldi et al. (2010) agreed with their observation, adding that competent staff was indispensable for the competitiveness of program management organizations. Aside from employing competent staff, program organizations should also configure their staff properly based on work and responsibility requirements so that the staff within a program organization can best fit for their work requirements.

7) Use of Project Breakdown Structure (PBS) /Work Breakdown Structure (WBS) Tools

PBS/WBS tools are managerial tools that enable the necessary communication between a clear understanding and statement of program-level objectives and results of the work to be performed (PMI, 2006). Shehu and Akintoye (2009) stated the significance of using proper tools to align constituent projects to program strategy. Son et al. (2010) noted that using WBS would be an indispensable procedure in applying a program management information system. Wang et al. (2011) emphasized that the combination of PBS and WBS tools could provide multiple-channel communications among program objectives, program work, program organization and program information system.

8) Standardized Process Management

Standardized process management refers to the design and implementation of a standard process for all project management tasks to improve management efficiency and ensure continuous improvement. According to Steel (2002), a project can be viewed as various processes. Thus, program processes serve as the core of program organization (Reiss et al., 2006; Crawford & Nahmias, 2010; Shehu & Akintoye, 2009). Maylor et al. (2006) stressed that process is more important in program management than in project management. Pellegrinelli et al. (2007) noted that program process was the key to establishing an effective program plan and control system. A program may involve various processes throughout the program lifecycle (Reiss et al., 2006; PMI, 2006). Thus, standardizing these processes may improve overall management performance. The case study of the London Heathrow airport 5 megaproject by Brady and Davies (2011) provided an evidence of this statement.

9) Partnership with Key Stakeholders

Partnership with key stakeholders (internal) refers to the establishment of a strong working relationship with key parties within a program (Chan et al., 2008). These stakeholders include designers, contractors, and suppliers involved in a construction megaproject. Since the 1980s, stakeholder management has been recognized having essential roles in project management and project success (Cleland, 1986; Olander & Landin, 2005). A growing number of studies have revealed that stakeholder management in program management has a function similar to that of project management (Reiss et al. 2006; Pellegrinelli et al. 2007; Crawford & Nahmias, 2010). Aaltonen et al. (2008) enumerated eight strategies for stakeholder management in global projects (including construction megaprojects): (1) direct withholding, (2) indirect withholding, (3) resource building, (4) coalition building, (5) conflict escalation, (6) creditability building, (7) communication, and (8) direct action. Coalition building is appropriate in managing key internal stakeholders of construction megaprojects (Aaltonen et al., 2008). Davies et al. (2009) enumerated the benefits of managing megaprojects by partnership with major contractors and stated that a more workable relationship could be established by developing an integrated strategy between a client and major contractors.

10) Risk Management

Risk management refers to tasks that keep the program's risk exposure at an acceptable level (Pellegrinelli et al., 2002). Lycett et al. (2004) stated that risk management at the program level needs which is more important than that at the project level, which could address strategic requirements. Previous studies indicated that program risk management not only should follow the proper process, but also consider the execution effectiveness of the corresponding process (OGC, 2003). Davies et al. (2009) pointed out that clients conducting megaprojects on a one-off basis should consider ways of sharing risks in managing megaprojects. This situation is common in most construction megaprojects. Thus, a balanced strategy must be formulated to properly share major risks among all major stakeholders. The US transportation agency attempted to introduce client insurance program in managing megaproject risks (Schexnayder, 2004). This method could serve as an alternative strategy to address extreme situations (Partington et al., 2005).

11) Cost Management

Cost management, the first of the "iron triangle" objectives, refers to tasks that control program expenditure within the approved budget. Program organizations typically face a strictly financial constraint approved by investors (Shehu & Akintoye, 2010). However, containing costs within the budget may face a larger risk in program management than in project management (Molenaar, 2005). Partington et al. (2005) stated that matured program organizations should be aware of budget ambiguities and financial certainty to manage relevant risks.

12) Schedule Management

Schedule management, the second of the "iron triangle" objective, ensures that a program can produce its required deliverables and solutions on time (PMI, 2006).

Thus, completing this objective is one of the core tasks in managing a program. Partington et al. (2005) further emphasized the strategic significance of this task in managing a program.

13) Functionality and Quality Management

Function and quality management, the last of the “iron triangle” objectives, refers to tasks that determine and ensure function and quality requirements to meet the prescribed objectives during program duration (Reiss et al., 2006). Functionality and quality management is vital for a construction program to deliver a long-term operation facility or an infrastructure. PMI (2006) defined function and quality management as a core process in program management processes. According to Crawford and Nahmias (2010), quality management is a core competency for program managers. Proper attention should be given to the handover of facilities and infrastructure delivered by megaprojects because unexpected incidents have been reported in the handover of megaprojects, such as London Heathrow Terminal 5, and Hong Kong International Airport (Davies et al., 2009).

14) Knowledge Management

Knowledge management refers to tasks that capture and share knowledge through monitoring and reviewing to improve a program’s likelihood of success (Reiss et al. 2006). Dvir and Shenhar (2011) stressed that great projects (including programs) should maximize the use of existing knowledge, often in cooperation with outside organizations. Beehleer (2009) stated that clients can obtain relevant experience by employing an external program management consultant. Lycett et al. (2004) analyzed the levels of knowledge transfer in program management and emphasized that more effective knowledge transfer could be obtained by identifying and improving transferable lessons at two levels within a program, namely, project to program and project to project. Reiss et al. (2006) classified program knowledge into three categories as shown in Table 6.5.

Table 6.5 Three categories of program knowledge (Reiss et al., 2006)

No.	Categories
1	Contextual knowledge
2	Best project practices
3	Program and project lessons learned

15) Program Control Information System (PCIS)

PCIS refers to an information management system that can collect, process and analyze all sub-project information regularly and report program progress regularly to decision makers. Numerous researchers have recognized the significance of establishing a separate management system (i.e., a PCIS) to control the objective measures at the program level (Shehu & Akintoye 2009; Pellegrinelli et al. 2007; Lycett et al. 2004). Since the 1980s Germany has developed its own PCISs and successfully used this system to manage construction megaprojects in Germany and Switzerland, such as Munich international airport, the German rail network reunion, and the new Gotthard railway tunnel in Switzerland (Greiner, 1998; Gibgreiner, 2011). South Korea has also been developing its own PCIS to manage urban renewal megaprojects for improving management efficiency and maintaining program performance (Kim et al., 2009). A PCIS can also be used as a communication platform to facilitate collaborative works among clients, designers, contractors, and other stakeholders (Davies et al., 2009).

16) Contingency Management

Contingency management refers to a capability to address any accidental or unexpected event or disaster. Unexpected events are common in megaprojects because the extremely large size of these projects challenges the experience in the management of similar projects (Fiori & Kovaka, 2005). For instance, London Heathrow Terminal 5 and Hong Kong International Airport had similar incidents that occurred during the handover phase (Brady & Davies, 2010; Davies et al., 2009). Thus, program organizations should response timely to these events. However, this issue was usually underestimated in previous studies (Artto et al. 2008). Geraldi et al. (2010) provided a three-pillar framework for managing contingency in program management (Table 6.6).

Table 6.6 Three pillars for program contingency management
(Geraldi et al., 2010)

No.	Pillars
1	Responsive and functioning structure at the organizational level
2	Good interpersonal relationship at the group level
3	Competent staff at the individual level

6.3.3 Motivational Capability

1) Program Culture

Program culture refers to the collectively accepted meaning that can manifest itself in the formal and informal rules within a program organization (IADB & IDRC, 2002). Program organizations established to manage megaprojects are temporary; a common culture should be established to improve organizational coherence within a program team and achieve its mission. Pellegrinelli (2002) emphasized that program culture was crucial in improving the capabilities of a program organization. Based on a 10-year investigation of over 400 great projects (including many construction megaprojects) in the construction industry and across other industries since the late 1950s, Dvir and Shenhar (2011) stated that a revolutionary culture should be created in megaprojects and be spread to an entire organization, which could significantly contribute to megaproject success.

2) Communication Management

Communication management refers to communication activities within a program organization and across organizational boundaries. Shehu and Akintoye (2010) stated that the lack of cross-functional communication was a major obstacle in establishing an effective program organization, while timely and effective communication between project teams or across organizational boundaries could contribute significantly to program success (Nguyen et al., 2004). According to Reiss et al. (2006), internal communication should be considered as an independent management activity in program management. Pellegrinelli et al. (2007) emphasized the importance of external communication in understanding stakeholder interest and formulating strategies.

3) Team Building

Program team building aims to build individual and group competencies to enhance program performance (PMI, 2006). Pellegrinelli (2002) stated that a strong program team would usually comprise a diverse group of people from different organizations. Although most program teams are temporary, coherence within a program team must be improved by adopting several measures (Ko & Paek, 2008). Thus, team building is an indispensable task in program management to unite individuals and improve their efficiency as a team, thereby ensuring program success. Shehu and Akintoye (2010) proposed a staff training program as an effective method to improve team building.

4) Program Incentives

Program incentives are commonly used to reduce overall contract cost, control time and increase the support of specific program performance, such as productivity, quality, safety, technological progress, innovation and management. Incentives, such as contract incentives, have been widely used in the construction industry to improve project performance. The European Construction Institute (2003) stated that contract incentives could be employed to strengthen the partnership between the client and key stakeholders, such as contractors, and therefore sustain program performance. This method has been practiced in several megaprojects and considered effective in improving program performance in the areas of safety, quality, environment, and innovation (Tang et al., 2008; Davies et al., 2009).

6.4 FINDINGS OF INTERVIEWS IN THE CASE STUDY

As shown in Table 6.7, five selected interviewees served at the senior management level of the case project's client organization. One interviewee was from the client organization, and the other four were from the program management consultant. The actual number of interviews conducted was determined by the saturation of data when no new categories emerged (Glaser, 1978). The following criteria were employed to identify eligible participants from the megaproject case as follows:

(1) More than 10 years of industrial experience.
(2) Hands-on experience in the megaproject case.
(3) Sound knowledge and understanding of the client organization of the megaproject case.

These experts had different construction management specialties and levels of experience in different divisions of the client organization in the megaproject cases, particularly in the functional division at the program level, which helped improve the validity of semi-structured interviews.

Table 6.7 Background of the five interviewees

Code	Positions	Origins	Professional specialties	Year of industry experience
A	Head of Program Mgt. Office	Consultant	Design mgt., contract mgt., and team building.	20
B	Associate head of Program Mgt. Office	Consultant	Team coordination and mgt. and integration mgt.	12
C	Associate head of Program Mgt. Office	Consultant	Schedule mgt. and PMIS	10
D	Associate head of Program Mgt. Office	Consultant	Design mgt. and PMIS.	10
E	Associate head of Cost & Contract Mgt. Division	Client	Contract and cost mgt. and PMIS	12

Note: ‘mgt.’=management; ‘PMIS’=Project management information system.

During the interviews, the five experts could freely express their opinions by enumerating POFs for the Shanghai Expo construction client organization (Appendix D). All interviews were recorded with the consent of the interviewees for better reference. Each interview typically lasted for almost an hour, and dialogues were transcribed into written reports after the interview (Appendix E). The accuracy of the reports was verified by the corresponding interviewees prior to subsequent analysis. Qualitative interview data acquired from the interviews were coded via a constant comparative method using the qualitative data analysis software NVivo 9.2 (King, 2008).

Table 6.8 List of identified POFs from the interviews

POFs	Expert A	Expert B	Expert C	Expert D	Expert E	Support rate
1. Schedule management	√	√	√	√	√	100%
2. Scope management	√	√		√	√	80%
3. PMO	√	√		√	√	80%
4. Cost management	√	√		√	√	80%
5. Procurement management		√		√	√	80%
6. Risk management		√	√	√	√	80%
7. Functionality and quality management		√		√	√	60%
8. Competent staff		√		√	√	60%
9. Communication management		√		√	√	60%
10. Program Strategy		√	√			40%
11. Program culture	√		√			40%
12. Process management			√	√		40%
13. Matrix organizational structure		√	√			40%
14. PCIS	√		√			40%
15. Use of PBS/ WBS tools	√		√			40%
16. Program governance			√			20%
17. Partnership with key stakeholder management			√			20%
18. Program leadership			√			20%
19. Emergency management			√			20%
20.Technology management	√					20%
Total	8	11	12	10	9	

Twenty POFs identified from the interviews are listed in Table 6.8. The top nine POFs that received the highest support rates (80% or above) coincided with those mentioned in PMI's project management knowledge framework. All the interviewees emphasized that the activities of "integration" and "coordination" were more important in program management than in project management. These results reinforced the findings of Chan (1994) and Kerzner (2001) that coordinating and integrating activities across multiple, functional lines are core activities in program management. Furthermore, all interviewees agreed that the program-level coordination and integration activities in managing megaprojects face more challenges than those in managing a project. Another 11 POFs were identified, most of which presented mild issues in project management. The support rate for each of the 20 POFs identified from the interviews also demonstrated the relative significance of each POF.

Two additional POFs, namely, technology management and procurement management, were identified from the interviews and could be grouped into the core capacity category of program organization. The remaining 18 POFs are presented in Table 6.8. Thus, interview results also validated 81% (18 of 22) of the 22 POFs identified from previous literature. The results indicated a high consistency with previous knowledge. Detailed interviews and examinations of archival documents related to the two new POFs were also conducted. The two additional POFs are the following:

1) Technology Management

Technology management refers to tasks related to the coordination and management of design and technical issues in construction. All the interviewees stated that technology management was a core task for the client to manage the Shanghai Expo construction megaproject. Construction megaprojects today may face growing technical complexity from a changing environment. Increased use of new construction technologies, such as three-dimensional technology, energy conservation technologies, and new construction materials, is inevitable in the construction industry (Harty et al., 2007). Archival documents indicated that the Shanghai Expo construction adopted hundreds of energy conservation and green construction technologies in its design and construction process (UNEP, 2009). China tests and innovates new construction technologies in construction megaprojects to practice technology transfer strategies with an "introduction–absorption–digestion–innovation" policy (Chi & Javernick-will, 2011); thus, clients managing megaprojects face a serious challenge in managing technical complexity. Such a case may be a typical example with high technical complexity. Therefore, program technology management is a critical and highly influential factor for clients in constructing program organizations and sustaining relevant objectives.

2) Procurement Management

Procurement management refers to tasks that procure the necessary equipment and materials. This task is an underestimated but indispensable aspect for clients managing construction megaprojects. The interviewees emphasized that the client of the Shanghai Expo construction faced a serious challenge in directly procuring materials and equipment, including value–in–kind equipment. Archival documents revealed that the Shanghai Expo client established a Materials and Equipment Procurement Division to manage and complete over 150 project contracts, including bidding, logistics arrangements, on-site support and contract payments, with nearly 10 major suppliers.

6.5 VALUE OF THE CONCEPTUAL MODEL OF PROGRAM ORGANIZATION

The conceptual model consisting of the 24 POFs represents an integrated model of program organization based on key academic viewpoints in the program management field, such as organizational capability and strategic management. The identified POFs are characterized by the program management approach, as indicated in previous studies on program management (Shehu & Akintoye, 2009; Pellegrinelli et al., 2011). The following are the characteristics of the conceptual model.

(1) A program organization is established to conduct its long-term undertaking and operates in a changing environment; thus, contextual understanding and strategic management are crucial to construct and sustain an effective program organization. The two POFs are contextual elements in program organizations because they represent the environmental capability.

(2) The 18 POFs are the regulative, structural, normative and technical elements of program organization that construct their core capacity. These POFs can represent the coordination and integration capabilities of the program organization to control dispensed executions (PMI, 2006; OGC, 2003; Davies et al., 2009). These POFs should take both coordination and integration roles in practice, such as PMO, cost management, as well as functionality and quality management.

(3) Motivation is an underestimated issue in sustaining the dynamics of program organization for managing megaprojects. The four POFs are the cultural–cognitive elements relevant to this aspect because they represent the

motivational capability of program organization. These findings reinforced the statement of Chan (1994) that the significance of motivation activities within a project had a positive relationship with the project size.

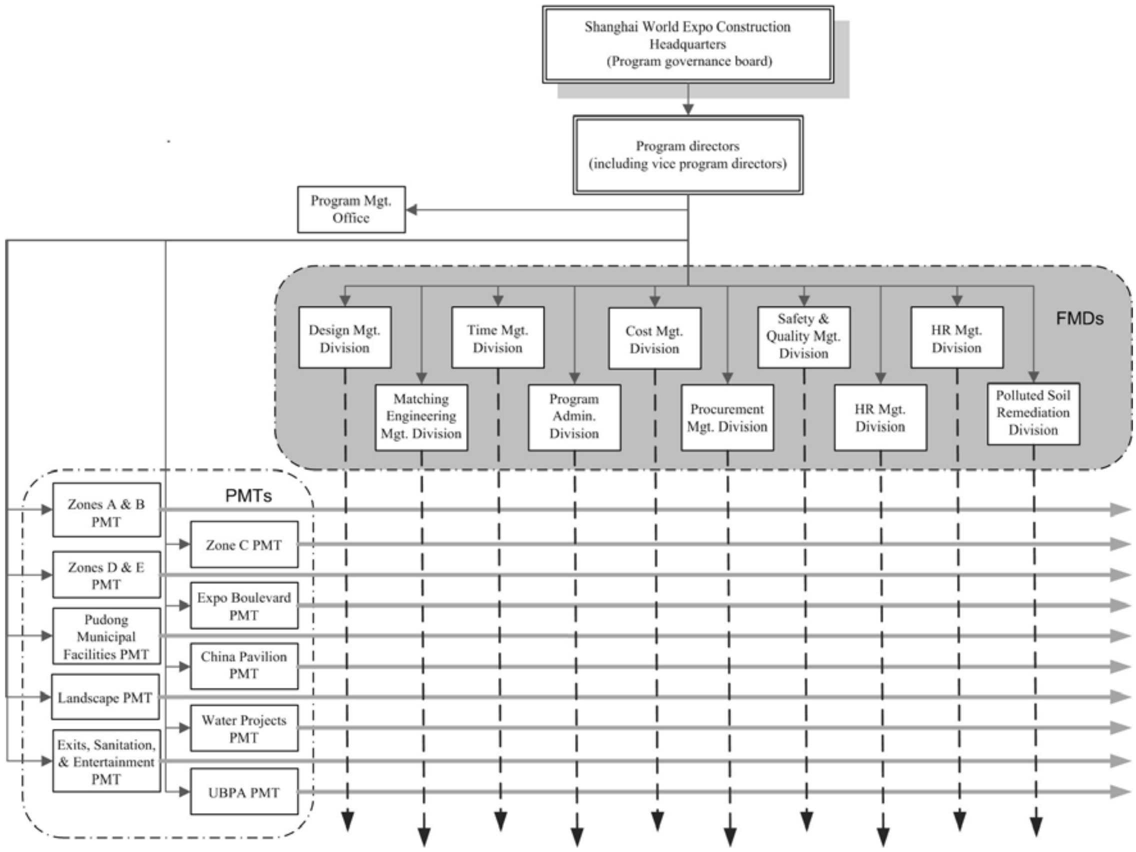
6.6 CHAPTER SUMMARY

This chapter has reported a pragmatic framework of program organization comprising 22 POFs based on an extensive review of hundreds of relevant publications. These POFs include (1) contextual understanding, (2) program strategy; (3) program leadership, (4) scope management, (5) program governance, (6) matrix organizational structure, (7) PMO, (8) competent staff, (9) use of PBS/ WBS tools, (10) standardized process management, (11) partnership with key stakeholder, (12) risk management, (13) cost management, (14) schedule management, (15) functionality and quality management, (16) knowledge management, (17) PCIS, (18) contingency management, (19) program culture, (20) communication management, (21) team building, and (22) program incentives. These 22 POFs are grouped into three categories, namely, environmental capability, core capacity, and motivational capability, which represent a capability framework of program organization for managing construction megaprojects from the perspective of a client. Interviews with five former executives involved in the Shanghai Expo construction client organization were conducted to validate the usefulness of this conceptual model. These interviews revealed 20 POFs. Of the 20 POFs, 18 (82%) are the same as those identified from the literature. The program organizational framework was further refined by interviews with experienced practitioners. Two additional POFs, procurement management and technology management, were identified in these interviews. Finally, a conceptual model consisting of 24 POFs was formulated. These findings can assist in developing a questionnaire to identify determinants of program management organization so that a simplified framework with a larger application value can be obtained.

CHAPTER 7: IDENTIFICATION OF DETERMINANTS OF THE PROGRAM ORGANIZATION FOR MANAGING A CONSTRUCTION MEGAPROJECT

7.1 INTRODUCTION

As the largest exposition site in history, the Shanghai Expo includes 136 pavilions and over 160 supporting facility buildings with a total floor area of 2.3 million m^2. Shanghai Expo construction is one of the most prominent construction megaprojects in China. The client faced multiple challenges in delivering this megaproject within a short deadline of nearly 45 months. These challenges include working on a mega construction scale, employing hundreds of contractors and designers, and coordinating a significant amount of tasks as a result of adopting a design–bid–build mode. The buildings, facilities and infrastructures within the Expo site were divided into 10 constituent projects to complete the construction on time. Each project was executed by a different PMT of the client. Thus, the client established a temporary program organization consisting of a governance board, a PMO, and 10 functional management divisions (FMDs) to coordinate and integrate the execution of the tasks performed by the ten PMTs (Figure 7.1). The established program organization helped the client to complete the Shanghai Expo construction megaproject 11 days ahead of schedule and attain prescribed objectives in safety, quality and environment within the approved budget. The client stated that applying the program management approach was the key to sustaining megaproject success at the organizational level (BSEC & SMURCTC, 2010).



Notes: "Mgt." —Management; "Admin" —Administration;
FMT—functional management division; PMT—project management team.

Figure 7.1 The client organization of the Shanghai Expo Construction

(Source: SECH office, 2008)

7.2 RESEARCH APPROACH

Mixed research methodology is adopted in this study. A two-round Delphi survey is a major tool used to identify principal POFs in the Shanghai Expo case. The Delphi survey is an effective communication technique employed to systematically solicit, organize, and structure judgments and opinions on a particularly complex subject matter from a panel of experts (Chan et al., 2001). Therefore, the Delphi survey is suitable for new research topics such as program organization, which has inadequate historical data for the use of other research methods (Martino, 1973; Pellegrinelli et al., 2011). Apart from the Delphi survey, the archival method was also employed in this study to further examine the operations of the principal POFs identified from the Delphi survey in the case study. The archival method can effectively trace changes, organization, processes, actions, and interpretations of these variables (Ventresca &

Mohr, 2005). Triangulation of the mixed research method in the case study can offset the disadvantage of using evidences from a single source, consequently ensuring the high validity of research design (Yin, 2009).

7.2.1 Identification of POFs

Twenty-four POFs were used in the Delphi survey as reported in Chapter 6. Table 7.1 presents the three categories and the definitions of the 24 POFs.

Table 7.1 List of the 24 POFs
(Hu et al., 2012a)

POFs	Definition
ENVIRONMENTAL CAPABILITY	
1. Contextual understanding	Refers to the understanding of the environment within which a program operates
2. Program strategy	Refers to a strategy ensuring the success and survival of a program in its environment
CORE CAPACITY	
3. Program leadership	Refers to the good leadership and clear direction setting at all levels within a program organization
4. Scope management	Refers to the identification, measurement, and achievement of the expected benefits that a program is intended to deliver.
5. Program governance	Refers to a decision board that can sustain the external resource input and ensure program progress in accordance with requirements of major stakeholders with various interests.
6. Matrix organizational structure	Refers to an organizational form in which staff should report to the departmental head and project leaders respectively.
7. PMO	Refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve program decision makers.
8. Competent staff	Refers to the qualified staff employed.
9. Use of PBS / WBS tools	Refers to tools that can provide necessary communication from the program-level perspective the clear understanding and statement of technical objectives and the results of the work to be performed.
10. Standardized process management	Refers to the design and implementation of standardized process to all project management works.
11.Partnership with key stakeholders	Refers to the establishment of a strong workable alliance with key internal stakeholders such as designer, contractors, and suppliers, within a program.
12. Risk management	Refers to tasks that can keep the program's exposure to risks at an acceptable level.
13. Cost management	Refers to tasks of ensuring that program expenditure can be attained in the approved budget.

POFs	Definition
14. Schedule management	Refers to tasks of ensuring that the program can produce its required deliverables and solutions on time.
15. Function and quality management	Refers to tasks that determine and ensure function and quality requirements to meet the prescribed objective during program duration.
16. Knowledge management	Refers to tasks that capture and share knowledge through monitoring and review to improve a program's likelihood of success.
17. PCIS	Refers to an information management system that can collect, process and analyze all the sub-project information regularly and report program progress regularly to decision makers.
18. Contingency management	Refers to an ability dealing with any accidental or unexpected event/disaster.
19. Technology management	Refers to tasks dealing with design and technical issues in construction.
20. Procurement management	Refers to tasks that procure equipment and materials needed.
MOTIVATIONAL CAPABILITY	
21. Program culture	Refers to the collectively accepted meaning that can manifest itself in the formal and informal rules of a program organization
22. Communication management	Refers to communication activities within the organization and across organization boundaries.
23. Team building	Refers to the building of individual and group competencies to enhance program performance
24. Program incentives	Refers to the incentives that are commonly used to increase the support of specific performance objectives such as productivity, quality, safety, and innovation.

7.2.2 Selection of the Expert Panel

One of the most significant considerations in using the Delphi technique is the selection of the expert panel (Stone & Busby, 1996). In this study, the expert panel consisted of 10 experts, of which 6 were from the client and 4 were form the consultant involved in the client organization. The selected size of the expert panel satisfies the normal requirement of the Delphi survey, that is, a range of 8 to16 experts (Hallowell & Gambatese, 2010). These experts were involved with almost all of the major tasks (e.g., schedule, cost, quality, safety, and environment) related to the overall control of the megaproject objectives. The composition of the expert panel provided good representation and knowledge base, which were critical in ensuring the validity of the Delphi survey (Hon et al., 2012). Moreover, 4 of the 10 experts were part of the interviews that identified 20 POFs. Table 7.2 presents the backgrounds of the 10 experts.

Table 7.2 Backgrounds of the 10 experts

Code	Positions	Divisions	Year of industry experience	Number of megaprojects involved
A	Head	Program management office	20	4
B	Associate head	Program management office	12	3
C	Associate head	Program management office	10	2
D	Senior consultant	Program management office	21	3
E	Associate head	Cost and contract management division	12	2
F	Associate head	Safety and Quality Management Division	37	2
G	Senior manager	Safety and Quality Management Division	11	2
H	Associate head	Integrated management division	37	1
I	Senior manager	Technology management division	8	1
J	Manager	Zone C project management team	34	2

7.2.3 Design and Implementation of the Delphi survey

The questionnaires in the two rounds of Delphi survey were designed with different objectives. In the first round, the respondents were requested to provide ratings for the level of importance of each proposed POF based on a five-point Likert scale. The questionnaire also included an option for the experts to express their opinions freely regarding POFs that might not be included in the questionnaire. In the second round, the respondents were asked to reassess their ratings of each POF in light of the consolidated results from Round 1. All 10 experts completed the two rounds of the Delphi survey.

Prior to the Delphi survey, a pilot questionnaire was sent to five senior researchers (assistant professor or above) to improve the design of the questionnaire.

7.2.4 Techniques for Survey Data Analysis

Two techniques were employed to extract the principal POFs based on the data acquired from the questionnaire survey. MS ranking was adopted to determine the relative importance of the 24 POFs. This technique is frequently used in similar studies to determine the relative significance of multiple factors (Xu et al., 2010). Normalization technique was adopted to facilitate the extraction of principal POFs by computing the normalized value of each POF based on the mean values acquired from the second round of the Delphi survey (Xu et al., 2010). The normalized value was calculated based on Equation (7.1) (Xu et al., 2010), as follows:

$$Normalized\_value_i = \frac{Value_i - Minimum\_value}{Maximum\_value - Minimum\_value} \quad \text{Equation (7.1)}$$

Where Normalized_value$_i$ —the normalized value of the factor *i*.

Value$_i$ — the importance scoring value of the factor *i*.

Minimum_ value — the smallest of all the importance scoring values of factors 1-N.

Maximum_ value — the largest of all the importance scoring values of factors 1-N.

Kendall concordance analysis was conducted using the Statistical Program for Social Sciences 19.0 software to measure the degree of agreement between the panel members. Kendall's coefficient of concordance (W) acquired from this analysis represents the ranking agreement among the panel members on the ordered list when considering the variations between the rankings (Doke & Swanson, 1995).

7.3 Data analysis of the Two-round Delphi Survey

7.3.1 First Round of the Delphi Survey

In the first round of the Delphi survey, the panel experts were requested to assess the relative importance of each of the 24 POFs. All 10 experts completed the questionnaires. No new POF was identified from the expert feedback. The first round of the Delphi survey was conducted in the middle of June 2012.

Table 7.3 Results of the first round of the Delphi survey

The first round Delphi survey	All experts		Client		Consultant	
	Mean	Ranking	Mean	Ranking	Mean	Ranking
1.Program strategy	4.70	1	4.83	1	4.50	3
2. Program leadership	4.60	2	4.33	6	5.00	1
3. Communication management	4.60	2	4.67	3	4.50	3
4. Contextual understanding	4.50	4	4.17	13	5.00	1
5. Use of PBS / WBS tools	4.50	4	4.83	1	4.00	7
6. Program governance	4.30	6	4.17	13	4.50	3
7. Schedule management	4.30	6	4.33	6	4.25	6
8. Matrix organizational structure	4.10	8	4.17	15	4.00	7
9. PMO	4.10	8	4.50	4	3.50	17
10. Standardized process management	4.10	8	4.33	6	3.75	13
11.Partnershipwith key stakeholders	4.10	8	4.50	5	3.50	17
12. Contingency management	4.10	8	4.33	6	3.75	13
13. Technology management	4.10	8	4.17	13	4.00	7
14. Team building	4.10	8	4.17	13	4.00	7
15. Scope Management	4.00	15	4.33	6	3.50	17
16. Competent staff	4.00	15	4.17	13	3.75	13
17. Risk management	4.00	15	4.33	11	3.50	17
18. Function and quality management	4.00	15	4.33	6	3.50	17
19. Cost management	3.90	19	4.17	13	3.50	17
20. Program culture	3.90	19	3.83	20	4.00	7
21. Procurement management	3.80	21	3.83	20	3.75	13
22. PCIS	3.70	22	3.50	22	4.00	7
23. Knowledge management	3.50	23	3.50	22	3.50	17
24. Program incentives	3.40	24	3.50	22	3.25	24
Number (N)	10		6		4	
Kendall's coefficient of concordance (W)	0.200		0.313		0.376	
Level of significance	0.003		0.006		0.057	

As shown in Table 7.3, a statistical analysis used to compute the mean for each identified POF was performed based on the 10 questionnaires received. Kendall's coefficient of concordance for the rankings of the 24 POFs was 0.200, indicating that it was statistically significant at the 1% significance level. The null hypothesis (H_0) that the respondent's opinions within the group were not in agreement was rejected. Therefore, a significant degree of agreement existed among the panel experts.

7.3.2 Second Round of the Delphi Survey

In the second round of the Delphi survey, all 10 experts were requested to reassess their ratings in terms of the consolidated results obtained in the first round. The second round of the Delphi questionnaire survey was distributed to the same panel experts either by personal interview or by e-mail in late June 2012. All feedback was received in late June 2012. Most of the experts reconsidered their ratings provided in the first round and adjusted their ratings accordingly.

Table 7.4 Results of the second round of the Delphi survey

The second round Delphi survey	All experts			Client		Consultant	
	Mean	Normalization	Ranking	Mean	Ranking	Mean	Ranking
1. Program strategy	4.80	1.0000	1	5.00	1	4.50	4
2. Program leadership	4.70	0.9333	2	4.50	3	5.00	1
3. Use of PBS/WBS tools	4.60	0.8667	3	4.83	2	4.25	6
4. Communication management	4.60	0.8667	3	4.50	3	4.75	3
5. Contextual understanding	4.50	0.8000	5	4.17	14	5.00	1
6. Program governance	4.50	0.8000	5	4.50	3	4.50	4
7. Scope management	4.20	0.6000	7	4.33	8	4.00	9
8. Matrix organizational structure	4.20	0.6000	7	4.17	14	4.25	6
9. PMO	4.20	0.6000	7	4.50	3	3.75	15
10. Partnership with key stakeholders	4.20	0.6000	7	4.50	3	3.75	15
11. Technology management	4.20	0.6000	7	4.33	8	4.00	9
12. Team building	4.20	0.6000	7	4.17	14	4.25	6
13. Competent staff	4.10	0.5333	13	4.17	14	4.00	9
14. Standardized process management	4.10	0.5333	13	4.33	8	3.75	15
15. Schedule management	4.10	0.5333	13	4.17	14	4.00	9
16. Contingency management	4.10	0.5333	13	4.33	8	3.75	15
17. Risk management	4.00	0.4667	17	4.33	8	3.50	19
18. Cost management	4.00	0.4667	17	4.33	8	3.50	19
19. Program culture	4.00	0.4667	17	4.00	21	4.00	9
20. Function & quality management	3.90	0.4000	20	4.17	14	3.75	15
21. PCIS	3.90	0.4000	20	3.83	22	4.00	9

22. Procurement management	3.90	0.4000	20	4.17	14	3.50	19
23. Knowledge management	3.40	0.0667	23	3.33	23	3.50	19
24. Program incentives	3.30	0.0000	24	3.33	23	3.25	24
Number(n)	10			6		4	
Kendall's coefficient of concordance (W)	0.272			0.336		0.448	
Level of significance	0.000			0.003		0.011	

Note: Normalized value = (actual mean value− minimum mean value)/(maximum mean value− minimum mean value).

As shown in Table 7.4, the rankings of all POFs changed when compared with the consolidated results in the first round. Kendall's coefficient of concordance for the rankings of the 24 POFs improved from 0.200 in the first round to 0.272 in the second round, which indicated that the ranking agreement among the 10 experts was successfully improved by the Delphi survey. The ranking agreements within the client and the consultant subgroups were also improved. Kendall's coefficient of concordance (W) for the client subgroup increased from 0.313 in the first round to 0.336 in the second round, whereas that for the consultant subgroup increased from 0.376 to 0.448. In this study, the use of the two-round Delphi survey successfully contributed to the improved agreement among the panel experts.

7.4 DISCUSSIONS OF THE PRINCIPAL POFS

As shown in Table 7.2, the respondents consist of two subgroups: the client and the consultant. Mann-Whitney test was conducted to determine whether a substantially similar agreement existed among the respondents from the two subgroups (H_0). The alternative hypothesis (H_1) is that the median scores of the two subgroups are different. If H_0 is accepted, then the test indicates that the two subgroups have a similar ranking (Siegel & Castellan, 1988). The null hypothesis testing via the Mann-Whitney test is presented in Table 7.5, which shows that H_0 is not rejected for all the identified POFs. This finding indicates that the rankings of the two subgroups are not significantly different from each other, thereby allowing the combination of these datasets to yield a larger sample size.

Table 7.5 Mann-Whitney test in the second round Delphi survey

POFs	Asymptotic significance of Mann Whitney test
1. Context understanding	0.051
2. Program strategy	0.066
3. Program leadership	0.224
4. Scope Management	0.464
5. Program governance	1.000
6. Matrix organizational structure	0.759
7. Program management office	0.171
8. Competent staff	0.693
9. Use of PBS / WBS tools	0.080
10. Standardized process management	0.247
11. Partnership with key stakeholders	0.067
12. Risk management	0.114
13. Cost management	0.171
14. Schedule management	0.693
15. Function and quality management	0.214
16. Knowledge management	0.480
17. PCIS	0.728
18. Contingency management	0.309
19. Technology Management	0.221
20. Procurement management	0.165
21. Program culture	1.000
22. Communication management	0.453
23. Team building	0.759
24. Program incentives	0.630

The relative importance of each POF was determined based on the reassessment of the 10 experts in the second round. A cross-comparison of the relative importance of all 24 POFs was made possible through normalization. As illustrated in Table 7.4, only 12 POFs with normalized values equal to or greater than 0.60 were considered as principal POFs because a normalized value of 0.60 was equivalent to 3 in the five-point Likert scale, which was the threshold for an important or very important ranking. Pearson correlation analysis was conducted to examine whether any multiplier effect existed among the 12 principal POFs. Table 7.6 presents the correlation matrix of the 12 principal POFs, which reveals that scope management correlates highly with the

PMO, matrix organization structure, and partnership with key stakeholders. Thus, scope management could be subsumed in these highly correlated factors and was removed from the list of principal POFs in the subsequent analysis. Table 7.7 presents the correlation matrix of the remaining principal POFs (11), which reveals that these 11 principal POFs are uncorrelated at the 5% significance level. These principal POFs also represented a major part of the 24 POFs with a ratio of over 60% in the sum of normalized values of the 24 POFs.

Table 7.6 Correlation matrix of the 12 principal POFs

	Contex-tual under-standing	Program strategy	Program leader-ship	Scope manage-ment	Program gover-nance	Matrix organiza-tional structure	Program managem ent office	Use of PBS / WBS tools	Partner with key stake-holders	Techno-logy manage-ment	Communi-cation manage-ment	Team building
Contextual understanding	1.000	-0.373	0.582	0.000	-0.447	0.000	-0.398	-0.304	-0.248	-0.373	0.000	0.000
Program strategy		1.000	-0.234	0.583	-0.500	0.250	0.468	0.102	0.583	0.250	-0.408	0.250
Program leadership			1.000	0.156	0.156	0.234	-0.083	0.255	-0.364	-0.547	-0.383	-0.547
Scope management				1.000	-0.333	0.667*	0.802**	0.272	0.722*	-0.167	-0.068	0.250
Program governance					1.000	0.000	0.000	0.408	-0.333	0.000	0.000	-0.500
Matrix organizational						1.000	0.535	-0.102	0.250	-0.250	-0.102	0.375
Program management							1.000	0.491	0.579	-0.134	0.218	0.200
Use of PBS / WBS tools								1.000	0.272	-0.102	-0.250	-0.612
Partnership with key stakeholders									1.000	0.250	-0.068	0.250
Technology management										1.000	-0.102	0.375
Communication management											1.000	0.408
Team building												1.000

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 7.7 Correlation matrix of the 11 principal POFs

	Contex-tual under-standing	Program strategy	Program leader-ship	Scope manage-ment	Program gover-nance	Matrix organiza-tional structure	Program managem ent office	Use of PBS / WBS tools	Partner with key stake-holders	Techno-logy manage-ment	Commu-nication manage-ment
Contextual understanding	1.000	-0.373	0.582	-0.447	0.000	-0.398	-0.304	-0.248	-0.373	0.000	0.000
Program strategy		1.000	-0.234	-0.500	0.250	0.468	0.102	0.583	0.250	-0.408	0.250
Program leadership			1.000	0.156	0.234	-0.083	0.255	-0.364	-0.547	-0.383	-0.547
Program governance				1.000	0.000	0.000	0.408	-0.333	0.000	0.000	-0.500
Matrix organizational					1.000	0.535	-0.102	0.250	-0.250	-0.102	0.375
Program management						1.000	0.491	0.579	-0.134	0.218	0.200
Use of PBS / WBS tools							1.000	0.272	-0.102	-0.250	-0.612
Partnership with key stakeholders								1.000	0.250	-0.068	0.250
Technology management									1.000	-0.102	0.375
Communication management										1.000	0.408
Team building											1.000

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

1) Contextual Understanding

Most megaprojects today operate in an environment with high uncertainty, such as widespread economic fluctuation, population growth, and increasing pressure from environmental and resource limitations (Shehu & Akintoye, 2010). A growing number of researchers have recognized the significance of contextual understanding to manage programs (Pellegrinelli et al., 2007; Partington et al., 2005). China is a transitional economy; thus the management of construction megaprojects encounters serious challenges not only from the fast-changing economic environment but also from the political and social sector, such as migrant worker management (Hu et al., 2012b), fast construction mode required by the client (Zou et al., 2007), and the growing demand for public engagement (Li et al., 2012). Therefore, the client's understanding of the environment is essential in addressing the contextual challenges and sustaining megaproject success. Understandably, the consultant subgroup ranked this POF first among the 11 identified principal POFs, earning a MS of 5.00 in the second round of the Delphi survey. Combined with the score given by six other experts, this POF was finally ranked fourth in the ordered list of the 11 identified principal POFs, with a score of 4.50. In the case study, the client organized several rounds of internal discussions to analyze the contextual constraints on project execution, and employed an external program management consultant to assist in addressing the contextual challenges (SECH Office, 2008).

2) Program Strategy

Program strategy was ranked first, with a MS of 4.80, among the 11 identified principal POFs. Rasdorf et al. (2010) noted that the strategy of employing an external program manager is increasingly advocated by public and private clients in the US. They also stated that most construction clients still favored a client-led organizational model or an integrated organizational model when employing external program management consultants. In the case study, the client established by the government temporarily constructed a client-led program organization by employing an external consultant because it lacked the managerial staff and professional expertise necessary to manage megaprojects (BSEC & SMURCTC, 2010).

3) Program Governance

Program governance refers to a decision board consisting of senior governmental officials, investors, and other major external stakeholders. Compared with regular construction projects, construction megaprojects involve more external stakeholders including government agencies, investors, and the public. Buuren et al. (2010) emphasized the key role of the program governance board in coordinating external stakeholders and improving work efficiency, such as interdepartmental integration within the government, multi-level governance integration, improving coherence between projects, and hastening decision making. Shehu and Akintoye (2010) also stated that a program governance board played a significant role in sustaining the external resources for program execution throughout the lifecycle of a program. In the case study, the client established a governance board with the support of Shanghai Municipal Government (SECH Office, 2008). This board was chaired by the Deputy Mayor and consisted of almost all senior officers from relevant governmental agencies and megaproject managers. The board facilitated project execution and coordinated the relationships with key external stakeholders. In the second round of the Delphi survey, this principal POF was ranked fifth, with a MS of 4.50, among the 11 identified principal POFs. The client and consultant subgroups had the same opinion regarding this principal POF (mean= 4.50). Moreover, intergroup analysis indicated that the two subgroups gave this principal POF nearly the same score (asymptotic significance =1.00).

4) Program Leadership

Client leadership is critical to the success of construction projects, particularly megaprojects (Chan et al., 2004). Numerous scholars have emphasized the central role of leadership in program execution (Pellegrinelli et al., 2007; Shehu & Akintoye, 2010; Dvir & Shenhar, 2011). The IPMA designated program managers as a subcategory of project management professional certification, stating that program managers who could manage a group of related projects would possess greater skills and competence than certificated project managers (IPMA, 2006). In the case study, most of the client leaders, including program directors, FMD heads and PMT heads, were strictly selected from the government or from state-owned construction designers, contractors and consultants. These leaders had hands-on experience in managing construction megaprojects prior to receiving the appointments in the client organization. Based on the experiences and qualifications of these leaders, they were considered qualified to form a strong executive level within the client organization and to contribute to improved efficiency in megaproject management. In the second round of Delhi survey, the consultant subgroup ranked this POF first, with a MS of 5.00, among the 11 identified principal POFs. Meanwhile, the combined Delphi panel ranked this POF second, with a MS of 4.70, in the ordered list of POFs. This finding reinforces the core role of leadership in program organization, as suggested by previous studies (Pellegrinelli et al., 2007; Shehu & Akintoye, 2010; Dvir & Shenhar, 2011).

5) Use of PBS/WBS Tools

The use of PBS/WBS tools is an often-underestimated but indispensable aspect of program management. These tools can enable the necessary communication between the clear understanding and statement of program-level objectives and the results of the work to be performed (PMI, 2006). Son et al. (2010) stated that PBS/WBS tools were essential in applying a PCIS to manage construction megaprojects. In the case study, the consultant assisted the client in using the PBS/WBS tools, the outputs of which aligned the tasks of different organizational units and the overall objectives of the megaproject. These tasks not only streamlined the relationships between the megaproject objectives and the organizational units, but also served as a basis to utilize the PCIS (SECH Office, 2008). In the second round of the Delphi survey, the use of PBS/WBS tools was ranked third among the 11 identified principal POFs, with a MS of 4.60. Thus, this issue should be given sufficient attention when constructing a program organization.

6) Matrix Organizational Structures

Program organizations are characterized by the use of matrix organizational structures (OGC, 2003). The matrix organizational structure should include the roles and responsibilities of the program organization as well as their clear-cut relationships with the PBS/WBS outputs and the major benefits of the stakeholders (Reiss et al., 2006). Lycett et al. (2004) stated that necessary caution should be given to program roles and responsibilities in designing a program organization. In the second round of the Delphi survey, this principal POF was ranked seventh with a MS of 4.20, a medium ranking among the 11 identified principal POFs. The client and consultant subgroups provided extremely close MSs on the weighting of this principal POF. In the case study, the Chinese client established a matrix organization with 10 FMDs and 10 PMTs involved in terms of the PBS/WBS output and project-type requirements (SECH Office, 2008). The strategy of decentralizing control to on-site PMTs was adopted to improve the autonomy of each PMT in facilitating timely front-line decisions on site (BSEC & SMURCTC, 2010).

7) PMO

PMO mainly serves decision makers (Reiss et al., 2006), an idea supported by most of the interviewees prior to the survey. In program organizations, PMO coordinates the relationships between projects and cross-functional tasks (Shehu & Akintoye, 2010; Artto et al., 2008) as well as handles the needed information for decision making (Reiss et al., 2006). In the case study, the PMO operated by the consultant performed the two duties mentioned. The PMO also sustained the operation of the PCIS (Le, 2009). In the second round of the Delphi survey, the PMO was ranked seventh among the 11 identified principal POFs with a score of 4.20. Although the consultant subgroup consisted of members comprising the PMO, it only gave this principal POF a MS of only 3.75, whereas the client subgroup gave a considerably higher MS of 4.50. As a result, this principal POF was ranked seventh in the ordered list of the 11 principal POFs.

8) Partnership with Key Stakeholders

Partnership with key (internal) stakeholders refers to establishing a strong working relationship with key parties such as designers, contractors, and suppliers (Chan et al., 2008). In practice, a construction megaproject typically involves a large number of internal stakeholders. Numerous studies have revealed that internal stakeholder management is crucial in sustaining program success (Reiss et al., 2006; Pellegrinelli et al., 2007; Crawford & Nahmias, 2010). Davies et al. (2009) highlighted the role of partnership with major contractors as a key strategy to ensure an effective working alliance between the client and the key internal stakeholders including major contractors. In the case study, the client established close partnerships with major designers and contractors by adopting multiple measures, such as using performance incentives in construction contracts and directly employing senior technical consultants from major contractors and designers (Hu et al., 2012a; SECH Office, 2008). In the second round of the Delphi survey, this principal POF was ranked seventh, with a MS of 4.20. The client subgroup ranked it third with a MS of 4.50, which was higher than the MS of 3.75 (the 15th place) given by the consultant subgroup.

9) Technology Management

Technology (design) management is an underestimated factor in previous studies. However, it is one of the central works in construction management. In the current construction industry, the increased use of new construction technologies, such as three-dimensional technology, energy conservation technologies, and new construction materials, is an inevitable trend (Harty et al., 2007). Consequently, certain construction megaprojects face serious technical complexity. Hundreds of energy-conserving and green construction technologies were applied to the design and construction of the case study (UNEP, 2009), which led the client to establish a separate Technology Management Division to manage the technical issues in constructing the pavilions, municipal infrastructures, and supporting facilities in the Expo site (SECH Office, 2008). Therefore, technology management can be reasonably accepted as one of the 11 principal POFs. In the second round of the Delphi survey, technology management received a MS of 4.20, ranking seventh.

10) Communication Management

Communication management is one of the critical success factors for construction projects (Chan et al., 2004). This principal POF usually involves two activities: internal and external communication. Shehu and Akintoye (2010) stated that the lack of cross-functional communication was a major obstacle in sustaining the effectiveness of program organization and that timely and effective communication between project teams or across organizational boundaries could significantly contribute to program success (Nguyen et al., 2004). Reiss et al. (2006) also stated that internal communication should be treated as a separate activity to be planned and executed within the program organization. In the case study, the client established several measures to promote communication among designers, contractors, suppliers, and government agencies. The forms of communication employed included regular and informal meetings, newsletters, training programs, joint working activities such as joint site inspection, and emergency drills with government agencies and contractors. In the second round of the Delphi survey, this principal POF received a MS of 4.60, ranking third among the 11 identified principal POFs.

11) Team Building

Team building refers to the building of individual and group competencies to enhance program performance (PMI, 2006). Kumaraswamy et al. (2005) emphasized that team working was essential in sustaining the performance of construction megaprojects and that team building was necessary to achieve effective team work. Ko and Paek (2008) emphasized the necessity of team building in managing megaprojects given the temporary nature of most project execution teams. Shehu and Akintoye (2010) suggested the use of staff training as an effective method for team building in program management. In the case study, the entire client organization included approximately 400 persons from different government agencies as well as contractors, designers, and consultants. Although the diversified composition of the client organization could constitute a strong management (Pellegrinelli, 2002), it also represented a serious challenge for the client in team building and management. Thus, the client established a HR & Cultural Division tasked with strengthening team building within the client organization. The division adopted the following measures to boost team building in the client organization: (1) regular training courses and seminars, (2) annual meetings, and (3) regular cross-functional communication activities. These activities considerably improved the unity and coherence of client staff, which consequently enhanced the efficiency of the program organization. In the second round of the Delphi survey, this principal POF was ranked seventh among the 11 identified principal POFs, with a MS of 4.20.

7.5 REFINEMENT OF THE PROGRAM ORGANIZATION MODEL

The Shanghai Expo Construction is considered as an example of a successful execution of a megaproject in China based on (1) the smooth delivery of facilities, building and infrastructures; (2) excellence in the performance of cost, safety, quality and environment; and (3) positive feedback from the client, (BSEC & SMURCTC, 2010). The success of this Chinese case can be attributed to the successful adoption of the program management approach in the client organization (BSEC & SMURCTC, 2010). The 11 principal POFs identified from the case study also integrate the contextual, normative, regulative, structural, technical and cultural–cognitive elements into the program organization, which still represent the three capabilities of program organization, namely, environmental capability, core capacity and motivational capability. They can provide practitioners with a more pragmatic program organization model that has a significant application value.

Although the findings reported in this study have been developed from a single case study of the Chinese megaproject, the model consisting of 11 principal POFs is not only highly consistent with existing definitions on program management, but also provides a clear picture of program management practices in general.

7.6 CHAPTER SUMMARY

This chapter has identified the 11 principal POFs and refined the program organization model (Chapter 6) based on a Delphi survey in the case study. These principal POFs constitute a simplified model of program organization for managing megaprojects with a significant application value, which are also grouped under the same three categories of environmental capability, core capacity, and motivational capability. The principal POFs in the environmental capability group are the same as those presented in Chapter 6. The POFs in other two groups are refined in terms of findings from the Delphi survey.

The core capacity of the program organization includes (1) program leadership, (2) program governance, (3) matrix organizational structure, (4) PMO, (5) use of PBS/ WBS, (6) partnership with key stakeholders, and (7) technology management. These POFs reflect the core capacity of the program organization established by the client to execute a construction megaproject.

The motivational capability of the program organization includes two principal POFs: communication management and team building. Chan (1994) stated that motivation was positively correlated with project size. In managing megaprojects, motivation is essential to sustain the dynamics of the program organization for a relatively long-term undertaking.

The relative importance of these principal POFs have also been examined and provided in this study.

CHAPTER 8: DEVELOPMENT OF A PROGRAM ORGANIZATIONAL PERFORMANCE INDEX FOR CONSTRUCTION MEGAPROJECTS: AN FSE ANALYSIS

8.1 INTRODUCTION

A simplified framework consisting of the 11 principal POFs has been obtained based on the case-based Delphi survey described in Chapter 7. Gil and Lundrigan (2012) stated that research on megaproject organization should be grounded in performance issues. Thus, this chapter aims to further examine the relationships between the 11 principal POFs and megaproject performance (KPIs) by developing and using a program organizational performance index (POPI) with the aid of FSE analysis. Based on this analysis, the relationships between the program organization and megaproject performance can be demonstrated.

FSE analysis is the main tool adopted to develop the POPI model in this study. Five steps in developing the POPI model are presented in this chapter. A step-by-step development of the POPI model for the case study is illustrated. Clients can apply the newly developed model to assess the relationships between program organization design and megaproject performance to enhance and tailor fit a program organization for managing a prescribed megaproject.

8.2 FSE MODEL FOR ASSESSING THE PERFORMANCE OF A PROGRAM ORGANIZATION

The FSE process includes five steps as shown in Figures 8.1 and 8.2 (Xu et al., 2010; Yeung et al., 2007).

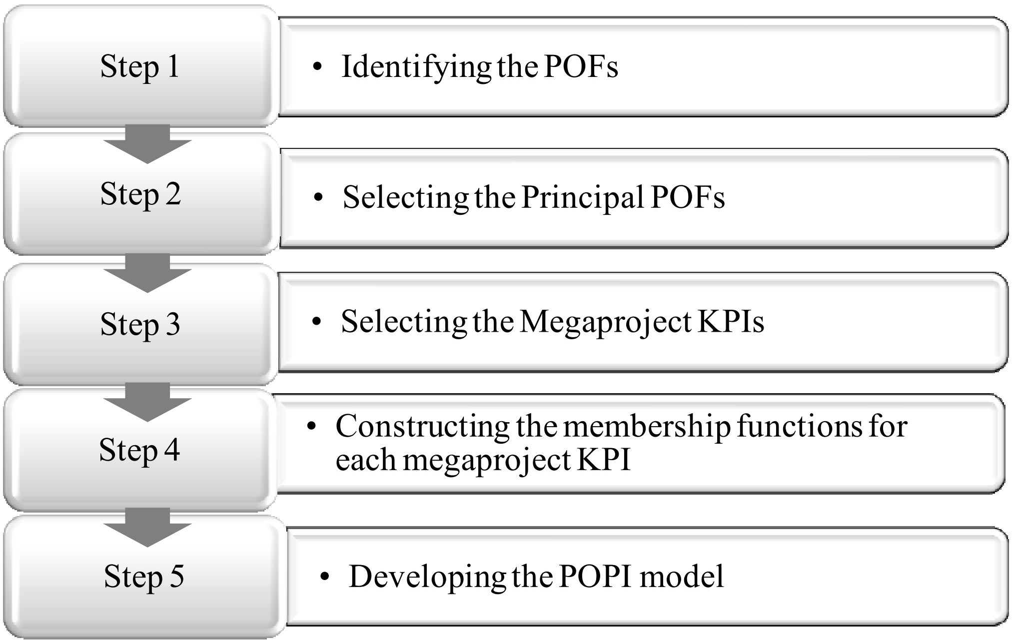


Figure 8.1 FSE analysis steps
(Source: Xu, et al., 2010; Yeung, et al., 2007)

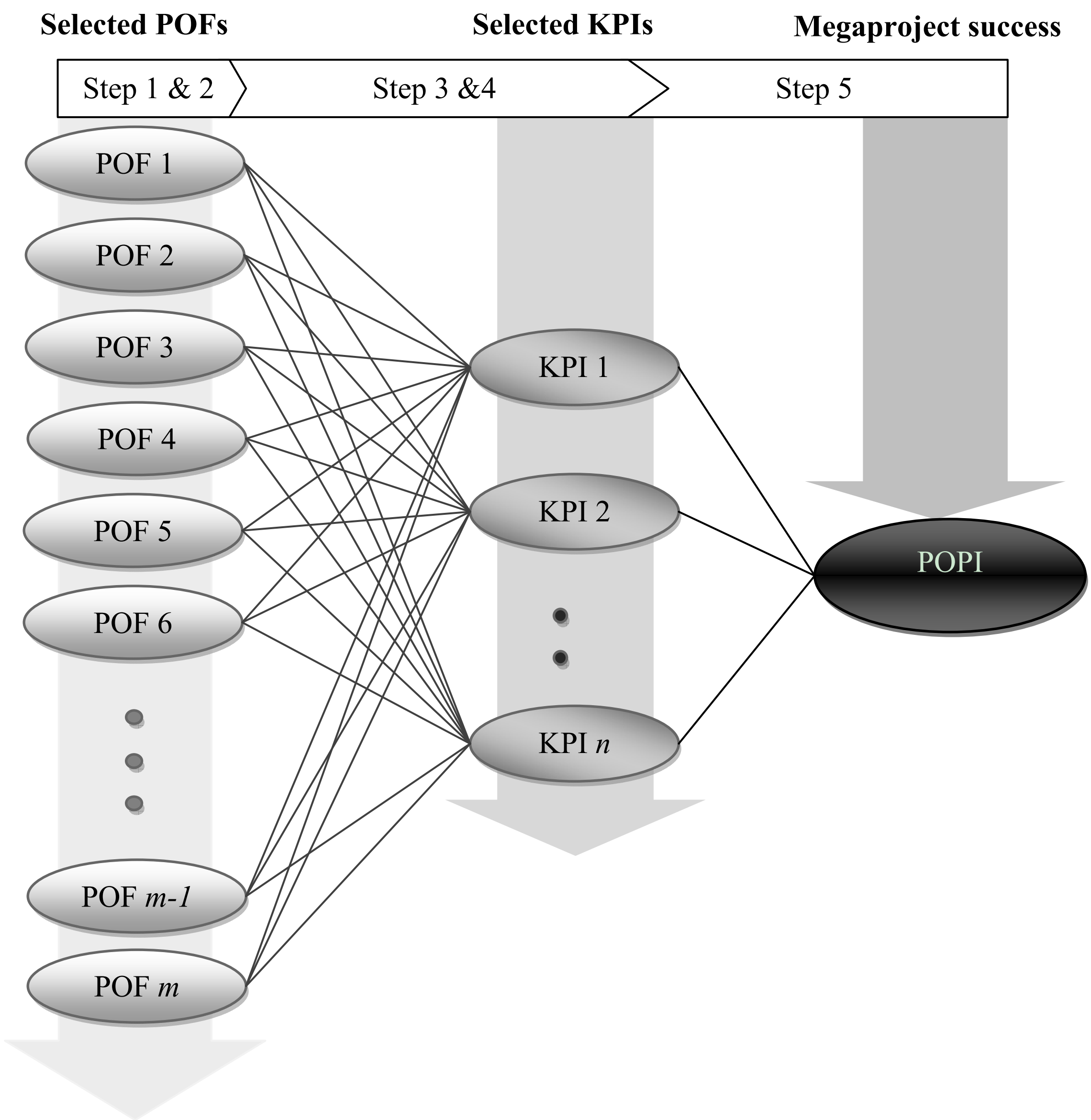


Figure 8.2 Relationships between FSE variables and analysis steps

8.2.1 Identifying POFs

The first step to establish the FSE model is to identify the POFs, which are regarded as indicators of the program organization. Literature review and interview methods were both employed in this study to identify POFs. A list of 24 POFs was formulated as reported in Chapter 6.

8.2.2 Selecting Principal POFs Associated with Construction Megaprojects in China

After identifying the POFs, appropriate POFs were selected as basic factors used for the FSE analysis. Principal POFs were extracted and used for FSE analysis in this study (Xu et al., 2010). The principal POFs were first identified based on the relative importance indicated by experts in the second round Delphi survey (Chapter 7). Only POFs with relative importance ratings that are equal to or greater than the threshold value are regarded as important and selected for the subsequent analysis (Xu et al., 2010). Pearson correlation analysis is conducted to examine whether a multiplier effect exists among the resulting principal POFs. Only those principal POFs that are not highly correlated with each other are used as basic factors in the subsequent analysis.

8.2.3 Selecting Megaproject KPIs

KPIs are used to evaluate the factors crucial to the success of construction megaprojects (Flyvbjerg et al., 2003). Five KPIs, namely, time performance (KPI1), cost performance (KPI2), functionality and quality performance (KPI3), and occupational health and safety (OHS) performance (KPI4), environmental performance (KPI 5) were selected to measure the performance of the Shanghai Expo construction megaproject. These KPIs are commonly regarded as key measures of megaproject success (Flyvbjerg et al., 2003; Yeung at al., 2013). The correlations of these KPIs in the case study were first assessed before adopting the five KPIs to avoid the multiplier effect among individual KPIs.

8.2.4 Constructing Membership Functions for Each Megaproject KPI

The construction procedure of fuzzy membership function advocated by Xu et al. (2010) is used in this study because of its rationality and simplicity. This procedure is widely advocated in the construction management field (Li et al., 2013; Liu et al., 2013). The procedure contains the following six steps:

1) The set of basic factors (criteria) are assumed to be π = {f_1, f_2 … f_m}, where m is the number of factors.
2) The set of grade categories are defined as E = {e_1, e_2, e_3… e_n}, where n is the number of grade categories. In the five-point Likert scale, the grades for selection are defined as {1, 2, 3, 4, 5}, where 1 = very low; 2 = low; 3 = medium; 4 = high; and 5 = very high.
3) The weighting for each factor is obtained as W= {w1, w2 … wm}. The weighting of each factor can be determined through surveys.
4) The membership function for each factor is established, which is a fuzzy subset of grade set in terms of ratings from the expert group.
5) The FSE result is obtained by calculating the fuzzy composition of the weighted fuzzy evaluation matrix. Four alternative models can be used to calculate the results of the evaluation results.

   Model 1: $M(\wedge,\vee), b_j = V_{i=1}^{m}(w_i \wedge r_{ij}) \quad \forall \mathrm{b}_j \in B$ Equation (8.1)

   Model 2: $M(\bullet,\vee), b_j = V_{i=1}^{m}(w_i \times r_{ij}) \quad \forall \mathrm{b}_j \in B$ Equation (8.2)

   Model 3: $M(\bullet,\oplus), b_j = \min(1, \sum_{i=1}^{m} w_i \times r_{ij}) \quad \forall \mathrm{b}_j \in B$ Equation (8.3)

   Model 4: $M(\wedge,+), b_j = \sum_{i=1}^{m}(w_i \wedge r_{ij}) \quad \forall \mathrm{b}_j \in B$ Equation (8.4)

   Models 1 and 2 are mainly used to evaluate single-item problems when only the major criteria are considered. Model 4 neglects some information with smaller weighting. Model 3 is employed in this study because the evaluation involves multiple factors with non-significant weighting differences.
6) The fuzzy evaluation is normalized, and a POPI for a particular megaproject KPI is calculated as follows:

$$POPI = \sum_{k=1}^{5} R \times L \qquad \text{Equation (8.5)}$$

Where POPI —the program organizational performance index

R— the degree of membership function of the program organization for a particular megaproject KPI

L— the linguistic variables where 1= very low; 2=low; 3=moderate; 4=high; 5=very high

8.2.5 Developing a POPI

Yeung et al. (2007) proposed a linear and additive model to develop a performance index for construction projects. Similarly, the POPI for the five KPIs can be computed as follows:

$$POPI = \sum_{i=1}^{n} POPI_i \times W_i \qquad \text{Equation (8.6)}$$

Where POPI—the program organizational performance index regarding all selected KPIs

$POPI_i$ —a particular $POPI_i$

W_i —the weighting of a particular KPI_i

The weighting of a particular KPI can be computed by using the following equation (Chow, 2005):

$$W_{KPI_a} = \frac{M_{KPI_a}}{\sum_g M_{KPI_a}} \quad \text{for} \quad a=1 \qquad \text{Equation (8.7)}$$

Where W_{KPIa}—the weightings of a particular selected KPI;

M_{KPIa}—the mean of a particular selected KPI;

$\sum_g M_{KPI_a}$ —the summation of meaning ratings of all the selected KPIs.

8.3 CASE STUDY

8.3.1 Identifying the POFs

A total of 24 POFs were identified in the literature review, and then were refined through the interviews in the case study, as mentioned in Chapter 6. The POFs represented all indicators of the program organization associated with a construction megaproject.

8.3.2 Selecting the Principal POFs

A total of 11 principal POFs were identified based on the first and second rounds of the Delphi survey (Chapter 7) as shown in Table 8.1.

Table 8.1 Rankings of the 11 principal POFs in the second Delphi survey

Principal POFs	Mean	Normalization
1. Program strategy	4.80	1.0000
2. Program leadership	4.70	0.9333
3. Use of PBS / WBS tools	4.60	0.8667
4. Communication management	4.60	0.8667
5. Contextual understanding	4.50	0.8000
6. Program governance	4.50	0.8000
7. Scope management	4.20	0.6000
8. Matrix organizational structure	4.20	0.6000
9. Program management office (PMO)	4.20	0.6000
10. Partnership with key stakeholders	4.20	0.6000
11. Technology management	4.20	0.6000

Pearson correlation analysis (Table 7.7) indicated that these 11 principal POFs were not correlated at the 5% significance level. Therefore, the 11 principal POFs were adopted to develop the FSE model.

8.3.3 Selecting the Megaproject KPIs

Five KPIs, namely, cost performance, time performance, functionality and quality performance, OHS performance, and environmental performance, were considered as the key performance measures of megaproject success in the case study. A questionnaire survey was conducted to assess the relative importance of the megaproject KPIs. Respondents were asked to evaluate the importance of KPIs based on a five-point Likert scale: 1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high. The target survey respondents included client staff, industrial participants and researchers involved in the Shanghai Expo construction to obtain a balanced view. All respondents should be involved in the Shanghai Expo construction and should have sound knowledge of performance management in megaproject practices. Invitations were sent to the target respondents by e-mail or personally through the Shanghai Expo Group Corporation (which was the former client of Shanghai Expo construction) as well as the Department of Construction Management and Real Estate at Tongji University. Subsequently, 11 valid questionnaires were recorded for the subsequent data analysis. Table 8.2 presents the profiles of all 11 questionnaire respondents.

Table 8.2 Profiles of the 11 questionnaire respondents

Profiles	Categorization	Percentages
Stakeholder role	Clients	45%
	Designers	10%
	Consultants	20%
	Universities and Research institutions	25%
Working experience in the construction industry	1-5 years	27%
	6-10 years	18%
	11-20 years	18%
	21-30 years	9%
	More than 30 years	27%

Pearson correlation analysis was again conducted to examine the correlations among these KPIs. As shown in Table 8.3, environmental performance was highly correlated with OHS performance at the 5% significance level. Only OHS performance was selected and used for subsequent analysis to avoid a potential multiplier effect between OHS and environmental performance. As shown in Table 8.4, the remaining four KPIs were not correlated at the 5% significance level. Therefore, they were adopted to develop the FSE model as indicated by Equation 8.7 (Yeung et al., 2007).

Table 8.3 The correlation matrix among the five KPIs

	KPI1	KPI2	KPI3	KPI4	KPI5
KPI1	1.00	-0.209	-0.334	0.399	0.152
KPI2		1	.134	0.239	0.474
KPI3			1	0.256	0.546
KPI4				1	0.698*
KPI5					1

* Correlation is significant at the 0.05 level (2-tailed).

Table 8.4 The correlation matrix among the four KPIs

	KPI1	KPI2	KPI3	KPI4
KPI1	1.00	-0.209	-0.334	0.399
KPI2		1	.134	0.239
KPI3			1	0.256
KPI4				1

* Correlation is significant at the 0.05 level (2-tailed).

The weighting for each megaproject KPI was calculated in terms of Equation (8.7), as shown in Table 8.5. The calculated weighting results are as follows: time performance, 0.2709; functionality and quality performance, 0.2658; cost performance, 0.2342, and OHS performance, 0.2291.

Table 8.5 The four KPIs and their corresponding weightings

Code	KPIs	Mean	Weightings
KPI 1	Time performance	4.73	0.2709
KPI 2	Cost performance	4.09	0.2342
KPI 3	Functionality and quality performance	4.64	0.2658
KPI 4	OHS performance	4.00	0.2291
	Number (11)	*N*	

8.3.4 Constructing the Membership Functions for Each Megaproject KPI

The 11 principal POFs reported in Section 8.3.2 were selected and used to construct the membership functions for the four KPIs. The set of basic factors (principal POFs) in the FSE model are assumed to be π = {f1, f2 … f11}. The grades for the impact of each principal POF on a particular KPI are defined as E = {1, 2, 3, 4, 5} where 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high (for each of the four KPIs). For each principal POF, the membership function can be established in terms of the ratings of experts provided in the fourth Delphi survey (Appendix I). For example, 40% of the respondents considered the impact of PMO on cost performance as moderate, 30% as high and 30% as very high. The membership function of PMO is expressed in Equation (8.8) as follows:

$$Principal\_POF1 = \frac{0.00}{very\_low} + \frac{0.00}{low} + \frac{0.40}{moderate} + \frac{0.30}{high} + \frac{0.30}{very\_high} \quad \text{Equation (8.8)}$$

It can also be written as (0.00, 0.00, 0.40, 0.30, 0.30). Similarly, the membership functions of the remaining 10 principal POFs for construction megaprojects can be derived in the same manner as indicated in Tables 8.6, 8.7 8.8, and 8.9.

Table 8.6 Membership functions of all principal POFs (Cost performance)

Principal POF	Weighting	Membership function of level 2
1. Program strategy	0.0986	(0.00, 0.00, 0.00, 0.80, 0.20)
2. Program leadership	0.0965	(0.00, 0.00, 0.00, 0.60, 0.40)
3. Use of PBS / WBS tools	0.0945	(0.00, 0.00, 0.00, 0.70, 0.30)
4. Communication management	0.0945	(0.00, 0.00, 0.20, 0.70, 0.10)
5. Contextual understanding	0.0924	(0.00, 0.00, 0.10, 0.60, 0.30)
6. Program governance	0.0924	(0.00, 0.00, 0.00, 0.90, 0.10)
7. Matrix organizational structure	0.0862	(0.00, 0.00, 0.20, 0.50, 0.30)
8. Program management office	0.0862	(0.00, 0.00, 0.00, 0.60, 0.40)
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.10, 0.60, 0.30)
10. Technology management	0.0862	(0.00, 0.00, 0.30, 0.60, 0.10)
11. Team building	0.0862	(0.00, 0.00, 0.10, 0.70, 0.20)

Table 8.7 Membership functions of all principal POFs (Functionality & quality performance)

Principal POF	Weighting	Membership function of level 2
1. Program strategy	0.0986	(0.00, 0.10, 0.20, 0.50, 0.20)
2. Program leadership	0.0965	(0.00, 0.00, 0.00, 0.50, 0.50)
3. Use of PBS / WBS tools	0.0945	(0.00, 0.00, 0.00, 0.70, 0.30)
4. Communication management	0.0945	(0.00, 0.00, 0.30, 0.60, 0.10)
5. Contextual understanding	0.0924	(0.00, 0.00, 0.40, 0.60, 0.00)
6. Program governance	0.0924	(0.00, 0.00, 0.10, 0.80, 0.10)
7. Matrix organizational structure	0.0862	(0.00, 0.00, 0.30, 0.60, 0.10)
8. Program management office	0.0862	(0.00, 0.00, 0.00, 0.20, 0.80)
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.10, 0.70, 0.20)
10. Technology management	0.0862	(0.00, 0.00, 0.40, 0.60, 0.00)
11. Team building	0.0862	(0.00, 0.00, 0.10, 0.60, 0.30)

Table 8.8 Membership functions of all principal POFs (Time performance)

Principal POF	Weighting	Membership function of level 2
1. Program strategy	0.1333	(0.00, 0.00, 0.00, 0.30, 0.70)
2. Program leadership	0.1067	(0.00, 0.00, 0.00, 0.40, 0.60)
3. Use of PBS / WBS tools	0.1040	(0.00, 0.00, 0.00, 0.30, 0.70)
4. Communication management	0.0667	(0.00, 0.00, 0.10, 0.60, 0.30)
5. Contextual understanding	0.0800	(0.00, 0.00, 0.00, 0.20, 0.80)
6. Program governance	0.0773	(0.00, 0.00, 0.00, 0.50, 0.50)
7. Matrix organizational structure	0.0693	(0.00, 0.00, 0.40, 0.50, 0.10)
8. Program management office	0.0587	(0.00, 0.00, 0.30, 0.50, 0.20)
9. Partnership with key stakeholders	0.0560	(0.00, 0.00, 0.00, 0.20, 0.80)
10. Technology management	0.0907	(0.00, 0.00, 0.00, 0.20, 0.80)
11. Team building	0.0960	(0.00, 0.00, 0.10, 060, 0.30)

Table 8.9 Membership functions of all principal POFs (OHS performance)

Principal POF	Weighting	Membership function of level 2
1. Program strategy	0.0986	(0.00, 0.00, 0.50, 0.40, 0.10)
2. Program leadership	0.0965	(0.00, 0.00, 0.20, 0.70, 0.10)
3. Use of PBS / WBS tools	0.0945	(0.00, 0.000, 0.20, 0.70, 0.10)
4. Communication management	0.0945	(0.00, 0.00, 0.00, 0.80, 0.20)
5. Contextual understanding	0.0924	(0.00, 0.00, 0.40, 0.40, 0.20)
6. Program governance	0.0924	(0.00, 0.00, 0.20, 0.80, 0.00)
7. Matrix organizational structure	0.0862	(0.20, 0.20, 0.60, 0.20, 0.00)
8. Program management office	0.0862	(0.00, 0.20, 0.50, 0.30, 0.00)
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.40, 0.50, 0.10)
10. Technology management	0.0862	(0.00, 0.10, 0.10, 0.70, 0.10)
11. Team building	0.0862	(0.00, 0.10, 0.30, 0.60, 0.00)

The membership function of the program organizational performance level (including the 11 principal POFs) for cost performance was calculated as follows:

$$(0.0986\times0.00+0.0965\times0.00+0.0945\times0.00+0.0945\times0.00+0.0924\times0.00+0.0924\times0.00+0.0862\times0.00+0.0862\times0.00+0.0862\times0.10+0.0862\times0.00+0.0862\times0.00,$$
$$0.0986\times0.00+0.0965\times0.00+0.0945\times0.00+0.0945\times0.00+0.0924\times0.00+0.0924\times0.00+0.0862\times0.00+0.0862\times0.00+0.0862\times0.00+0.0862\times0.00+0.0862\times0.00,$$
$$0.0986\times0.00+0.0965\times0.00+0.0945\times0.00+0.0945\times0.20+0.0924\times0.10+0.0924\times0.00+0.0862\times0.20+0.0862\times0.00+0.0862\times0.10+0.0862\times0.30+0.0862\times0.10,$$
$$0.0986\times0.80+0.0965\times0.60+0.0945\times0.70+0.0945\times0.70+0.0924\times0.60+0.0924\times0.90+0.0862\times0.50+0.0862\times0.60+0.0862\times0.60+0.0862\times0.60+0.0862\times0.70,$$
$$0.0986\times0.20+0.0965\times0.40+0.0945\times0.30+0.0945\times0.10+0.0924\times0.30+0.0924\times0.10+0.0862\times0.30+0.0862\times0.40+0.0862\times0.30+0.0862\times0.10+0.0862\times0.20)$$
$$= (0.00, 0.00, 0.09, 0.67, 0.25)$$

Similarly, the membership functions of the program organization performance level (including the 11 principal POFs) for the other KPIs were calculated. The FSE results regarding the other three KPIs are also shown in Table 8.10.

Table 8.10 FSE results

Principal POF	Weighting	Membership function of level 2	Membership function of level 1
Cost performance (from level 2 to level 1)			
1. Program strategy	0.0986	(0.00, 0.00, 0.00, 0.80, 0.20)	(0.00, 0.00, 0.09, 0.67, 0.25)
2. Program leadership	0.0965	(0.00, 0.00, 0.00, 0.60, 0.40)	
3. Use of PBS / WBS tools	0.0945	(0.00, 0.00, 0.00, 0.70, 0.30)	
4. Communication management	0.0945	(0.00, 0.00, 0.20, 0.70, 0.10)	
5. Contextual understanding	0.0924	(0.00, 0.00, 0.10, 0.60, 0.30)	
6. Program governance	0.0924	(0.00, 0.00, 0.00, 0.90, 0.10)	
7. Matrix organizational structure	0.0862	(0.00, 0.00, 0.20, 0.50, 0.30)	
8. Program management office	0.0862	(0.00, 0.00, 0.00, 0.60, 0.40)	
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.10, 0.60, 0.30)	
10. Technology management	0.0862	(0.00, 0.00, 0.30, 0.60, 0.10)	
11. Team building	0.0862	(0.00, 0.00, 0.10, 0.70, 0.20)	
Functionality and quality performance (from level 2 to level 1)			
1. Program strategy	0.0986	(0.00, 0.10, 0.20, 0.50, 0.20)	(0.00, 0.01, 0.17, 0.58, 0.24)
2. Program leadership	0.0965	(0.00, 0.00, 0.00, 0.50, 0.50)	
3. Use of PBS / WBS tools	0.0945	(0.00, 0.00, 0.00, 0.70, 0.30)	

Principal POF	Weighting	Membership function of level 2	Membership function of level 1
4. Communication management	0.0945	(0.00, 0.00, 0.30, 0.60, 0.10)	
5. Contextual understanding	0.0924	(0.00, 0.00, 0.40, 0.60, 0.00)	
6. Program governance	0.0924	(0.00, 0.00, 0.10, 0.80, 0.10)	
7. Matrix organizational structure	0.0862	(0.00, 0.00, 0.30, 0.60, 0.10)	
8. Program management office	0.0862	(0.00, 0.00, 0.00, 0.20, 0.80)	
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.10, 0.70, 0.20)	
10. Technology management	0.0862	(0.00, 0.00, 0.40, 0.60, 0.00)	
11. Team building	0.0862	(0.00, 0.00, 0.10, 0.60, 0.30)	
Time performance (from level 2 to level 1)			
1. Program strategy	0.1333	(0.00, 0.00, 0.00, 0.30, 0.70)	(0.00,0.00, 0.08,0.39,0.53)
2. Program leadership	0.1067	(0.00, 0.00, 0.00, 0.40, 0.60)	
3. Use of PBS / WBS tools	0.1040	(0.00, 0.00, 0.00, 0.30, 0.70)	
4. Communication management	0.0667	(0.00, 0.00, 0.10, 0.60, 0.30)	
5. Contextual understanding	0.0800	(0.00, 0.00, 0.00, 0.20, 0.80)	
6. Program governance	0.0773	(0.00, 0.00, 0.00, 0.50, 0.50)	
7. Matrix organizational structure	0.0693	(0.00, 0.00, 0.40, 0.50, 0.10)	
8. Program management office	0.0587	(0.00, 0.00, 0.30, 0.50, 0.20)	
9. Partnership with key stakeholders	0.0560	(0.00, 0.00, 0.00, 0.20, 0.80)	
10. Technology management	0.0907	(0.00, 0.00, 0.00, 0.20, 0.80)	
11. Team building	0.0960	(0.00, 0.00, 0.10, 060, 0.30)	
Occupational health and safety performance (from level 2 to level 1)			
1. Program strategy	0.0986	(0.00, 0.00, 0.50, 0.40, 0.10)	(0.02,0.05, 0.31,0.56,0.08)
2. Program leadership	0.0965	(0.00, 0.00, 0.20, 0.70, 0.10)	
3. Use of PBS / WBS tools	0.0945	(0.00, 0.00, 0.20, 0.70, 0.10)	
4. Communication management	0.0945	(0.00, 0.00, 0.00, 0.80, 0.20)	
5. Contextual understanding	0.0924	(0.00, 0.00, 0.40, 0.40, 0.20)	
6. Program governance	0.0924	(0.00, 0.00, 0.20, 0.80, 0.00)	
7. Matrix organizational structure	0.0862	(0.20, 0.20, 0.60, 0.20, 0.00)	
8. Program management office	0.0862	(0.00, 0.20, 0.50, 0.30, 0.00)	
9. Partnership with key stakeholders	0.0862	(0.00, 0.00, 0.40, 0.50, 0.10)	
10. Technology management	0.0862	(0.00, 0.10, 0.10, 0.70, 0.10)	
11. Team building	0.0862	(0.00, 0.10, 0.30, 0.60, 0.00)	

After the membership function of Level 1 was derived, the POPI for a particular KPI was calculated using Equation (8.5). For instance, the POPI for cost performance was calculated as follows:

$0.00\times1+ 0.00\times2+0.09\times3+ 0.67\times4+0.25\times5=4.200$

Similarly, the POPIs for the three KPIs, functionality and quality performance, time performance, and OHS performance were determined as follows:

$0.00\times1+0.01\times2+0.17\times3+0.58\times4+0.24\times5=4.050$ (Functionality and quality performance)

$0.00\times1+0.00\times2+0.08\times3+0.39\times4+0.53\times5=4.450$ (Time performance)

$0.02\times1+0.05\times2+0.31\times3+0.56\times4+0.08\times5=3.690$ (OHS performance)

8.3.5 Developing the Case Study POPI for All Four KPIs

The overall POPI in the case study with regard to the four KPIs can be developed as follows:

$$Overall\_POPI = 0.2342\times KPI1 + 0.2658\times KPI2 + 0.2709\times KPI3 + 0.2291\times KPI4 \quad \text{Equation (8.9)}$$

Based on the four POPIs obtained in Section 8.3.4, the overall POPI can be calculated as follows:

$$4.450\times0.2342+4.200\times0.2658+4.050\times0.2709+3.690\times0.2291=4.10$$

The overall POPI is 4.10, which is higher than the "high" value of 4.00. Therefore, the performance level of the program organization in the case study is better than "high," with a great and positive performance level. Moreover, the program organization framework consisting of the 11 principal POFs developed in this study can be considered significant in improving organizational efficiency and in sustaining megaproject performance. Figure 8.3 shows the POPI model of the case study.

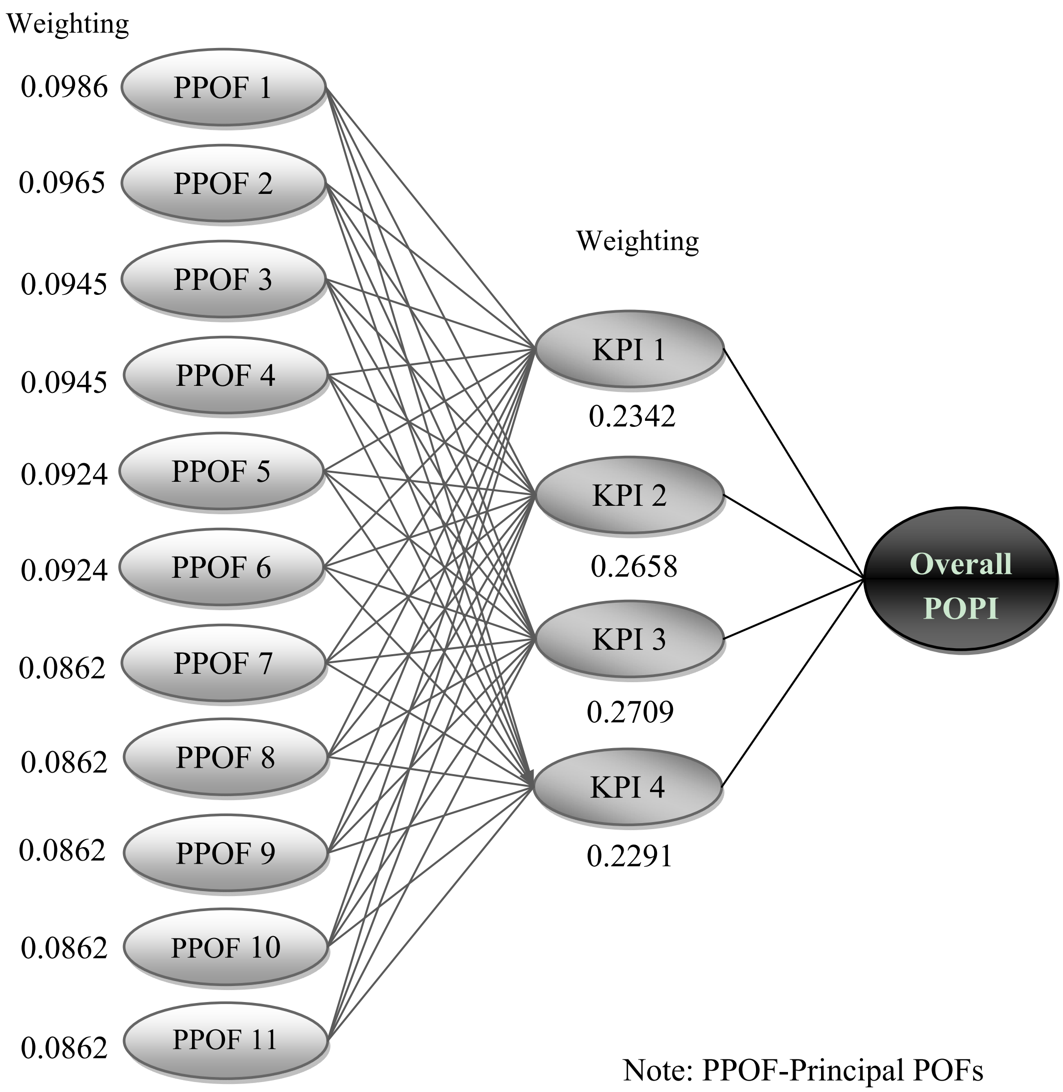


Figure 8.3 POPI model of the case

The effect of the program organization on each KPI in the case study was examined to ensure in-depth analysis. The performance level of the program organization on each KPI is presented in Table 8.11 according to the maximum membership principle. Analysis results indicated that the design and operation of the program organization consisting of the 11 principal POFs were consistent with the client's prioritization of four KPIs in the case study. Among the four KPIs in the case study, program organization had the largest contribution to time performance (4.450), followed by cost performance and functionality as well as quality performance (4.200 and 4.050, respectively). This model also indicated high performance in OHS (3.690).

Table 8.11 Performance scores and levels of the case's program organization

KPIs	Score	Membership function	POPI (Categories)
Time performance	4.450	(0.00,0.00, 0.08,0.39,0.53)	Very high (5)
Cost performance	4.200	(0.00,0.00, 0.09,0.67,0.25)	High (4)
Functionality and quality performance	4.050	(0.00,0.00, 0.17,0.58,0.24)	High (4)
OHS performance	3.690	(0.02,0.05, 0.31,0.56,0.08)	High (4)

Although this calculation was specific to the Shanghai Expo construction, the developed methodology and program organization framework could be applied to other megaprojects in China. Clients with different settings on the priority of KPIs in construction megaprojects may replicate the methods of identifying principal POFs and evaluating their relationships with KPIs using the POF framework to tailor fit their own program organizations.

8.4 VALIDATION OF THE STUDY

Validation is the final and indispensable step in each research cycle to test whether the quality of a developed model has achieved an acceptable requirement. Gupta (1991) stated that the aim of model validation was to determine the degree of the system in fulfilling user needs. Validation could be conducted qualitatively and quantitatively. In qualitative validation, opinion-based data on the effectiveness and performance of an expert system are collected, whereas in quantitative validation, statistical data are collected to evaluate the appropriateness of an expert system against prescribed criteria (O'Keefe et al., 1987).

Walsh (1998) suggested that ethnographic research could be verified through respondent validation and triangulation. Thus, this study conducted qualitative validation of the developed models and relevant tools. This study also considered several reasons for performing qualitative validation. First, the program organization models proposed in this study associated with an abstract construct that is difficult to validate quantitatively. Second, no other successful cases have been identified in China with other clients that have also adopted the program management approach to achieving megaproject success. Therefore, collecting opinion-based data against prescribed assessment criteria through interviews is a more practical method of conducting model validation in this study.

Lucko and Rojas (2010) enumerated seven validity aspects for evaluating construction management research: (1) internal validity, (2) external validity, (3) face validity, (4) content validity, (5) criterion validity, (6) construct validity, and (7) reliability. According to the framework for evaluating organization studies proposed by Bacharach (1989), validation of this study mainly considered construct, external and internal validity. Seven validation questions were developed in this study to measure these validation aspects (Appendix K).

Structured interviews were subsequently conducted based on the validation questions with five selected experts who had been involved in the practice and research of construction megaprojects in China in late July 2013. All interviewees also met the following criteria: (1) seven year industrial experience or above, (2) non-involvement in the development works of the models and relevant tools in this study, and (3) sound knowledge and understanding of client organizations that manage construction megaprojects. Majority of these interviewees have not been involved in the Shanghai Expo construction megaproject but have participated in other construction megaprojects in China. The selection of these interviewees could improve the effectiveness of validation. Table 8.12 presents the profiles of the five interviewees. In each interview, the five respondents were asked to comment on each of the seven validation questions after the overall research process and major research findings were explained.

Table 8.12 Backgrounds of the five interviewees

Code	Positions	Origins	Year of industry experience	Number of megaprojects involved
F	Professor	University	21	1
G	Vice general manager	Construction project management consulting company	9	3
H	Vice general manager	Construction project management consulting company	11	1
I	Manager	Listed real estate developer	12	2
J	Manager	Construction management information system consulting company	7	1

8.4.1 Results of Construct Validity Evaluation

Construct validity evaluates whether theoretical constructs are appropriate for operationalization (Lucko & Rojas, 2010). Bacharach (1989) noted that a good research construct is usually defined in terms of other established and well-understood constructs. Although program management remains an emerging and debatable concept (Morris, 2011), the principal POF model developed in this study has presented a clear picture of this construct based on organizational capability theory. This framework demonstrates high consistency with the widely accepted definitions related to program management. Lucko and Rojas (2010) further stated that despite the lack of numeric measures in this aspect of research validity, this aspect can be measured by soliciting comments from experts in this domain. The following questions are designed in this study to measure this type of validity:

(1) Are the identified POFs comprehensive and practical?
(2) Are the categories of the POFs appropriate?

Almost all of the interviewees (4 out of 5) agreed that the conceptual POF framework was comprehensive and adequate to include all the organizational elements within the client program organization managing a megaproject. Expert J stated that numerous clients partially adopted the program management approach in megaproject practice, which had a significant effect on the overall management of constituent projects within a megaproject, such as the Changchun urban infrastructure megaproject. All of the interviewees agreed that the categorization of the POFs was appropriate. Expert G pointed out that although the categorization was simple, it was appropriate and practical. Expert I had a slightly different opinion on the categorization of a specific POF, but he confirmed the appropriateness of the POF categorization. Expert J affirmed the importance of the POFs under the motivation category, adding that consideration of this issue is lacking in practice.

In general, all of the experts agreed that the conceptual framework and its categorization were comprehensive and practical when applied to construction megaprojects in China. The framework can provide clients with a clear understanding of program organizational factors related to construction megaproject management. These positive comments revealed that this study had high construct validity.

8.4.2 Results of External Validity Evaluation

External validity refers to the generalizability of research results (Rojas & Lucko, 2010). According to Bacharach (1989), good organization theories have explanatory potential and predictive adequacy. The following questions are designed in this study to measure this type of validity:

(1) Are the importance rankings of the principal POFs reasonable?
(2) Is the simplified framework pragmatic and generalized?

The identified principal POFs and their rankings were presented to the interviewees. The processes of the two-round Delphi questionnaire survey were also explained. The interviewees were requested to examine the suitability of these principal POFs together with their individual weightings.

To sum up, although minor differences existed in the ranking of the principal POFs, the majority of the interviewees agreed that these principal POFs and their individual weightings were appropriate in terms of their megaproject experiences. Expert H stated that the use of PBS/WBS tools should be ranked before program leadership because this principal POF referred to the fundamental issue of constructing client program organizations to manage megaprojects. Moreover, the function of program leadership was established based on the foundation established by using these structured tools. Thus, the findings of this study have high external validity when considering the relevant findings that have been developed based on a single case study.

8.4.3 Results of Internal Validity Evaluation

Internal validity is the causality that derives the relationships among data (Leedy & Ormrod, 2001). Lucko and Rojas (2010) stated that establishing causality was a serious challenge in construction management research, because numerous studies were conducted in real-life settings where several variables interacted with one other, many of which were uncontrollable. Bacharach (1989) also stressed that good organization research should have high logical adequacy. The following questions were designed in this study to evaluate this type of validity:

(1) Can the fuzzy membership function effectively reduce the subjectivity of measuring the effectiveness of the program organization with regard to the selection criteria?
(2) Is FSE analysis applicable such that clients can apply the program organization framework?
(3) Are the research design and methodology logical and replicable?

The reasons and procedure for developing fuzzy membership functions for the performance evaluation of the program organization were first briefly explained before interviewees were asked to comment on the questions. The findings of the case study using the POPI model were also explained.

All of the interviewees agreed that the performance of the program organization was the most challenging and essential work for clients who wanted to apply the program management approach in managing megaprojects. The FSE technique is innovative and appropriate for this purpose because it can enable clients to use the program organization in practice in a quantitative manner. Clients can perform their evaluation process using the POPI model. With regard to the research methodology, all of the interviewees said that the overall research design was logical and appropriate. Expert J also noted that this research methodology should be replicated in similar cases because the findings of this study had been developed based on a single case study.

These positive comments suggest that the internal validity of this study remains high. In addition to qualitative comments, the five interviewees were also asked to provide a rating against each validation criterion (question) according to an 11-point Likert scale. Table 8.13 shows the mean values for all validation questions.

Table 8.13 Ratings of the five interviewees

Aspects	Validation questions	Expert F	Expert G	Expert I	Expert J	Expert K	Mean ratings
Construct validity	1. Are the identified POFs comprehensive and practical?	9	9	8	9	8	8.6
	2. Are the categories of the POFs proper?	10	8	8	8	8	8.4
External validity	4. Are the importance rankings of the principal POFs reasonable?	8	9	7	9	8	8.2
	3. Is the simplified framework pragmatic and generalized?	9	9	7	8	7	8.0
Internal validity	5. Can the fuzzy membership function effectively reduce the subjectivity of measuring the effectiveness of the program organization with regard to the selection criteria?	10	10	7	9	9	9.0
	6. Is FSE analysis applicable such that clients can utilize the program organization framework?	10	8	7	8	8	8.2
	7. Is the research design and methodology is logical and replicable?	9	8	8	9	9	8.6

Note: 0=very poor; 5=average; 10=excellent.

As shown in Table 8.15, this study received high mean ratings of 8.0 or above in all three validity aspects, particularly in internal validity. This result suggests that the implementation and findings of this study are valid and reliable. Thus, the findings of this study can be useful for clients who want to design and evaluate program organizations to manage construction megaprojects.

8.5 CHAPTER SUMMARY

The relationships of the principal POFs with the four megaproject KPIs in the case study have been examined based on the newly developed POPI model. The procedure for developing POPI model includes five steps: (1) identifying the POFs, (2) selecting the principal POFs, (3) selecting the megaproject KPIs, (4) constructing the membership functions for each megaproject KPI, and (5) developing the POPI model. The newly developed POPI model can be used as a tool by clients to manage construction megaprojects through program organization, particularly in China.

A two-round Delphi survey and a questionnaire have been used in the case study to obtain the data as input for the POPI model. The performance level of the program organization in the case study was examined based on the data acquired through the Delphi survey and questionnaire using the POPI model with FSE. The computed results revealed that high performance was achieved in the case study. The program organization model developed in this study is effective in managing construction megaprojects. Moreover, the POPI model can be used as an additional tool to assist professionals in designing an appropriate program organization to manage future megaprojects, particularly in China.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

9.1 INTRODUCTION

With the rapid growth of construction megaprojects in China, program management has been increasingly advocated as a new profession in the project management field. However, limited pragmatic frameworks of program management for managing construction megaprojects are available (Rasdorf et al., 2010). This deficiency may decrease the interest of industrial professionals in program management (Milosevic et al., 2007). Industrial professionals may not be able to improve the performance of construction megaprojects by adopting this new approach.

The aim of this study was to develop a pragmatic and systematic program organization model for managing construction megaprojects in China. Five specific research objectives were identified to develop this model:

(1) To review the history, viewpoints and developments of construction megaproject research;
(2) To define program management and evaluating the applicability of this approach to managing construction megaprojects;
(3) To identifying the POFs for managing megaprojects;
(4) To extract the principal POFs; and
(5) To develop the POPI model for managing construction megaprojects.

9.2 REVIEW OF THE RESEARCH OBJECTIVES

9.2.1 Construction Megaproject Research and Practice

A comprehensive review was conducted to define construction megaprojects, to identify real-life problems in relevant practice and to assess the state of the art in this field. The review scope included relevant papers published in nine peer-reviewed construction management journals, proceedings, books, news reports, and reliable online information. These tasks are crucial to provide this study with a solid theoretical foundation, which has not been conducted previously. All available literature from various sources was reviewed and presented in a unified framework reported in Chapters 3 and 4. First, the definitions of construction megaprojects from the viewpoints of governments, industries and academics were reviewed. A 0.01% of GDP is recommended worldwide as a criterion to define a construction megaproject in its location. Underperformance problems in construction megaprojects in cost, schedule, safety, functionality and quality and environment were further examined in terms of relevant literature and reports in China. The key perspectives and developments in megaproject research were systematically reviewed and presented to address these problems. Analysis results indicated that megaproject organization remained a critical but promising domain in megaproject practice and research.

9.2.2 Applicability of Program Management Approach to Managing Construction Megaprojects

An extensive review was conducted to identify relevant literature on program management in books, journals, conference proceedings, and online information. Aside from discussions on the definitional issues of program management, justifications of the applicability of program management approach to managing megaprojects were also presented from the viewpoints of academics and practitioners. These reviews revealed that program management had been widely accepted as a key approach in managing construction megaprojects because of its strong coordination ability in integrating the dispensed execution of these projects.

9.2.3 Program Organization Model for Managing Construction Megaprojects

A critical review of papers either on program management or on megaproject management published between 2000 and 2010 was conducted in the nine peer-reviewed construction management journals. Twenty-two POFs were identified from the over 100 papers identified from the literature review. These POFs were grouped into three categories, environmental capability, core capacity, and motivational capability, which represented a conceptual framework of program organization for managing construction megaprojects from the client's perspective. Furthermore, interviews with five former executives with hands-on experience in the Shanghai Expo construction client organization were conducted to validate the usefulness of this preliminary model, which resulted in 20 POFs. Eighteen (82%) of the 22 POFs were the same as those identified from the literature. The 22-POF framework formulated by the literature review was further refined with the addition of two POFs. Finally, a conceptual model consisting of 24 POFs was formulated.

9.2.4 Principal POFs

A two-round Delphi survey was conducted in the case study to extract principal POFs to establish a more pragmatic program organization framework. Eleven principal POFs were derived: (1) contextual understanding, (2) program strategy, (3) program leadership, (4) program governance, (5) matrix organizational structure, (6) PMO, (7) use of PBS/ WBS, (8) partnership with key stakeholders, (9) technology management, (10) communication management, and (11) team building. These principal POFs were grouped under the same three categories of environmental capability, core capacity, and motivational capability, which represented a simplified model of program organization for managing megaproject with higher application value. The operation of these principal POFs in the case study was also presented by examining relevant archival documents.

9.2.5 Program Organizational Performance Index for Managing Construction Megaprojects

A POPI model was established to better understand the relationship between program organization and megaproject performance. FSE was the most suitable technique to resolve this problem. After identifying the four KPIs for managing the performance of construction megaprojects, a performance index was derived based on feedback from a questionnaire survey on the relative importance of the four KPIs in the case study. Based on the feedback, the membership function against each KPI was established for the case study. By incorporating these membership functions into the overall performance index, an overall POPI for assessing the case was developed and computed. Results of the analysis indicated that the program organization was highly and positively correlated with the overall performance of the case under scrutiny. These results also revealed that the 11 principal POFs were consistent with the client's prioritization of the four KPIs in the case study. The POPI model can assist client in evaluating the design of a program organization and examining the effectiveness of this organization for managing megaprojects.

9.3 VALUES AND SIGNIFICANCE OF THIS STUDY

With the rapid emergence of construction megaprojects over the past decade, program management has been increasingly supported as a contextual and pragmatic means of procuring construction megaprojects worldwide because it can efficiently coordinate the dispensed execution (Arrto et al., 2008; Kim et al., 2009; Pellegrinelli et al., 2011). However, the lack of clarity and concern for establishing a program management standard in the construction industry might decrease the interest in this emerging discipline (Milosevic et al. 2007; Arrto et al., 2008). This study has focused on the specific subject of program organization established by a client to manage construction megaprojects. Three major contributions to the research area of construction megaprojects were made.

First, a comprehensive review of megaproject research and practice was conducted, which provided an overall picture of construction megaprojects. Results of the analysis paved the way for the subsequent analyses in this study and future research in this area.

Second, a program organization framework was developed based on the mixed methodology, including literature reviews, interviews, Delphi survey and case study. The principal POFs were identified based on the case study of the Shanghai Expo construction. The pragmatic framework of program organization developed in this study can guide clients to manage construction megaprojects more effectively and efficiently through the program organization. The POFs are beneficial to other construction professionals involved in construction megaprojects not only in China, but also in other countries. The validity of this framework was verified.

Finally, a POPI model using the FSE technique was developed to assist clients in applying the program organization model to megaproject practice. The design and construction of a program organization to sustain megaproject performance are multi-criteria issues. Clients have to understand the relationship between principal POFs and KPIs. FSE technique was then applied to establish the fuzzy membership functions relating to each KPI. The newly developed POPI model enables clients to quantify the relationship between organizational factors and the performance of megaprojects. The Shanghai Expo was used as an example to illustrate the application of this newly developed model. Analysis results revealed that the program organization was highly and positively correlated with the performance of the Shanghai Expo case. The newly developed POPI model may serve as a useful tool for clients to design an appropriate program organization to manage megaprojects successfully, particularly in China.

9.4 LIMITATION OF THE STUDY

Program management has emerged as a separate research area over past few years. Thus, only 38 published papers have been identified from nine peer-reviewed construction management journals between 2000 and 2010. The theoretical foundation derived from this literature search has room for improvement. Search for relevant materials should be continued to refine the theoretical foundation.

The development of a pragmatic program organization model based on limited empirical data is difficult. The main limitation of this study lies in the small sample size of a single case study. Construction megaprojects may have different types, characteristics, and requirements; thus, the program organization framework developed in this study may require further refinements to adjust for other types of megaprojects.

China is still undergoing societal transformation and has a different context from western societies (Tsui et al. 2004), the current study, which was based primarily on a single case study, might not have fully addressed the contextual effects on the formation and operation of program organization in megaprojects, future research should be conducted by examining more megaprojects of that scale.

Nevertheless the stated limitations may be overcome by replicating and elaborating the developed methodology to study more megaprojects in China and other developing countries. The findings of this study pave the way for further research in program management practice in the construction industry.

9.5 RECOMMENDATIONS FOR FUTURE RESEARCH

This study investigated the program organization of a construction megaproject, namely, the Shanghai Expo construction in China. The methodology used in this study to develop a program organization framework can be applied to other megaprojects, such as the construction of high-speed railways, dams, and major theme-parks. It is recognized that different countries may be subject to different cultures, social and political challenges (Engwall, 2003; Mahalingam and Levitt, 2007; Scott, 2012), a new set of principal POFs and their influence on the success of different megaprojects may be identified. Further research studies should be conducted in other developing countries and with different types of megaprojects. With sufficient empirical findings generated from different megaprojects and from different countries, a Megaproject Management Body of Knowledge may be established for wider practical application.

APPENDICES

APPENDIX A: LIST OF ACCIDENTS IN MEGAPROJECTS BETWEEN 2000 AND 2010

No.	Project names and location	Time	Accident description
1	Three Gorges Dam, Yichang, Hubei province	September 3, 2000	In the early morning (6:50 am), while workers from Gezhouba Group Corporation were working on the site, a leather belt on tower No. 3 suddenly broke, sending the 29 workers working on the belt falling. The four workers underneath the belt at that time were also unable to escape in time. A total of three workers were killed by the accident and 30 more workers were injured.
2	Metro Line 4 *, Shanghai	July 1, 2003	A serious building collapse occurred along the site between Dongjiadu road and Pudong South Road of Metro Line 4, which made a total economic loss of more than RMB 150 million.
3	Changle International Aiport, Fuzhou, Fujian province	November 28, 2004	A crane collapse killed three workers and injured four others on the highway construction site. The accident made a total economic loss of RMB 600,000.
4	Hechuan Shuanghuai Thermal Power Plant, Chongqing	July 30, 2005	At 4:20 am, the No.1 steam turbine foundation under construction collapse killed five workers and injured seven others at
5	Tianshengqiao Hydropower Station, Guangxi province	August 1, 2005	A gantry crane collapse killed fourteen workers and injured four others.
6	Guangzhou University town, Guangzhou, Guangdong province	January 27, 2005	A tower crane collapse killed four workers during its dismantling process on a student dormitory construction site.
7	Xidan Xixi project, Beijing	September 5, 2005	A scaffold collapse killed eight workers and injured 21 others on the construction site for the complex building in Block No. 4.
8	Subway Line 10, Beijing	February 27, 2006	Fallen objects killed three persons on the No.10 project site.
9	Subway Line 10, Beijing	March 28, 2007	A foundation pit collapse killed six persons on Suzhou Street Subway station construction site.

No.	Project names and location	Time	Accident description
10	Yanglong River Lianghekou Hydropower Station, Sichuan province	April 10, 2007	A slope collapse killed seven workers on the 1# construction site constructed by No. 1 company of China Railway No. 5 Bureau Group corporation.
11	Metro Line 2, Nanjing, Jiangsu province	May 28, 2007	A slope collapse killed two workers on Chating Station construction site.
12	Pingliang-Dingxi Highway, Gansu province	July 11, 2007	A collapse on No. 7 Jingting Tunnel project site killed two residents nearby and injured five others.
13	Yichang-Wanzhou Railway, Hubei province	August 5, 2007	A water burst accident killed three workers, injured nine and made seven others on Yesanguan Tunnel construction site along the railway.
14	Metro Line 3, Shenzhen, Guangdong province	April 1, 2008	A formwork collapse killed three workers and injured two others on Heao construction site.
15	Xiaoshan Metro, Hangzhou, Zhejiang Province	Novemeber 15, 2008	A 75-meter section of the tunnel near Fengqing Avenue in Xiaoshan District collapsed while under construction, killing 4 people and making 17 lost. The collapse swallowed 11 vehicles and bus and trapped dozens of persons in the chasm.
16	Kajiwa Hydropower station, Sichuan province	May 10, 2009	A constructing bridge collapse killed four workers and made one other lost on the transportation engineering site.
17	Metro Line 3, Guangzhou, Guangdong province	May 15, 2009	Three workers were killed accidentally while the tunnel shiel was working on North Extension No.9 site. The cause of the death may be because of poisonous gases from the soil.
18	Majialiang Coal Mines, Suzhou, Shanxi province	May 16, 2009	At 9:00 a.m., eleven workers were killed accidentally and six others were poisoned at the Majialiang coal mine in Shanxi Province because the concentration of toxic gas was too high in the work location.
19	Shenzhen Metro, Shenzhen, Guangdong province	July 6, 2009	Two workers were killed during foundation excavation process on the 3101 project site.

No.	Project names and location	Time	Accident description
20	Subway Line 1, Xi'anShannxi province	August 2, 2009	A collapse killed two workers on Sajinqiao subway station construction site.
21	Beijing-shanghai high-speed railway	August 19, 2009	At 6:00 am, a tower crane collapse killed four workers and injured two others on the No.6-10 project site.
22	Metro Line 5, Shenzhen, Guangdong province	October 26, 2009	At 21:00 p.m., one worker accidentally died in the blasting construction accident on No. 5305-4 project site at Lihu Garden, Buji town.

Note: * This accident caused an extremely great economic loss, although it did not cause any death.

APPENDIX B: LIST OF CONSTRUCTION MEGAPROJECT PAPERS IN CONSTRUCTION JOURNALS

No.	Journal	Year	Vol.(Issue)	Author(s)
1	IJPM	2010	28 (5)	Müller, R., & Turner, R.
2	IJPM	2010	28 (3)	Toor, S.U.R., & Ogunlana, S.O.
3	IJPM	2010	28 (2)	Brady, T., & Davies, A.
4	IJPM	2009	27 (3)	Zammori, F.A., Braglia, M., & Frosolini, M.
5	IJPM	2009	27 (3)	Whitty, S.J., & Maylor, H.
6	IJPM	2009	27 (2)	Ruuska, I., Artto, K., Aaltonen, K., & Lehtonen, P.
7	IJPM	2008	26 (6)	A., Clegg, S.R., Pitsis, T.S., & Veenswijk, M.
8	IJPM	2008	26 (3)	Thomas, J.,& Mengel, T.
9	IJPM	2007	25 (8)	Jaafari, A.
10	IJPM	2007	25 (7)	de Camprieu, R., Desbiens, J., & Feixue, Y.
11	IJPM	2007	25 (7)	Murtoaro, J., & Kujala, J.
12	IJPM	2007	25 (6)	Yang, I.T.
13	IJPM	2007	25 (4)	Alderman, N., & Ivory, C.
14	IJPM	2007	25 (3)	van Marrewijk, A.
15	IJPM	2006	24 (8)	Crawford, L., Morris, P., Thomas, J.,& Winter, M.
16	IJPM	2006	24 (2)	Yang, L.R., O'Connor, J.T., & Wang, C.C.
17	IJPM	2005	23 (6)	Dzeng, R.J., & Wen, K.S.
18	IJPM	2004	22 (5)	Busby, J.S., & Hughes, E.J.

No.	Journal	Year	Vol.(Issue)	Author(s)
19	IJPM	2004	22 (2)	von Branconi, C., & Loch, C.H.
20	IJPM	2003	21 (1)	Williams, T.
21	IJPM	2002	20 (6)	Ling, Y.Y., & Lau, B.S.Y.
22	IJPM	2002	20 (4)	Ibn-Homaid, N.T.
23	IJPM	2001	19 (8)	Lampel, J.
24	IJPM	2001	19 (7)	Hardie, N.
25	IJPM	2000	18 (2)	Tam, C.M.
26	PMJ	2010	41 (5)	Saynisch, M.
27	PMJ	2010	41 (2)	Williams, T., & Samset, K.
28	PMJ	2010	41(1)	Krane, H.P., Rolstadås, A.,& Olsson, N.O.E
29	PMJ	2009	40(3)	Yasin, M. M., Gomes, C. F., & Miller, P. E.
30	PMJ	2009	40(1)	Zhai, L., Xin, Y.F.,& Cheng, C.S.
31	PMJ	2008	39 (Supplement)	Klakegg, O. J., Williams, T., Magnussen, O. M., & Glasspool, H.
32	PMJ	2008	39(4)	Jergeas,G.
33	PMJ	2007	38(3)	Frank, M., Zwikael, O., & Boasson, M.
34	PMJ	2007	38(2)	Boersma, K., Kingma, S. F., & Veenswijk, M.
35	PMJ	2006	37(3)	Flyvbjerg, B.
36	PMJ	2006	37(1)	Bonnal, P., de Jonghe, J., & Ferguson, J.
37	PMJ	2005	36(3)	Ivory, C. & Alderman, N.
38	PMJ	2005	36(3)	Miller, R., & Hobbs, B.

No.	Journal	Year	Vol.(Issue)	Author(s)
39	PMJ	2005	36(3)	Helm, J., & Remington, K.
40	PMJ	2005	36(2)	Eden, C., Ackermann, F., & Williams, T.
41	PMJ	2005	36(1)	Vanhoucke, M., Vereecke, A., & Gemmel, P.
42	PMJ	2003	34(3)	Badir, Y. F., Founou, R., Stricker, C., & Bourquin, V.
43	PMJ	2001	32(3)	Berggren, C., Soderlund, J., & Anderson, C.
44	JCEM	2010	136 (5)	Creedy, G.D., Skitmore, M., & Wong, J.K.W.
45	JCEM	2010	136 (4)	Harty, C., & Whyte, J.
46	JCEM	2009	135 (10)	Rajendran, S.,& Gambatese, J.A.
47	JCEM	2007	133 (10)	Algarni, A.M., Arditi, D.,& Polat, G.
48	JCEM	2006	132 (8)	Touran, A.,& Lopez, R.
49	JCEM	2006	132 (4)	Beheiry, S.M.A., Chong, W.K., & Haas, C.T.
50	JCEM	2005	131 (6)	Chua, D.K.H., & Goh, Y.M.
51	JCEM	2005	131 (3)	Molenaar, K.R.
52	JCEM	2005	131 (2)	Elhakeem, A., & Hegazy, T.
53	JCEM	2004	130 (4)	Liu, J.,& Rahbar, F.
54	JCEM	2004	130 (4)	Schexnayder, C.J., Weber, S.L.,& David, S.A.
55	JCEM	2002	128 (2)	Kumaraswamy, M.M.,& Morris, D.A.
56	JCEM	2001	127 (5)	Thorpe, T.,& Mead, S.
57	JCEM	2000	126 (6)	Wang, W.C.,& Demsetz, L.A.
58	ECAM	2010	17(3)	Rose, T.& Manley, K.

No.	Journal	Year	Vol.(Issue)	Author(s)
59	ECAM	2009	16(4)	Attar, A. Boudjakdji, M. A., Bhuiyan, N., Grine, K., Kenai, S. & Aoubed, A.
60	ECAM	2009	16(3)	Toor, S.U.R. & Ogunlana, S.
61	ECAM	2009	16(2)	Tai, S., Wang, Y. & Anumba, C. J.
62	ECAM	2008	15(1)	Badenfelt, U.
63	ECAM	2007	14(2)	Lê, M. A. T., & Brønn, C.
64	ECAM	2004	11(5)	Edum-Fotwe, F.T., Gibb, A.G.F.,& Benford-Miller, M.
65	ECAM	2004	11(6)	Nguyen, L. D., Ogunlana, S. O.,& Lan, D. T. X.
66	ECAM	2004	11(2)	Kumaraswamy, M.M., Ng, S. T., Ugwu, O. O., Palaneeswaran, E., & Rahman, M.M.
67	ECAM	2003	10(2)	Underwood, J. & Watson, A.
68	ECAM	2003	10 (1)	Santoso, D.S., Ogunlana, S.O.,& Minato, T.
69	CME	2010	28 (10)	Helen, C.L., Francis, V.,& Turner, M.
70	CME	2010	28 (6)	Whyte, J.,& Lobo, S.
71	CME	2008	26 (5)	Aziz, A.M.A.
72	CME	2008	26 (4)	Toor, S.U.R.,& Ogunlana, S.
73	CME	2007	25 (3)	Rowlinson, S.
74	CME	2004	22 (7)	Leung, M.Y., Chong, A., Ng, S.T.,& Cheung, M.C.K.
75	CME	2002	20 (4)	Awakul, P., Ogunlana, S.O.
76	CME	2002	20 (1)	Walker D.H.T.,& Shen, Y.J.
77	CME	2000	18 (7)	Winch, G.M.
78	PICE-CE	2009	162 (6)	Hassanain, M.

No.	Journal	Year	Vol.(Issue)	Author(s)
79	PICE-CE	2003	156 (Special)	Keeling, D.
80	PICE-CE	2003	156 (Special)	Cathcart, A.
81	PICE-CE	2009	162(3)	Chakraborty, R.
82	LM	2010	10 (1)	Genadio, F.,& Singh, A.
83	LM	2006	6 (3)	Anderson Jr., L.L., Douglass, R.D.,& Kaub, B.C.
84	LM	2003	3 (4)	Ahmad, I., Azhar, S.,& Ahmed, S.M.
85	JME	2008	24 (1)	Sun, Y., Fang, D., Wang, S., Dai, M.,& Lv, X.

Note: JCEM—*Journal of Construction Engineering and Management*, CME—*Construction Management and Economics*, PICE-CE—*Proceeding of the Institution of Civil Engineers- Civil Engineering*, LME—*Leadership and Management in Engineering* (LME), ECAM—*Engineering, Construction and Architectural Management* (ECAM), JME —*Journal of Management in Engineering*, IJPM—*International Journal of Project Management*, and PMJ—*Project Management Journal*.

Appendix C: List of Program Management Papers in Construction Journals

No.	Journal	Year	Vol.(Issue)	Author (s)
1	JCEM	2010	136 (2)	Rasdorf, W., Grasso, B., & Bridgers, M.
2	JCEM	2005	131 (3)	Molenaar, K. R.
3	LME	2009	9 (4)	Remer, D.S., & Martin, M.A.
4	AABE	2009	8(1)	Kim, J. H., Yoon, J. Y., Kim, K. H., & Kim, J.J.
5	AABE	2008	7(1)	Ko, O.Y., & Paek, J. H.
6	IJPM	2010	28 (7)	Buuren, A.V., Buijs, J.M., & Teisman, G.
7	IJPM	2010	28 (6)	Geraldi, J.G., Lee-Kelley, L., & Kutsch, E.
8	IJPM	2010	28 (5)	Clarke, N.
9	IJPM	2010	28 (4)	Crawford, L., & Nahmias, A.H.
10	IJPM	2010	28 (4)	Gareis, R.
11	IJPM	2010	28 (4)	Cowan-Sahadath, K.
12	IJPM	2010	28 (4)	Fiedler, S.
13	IJPM	2010	28 (1)	Shehu, Z., & Akintoye, A.
14	IJPM	2009	27 (8)	Kwak, Y.H., & Smith, B.M.
15	IJPM	2009	27 (7)	Shehu, Z. & Akintoye, A.
16	IJPM	2009	27 (7)	Pellegrinelli, S., & Garagna, L.
17	IJPM	2008	27 (1)	Artto, K., Martinsuo, M., Gemuenden. H. G., & Murtoaro, J.

No.	Journal	Year	Vol.(Issue)	Author (s)
18	IJPM	2008	26 (6)	Ipsilandis, P.G., Samaras, G., & Mplanas, N.
19	IJPM	2008	26 (5)	O'Leary, T., & Williams, T.
20	IJPM	2008	26 (1)	Lehtonen, P., & Martinsuo, M.
21	IJPM	2008	26 (1)	Nieminen, A., & Lehtonen, M.
22	IJPM	2007	25 (8)	Modig, N.
23	IJPM	2007	25 (7)	Thiry, M., & Deguire, M.
24	IJPM	2007	25 (4)	Martinsuo, M., & Lehtonen, P.
25	IJPM	2007	25 (1)	Pellegrinelli, P., Partington, D., Hemingway, C., Mohdzain, Z. & Shah, M.
26	IJPM	2006	24 (8)	Maylor, H., Brady, T., Cooke-Davies, T., & Hodgson, D.
27	IJPM	2005	23 (2)	Partington, D., Pellegrinelli, S., & Young, M.
28	IJPM	2004	22 (8)	Crawford, L., & Pollack, J.
29	IJPM	2004	22 (4)	Lycett, M. Rassau, A., & Danson, J.
30	IJPM	2004	22 (3)	Thiry, M.
31	IJPM	2003	21 (8)	Kasvi, J. J. J., Vartiainen, M., & Hailikari, M.
32	IJPM	2003	21 (6)	Elonen, S., & Artto, K.A.
33	IJPM	2003	21 (6)	Andersen, E.S., & Jessen, S.A.
34	IJPM	2002	20 (3)	Thiry, M.
35	IJPM	2002	20 (3)	Pellegrinelli, S.
36	IJPM	2001	19 (2)	Thiry, M.
37	CME	2007	25 (1)	Rwelamila, P. M. D.

Note: JCEM—*Journal of Construction Engineering and Management*, CME—*Construction Management and Economics*, PICE-CE—*Proceeding of the Institution of Civil Engineers- Civil Engineering*, LME—*Leadership and Management in Engineering* (LME), ECAM—*Engineering, Construction and Architectural Management* (ECAM), JME —*Journal of Management in Engineering*, IJPM—*International Journal of Project Management*, and PMJ—*Project Management Journal*.

APPENDIX D: INTERVIEW QUESTIONS FOR IDENTIFYING THE PROGRAM ORGANIZATIONAL FACTORS

The objective of this interview is to identify program organization factors so that the first round Delphi questionnaire can be improved before the formal conduction.
本访谈的目的在识别群体项目管理组织要素，完善第一轮德尔菲问卷的编制。

Interviewee: ____________________ Position: ____________________________
访谈对象：____________________ 职位：______________________________
Interviewer: ___________________ Time and Date: ______________________
访谈人：______________________ 日期时间：__________________________
Venue: ________________________ Record taken by: ____________________
地点：________________________ 记录人：____________________________

1. What is your understanding of program management?
   您认为什么是群体项目管理？

2. What are your opinions on hiring the external a program management consultant to manage construction megaprojects?
   您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

3. What are the program organizational factors for managing megaprojects?
   您认为业主方群体项目管理组织要素有哪些？

4. What are the key performance indicators that should be considered in managing megaprojects?
   您认为巨型建设项目的绩效指标应当包括哪些？

APPENDIX E: INTERVIEW DIALOGUES FOR IDENTIFYING THE PROGRAM ORGANIZATIONAL FACTORS

Expert A

日期及时间：2012 年 1 月 10 日 上午 10:00-11:00

地点：同济大学复杂工程管理研究院（同济大厦 9 楼）

访问及记录人：胡毅

1、您认为什么是群体项目管理？

[访谈原文] 项目是指一次性、单件生产、有开始、有结束的产品生产和服务过程，具有明确的目标、一定的约束条件和特殊管理方式。群体项目是指不止一个、多个的项目，相互间关联度很高，应该在同一时间、甚至在同一地点，要把以前若干分开来的（项目）同时进行。群体项目是由单个项目构成，之间有联系。这些表现为有些项目完成，有些项目没完成，它总的没完。它不能够形成整体合力，对整个项目有制约。它必须整体完，才算完，而且要各个单项功能实现以后，整体的功能才能实现。群体项目会带来新的特征：一是子项目与子项目相互之间并行性、干扰性增加了。如果是能完全区分为各单个项目的话，相互之间影响比较小，但现在其相互间影响比较大。以往传统项目管理可能不大关注不同项目之间并行性带来的干扰，现在必须要关注。因为它们之间集中度高了，同时要进行，在它们之间的影响下，这维是新生的。二是由于它们之间的干扰，在项目实施过程当中增加了不确定性，风险增加了，突发事件增加了，甚至还有些意想不到的（事件）。原先简单的事情由于这个干扰变得复杂了，包括相互之间信息沟通的影响、指令关系等，相互之间关系复杂了，所以这样一来，传统项目管理就有它的局限性。比如国际项目管里体系应用指南（PMBOK）里，第一步就是 WBS。为什么是 WBS? 他就认为项目是一次性，它就是一个过程。在项目目标基础上就要进行工作任务分解（WBS），然后就是要把这个工作任务之间逻辑关系建立清楚，先后次序确定清楚，进行统筹安排，在此基础上进行项目计划。但是项目复杂了以后，在做 WBS 前，要增加一个工作，我提出是三维视角，第一个要对群体项目对象进行梳理，不能

单纯依耐技术方面的分类，像设计图纸对于项目构成的分类，还必须从管理组织和沟通协调角度把项目群进行分类、分解。这个分解实际上又牵涉到第三个东西，就是组织管理，即管理的组织结构，针对管理组织结构情况来进行分解。比如群体项目有不同投资主体、项目组织、项目甲方或业主，在进行项目对象梳理的时候，要针对不同投资主体、管理组织、指令关系进行梳理。还要增加一维 PBS。加上组织分解 OBS、WBS，来解决要建设什么、由谁来建、怎么建的问题，这就是群体项目管理与传统项目管理不一样的地方。

2、您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

需要。[访谈原文] 在大陆，管理是一个专业大类。它也分一级学科，像管理科学和工程就是。我们设计委托，是一个技术性工种，提供规划设计服务。作为一个专业性工种，提供管理顾问也是非常需要的。另外，随着群体项目不断涌现，专业化管理顾问服务这种需求量更加出现。因为对于简单项目，可以不请顾问，自己组建力量进行管理，但随着技术不断复杂，技术专业分工越来越细，没有一个建设项目是不请技术顾问，比如设计。但要把所有这些技术综合集成，这就需要管理，管理工作更加复杂，任务量更大，工作更重、更艰巨、这就需要一个专业服务。委托专业管理咨询机构承担管理顾问，这是大势所趋。在大陆也是这个情况，越来越多甲方意识到管理是一个专业。第二点群体项目具有一个典型特征——复杂性，这是过去研究还比较欠缺的。比如生物领域中，对于蜜蜂和蚂蚁生活规律的研究，往往会发现在大量涌现状态下，不想以前存在一个清晰的指令关系，有时候是找不到一个头，似乎各个元素自己按自己的意图在做，但是在整体上体现出一种规律性行为，这个是复杂性科学要研究和解决的…… 群体项目是由大量元素构成的一个系统，各元素要素可能没有规律性，但是大量涌现后呈现出一种规律性。例如高速公路上堵车，不堵车是常态，堵车是突发事态的。在复杂性科学里，堵车是有序的，不堵车是无序的。通常状况是无序的。但是没有任何人牵头说，我们开始堵车了，大家跟着我。它突然在堵车时侯，车子排成一行，反而是有害的。群体项目会产生很多新的问题，是要进行研究的。所以，这个可能不像以前，简单的项目可以自己

管，复杂项目更凸显它的专业性，管理咨询本身有大量研究问题，和以往是不一样的。

3、您认为业主方群体项目管理组织要素有哪些？

(1) 总体技术集成，(2) 总体目标集成，(3) 总控信息系统（信息集成），(4) 群体项目组织集成和协调，(5) 总体进度管理，(6) PBS/WBS 工具的应用，(7) 总体投资管理，(8) 项目文化（参看第四个问题访谈记录）。[访谈原文] 群体项目管理有这么几个值得注意：第一个是要区分管理和技术。技术是专业分工很细的。群体项目构成元素更多，每个元素又是分专业的，更加要强调综合集成。管理最大的一个特征、主要要解决的问题是综合集成。在群体项目上最主要强调的是综合集成，集成要分三个层级：最底下一层是技术集成，各个专业都只是某个技术的专业，没有一个专业说自己要负责技术集成的，所以这个责任就在管理者身上，管理者必须做到技术集成。但并不是说一个人代替所有人工作，那不是的。如果是一个人能干完的，那还需要管理干吗？管理是说要两个人以上，那才需要管理，群体项目管理两个人也不够，人越来越多，这样才叫群体项目。管理者首先要通过集成方法（管），不是代替人家，但是要把他们召集起来、把这个技术集成起来，形成整体合力。在它上面一个层次是项目集成。这个项目集成是指在群体项目当中每一个单体项目的目标（管理），就是我们传统的项目管理，不能替代。群体项目管理是做加法，不是说传统项目管理不要，它必须通过管理者要使每个单体项目实现三大目标，而且要做到它的合同管理、信息管理、组织协调，每个项目单体目标要很好的实现。在航天领域里，它叫型号集成。航天技术更复杂，组成也更复杂，专业分得更细，但是它也分各大系统。如型号系统，每一个型号相当于我们一个单体建筑。他要把他整体管起来。第三层最高层次是组织集成。这是一个核心，包括指挥控制中心、强有力的指令关系。这个指令是一定要清晰的。扁平化是指指令关系，步调一致，一切行动听指挥，否则，项目是干不成的。像我们大陆的项目就非常明显。凡是政府重大项目、重点工程，不是单单靠合同，市场行为形成一个强有力的行政指令，而是干不好就丢乌纱帽，这样干。把搞工程项目像打仗，把战时作战军队指挥系统来指挥工程建设，也取得了很多成绩。第二个是单纯针对管理来讲，相比技术可以分为管理是软的，软的管理还可以细分硬的和软

的。以往我们比较注重管理中硬技术，比如计划评审技术、价值工程、挣值法、网络计划技术。还是有很多通过计算来实现，包括投资控制。价值工程也是要计算。但是随着群体项目的大量涌现，管理技术中要更加注重软的东西，比如说协同、比如说博弈，在实践中的沟通协调，相互之间干扰和影响。比如进度控制，还存在大量的隐形问题。我们过去的 WBS 其实都是线性的，为了实现这项目标，那些、那些工作要做，每一项工作我们去计算它们需要多少时间，确定他们的逻辑关系。但是比如说忽略了我们要沟通，协调，开会和决策，这些因素达到了或超过那些用计划评审工作技术可计算的时间因素，它可能会占很大的比例，绝对是超过 30%。那就是说你一年的话，又要增加 4 个月干这些事情，甚至更多，超过一半，等决策，开会，解决各方面的矛盾。甚至包括不同的项目经理、团队，这个团队组织不清楚，这个项目经理能力不够，都会影响到项目进度。这些隐性影响在群体项目中的作用比较明显，是个挑战，要加以研究和解决。

4、您认为巨型建设项目的绩效指标应当包括哪些？

(1) 投资， (2) 安全， (3) 质量， (4) 进度， (5) 可持续发展（尊重自然规律的设计、功能布局等等）， (6) 农民工。

[访谈原文] 投资、进度、质量、安全还是一个狭义范围的思考。对于国内重大项目而言，规模很大、意义很大、投资很大，具有很大的影响，做与不做要更加慎重。对于重大项目而言，决策的研究需要加强。过去我们做项目，关注经济效益比较多。一个项目要不要上，更多关注的是它投产以后能赚多少钱，能带来多大的经济效益。现在事实证明，这样是不行的。中国发展到今天，再也不能只考虑前，还要考虑别的，比如说可持续发展，地球资源是有限的。我们花这么大的代价，换得提前的消费，眼前的繁荣，所以有些要留给子孙后代。我认为最大的问题是要避免过度开发，要给后代留下一些资源。至于节能环保，我们要当心，就是科学高度发展，不要违背自然。否则，人类与自然对抗，必败无疑。我们在做重大项目工程决策的时候头脑发热、人定胜天，这一定会带来灾难。从实施的角度说，节能环保，低碳绿色建筑，也有一条原则，遵守自然规律。我举个例子，如果说把绿色植物都种到墙上去，这是违背自然

规律的。如果说把大树都请进室内，这是违背自然规律的。最最关键的是该种树的地方要种树，该种草的地方要种草。不能把所有闲置的地方通通想办法让它去生钱，一点土地储备都不留。遍地都是建筑物，造的东西质量很低劣、品质很差、一堆垃圾，过不了很多年马上又要拆，这是最不节能、最不环保、最不绿色的。与之相反，花的钱更多，用新的投资点去采用高科技手段打造绿色建筑，这是违背自然规律的。比如在墙上种草、种树的话，要灌溉系统、无土栽培，要多花很多钱，营养都要上去。而所有植物没有根的，你说能够长久吗？不自然。再谈农民工问题，是中国现阶段一个阶段性过程。最大的根源在于中国城乡差别太大，农民太苦，所以他要进城。正因为此，中国政府发现城乡差别这样大，就要城市化，城市多了、大了，中国就发达了，这是一个不正常现象。作为建筑业，在现场施工的不是工人，而是农民。这些农民往往没受过专业的培训，没有什么保护措施。而且很大的一个问题，它是流动性的。所以，我们甲方不清楚现场是谁在干。总包不清楚，要问分包，分包再往下是包工头。包工头按理说是所有人员在册，但是由于流动性很大，它往往也不在册。这样往往要造成很大的风险。质量是农民工赶出来的，安全事故是发在农民工身上。无论是质量，还是安全，都是处于一个失控状态下，这个问题是非常非常严重的... 整个建筑业，我们政府应该清醒的是，总包作为具体生产单位，他的这个生产运作应该分三层，最上面一层是总包管理，所谓一级施工企业，现在没有工人，他是在做管理。我们在签订总承包合同的时候要清醒认识到，我们签订的是一个总包管理合同。所以，总包管理要做什么他要清楚，他要做到综合集成。他不干活，他要分包。分包给谁？第二层。第二层是专业分包，比如基础、装修的，室外室内的...... 应该大力发展这些专业性的分包企业。我们现在的情况是只重视总包，下面的放任自流，也没有资质管理，也没有对他的约束，也没有淘汰制，对于它的要求不清楚。实际上任何一个施工单位，他都不可能把项目全部工作都包了，他要分。这个第二层的很关键。比如这个单位是专门打桩，打桩打得最好；那个单位是专门做装修的。国外是分得很细的，气枪就是砌墙。中国可以分得稍微大一点。比如我是做设备安装的，设备安装也有水暖电，分得很细的，土建不搞。这个要给它一定法律定位，他的任务专长是什么。这个专长要有技术的核心竞争力，要有技术特长，要对它制定一定的标准，进行竞争，要透明。这个,总包他不管，他是搞管理的，要知

道分哪几大专业系统，每大系统要给哪一个专业分包干，这个要抓。这是第二层。第三层就是包工头，所有的工人都是他的。但是没有人管，甚至没有任何他的法律地位。现在我们大项目都是总包要资质，抓来抓去都是抓总包，但是总包是隔靴搔痒。必须要承认这个现状，当前是农民工过度，具体是农民工在做，农民工要管，要提要求。总包单位要求在册的，每个人是要有档案的。但人是流动的，人都不知道是谁，不用要说每一个人资料，他的健康状况怎么样，他的技能情况怎么样，他的师傅是谁，然后，他的家庭情况怎么样。所有的一切都不知道。所以说，关怀农民工是表面上的... 他不能单纯靠甲方，向民工送毛巾等等，这个是不够的。他必须从体制上承认他的存在和地位，各层把各层事情要做好。中国传统文化讲，各尽本分是最好的。自己把自己的事情做好，总包把总包管理事情做好，专业分包把专业分包的事情做好，劳务分包把劳务分包事情要做好。这个事情就好了。对于安全和质量来讲，是要防范于未然。死了一个人，赔人二十万，这个不解决问题。要从根本解决问题，是要做在前面，避免死亡事故的发生...... 再扩展一点，农民工问题，这是一个非正确问题。最大毛病是在于城乡差别，这是政府的问题。重大、重点项目不应该再去搞直接面向市场的商业大楼，而应该是去搞城乡，特别是乡镇，广大土地上的基础设施建设。城乡差别最大的原因是因为不通路、不通电、不通水，没有办法很好地居住。另外，企业也过不去...... 它有一个很重要的根源，没有产业，企业不过去，因为它不通路、不同电、不通水，什么都不通。如果路通了，一下子观念就转变了。为什么企业不过去？那边劳动力便宜，他为什么不过去？他自然会过去。政府做什么实际是很清楚的。但是这点没有看清楚。政府应该做什么？政府不应该直接经商。我们搞开发区，政府要求这一块收入要上去。在改革开发初期，中国穷得没办法，靠这种办法经济上去。但是发展到今天，千万不能这样干。哪一个国家是直接经商的？必然会出问题。腐败也会产生，市场也会乱。所以，政府应该退出市场，做市场、民间资本不愿意干的事情，他应该就是这样。要让道路四通八达，要让机场遍布全国，要让铁路、公路（包括一级、二级），不能光有干线，必须像毛细血管一样，四通八达到每一个角落。现在高速公路发展是很快，但都是造干线，这是对的。接下来支线要通，要通到每一个镇、每一个乡，不能只通到每一个县城。否则的话，他永远解决不了这个问题，农民离开土地、背井离乡，大量农民涌进少量城市中

去。所谓城市化都是已有城市大了还要再大，这都是反自然的。我们的一切行为要遵守自然规律，城市形成和产生也是有自然规律的。特大城市绝对会带来很多灾难性的后果，不适合人类居住，也不适合自然胜场，甚至还会影响到今后的经济发展。所谓城市化，它不是无限制扩大已有城市的规模，而是增加城市的数量。换句话说，把现有小城市变成大城市。举个例子，贵州省（我的家乡），你能举出几个城市吗？（贵阳）除了贵阳呢？还有遵义，稍微差一点，除了遵义，就说不出了。这就说明，这么大一个省，面积相当于整个德国，就这么一两个城市，其他广大都是乡村。为什么？不通电、不同气、不通水，问题就在这里。这个谁来干？政府。税收干什么？就是干这个。再加上其他的，比如水利设施、发电设施...... 但是现在这个发电厂已经过头了，造得太多了。为什么？因为他的目的不对。现在他的一切东西目的都是为了带来短期经济效益，不是为了可持续发展。你去造那个毛细血管的路，不能带来短期的经济效益。这才叫可持续发展......这个问题也要从根本性角度来看。 如果说一切向钱看，追求经济利益，效益最大化，就是西方的思想。亚当·斯密《财富论》就是要争、要夺。在这样情况下，它必然会造成，出钱的人希望出得越少越好，赚钱的人希望赚得越多越好，实在拿不到更多的钱，就去偷去抢，各个人想尽一切办法去把别人的钱放在自己的口袋里的。其实西方社会也认识到这一点。市场经济，有什么问题就靠法律法规去解决。噪音、污染，靠罚...... 从根本上来讲，这（例如成本加费用总包合同等激励机制）替代不了整个基本建设程序，就是交易在前，生产在后，风险很大，它是一个承包行为。所以，从根源上来讲是包成本、保工期、保质量。这不是一个根本解决的办法。根本性解决问题的办法，一个是靠法规约束。我国法规体系不完善、漏洞很多，而且标准不清楚，第二个真正有了，执法不严。该罚的不罚，有的罚了，有的没罚；今天罚了，明天不罚。对法律这块，我们赶不上西方社会。西方社会是法制社会，一切都有法，而且它很严谨。说罚就罚，而且还罚的很厉害。铁面无情，天王老子也罚。我们国家讲究的是人情关系、感情维系，这样一个社会往往具体问题具体分析。第二个问题是不能一切向钱看。如果金钱变成生命的唯一意义的话，那就会去钻法律的漏子。现在提出要“文化大发展”。对于中国人来讲，就是人要讲究一个道德，要厚德载物。中国传统文化，其实是非常讲究人的德行。（是不是在重大项目中也要讲究一种和谐文化？）对。这一条应该是具有

中国特色。总体上来讲，西方社会是法制社会，法制社会的体现是人是一种动物，人之间感情是淡化的，是把人当作机器。而中国传统文化，根深蒂固就是讲人情、讲关系。在这样的情况下，光靠法制不行，靠德治，以德来治。一百年来中国是文化断层，现代人代表不是中国文化，不是西方文化，现代人代表什么文化？是没有文化…… 但是中国文化的根在日本、韩国，文化大革命期间，中国政府代表团去参加国际会议，说孔老二。韩国代表团抗议，说这是他们最尊重的孔夫子。因为孔夫子不是韩国人，他们痛哭流涕，是这样的。中国的老祖宗是全世界公认的，是厚德载物。现在讲文化复兴、文化发展、文化繁荣，这句话绝对的是对的。但什么叫文化繁荣？它是不能一切都向钱看。现在有些领导提倡大力提倡文化产业，还是赚钱的。因此，在重大项目上，要谈项目文化，就是中国传统文化，礼义智信，恭良谦俭让。它就是处理这个人与人之间的关系，群体项目人与人之间的关系比一般的项目更复杂。

Expert B

日期及时间：2012 年 1 月 16 日 下午 14:15-15:30

地点：同济大厦同济复杂工程管理研究院

访问及记录人：胡毅

1、您认为什么是群体项目管理？

当前在实践中，群体项目、项目群和企业级的多项目管理用得较多。美国 PMI 对于群体项目管理定义是指针对一组有关联项目的管理。与单个项目管理相比，群体项目强调要通过协调化方式来管理。它们项目之间是有牵制的。此外，目前多项目和群体项目管理的概念现在区分还不是很清楚。

2、您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

视业主方驾驭项目的能力和经验而定。[访谈原文] 这个问题要对不同项目业主进行区分，有的是一次性业主，有的是持续性业主。即使是持续性的业主，也会有新项目和老项目的差别、特征有没有显著的变化，需要综合考量要不要引入外部项目管理公司。对于一次性的业主，如上海迪斯尼业主，尽管它之前做过五个迪斯尼，但进入中国驾驭巨项目或大型项目，在总体层面或某一方面引入有经验的外部项目管理公司，是能为业主提供增值服务的。这可能是因为业主方没有经验或者经验比较少。

3、您认为业主方群体项目管理组织要素有哪些？

(1) 总体范围管理， (2) 群体项目愿景，(3) 总体组织管理（包括分工、结构等），(4) 总体组织集成，(5) 总体进度管理，(6) 总体投资管理，(7) 总体质量管理，(8)总体采购管理，(9) 总体人力资源管理，(10) 总体风险管理， (11) 总体沟通管理。

[访谈原文] 第一条是梳理大型巨型项目的范围，例如世博会里面，整个项目描述不是很困难，但是子范围和子范围之间的关联要很清晰，包括从整体到局部

的整个体系。第二个是巨项目和大型项目的 Vision，有可能巨项目和大型项目实施过程比较长，它们之间不确定因素还比较多。传统项目目标策划和规划，在巨项目中不一定适用，20 年前制定一个很细化的目标是很困难的（整个项目周期是 20 年），但是这个 vision 值是很重要，它是指目标更高一个层次，反而细化的目标是可以随着环境而进行调整的。第三点还是组织，在前两者基础上可以匹配合适的组织，组织结构、组织分工和授权 Authority，compatibility，还有组织里面引入集成部门，是比较重要，比如计划、部门与部门之间。PMI 要素是包括在里面的，但（单独）拿出去会遇到很多新问题。

4、您认为巨型建设项目的绩效指标应当包括哪些？

(1) 投资，(2) 安全，(3) 质量，(4) 进度，(5) 项目团队管理效率，(6) 项目团队成员满意度，(6) 对客户（包括使用方）和社会的影响，(7) 对未来商业机会的影响（如管理和技术知识创新）。[访谈原文] 我想换一个纬度，从 Effectiveness（效果）的角度来谈这个问题。效果要包括 Cost、Time…… 它是指这个结果，也就是绩效评估，投资、进度、质量、安全、环境，都应该包括进去，是很关键的部分。第二个绩效设置里面可能还要考虑 efficiency。有些项目可能投资控制很好，进度控制很好，但效率不一定是高的。这也应该作为一个评估的指标。第三个有些项目绩效里面还有对客户以及社会（主要利益相关者）的影响，比如使用方。（第四个）绩效还有对于项目实施团队本身产生的效率，比如（团队成员）有没有满足感、团队成员有没有成长进步、有没有得到很多东西，例如三年世博会做下来是不是满身疲惫。（第五条）对于未来商业机会到底带来什么？比如华润在这个项目里面提出来新的城市综合体，可能他原来做了个第一版，这个项目花了很多心思是做第二版，可能第一版项目可能没有经验，投资是超的，进度是拖的，可能绩效不是很好，但是变成了他在中国大地的一个标杆的成熟管理模式，可能对他做第二个、第三个、第四个，它就可能就很好，成为未来商业开拓的新机遇。

Expert C

日期及时间：2012 年 1 月 11 日上午 10:15-11:15

地点：同济大学复杂工程管理研究院（同济大厦 9 楼）

访问及记录人：胡毅

1、您认为什么是群体项目管理？

群体项目管理和单个项目之间的交界部分是模糊的。例如上海世博会是算一个大型复杂项目，还是项目群？单看世博会工程建设是完全符合项目的定义，有开始和结束的时间、资源的限制，但由一个个子项目构成。但是我们在做长春的（城市基础设施）建设，它是一个典型的项目群，它项目和项目之间关联度不是太大。这是两类不一样的项目群。世博会也好，长春项目也好，如果管理对象够分解成若干个单元，分解到某一个层次，可以作为一个单独项目去管，可以视为一个项目群。项目群和群体项目严格来讲不是一个东西。例如世博会是一个项目群，长春的也是一个项目群，奔驰（全国 4S 店）项目是一个群体项目（除管理关系外，项目之间几乎没有任何关系）。例如世博会能形成一个大项目的概念，但奔驰 4S 店无法形成一个大项目。项目群对应的是英文 program，群体项目是 multiple projects。

2、您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

主要取决于业主的能力和需要。例如万科有群体项目或者项目群，业主能力很强，可以不请咨询，也可以局部请咨询，这取决于业主能力、实力和管控能力。如果你没有，可以请；如果你有，那就不需要请……又比如世博会（业主）人员可能不够，他就请，但这种又不是外包的，是集成项目团队 IPMT 一样，是合在一起的项目管理（一体化项目管理）。

3、您认为业主方群体项目管理组织要素有哪些？

(1) 总体组织策略， (2) 总体组织结构， (3) 政府、投资方和使用单位等主要相关利益方的管理， (4) 进度计划， (5) 总体风险应对， (6) 制度标准化管理， (7) 群体项目文化和信任， (8) 领导者的能力和技巧， (9) 总体危机管理， (10) 群体项目总控信息系统，(11) PBS/WBS 等工具的应用，(12) 群体项目治理。 [访谈原文] 我就以我参与的长春项目，一个就是关于组织问题，原来在 PMBOK 单项目里面有这个人力资源管理等，但是在项目群里面，组织战略、组织架构、组织策略尤其重要，在项目群里像参建单位、业主内部程序比较复杂，例如长春政府部门很多。。。然后，就是政府它有很多部门，建委、规划局、财政很多部门，包括市政府，政府下面还有一些融资机构、融资平台、城投公司等，还有一些使用单位，教育局等，整个这个政府这一层关系比较复杂。下面还有业主，比如有代建机构，代建机构下面又有很多部门，工程部、技术部、规划部、采购部、合同部等，再往下还有设计单位、总包等，整个这个组织关系是非常复杂，利益相关者非常多。这个方面比单个项目更突出。相关利益方管理更重要，有都有，但是侧重点，难度和重要性都不一样。一般提到项目群，往往是重大项目，关系国计民生的项目，所以，它和一般的项目是不一样的。自然科学基金委把它定义为复杂重大工程，这是一个方面。第二个方面，原来是进度，是计划管理或进度控制，对于大型项目，除了正常的进度外，还有战略问题，比如说世博会，它有很多刚性调整，这是国家战略、城市战略。长春也是。这些战略会影响我们计划控制。从战略到宏观计划，到微观计划，这又是一个体系，这个和一般小项目不一样。像汽车 (4S) 店项目，会受到奔驰在中国的战略的影响，受外部宏观情况的影响，还有比如铁路例子。我们做计划时，要关注重大政策的调整。在排计划的时候，要创造一个项目稳定性，项目有风险，这个风险就是决定项目上或者不上的风险，是不是存在稳定，这个和单个项目不一样的地方。还有一个是制度建设，好像项目管理知识管理体系好像没有这块。在一般项目中，项目规模比较小，关系比较简单，项目制度和项目长章程不是那么重要，比较简单。在这种项目群中，关系比较复杂，有政府之间的行政关系、市场合同关系、还有管理关系，监理和施工单位关系、总分包单位，这个关系比较复杂，光靠合同合约是不够的，参建单位很多，必须要有制度流程。比如奔驰项目花了很多时间去制定标准流程。在中国很多出现很多集

群项目，我们国家政府投资项目规范不健全，比如代建制，代建制是没有法律的，大多出现地方性法规，但是地方性法规是比较粗的，但怎么操作在现场往往存在很多问题，如果你没有一个规章制度，具体事情不知道怎么操作，然后出现很多灰色的腐败问题。这是一个关于规范化、制度化的问题。还有一个共同文化问题，有人把它叫做长期的利益，这个东西是抽象的，有人说项目利益高于一切，这对人的道德有一个要求，对企业道德是有一定要求的，大家都去追求这个利益，还是信用的问题，这里面是比较软的行为，比如世博会共同文化比较好，有政治责任感和项目荣誉感，但是很多项目不具备这个条件。现在政府信用很差，但是项目利益高于一切，我们先把这个做好，施工单位不信，partnering、长期战略合作伙伴都谈不上了，关注短期利益。中国建筑市场问题，小包工头，都是短视的。寻求长期合作机会不是很大。长春有个私营企业，把做好项目、服务业主能作为企业的理念，这样的企业是能做到的。但是很多企业是没有这个的。长春有个中庆（音译，施工企业名字），政府非常喜欢。好的原因是因为老板思路非常好，做好项目。我举个例子，一条路出了质量问题，路面出现大面积的损坏，然后政府很恼怒，调查什么原因。怕当地专家被收买，从北京、天津找些专家来看，专家一查，说这个是很多方面造成的。有客观因素造成，工程质量问题，也有施工方案问题等等很多原因，不单是施工质量和材料的问题。但是这个承包商做了什么事情。他说我来返工，他把整个这段路全部返工，花掉好几千万，然后就说，他说自己掏腰包，这是为了企业的信用，我把它全部分摊掉。政府很欣赏，说这样的企业值得信任，我们下一个项目，我们就有可能优先地把它发包给他。这要是小包工头，他肯定是会推卸责任。所以说这个东西，在一定范围和情况下是可以实现的。我觉得针对软性的这一块，长期战略合作、一致性工作文化还是蛮重要的。一个成功的项目可能没有一个良好的文化，可能能使项目成功。但是一个良好的文化，一定能保证项目成功，有类似这种感觉。我回头看了下，很多项目做得非常好，项目文化都是非常好的。这是关于这一块的结论。还有一块对于项目群管理的技巧，我们以前讲项目管理工具方法， WBS、网络进度技术等，除工具方法以外，对很多管理者的管理技能要求比较高。比如领导力、政治能力、方方面面的，它涉及关系比较复杂，不同于对一般项目的项目经理的要求。对于这种项目，它实际上不但是一个工程项目管理的问题，它和政府的公共管理、社

会公关问题，比如有很多项目危机，还有拆迁问题，还有公共安全问题，死了人了，这需要团队很好的公关能力、谈判能力、协商能力的，这是包括在一起的。包括世博会有协调处，一般项目是没有的。这可能超过传统项目管理的范畴，对于管理者技能的要求上是不一样的。还有一块，在复杂重大项目群里面，工具还是很重要的，项目多了、管理内容多了、管理人员多了，为了提高效率可能要利用一些工具和手段来提高效率，BIM 是如何产生的，可能是复杂项目引发出来的，我们平台怎么出来的，也是适应项目复杂程度，可能对于这些项目群更多会有一些工具性要求。对于这个问题，英国对于重大项目，他们叫项目治理，governance 这个词，美国不是这样，我在想项目治理和项目管理有什么区别，后来我查了一些文献，我想项目治理和项目管理大多数时候是差不多的，只是用不同的视角解决不同的问题，比如 prince 2 这种概念。可能对于重大项目，这种治理概念可能会更充分一些，它不是指控制的概念，控制的概念是指一个目标或方向，怎么达到某个目标。治理更多是体制、机制和制度问题。这是一个有交集的，这个问题我没有很深入的研究。

4、您认为巨型建设项目的绩效指标应当包括哪些？

(1) 投资， (2) 安全， (3) 质量， (4) 进度， (5) 绿色节能， (6) 农民工， (7) 技术攻关（技术转移）与管理创新， (8) 长期收益。[访谈原文] 这个问题应该从两个方面来看。从至上而下的战略角度，世博会有很多目标，最关键的是进度。从矛盾对立统一的角度，进度优先可能会牺牲其它的目标，一定会有很多问题，质量可能会受影响，这是一个自然的问题。从上往下的角度看，会有单一目标的感觉，尤其是进度目标。例如长春一个桥被压塌了，重建时毫无疑问进度是最优先的，要在质量要能满足基本的要求情况下，要花最短的时间要把桥建起来，满足城市的运行。但是从下往上，这个目标就很多…… 按道理来讲，进度、质量等四大目标都要。还有很多项目强调绿色环保，现在低碳问题、碳排放问题、建筑业能耗问题谈得很多，对很多项目变成硬性要求。比如公共建筑现在有一些绿色评估。还有能源消耗，尽量采用地热供暖、地源热泵、集中供暖，减少能源消耗，这是一个工程从全寿命运营的角度所形成的。在项目微观角度，这些都得管，也是一个事实。还有农民工也是现在工程的社会（属）性（之一），是工程社会学方面问题。它从另外一个视角分析。工程作为人类

三大活动之一，工程实践是很重要的一个活动。这个工程就具有社会性，农民工是一个方面，还有很多其它问题。这些特征都会影响到项目管理。还有一个是融资这块，比如 PPP。它牵涉一个项目怎么运作的问题，它对整个项目管理模式还是有很大的影响，例如 BOT、BT。它会让我们管理模式发生变化，还有会受到国家宏观政策的影响，涉及到融资成本的问题。例如 08 年、09 年这个问题很严重，产生很多浪费。08 年政府投了四万亿。很多项目是不具有可行性的，但是政府可能拟定 50 亿在这里面，但现在项目还是做，利息就很高。这个资本成本就比较高，这也是重大项目会遇到的问题。但这个突破了以前项目管理的范畴。还有一个是重大项目群承担了很多示范效应，比如世博会就是一个大型复杂项目。为什么我们会获得一等奖？有很多的课题、很多的研究在里面，它会带动建筑业工程管理的发展。例如最近上海有一个绿色超高层技术规范，上海中心业主在带很多团队在做，是上海科委资助的。这是关于科技创新的。

Expert D

日期及时间：2012 年 1 月 19 日 19 时 30 分-20 时

地点：电话访谈[5]

访问及记录人：胡毅

1、您认为什么是群体项目管理？

单个项目管理比较关注专业性、技术性；群体项目管理则比较关注计划、组织、制度管理。

2、您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

有必要。当前，国内许多大型开发建设项目业主缺乏相关管理经验，有必要聘请管理咨询公司帮助业主方在宏观层面对组织和制度等方面管理进行梳理。

3、您认为业主方群体项目管理组织要素有哪些？

(1) 总体组织集成， (2) 总体流程管理， (3) 总体范围管理， (4) 总体进度管理， (5) 总体投资管理， (6) 总体质量管理， (7) 总体采购管理，(8) 总体人力资源管理， (9) 总体风险管理， (10) 总体沟通管理。

4、您认为巨型建设项目的绩效指标应当包括哪些？

(1) 投资， (2) 安全， (3) 质量， (4) 进度， (5) 使用方的要求， (6) 长期投资收益。

[5] 由于电话访谈录音效果不佳，无法记录访谈全文，但此访谈记录经被访谈者确认过。

Expert E

日期及时间：2012 年 1 月 11 日 下午 13 时 15 分-14 时

地点：世博局 4 号楼 2 楼会议室

访问及记录人：胡毅

1、您认为什么是群体项目管理？

[访谈原文] 项目管理大多是指单一项目的管理。以前做的公共建筑，它总是一个。群体项目作为一个群来讲，大多是集中在某一个区域里面，根据建设时序不一样、建设范围不一样，建设功能不一样，它会形成多个项目。从项目来讲，不单是单体建筑。群体项目和原来项目管理的区别还是有，但是从管理方式，但从管理方式和方法没有太本质的区别。像世博会一样，主要是项目时序不一样、范围不一样，（但）都是项目。

2、您认为业主方有必要聘请外部项目管理顾问管理巨型建设项目吗？对此您有什么看法？

有必要。[访谈原文] 群体项目对于一个组织来讲，不可能够一直处于延续的状况，群体项目应该会集中在（组织）某一个阶段。如果业主配置很多的人，也可以做，但是做完了这些人没办法，包括世博会也是这样。大的群体项目应该采用咨询公司这种方式来做，不然的话，后面的后遗症会蛮多的。但是不同的咨询公司管理理念、思路和方法可能不一样，这个总集成者——业主的责任和角色还是只能由业主来做。业主管理成熟度和粗细和一般项目管理是有不同的。业主有责任让咨询公司在统一的框架去做这个事情，不然的话，也会乱的… 咨询公司只能是咨询，业主责任比较大，要完成任务。

3、您认为业主方群体项目管理组织要素有哪些？

(1) 总体范围管理，(2) 总体进度管理，(3) 总体投资管理，(4) 总体质量管理，(5) 总体采购管理，(6) 总体人力资源管理，(7) 总体风险管理，(8) 总体沟通管理，(9) 总体集成管理（组织）。[访谈原文] 以往 PMI 要素是包括在（群体项目管理）里面，方法、方式和体系是差不多的，在群体项目，范围管理非常重要，比如世博会到底有多少个项目，怎么划分，实体上和时序上是怎么衔接，这个是很重要的。进度肯定是很重要的，在做项目的时候，会发现经常在改进度，后期时候往往会发现投资很重要，安全质量更不用讲。以前的项目也是差不多的，基本设施建设就是要形成固定资产扩大再生产。以前讲三个目标，上面应该还有一个目标，就是这个…… 项目管理不能就讲项目管理，外面还有一块。

4、您认为巨型建设项目的绩效指标应当包括哪些？

(1) 长期效益，(2) 投资，(3) 安全，(4) 质量，(5) 进度，(6) 绿色节能，(7) 农民工。[访谈原文] 项目管理还是后面一个阶段。前面一个阶段是在做土地规划时候，这片土地怎么开发，形成怎样一个品质，和整个城市、大区域是怎样一个定义，处于怎样的一个位置，这个也很重要的。在规划里面，这个园区、这一带土地会形成怎样一个风格，即一个园区开发的定位。这个定位是对整个城市的一个涵义，从它的单一角度（对城市）具有互补性。从这个定位往下分解，这块地方做什么，那块地方做什么，这就是一个（它）外延，还有一个内涵。我觉得这一块很重要。后面这个怎么开发和政府部门的关系，怎样去影响政府决策，到后面时候，具有一定的普遍性……（关于农民工问题的看法）农民工是中国的特色，这个肯定是要考虑的。从业主角度来讲，肯定不想这一块出问题……（关于低碳、环保绿化建设目标）例如城市最佳实践区对低碳环保绿化，也有这个要求，后面园区开发的时候，也有这个要求。在这种趋势里面，重大项目肯定要考虑这个问题… 但不管复杂还是简单建筑，要做好低碳环保，要花很多心思。现在审图也有这个要求。但从投资主体来讲，没有这个限制，肯定没有很大的动力，成本很高。比如世博会以前那些低碳环保技术，现

在维修维护费用是非常高的，高得不得了。例如江水源空调，现在成了一个鸡肋。

APPENDIX F: FIRST ROUND QUESTIONNAIRE OF THE DELPHI SURVEY

(This research has been funded by The Hong Kong Polytechnic University and supported by the Tongji University in Shanghai and the office of Shanghai Expo Construction Headquarters.)

Dear Sir or Madam,

In this questionnaire survey, you are invited to answer the questions according to your experience and knowledge obtained from the involvement in the Shanghai Expo construction. This questionnaire aims to investigate how the client can successfully apply program management to procure the Shanghai Expo construction megaproject. Program Management is "the centralized coordinated management of a program to achieve the program's strategic benefits and objectives" (Project Management Institute, the US). This approach has been increasing advocated by scholars and practitioners as a key approach to the success of construction megaprojects, each of which costs RMB 5 billion or above.

Your expertise and knowledge shared through your participation in this study will benefit the Construction Industry and the academic community at large after analysis. All the data you provide will be used only for this research. If you have any question about the questionnaire survey, please do not hesitate to contact me by email: huyi82@__________

Thank you very much for your participation and support!

Name of Respondent: ____________

Role in the Shanghai Expo construction client organization: ☐ Client ☐ Consultant

Position: ______________________

Note: Please fill in the blank space with your answer such as choices and numbers. This questionnaire survey will take no more than 20 minutes to complete.

Section A: Personal Particulars

1. Your age: ____________

A) 30 or below B) 31-40 C) 41-50 D) 51-60 E) 61 or above

2. Your education level: ____________

A) Associate or below B) Bachelor Degree C) Master Degree D) PhD Degree

3.Your specialty (Multiple choices): ____________

A) Government supervision B) client management C) Design & management
D) Construction & Management E) construction consultancy F) Scientific research

4. Work experience in the construction industry: ____________

A) 5 years or below B) 6-10 years C) 11-20 years D) 21-30 years E) > 30 years

Work experience serving for construction megaprojects: ____________

A) 5 years or below B) 6-10 years C) 11-20 years D) 21-30 years E) > 30 years

5. Names of construction megaprojects involved (A project costs RMB 5 billion or above):

1) ______________________ 2) ______________________
3) ______________________ 4) ______________________
5) ______________________ 6) ______________________
7) ______________________ 8) ______________________
9) ______________________ 10) ______________________

Section B: Program Organization Factors (POFs) for Construction Megaprojects
(The POFs, which are critical components of program organization for megaproject success, were identified from the structured interviews and the literature review.)

Please provide your rating to show the degree of importance against each POF	The degree of importance	
	Score	Note
Environmental Capability		1 = not important, 2=slightly important, 3=moderately important, 4=important, and 5 = very important.
POF 1 (Contextual understanding): refers to the understanding of the environment within which a program operates, e.g. the administrative, technological, economic, socio-cultural, and stakeholder factors.		
POF 2 (Program strategy): refers to a strategy ensuring the success and survival of a program in its environment, e.g. employing an external consultancy or recruiting the employee directly.		
Core Capacity		
POF3 (Program leadership): refers to the good leadership and clear direction setting at all level within the program management organization, e.g. technical, communication, and negotiation abilities.		
POF4 (Scope management): refers to the identification, measurement, and achievement of the expected benefits that a program is intended to deliver (including change management if necessary).		
POF 5 (Program governance): refers to a decision board, e.g. the construction headquarters established by the government.		
POF 6 (Matrix organizational structure): refers to an organizational form in which staff should report to departmental head and project leaders respectively.		
POF 7 (Program management office): refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve program decision makers.		
POF 8 (Program human resource management): refers to the qualified staff employed.		
POF 9 [Use of project breakdown structure (PBS) / work breakdown structure (WBS) tool]: refers to tools that enable necessary communication from the program-level perspective a clear understanding and statement of program-level objectives and results of the work to be performed.		
POF 10 (Standardized process management): refers to the design and conduction of standard process to all project management works for improving work efficiency.		
POF 11 (Partnership with key stakeholders): refers to the establishment of a strong workable alliance with key program stakeholders, such as designer, contractors, and other parties.		

Please provide your rating to show the degree of importance against each POF	The degree of importance	
	Score	Note
POF 12 (Risk management): refers to activities that can keep the program's exposure to risks at an acceptable level and adapt the proper insurance program when necessary, e.g. plans, procedures, and execution.		1 = not important, 2=slightly important, 3=moderately important, 4=important, and 5 = very important.
POF 13 (Cost management): refers to activities of ensuring that project expenditure can be attained in the approved budget, e.g. the responsible division, plans, procedures and control.		
POF 14 (Schedule management): refers to activities of ensuring that the program will produce its required deliverables and solutions on time, e.g. the responsible division, plans, procedures and control.		
POF 15 (Function and quality management): refers to activities that determine and ensure function and quality requirements to meet the prescribed objective during project duration, e.g. the responsible division, plans, procedures and control.		
POF 16 (Knowledge management): refers to activities that capture and share knowledge through monitoring and review in order to improve a program's likelihood of success.		
POF 17 (Program control information system): refers to an information management system that can collect, process and analyze all the sub-project information regularly and output various program progress reports, e.g. cost and time reports.		
POF 18 (Contingency management): refers to an ability dealing with any accidental or unexpected event/disaster, e.g. fire, typhoon, flood, and emergency medical rescue.		
POF 19 (Technology management): refers to activities dealing with design and technical issues in construction, e.g. the responsible division, plans, procedures and control.		
POF 20 (Procurement management): refers to activities that procure equipment and materials needed, e.g. the responsible division, plans, procedures and control.		
Motivational capability		
POF 21 (Program culture): refers to the collectively accepted meaning that manifests itself in the formal and informal rules of a program organization for program success.		
POF 22 (Communication management): refers to communication activities within and across the organizational boundary.		
POF 23 (Team building): refers to the building of individual and group competencies to enhance program performance, e.g. development training.		
POF 24 (Program incentives): refers to incentives that are commonly used to improve the performance of key participants, e.g. contract incentives.		

Please provide your rating to show the degree of importance against each POF	The degree of importance	
	Score	Note
Others (Please specify): ______________________________		1 = not important, 2=slightly important, 3=moderately important, 4=important, and 5 = very important.

End of the questionnaire.
Thank you for your contribution!

关于上海世博会工程建设业主方群体项目管理组织模型的第二轮德尔菲专家问卷

（该课题得到香港理工大学的资助，以及上海世博会工程建设指挥部和同济大学的支持）

尊敬的先生/女士：

您好！鉴于您参与上海世博会工程建设的相关经验和知识，我们诚挚地邀请您参加名为"业主方群体项目管理组织模型"的问卷调查。本项研究旨在通过调查上海世博会业主方是如何成功地应用群体项目管理方法实现项目成功的。群体项目管理是指通过总体协调管理方式管理一组相关联的项目以实现项目总体价值和目标（美国项目管理协会）。该种方法近年来被视为实现单项投资超过 50 亿元的巨型建设项目成功实施的关键，并得到业界和学界的广泛支持。

您可以通过本研究分享您的相关专业经验和知识，行业和学术界都将有所受益。您提供的信息将仅用于本项课题研究。如有任何问题，可发送电子邮件至 huyi82@__________与我们联系。

非常感谢您的参与和支持。

填写人: ______

曾服务于上海世博会工程建设的 □ 指挥部办公室（甲方） □总体项目管理方

职位: ________________

填写说明： 见" _____"请在横线上填写，见"□"请打勾选择。完成此问卷需要 20 分钟。

第一部分：个人背景 (请将代表最佳答案前的选项字母或答案填写在横线上)

1. 年龄： _________

A)30 岁或以下 B) 31-40 岁 C) 41-50 岁 D) 51-60 岁 E) 61 或以上

2. 教育程度：_________

A) 大专及以下 B) 大学本科 C) 硕士/ 研究生 D) 博士

3.专业领域： _________ （此项可选择一项以上的答案）

A) 政府监管 B) 甲方管理 C) 设计及管理

D) 施工及管理 E) 工程监理及咨询

4. 从事工程建设行业的工作时间：_________

A) < 1 -5 年 B) 6-10 年 C)11-20 年 D) 21-30 年 E) 大于 31 年

其中参与 巨型建设项目的工作时间：_________

A) < 1 -5 年 B) 6-10 年 C)11-20 年 D) 21-30 年 E) 大于 31 年

5.参与巨型建设项目的名称 (巨型项目是指投资达到或超过 50 亿人民币以上的项目。)

1) ________________________________ 2) ________________________________

3) ________________________________ 4) ________________________________

5) ________________________________ 6) ________________________________

7) ________________________________ 8) ________________________________

9) ________________________________ 10) ________________________________

第二部分： 巨型建设项目业主方的群体项目组织要素

(群体项目组织要素是群体项目组织实现目标的不可或缺组成部分。下列要素是通过访谈和文献分析所得出的。)

请对各要素的重要性进行打分 （分数必须为 **1-5** 之间的整数）	重要程度	
	打分	打分说明
（一）环境能力		1 分—不重要 2 分—次重要 3 分—一般 4 分—重要 5 分—非常重要
要素 1：充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等		
要素 2：具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司等		
（二）核心能力		
要素 3：管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等		
要素 4：具备明确的目标定义及进行必要变更管理，包括目标识别、量化控制指标制定以及过程监控等		
要素 5：设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部		
要素 6：合理设计项目部和职能部门的职能和分工，确保二者的分工明确与合作顺畅		
要素 7：设置群体项目管理办公室（又称总体项目管理部），协调职能和项目部门关系，提供决策支持		
要素 8：聘用称职的项目团队人员及提供必要培训支持		
要素 9：应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系		
要素 10：建立标准化项目管理流程和作业指引， 提高工作效率		
要素 11：与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作		
要素 12：建立有效的群体项目风险管理体系，采取适当保险措施，如计划、流程和实施		
要素 13：建立有效的群体项目投资管理系统，如责任部门、计划、流程和实施控制		
要素 14：建立有效的群体项目进度管理系统，如责任部门、计划、流程和实施控制		
要素 15：建立有效的设施功能及质量管理系统，如责任部门、计划、流程和实施控制		

请对各要素的重要性进行打分 （分数必须为 **1-5** 之间的整数）	重要程度	
	打分	打分说明
要素 16：建立群体项目知识管理系统，促进项目成功实施，如阶段小结和经验交流会		
要素 17：应用群体项目管理信息系统，生成各种项目进展报告辅助决策，如投资报告和进度报告		
要素 18：建立应急管理系统，处理各种突发事故，例如火灾、台风、洪水和医疗急救		
要素 19：建立有效的设计和技术管理系统，如责任部门、计划、流程和实施控制		
要素 20：建立有效的采购管理系统，如责任部门、计划、流程和实施控制		
（三）激励能力		
要素 21：在项目参与方间建立共同项目文化，促进项目成功实施		
要素 22：建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流		
要素 23：提升群体项目管理团队能力，确保项目绩效，如拓展培训		
要素 24：建立总包单位等主要参与方的绩效奖励机制，例如奖励合同条款		
其他要素：______________________________ (如有补充要素，请注明和打勾；若无，可不填)		

问卷到此结束，感谢您的参与！

APPENDIX G: SECOND ROUND QUESTIONNAIRE OF THE DELPHI SURVEY

(This research has been funded by The Hong Kong Polytechnic University and supported by the Tongji University in Shanghai and the office of Shanghai Expo Construction Headquarters.)

Name of Respondent: ___A_____

Role in the Shanghai Expo construction client organization: ☐ Client ☐ Consultant

Position: ___________________

Please fill in the blank space with your answer such as choices and numbers in terms of the mean scores provided by all experts involved in the first round.

Note: 1 = not important, 2=slightly important, 3=moderately important, 4=important, and 5 = very important.

Please reassess your rating against the degree of importance against each POF in Round 1.	Degree of importance		
	Mean ratings of all experts in Round 1	Your rating in Round 1	Your rating in Round 2
Environmental Capability			
POF 1: refers to the understanding of the environment within which a program operates, e.g. the administrative, technological, economic, socio-cultural, and stakeholder factors.	4.5	5	
POF 2: refers to a strategy ensuring the success and survival of a program in its environment, e.g. employing an external consultancy or recruiting the employee directly.	4.7	5	
Core Capacity			
POF3: refers to the good leadership and clear direction setting at all level within the program management organization, e.g. technical, communication, and negotiation abilities.	4.6	5	
POF4: refers to the identification, measurement, and achievement of the expected benefits that a program is intended to deliver (including change management if necessary).	4.0	5	
POF 5: refers to a decision board, e.g. the construction headquarters established by the government.	4.3	4	
POF 6: refers to an organizational form in which staff should report to departmental head and project leaders respectively.	4.1	5	
POF 7: refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve program decision makers.	4.1	5	
POF 8: refers to the qualified staff employed.	4.0	5	

Please reassess your rating against the degree of importance against each POF in Round 1.	Degree of importance		
	Mean ratings of all experts in Round 1	Your rating in Round 1	Your rating in Round 2
POF 9: refers to tools that enable necessary communication from the program-level perspective a clear understanding and statement of program-level objectives and results of the work to be performed.	4.5	4	
POF 10: refers to the design and conduction of standard process to all project management works for improving work efficiency.	4.1	5	
POF 11: refers to the establishment of a strong workable alliance with key program stakeholders, such as designer, contractors, and other parties.	4.1	4	
POF 12: refers to activities that can keep the program's exposure to risks at an acceptable level and adapt the proper insurance program when necessary, e.g. plans, procedures, and execution.	4.0	5	
POF 13: refers to activities of ensuring that project expenditure can be attained in the approved budget, e.g. the responsible division, plans, procedures and control.	3.9	5	
POF 14: refers to activities of ensuring that the program will produce its required deliverables and solutions on time, e.g. the responsible division, plans, procedures and control.	4.3	5	
POF 15: refers to activities that determine and ensure function and quality requirements to meet the prescribed objective during project duration, e.g. the responsible division, plans, procedures and control.	4.0	5	
POF 16: refers to activities that capture and share knowledge through monitoring and review in order to improve a program's likelihood of success.	3.5	5	
POF 17: refers to an information management system that can collect, process and analyze all the sub-project information regularly and output various program progress reports, e.g. cost and time reports.	3.7	5	
POF 18: refers to an ability dealing with any accidental or unexpected event/disaster, e.g. fire, typhoon, flood, and emergency medical rescue.	4.1	5	
POF 19: refers to activities dealing with design and technical issues in construction, e.g. the responsible division, plans, procedures and control.	4.1	4	
POF 20: refers to activities that procure equipment and materials needed, e.g. the responsible division, plans, procedures and control.	3.8	5	
Motivational capability			
POF 21: refers to the collectively accepted meaning that manifests itself in the formal and informal rules of a program organization for program success.	3.9	5	

Please reassess your rating against the degree of importance against each POF in Round 1.	Degree of importance		
	Mean ratings of all experts in Round 1	Your rating in Round 1	Your rating in Round 2
POF 22: refers to communication activities within and across the organizational boundary.	4.6	5	
POF 23: refers to the building of individual and group competencies to enhance program performance, e.g. development training.	4.1	5	
POF 24: refers to incentives that are commonly used to improve the performance of key participants, e.g. contract incentives.	3.4	5	

End of the questionnaire.
Thank you for your contribution!

Appendix Table Results of the first round of the Delphi survey

Ranking	POFs	Mean rating of all experts in Round 1
1	**POF 2:** refers to a strategy ensuring the success and survival of a program in its environment, e.g. employing an external consultancy or recruiting the employee directly.	4.7
2	**POF3:** refers to the good leadership and clear direction setting at all level within the program management organization, e.g. technical, communication, and negotiation abilities.	4.6
3	**POF 22:** refers to communication activities within and across the organizational boundary.	4.6
4	**POF 1:** refers to the understanding of the environment within which a program operates, e.g. the administrative, technological, economic, socio-cultural, and stakeholder factors.	4.5
5	**POF 9:** refers to tools that enable necessary communication from the program-level perspective a clear understanding and statement of program-level objectives and results of the work to be performed.	4.5
6	**POF 5:** refers to a decision board, e.g. the construction headquarters established by the government.	4.3
7	**POF 14:** refers to activities of ensuring that the program will produce its required deliverables and solutions on time, e.g. the responsible division, plans, procedures and control.	4.3
8	**POF 6:** refers to an organizational form in which staff should report to departmental head and project leaders respectively.	4.1
9	**POF 7:** refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve program decision makers.	4.1
10	**POF 10:** refers to the design and conduction of standard process to all project management works for improving work efficiency.	4.1

11	**POF 11:** refers to the establishment of a strong workable alliance with key program stakeholders, such as designer, contractors, and other parties.	4.1
12	**POF 18**: refers to an ability dealing with any accidental or unexpected event/disaster, e.g. fire, typhoon, flood, and emergency medical rescue.	4.1
13	**POF 19**: refers to activities dealing with design and technical issues in construction, e.g. the responsible division, plans, procedures and control.	4.1
14	**POF 23:** refers to the building of individual and group competencies to enhance program performance, e.g. development training.	4.1
15	**POF4:** refers to the identification, measurement, and achievement of the expected benefits that a program is intended to deliver (including change management if necessary).	4.0
16	**POF 8:** refers to the qualified staff employed.	4.0
17	**POF 12:** refers to activities that can keep the program's exposure to risks at an acceptable level and adapt the proper insurance program when necessary, e.g. plans, procedures, and execution.	4.0
18	**POF 15:** refers to activities that determine and ensure function and quality requirements to meet the prescribed objective during project duration, e.g. the responsible division, plans, procedures and control.	4.0
19	**POF 13:** refers to activities of ensuring that project expenditure can be attained in the approved budget, e.g. the responsible division, plans, procedures and control.	3.9
20	**POF 21:** refers to the collectively accepted meaning that manifests itself in the formal and informal rules of a program organization for program success.	3.9
21	**POF 20:** refers to activities that procure equipment and materials needed, e.g. the responsible division, plans, procedures and control.	3.8
22	**POF 17:** refers to an information management system that can collect, process and analyze all the sub-project information regularly and output various program progress reports, e.g. cost and time reports.	3.7
23	**POF 16:** refers to activities that capture and share knowledge through monitoring and review in order to improve a program's likelihood of success.	3.5
24	**POF 24:** refers to incentives that are commonly used to improve the performance of key participants, e.g. contract incentives.	3.4

关于上海世博会工程建设业主方群体项目管理组织模型的第二轮德尔菲专家问卷

（该课题得到香港理工大学的资助，以及上海世博会工程建设指挥部和同济大学的支持）

填写人: A 职位: 总体项目管理部总经理
曾服务于上海世博会工程建设的 □指挥部办公室（甲方） ☑ 总体项目管理方

请根据专家平均打分和您第一轮打分,在空格处填写您对各要素的重要性最终打分

说明:1 分—不重要，2 分—次重要，3 分—一般，4 分—重要，5 分—非常重要。

请根据专家平均评分和您第一轮打分对各要素的重要性进行最终打分 （分数必须为 1-5 之间的整数）	重要程度		
	专家平均分	第一轮打分	第二轮打分
（一）环境能力			
要素 1：充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等	4.5	5	
要素 2：具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司等	4.7	5	
（二）核心能力			
要素 3：管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等	4.6	5	
要素 4：具备明确的目标定义及进行必要变更管理，包括目标识别、量化控制指标制定以及过程监控等	4.0	5	
要素 5：设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部	4.3	4	
要素 6：合理设计项目部和职能部门的职责和分工，确保二者的分工明确与合作顺畅	4.1	5	
要素 7：设置群体项目管理办公室（或称总体项目管理部）， 协调职能和项目部门关系，提供决策支持	4.1	5	
要素 8：聘用称职的项目团队人员及提供必要培训支持	4.0	5	
要素 9：应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系	4.5	4	
要素 10：建立标准化项目管理流程和作业指引， 提高工作效率	4.1	5	

请根据专家平均评分和您第一轮打分对各要素的重要性进行最终打分 （分数必须为 1-5 之间的整数）	重要程度		
	专家平均分	第一轮打分	第二轮打分
要素 11：与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作	4.1	4	
要素 12：建立有效的群体项目风险管理体系，采取适当保险措施，如计划、流程和实施	4.0	5	
要素 13：建立有效的群体项目投资管理系统，如责任部门、计划、流程和实施	3.9	5	
要素 14：建立有效的群体项目进度管理系统，如责任部门、计划、流程和实施	4.3	5	
要素 15：建立有效的设施功能及质量管理系统，如责任部门、计划、流程和实施	4.0	5	
要素 16：建立群体项目知识管理系统，促进项目成功实施，如阶段小结、项目考察和经验交流会	3.5	5	
要素 17：应用群体项目管理信息系统，生成各种项目进展报告辅助决策，如投资报告和进度报告	3.7	5	
要素 18：建立应急管理系统，处理各种突发事故，例如火灾、台风、洪水和医疗急救	4.1	5	
要素 19：建立有效的设计和技术管理系统，如责任部门、计划、流程和实施	4.1	4	
要素 20：建立有效的采购管理系统，如责任部门、计划、流程和实施	3.8	5	
（三）激励能力			
要素 21：在项目参与方间建立共同项目文化，促进项目成功实施	3.9	5	
要素 22：建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流	4.6	5	
要素 23：提升群体项目管理团队能力，确保项目绩效，如拓展培训	4.1	5	
要素 24：建立总包单位等主要参与方的绩效奖励机制，如奖励合同条款	3.4	5	

问卷到此结束，感谢您的参与！

附表 第一轮德尔菲专家问卷统计结果

排名	要素及名称	平均分
1	要素 2：具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司等	4.7
2	要素 3：管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等	4.6
3	要素 22：建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流	4.6
4	要素 1：充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等	4.5
5	要素 9：应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系	4.5
6	要素 5：设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部	4.3
7	要素 14：建立有效的群体项目进度管理系统，如责任部门、计划、流程和实施	4.3
8	要素 6：合理设计项目部和职能部门的职能和分工，确保二者的分工明确与合作顺畅	4.1
9	要素 7：设置群体项目管理办公室（又称总体项目管理部）， 协调职能和项目部门关系，提供决策支持	4.1
10	要素 10：建立标准化项目管理流程和作业指引， 提高工作效率	4.1
11	要素 11：与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作	4.1
12	要素 18：建立应急管理系统，处理各种突发事故，例如火灾、台风、洪水和医疗急救	4.1
13	要素 19：建立有效的设计和技术管理系统，如责任部门、计划、流程和实施	4.1
14	要素 23：提升群体项目管理团队能力，确保项目绩效，如拓展培训	4.1
15	要素 4：具备明确的目标定义及进行必要变更管理，包括目标识别、量化控制指标制定以及过程监控等	4.0
16	要素 8：聘用称职的项目团队人员及提供必要培训支持	4.0
17	要素 12：建立有效的群体项目风险管理体系，采取适当保险措施，如计划、流程和实施	4.0
18	要素 15：建立有效的设施功能及质量管理系统，如责任部门、计划、流程和实施	4.0
19	要素 13：建立有效的群体项目投资管理系统，如责任部门、计划、流程和实施	3.9
20	要素 21：在项目参与方间建立共同项目文化，促进项目成功实施	3.9
21	要素 20：建立有效的采购管理系统，如责任部门、计划、流程和实施	3.8
22	要素 17：应用群体项目管理信息系统，生成各种项目进展报告辅助决策，如投资报告和进度报告	3.7
23	要素 16：建立群体项目知识管理系统，促进项目成功实施，如阶段小结和经验交流会	3.5
24	要素 24：建立总包单位等主要参与方的绩效奖励机制，例如奖励合同条款	3.4

APPENDIX H: THIRD ROUND QUESTIONNAIRE OF THE DELPHI SURVEY

(This research has been funded by The Hong Kong Polytechnic University and supported by the Tongji University in Shanghai and the office of Shanghai Expo Construction Headquarters.)

Dear expert,

We appreciate your participation in Rounds 1 and 2 of the Delphi survey. In the following questionnaire survey, you are invited to examine the relationship between the 11 identified principal program organizational factors (PPOFs) and the five selected KPI. The five KPIs include cost performance, functionality and quality (FQ) performance, time performance, occupational health and safety performance, as well as environmental performance.

Thank you very much for your participation and constant support!

Name of Respondent: _______________

Note: Please fill in the blank space with your ratings against the impact of each principal POF on each KPI. This questionnaire survey will take no more than 20 minutes to complete.

PPOFs	KPIs	Impact of each PPOF on each KPI	
		Ratings	Note
PPOF 1: refers to the understanding of the environment within which a program operates, e.g. the administrative, technological, economic, socio-cultural, and stakeholder factors.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF 2: refers to a strategy ensuring the success and survival of a program in its environment, e.g. employing an external consultancy or recruiting the employee directly.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF3: refers to the good leadership and clear direction setting at all level within the program management organization, e.g. technical, communication, and negotiation abilities.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF 4: refers to tools that enable necessary communication from the program-level perspective a clear understanding and statement of program-level objectives and results of the work to be performed.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		

PPOFs	KPIs	Impact of each PPOF on each KPI	
		Ratings	Note
PPOF 5: refers to a decision board, e.g. the construction headquarters established by the government.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF 6: refers to an organizational form in which staff should report to departmental head and project leaders respectively.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF 7: refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve program decision makers.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
PPOF 8: refers to activities dealing with design and technical issues in construction, e.g. the responsible division, plans, procedures and control.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
POF 9: refers to the establishment of a strong workable alliance with key program stakeholders, such as designer, contractors, and other parties.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
POF 10: refers to communication activities within and across the organizational boundary.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		
POF 11: refers to the building of individual and group competencies to enhance program performance, e.g. development training.	Cost performance		1= very low, 2= low, 3= medium, 4= high, and 5 = very high.
	FQ performance		
	Time performance		
	OHS performance		
	Environmental performance		

End of the questionnaire.
Thank you for your contribution!

关于上海世博会工程建设的业主方群体项目组织模型的第三轮德尔菲专家问卷

（该课题得到香港理工大学的资助，以及上海世博会工程建设指挥部办公室和同济大学的支持）

尊敬的专家：

您好！非常感谢您参与第一及第二轮德尔菲专家问卷，希望您能继续填写如下问卷，帮助我们进一步识别 11 个关键群体项目组织要素（根据前两轮专家平均打分确定）和五项关键绩效指标的关系。

非常感谢您的继续参与和支持。

填写人: ___________________________

请在表内专家打分空格内填入认为关键群体项目组织要素对各项关键绩效指标的影响打分。完成此问卷需要 20 分钟。

关键群体项目组织要素	关键绩效指标	对各绩效指标影响程度的评估	
		专家打分	打分说明
要素 1：充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等	投资绩效		1 分—非常小 2 分—较小 3 分—一般 4 分—较大 5 分—非常大
	功能及质量绩效		
	进度绩效		
	安全绩效		
	环境绩效		
要素 2：具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司等	投资绩效		1 分—非常小 2 分—较小 3 分—一般 4 分—较大 5 分—非常大
	功能及质量绩效		
	进度绩效		
	安全绩效		
	环境绩效		
要素 3：管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等	投资绩效		1 分—非常小 2 分—较小 3 分—一般 4 分—较大 5 分—非常大
	功能及质量绩效		
	进度绩效		
	安全绩效		
	环境绩效		
要素 4：应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系	投资绩效		1 分—非常小 2 分—较小 3 分—一般 4 分—较大 5 分—非常大
	功能及质量绩效		
	进度绩效		
	安全绩效		
	环境绩效		
要素 5：设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部	投资绩效		1 分—非常小 2 分—较小 3 分—一般 4 分—较大 5 分—非常大
	功能及质量绩效		
	进度绩效		
	安全绩效		
	环境绩效		

关键群体项目组织要素	关键绩效指标	对各绩效指标影响程度的评估	
		专家打分	打分说明
要素 6：具备明确的目标定义及进行必要变更管理，包括目标识别、量化控制指标制定以及过程监控等	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 7：合理设计项目部和职能部门的职能和分工，确保二者的分工明确与合作顺畅	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 8：设置群体项目管理办公室（又称总体项目管理部）， 协调职能和项目部门关系，提供决策支持	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 9：建立有效的设计和技术管理系统，如责任部门、计划、流程和实施	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 10：与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 11：建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大
要素 12：提升群体项目管理团队能力，确保项目绩效，如拓展培训	投资绩效		1 分—非常小
	功能及质量绩效		2 分—较小
	进度绩效		3 分—一般
	安全绩效		4 分—较大
	环境绩效		5 分—非常大

问卷到此结束，感谢您的参与！

APPENDIX I: FOURTH ROUND QUESTIONNAIRE OF THE DELPHI SURVEY

Name of Respondent: ___A_____

Please fill in the blank space with your answer such as choices and numbers in terms of the mean scores provided by all experts involved in the first round.

Note: 1= very low 2= low, 3= medium, 4= high, and 5 = very high.

PPOFs	KPIs	Impact of each PPOF on each KPI		
		Mean Ratings of all experts in Round 3	Your rating in Round 3	Your rating in Round 4
PPOF 1: refers to the understanding of the environment within which a program operates, e.g. the administrative, technological, economic, socio-cultural, and stakeholder factors.	Cost performance	4.1	5	
	FQ performance	3.9	2	
	Time performance	4.6	5	
	OHS performance	3.4	3	
	Environmental performance	3.2	5	
PPOF 2: refers to a strategy ensuring the success and survival of a program in its environment, e.g. employing an external consultancy or recruiting the employee directly.	Cost performance	4.4	5	
	FQ performance	4.5	5	
	Time performance	4.6	4	
	OHS performance	4.0	4	
	Environmental performance	3.4	3	
PPOF3: refers to the good leadership and clear direction setting at all level within the program management organization, e.g. technical, communication, and negotiation abilities.	Cost performance	4.3	4	
	FQ performance	4.4	5	
	Time performance	4.7	5	
	OHS performance	3.8	3	
	Environmental performance	3.1	3	
PPOF 4: refers to tools that enable necessary communication from the program-level perspective a clear understanding and statement of program-level objectives and results of the work to be performed.	Cost performance	3.9	5	
	FQ performance	3.9	5	
	Time performance	4.1	5	
	OHS performance	3.2	4	
	Environmental performance	2.7	3	
PPOF 5: refers to a decision board, e.g. the construction headquarters established by the government.	Cost performance	4.1	4	
	FQ performance	3.8	4	
	Time performance	4.7	5	
	OHS performance	3.8	4	
	Environmental performance	3.1	4	
PPOF 6: refers to an organizational form in which staff should report to departmental head and project leaders respectively.	Cost performance	4.0	4	
	FQ performance	4.2	4	
	Time performance	4.5	5	
	OHS performance	3.7	4	
	Environmental performance	3.0	3	
PPOF 7: refers to a collection of functions that can coordinate the relationships between functional divisions and project teams and serve	Cost performance	4.0	4	
	FQ performance	3.6	4	
	Time performance	3.7	4	
	OHS performance	3.1	3	

PPOFs	KPIs	Impact of each PPOF on each KPI		
		Mean Ratings of all experts in Round 3	Your rating in Round 3	Your rating in Round 4
program decision makers.	Environmental performance	2.5	3	
PPOF 8: refers to activities dealing with design and technical issues in construction, e.g. the responsible division, plans, procedures and control.	Cost performance	4.3	5	
	FQ performance	4.6	5	
	Time performance	4.0	5	
	OHS performance	3.2	3	
	Environmental performance	3.1	5	
POF 9: refers to the establishment of a strong workable alliance with key program stakeholders, such as designer, contractors, and other parties.	Cost performance	4.2	5	
	FQ performance	4.0	5	
	Time performance	4.8	5	
	OHS performance	3.9	4	
	Environmental performance	3.0	4	
POF 10: refers to communication activities within and across the organizational boundary.	Cost performance	3.7	4	
	FQ performance	3.6	4	
	Time performance	4.5	5	
	OHS performance	3.7	5	
	Environmental performance	2.8	3	
POF 11: refers to the building of individual and group competencies to enhance program performance, e.g. development training.	Cost performance	4.2	4	
	FQ performance	4.1	5	
	Time performance	4.3	5	
	OHS performance	3.7	4	
	Environmental performance	2.8	4	

End of the questionnaire.
Thank you for your contribution!

关于上海世博会工程建设业主方群体项目管理组织模型的
第四轮德尔菲专家问卷（示例）

（该课题得到香港理工大学的资助，以及上海世博会工程建设指挥部办公室和同济大学的支持）

请您根据第三轮 10 位专家平均打分和您的初次打分确定您的最终打分。完成此问卷需要 10 分钟。

说明:1 分—非常小，2 分—较小，3 分—一般，4 分—较大，5 分—非常大。

填写人: A

关键群体项目组织要素	关键绩效指标	对于各项绩效指标影响程度的评估		
		专家平均分	第三轮打分	最后打分
要素 1：充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等	投资绩效	4.1	5	
	功能及质量绩效	3.9	2	
	进度绩效	4.6	5	
	安全绩效	3.4	3	
	环境绩效	3.2	5	
要素 2：具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司等	投资绩效	4.4	5	
	功能及质量绩效	4.5	5	
	进度绩效	4.6	4	
	安全绩效	4.0	4	
	环境绩效	3.4	3	
要素 3：管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等	投资绩效	4.3	4	
	功能及质量绩效	4.4	5	
	进度绩效	4.7	5	
	安全绩效	3.8	3	
	环境绩效	3.1	3	
要素 4：应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系	投资绩效	3.9	5	
	功能及质量绩效	3.9	5	
	进度绩效	4.1	5	
	安全绩效	3.2	4	
	环境绩效	2.7	3	
要素 5：设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部	投资绩效	4.1	4	
	功能及质量绩效	3.8	4	
	进度绩效	4.7	5	
	安全绩效	3.8	4	
	环境绩效	3.1	4	
要素 6：合理设计项目部和职能部门的职能和分工，确保二者的分工明确与合作顺畅	投资绩效	4.0	4	
	功能及质量绩效	4.2	4	
	进度绩效	4.5	5	
	安全绩效	3.7	4	
	环境绩效	3.0	3	

关键群体项目组织要素	关键绩效指标	对于各项绩效指标影响程度的评估		
		专家平均分	第三轮打分	最后打分
要素 7：设置群体项目管理办公室（又称总体项目管理部），协调职能和项目部门关系，提供决策支持	投资绩效	4.0	4	
	功能及质量绩效	3.6	4	
	进度绩效	3.7	4	
	安全绩效	3.1	3	
	环境绩效	2.5	3	
要素 8：建立有效的设计和技术管理系统，如责任部门、计划、流程和实施	投资绩效	4.3	5	
	功能及质量绩效	4.6	5	
	进度绩效	4.0	5	
	安全绩效	3.2	3	
	环境绩效	3.1	5	
要素 9：与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作	投资绩效	4.2	5	
	功能及质量绩效	4.0	5	
	进度绩效	4.8	5	
	安全绩效	3.9	4	
	环境绩效	3.0	4	
要素 10：建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流	投资绩效	3.7	4	
	功能及质量绩效	3.6	4	
	进度绩效	4.5	5	
	安全绩效	3.7	5	
	环境绩效	2.8	3	
要素 11：提升群体项目管理团队能力，确保项目绩效，如拓展培训	投资绩效	4.2	4	
	功能及质量绩效	4.1	5	
	进度绩效	4.3	5	
	安全绩效	3.7	4	
	环境绩效	2.8	4	

问卷到此结束，感谢您的参与！

APPENDIX J: QUESTIONNAIRE SURVEY ON THE IMPORTANCE OF KPIS IN THE SHANGHAI EXPO CONSTRUCTION

(This research has been funded by The Hong Kong Polytechnic University and supported by Tongji University and the office of the Shanghai Expo Construction Headquarters.)

Dear Sir or Madam,

In this questionnaire survey, you are invited to answer the questions according to your experience and knowledge obtained from the involvement of the Shanghai Expo construction. This questionnaire aims to evaluate the relative importance of selected key performance indicators in the Shanghai case.

All data you provide will be used only for this research. If you have any query, please contact us via the email: hu.yi@_____________

Thank you very much for your participation and support!

Name of Respondent: _________ **Your work organization & position**: ________________

Note: Please fill in the blank space with your answer such as choices and numbers. This questionnaire survey will take no more than 20 minutes to complete.

Section A: Personal Particulars

1. Your age: _____________
A) 30 or below B) 31-40 C) 41-50 D) 51-60 E) 61 or above

2. Your education level: _____________
A) Associate or below B) Bachelor Degree C) Master Degree D) PhD Degree

3.Your specialty (Multiple choices): _____________
A) Government supervision B) client management C) Design & management
D) Construction & Management E) construction consultancy F) Scientific research

4. Work experience in the construction industry: _____________
A) 5 years or below B) 6-10 years C) 11-20 years D) 21-30 years E) > 30 years
Work experience serving for construction megaprojects: _____________
A) 5 years or below B) 6-10 years C) 11-20 years D) 21-30 years E) > 30 years

6. Names of construction megaprojects involved (Construction projects cost RMB 5 billion):
1) ________________ 2)________________
3) ________________ 4)________________
5)________________ 6)________________
7)________________ 8)________________
9)________________ 10)________________

Section B: Key Performance Indicators (KPIs)

Note: 1—"not important", 2— "slightly important", 3— "moderately important", 4— "important", and 5— "very important".

KPIs	*Please provide your rating to the importance level with each KPI for the Shanghai Expo megaproject*
1. Time performance (e.g. ahead schedule, on schedule or behind schedule)	
2. Cost performance (e.g. within budget, on budget or cost overrun)	
3. Functionality and quality performance (e.g. receiving quality awards, meeting design requirements, smooth handover, etc.)	
4. **Health and safety performance** (e.g. low safety incidents and injury, safe workplace, safety training and supervision system, and receiving relevant awards)	
5. Environment (e.g. dust, noise, solid waste, gas waste, liquid waste, etc.)	

End of the questionnaire.
Thank you for your contribution!

For those who wish to receive a summary of the research finding, please enter the details below (optional):

Name: ___________________ Telephone Number: _______________________

Email Address: ____

关于上海世博会工程建设中关键绩效指标的重要性问卷调查

（该课题得到香港理工大学的资助，以及同济大学和上海世博会工程建设指挥部办公室的支持）

尊敬的先生/女士：

您好！鉴于您在参与上海世博会工程建设的实践和研究经验，我们诚挚地邀请您参加此次问卷。本项问卷旨在调查上海世博会工程建设中关键绩效指标的相对重要性。

您所提供的信息将仅用于本项课题研究。如有任何问题，可发送电子邮件至 hu.yi@______________与课题组联系。

非常感谢您的参与和支持。

填写说明： 见“ _____”请在横线上填写。完成此问卷需要 20 分钟。

填写人: __________________ 工作单位及职位: ___________________________

第一部分：个人背景

1. 年龄： ________

A)30 岁或以下 B) 31-40 岁 C) 41-50 岁 D) 51-60 岁 E) 61 或以上

2. 教育程度：________

A) 大专及以下 B) 大学本科 C) 硕士/ 研究生 D) 博士

3.专业领域： ________ （此项可选择一项以上的答案）

A) 政府监管 B) 甲方管理 C) 设计及管理

D) 施工及管理 E) 工程监理及咨询

4. 从事工程建设行业的工作时间：________

A) < 1 -5 年 B) 6-10 年 C)11-20 年 D) 21-30 年 E) 大于 31 年

其中参与 巨型建设项目的工作时间：________

A) < 1 -5 年 B) 6-10 年 C)11-20 年 D) 21-30 年 E) 大于 31 年

5.参与巨型建设项目的名称 (巨型项目是指投资达到或超过 50 亿人民币以上的项目。)

1) ________________________________ 2) ________________________________

3) ________________________________ 4) ________________________________

5) ________________________________ 6) ________________________________

7) ________________________________ 8) ________________________________

9) ________________________________ 10) ________________________________

第二部分：关键绩效指标重要性评估

填写说明： 1—“最不重要”，2— “较不重要”，3—“一般”，
4—“较重要”，5—“最重要”。

主要关键绩效指标	**重要性评估** （请填入 1-5 的整数对各指标的重要性打分）
1. 进度绩效 （是指项目进度偏差情况，例如提前、按时或延迟）	
2. **投资绩效**（是指项目投资情况，例如节约、受控或超支）	
3. **功能及质量绩效**（是指项目功能及质量情况，例如满足技术要求，有质量缺陷或质量良好）	
4. **职业健康及安全**（是指项目伤亡事故情况，例如无安全事故、安全事故较多或很多）	
5. 环境绩效（是指项目施工过程的环境影响程度，例如污染控制、能源节约或三废控制	

问卷到此结束，感谢您的参与！

关于本课题，如果您有兴趣获取我们的研究成果，欢迎您留下您的联系方式（自愿提供）：
姓名：_______电话：________电子邮件：____________________

APPENDIX K: INTERVIEW QUESTIONS FOR VALIDATING THE RESEARCH FINDINGS

Interview Outlines/ 访谈概要

The purpose of this interview is to validate whether the program organization framework and its performance index for construction megaprojects in China is comprehensive, objective, reliable and practical enough to guide megaproject practices in China and evaluate the performance of program organization in these practices. Please provide your comment and score to represent the extent of satisfaction (ten-point Likert scale, i.e. 1 presents "very poor" and 10 indicates "excellent") to the model against each validation aspect.

本访谈的目的在与验证针对中国巨型建设项目的群体项目组织框架及其绩效指数模型是否全面、客观、有效和实用，满足指导巨型项目实践及相关实践中群体项目组织的绩效评估。请根据下列模型验证具体问题给出您的评价和打分（11分制，即0分表示很差，10分表示很好）。

Phase 阶段	Validation questions 验证评估问题	Scoring 评分	Comment 评价
I	1-1 Are the identified program organizational factors (POFs) comprehensive and practical? 所识别的群体项目组织要素是否全面、切实?		
	1-2 Are the categories of the POFs proper? 对于群体项目组织要素的分类是否合理？		
II	2-1 Are the framework consisting of the principal POFs pragmatic and generalized? 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?		
	2-2 Are the importance rankings of the principal POFs reasonable? 对于关键群体项目组织要素重要性是否合理？		
III	3-1 Can the fuzzy membership function effectively reduce the subjectivity of measuring the effectiveness of the program organization with regard to the selection criteria? 应用模糊关系函数，对于群体项目管理组织有效性评估能起到降低主观性、增强客观性的作用？		
	3-2 Is fuzzy synthetic evaluation analysis applicable such that clients can apply the program organization framework? 应用模糊综合评价能否帮助业主应用群体项目管理组织模型？		
	4-1 Are the research design and methodology logical and replicable? 该研究设计和方法是否具有可验证性？		

研究背景及实施情况介绍

第一阶段：识别群体项目组织要素

通过对国际八本顶级期刊近十年相关文章（超过 120 篇）及相关文献的回顾和上海世博会五位专家的访谈，共识别 24 个群体项目组织要素。他们代表了管理巨型建设项目的业主方群体项目组织不同层面的要素，形成了一个具有调节性（regulative）、规范性（normative）、 技术性（technical）和 cultural-cognitive（文化认知性）的集成框架，形成了环境、能力和激励三种聚类， 如下表 1 所示。

表 1 识别的 24 个群体项目组织要素

要素	定义
环境能力	
1、外部环境认知	充分了解各种外部环境条件对于项目实施的限制，例如政治、技术、经济以及社会文化等
2、项目总体战略	具有明确的群体项目战略和方向，确保项目能持续进行，包括合理聘用外部咨询公司、形成总体采购战略等
核心能力	
3、 组织领导力	管理层具备必要的领导技巧和能力，能推进项目顺利实施，比如技术能力、沟通能力和谈判能力等
4、 总体范围管理	具备明确的目标定义及进行必要变更管理，包括目标识别、量化控制指标制定以及过程监控等
5、 项目治理机构	设立项目治理机构作为项目最高决策结构，如政府设立的工程建设指挥部
6、 矩阵式组织结构	合理设计项目部和职能部门的职责和分工，确保二者的分工明确与合作顺畅
7、 群体项目管理办公室	设置该类机构，如总体项目管理部等， 协调职能和项目部门关系，提供决策支持
8、 聘用称职的人员	聘用称职的项目团队人员及提供必要培训支持
9、 PBS /WBS 等结构化分解工具应用	应用项目分解结构(PBS)/工作分解结构(WBS)工具，确定项目战略、总体目标和项目任务的关系

要素	定义
10、标准化流程管理	建立标准化项目管理流程和作业指引， 提高工作效率
11、与关键参与方建立伙伴合作关系	与施工总承包、设计单位等主要内部参与方建立伙伴合作关系，加强施工过程协作
12、总体风险管理及保险措施	建立有效的群体项目风险管理体系，采取适当保险措施，如计划、流程和实施
13、 总体投资管理	建立有效的群体项目投资管理系统，如责任部门、计划、流程和实施
14、总体进度管理	建立有效的群体项目进度管理系统，如责任部门、计划、流程和实施
15、总体功能及质量管理	建立有效的设施功能及质量管理系统，如责任部门、计划、流程和实施
16、 总体知识管理	建立群体项目知识管理系统，促进项目成功实施，如阶段小结、项目考察和经验交流会
17、 总控信息系统	应用群体项目管理信息系统，生成各种项目进展报告辅助决策，如投资报告和进度报告
18、总体应急管理	建立应急管理系统，处理各种突发事故，例如火灾、台风、洪水和医疗急救
19、 总体技术和设计管理	建立有效的设计和技术管理系统，如责任部门、计划、流程和实施
20、材料设备采购管理	建立有效的采购管理系统，如责任部门、计划、流程和实施
激励能力	
21、 共同项目文化	在项目参与方间建立共同项目文化，促进项目成功实施
22、 内外沟通管理	建立有效沟通管理系统，促进业主方内部以及与外部之间的沟通交流
23、总体团队建设	提升群体项目管理团队能力，确保项目绩效，如拓展培训
24、 激励措施管理	建立总包单位等主要参与方的绩效奖励机制，如奖励合同条款

第二阶段：识别关键群体项目组织要素

在第一阶段研究工作基础上，编制德尔菲问卷，通过对参与上海世博会案例的 10 位专家(包括业主方及总体项目管理顾问的代表)进行两轮问卷，识别出关键群体项目组织要素，如表 2 所示。该 11 个关键要素能涉及群体项目组织的环境能力、核心能力和激励能力三类，仍然可视为一个更具实用性（较为简化）的具有调节性（regulative）、规范性（normative）、 技术性（technical）和 cultural-cognitive（文化认知性）的集成框架。

表 2 关键群体项目管理组织要素的平均权重及排名

关键群体项目组织要素	平均权重	排名
1、项目总体战略	4.80	1
2、组织领导力	4.70	2
3. PBS /WBS 等结构化分解工具的应用	4.60	3
4. 内外沟通管理	4.60	3
5. 外部环境认知	4.50	5
6. 项目治理机构	4.50	5
7. 矩阵式组织结构	4.20	7
8. 群体项目管理办公室	4.20	7
9. 与关键参与方建立伙伴合作关系	4.20	7
10. 总体技术管理	4.20	7
11. 总体团队建设	4.20	7

第三阶段：基于模糊综合评价模型的巨型建设项目群体项目组织绩效评估

在前两阶段研究工作基础上，继续通过对参与上两轮问卷的 10 位专家继续采用德尔菲问卷方式，评估上海世博会案例中关键群体项目组织要素对四项关键绩效指标影响（包括投资、进度、安全及质量），构建模糊综合评价矩阵。初步评估结果表明，关键群体项目组织要素对于各关键绩效指标的总体影响水平， 三项达到“很高”的水平，一项达到“高”的水平，结果如表 3 所示。

表 3 关键群体项目组织要素对于各关键绩效指标的总体影响表现评价

关键绩效指标	关键群体项目组织要素的总体影响表现 （5 分为满分，即影响很大）
进度	4.450
投资	4.200
功能及质量	4.050
职业健康及安全	3.690

在此基础上，利用专家问卷形式，对 11 位参与上海世博会的专家进行问卷，确定四项关键绩效指标的相对权重，构建衡量其总体绩效指数。最终评估结果表明关键群体项目组织要素对于总体绩效的影响指数为 4.10，超过“高”水平。因此，可以认为，在上海世博会案例中，业主方群体项目组织对于项目成功（四项关键绩效指标）是至关重要的。

APPENDIX L: INTERVIEW DIALOGUES FOR VALIDATING THE RESEARCH FINDINGS

Expert F

地点：同济大学复杂工程管理研究院（彰武路1号同济大厦A楼1701室）

时间：2013年7月23日 上午 9:37-10:30　　记录人：胡毅

阶段	验证评估问题	评分	评价
I	1-1 所识别的群体项目组织要素是否全面、切实?	9	应该是比较全面的。
	1-2 对于群体项目组织要素的分类是否合理？	10	分类应该是合理。
II	2-1 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?	9	这个可以。
	2-2 对于关键群体项目组织要素的重要性排序是否合理？	9	这个应该是有道理的，专家出来的。这个还是比接近的（接近专家参与的非世博巨型项目情况）。
III	3-1 通过应用模糊关系函数，对于群体项目组织评估可以起到减少主观性、增强客观性的作用？	10	这个可以的。
	3-2 应用模糊综合评价模型能否帮助业主应用群体项目组织模型？	10	这个方法很好。
	4-1 该 研究设计及方法是否具有可重复性？	9	这个方法可以的。

Expert G

地点：同济大学复杂工程管理研究院（彰武路1号同济大厦A楼901室）

时间：2013年7月21日 下午17:47-18:28　　记录人：胡毅

阶段	验证评估问题	评分	评价
I	1-1 所识别的群体项目组织要素是否全面、切实?	9	可否把外部环境认知分为宏观和微观两个层次，这只是一个建议。最近，我们和盛老师（南京大学盛昭翰教授）一起研究重大工程组织，盛老师提出来的一个观点，也是我的一个观点：投融资模式很重要。外部环境认知确实是都包括了，都是这个很大，是不是分成两大类，一个是宏观的，现在社会越来越重视环境评价，越来越重视绿色建筑，越来越重视安全评价，包括媒体都这个项目有很重要的影响，这是一方面。但是真正对组织影响最大（是）投融资模式。如果你是政府投资，那必然是指挥部；如果是私人投资，必然是 PPP（等）各种方式，是不是可以把投融资模式考虑一下。投融资模式对组织设计还是有影响。
	1-2 对于群体项目组织要素的分类是否合理？	8	分类还是比较合理的，相对比较粗。
II	2-1 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?	9	应该是这样，答案还是肯定的。如果从研究角度，现在（关键群体项目组织要素）平均权重都是四点几，是不是意味后面舍掉这些要素的权重是不是都很高？那这里是不是有一个统一口径问题。照道理来讲，平均权重三点几以上的（要素）能不能舍掉？或者反过来说，会不会所有的权重都这么重？是不是存在打分专家他的理解是不是在同一 level 的问题？别的暂时没有问题。

阶段	验证评估问题	评分	评价
	2-2 对于关键群体项目组织要素的重要性排序是否合理？	9	还是有道理的。总体战略，其实你是政府项目，还是私人项目，都可以放在里面，包括投融资模式，这个确实也是最重要的。组织领导力这个（要素）还有争议，至少在国内项目，领导力还是很重要。第三个如果是结构化分解技术，（涉及到项目组合和分解，这样我更能接受，如果你说是 PBS/WBS 对于做项目的人来说比较难理解，可以加点备注。另外，沟通管理、外部环境认知这个也很重要。项目治理机构呢，当然国内不怎么这么提，国内指挥部是一个甲方的感觉，如果把它作为一个治理的话，有几个层次，都在这个治理范围之内，比方讲政府，对吧？（对）这个是界定问题，我觉得问题也不大。总体范围管理、矩阵式组织结构、群体项目管理办公室，这都 OK。
III	3-1 通过应用模糊关系函数，对于群体项目组织评估可以起到减少主观性、增强客观性的作用？	10	那肯定是的，那一定能对业主是有帮助的。
	3-2 应用模糊综合评价模型能否帮助业主应用群体项目组织模型？	8	应该可以。
	4-1 该 研究设计及方法是否具有可重复性？	8	目前这个阶段（研究设计）也是有复制性的。

Expert H

地点：同济大学复杂工程管理研究院（彰武路1号同济大厦A楼911室）

时间：2013年7月27日 上午 10:55-11:30　　　记录人：　胡毅

阶段	验证评估问题	评分	评价
I	1-1 所识别的群体项目组织要素是否全面、切实?	8	我觉得打八分没问题。
	1-2 对于群体项目组织要素的分类是否合理？	8	合理。
II	2-1 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?	7	我觉得整体通用性可以打七分。
	2-2 对于关键群体项目组织要素的重要性排序是否合理？	7	我个人认为是合理的。个人认为唯一不合理的地方是 PBS/WBS 等工具是基础，应该排在组织领导力之前。首先是有这个基础，才能有组织领导力问题，其他我觉得没问题。
III	3-1 通过应用模糊关系函数，对于群体项目组织评估可以起到减少主观性、增强客观性的作用？	7	那当然，我觉得是对的。你把它分解，在进行模糊，我觉得就是对的。
	3-2 应用模糊综合评价模型能否帮助业主应用群体项目组织模型？	7	我觉得可以的，对的。
	4-1 该 研究设计及方法是否具有可重复性？	8	我觉得蛮好的。

Expert I

地点：同济大学复杂工程管理研究院（彰武路1号同济大厦A楼911室）

时间：2013年7月26日 下午 19:45-20:17　　记录人：胡毅

阶段	验证评估问题	评分	评价
I	1-1 所识别的群体项目组织要素是否全面、切实?	8	组织要素还是非常全面的。我还有一个个人想法就是，（这里）针对的巨型项目主要其实是政府投资的非常大型项目，但是超过 50 亿元这些项目，比如一些开发商投资的大型城市综合体，但是他的这些既定要素和政府投资的这种侧重点还是稍有些出入。
	1-2 对于群体项目组织要素的分类是否合理？	8	分类还是很合理的。个人认为内外部沟通管理是可以放到能力里面。点是很全的，基本上可以。
II	2-1 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?	7	这个还是毕竟国外的资料参考比较多一点，从世博会上这种大项目上也完全适用，但是还要扎根一点本土的中国的这种特色，更多的这种还是要依据经验多一点。国外相对比较规范，国内还是没有相关经验，很多项目都是摸着石头过河，代价是很大的。
	2-2 对于关键群体项目组织要素的重要性排序是否合理？	7	相对来说可以的。
III	3-1 通过应用模糊关系函数，对于群体项目组织评估可以起到减少主观性、增强客观性的作用？	7	这个我觉得可以的。
	3-2 应用模糊综合评价模型能否帮助业主应用群体项目组织模型？	7	可以的。
	4-1 该 研究设计及方法是否具有可重复性？	8	可以的。

Expert J

地点：同济大学复杂工程管理研究院（彰武路1号同济大厦A楼911室）

时间：2013年7月22日 上午 9:13-9:40　　　记录人：胡毅

阶段	验证评估问题	评分	评价
I	1-1 所识别的群体项目组织要素是否全面、切实?	8	觉得还是比较全面的。而且有些东西就是从我们长春那个项目（来看），像矩阵式结构对于他们整个项目管理还是影响蛮大的，因为长春那边项目很多，一年要做掉60、70 个， 100 个项目左右。他们有个工程部，主要负责实施整个建设过程，他们那个矩阵式结构，我们讲是弱矩阵，在实施过程中，明显就实施力就不够。像你们列的这些，像矩阵式结构、环境（等）这些（要素），都和那边比较贴合。
	1-2 对于群体项目组织要素的分类是否合理？	8	还是比较（合理），尤其是你们还提出了激励这块。对他们（长春）政府这些项目，平时（承）接他们这些项目的单位，每年都有很多项目都送到他们手上，有时候他们做得好、做得坏，也不是太在意，因为总归还是有事情做。像你提出的这个东西提出，对他们（施工单位等参与方）的筛选、（名录）库的整理都比较有帮助。其实，他们也差不多也直接在建立自己的一个信用评价库。
II	2-1 关键群体项目组织要素构成的优化框架是否具有实用性和通用性?	7	就我自己做过的项目来看，投资控制和标准化流程还是要提得更明显一点。其实我们做的很多政府类（项目），他们对投资控制提得还不是太重要，他们最重要的还是任务性节点、工期达到要求，但实际上这个过程中，他们一直要抢工期，因为时间很紧，造成他们有些事情不一定会照规程来办，总是应付急的事情做。

	2-2 对于关键群体项目组织要素的重要性排序是否合理？	9	基本上看还是比较合理的。我看你这个排名，前面还是关键性因素，后面一些是（相对）弱化的协调沟通的东西。
III	3-1 通过应用模糊关系函数，对于群体项目组织评估可以起到减少主观性、增强客观性的作用？	9	我觉得你做的这个东西和这个模型还是看起来比较有说明力的。
	3-2 应用模糊综合评价模型能否帮助业主应用群体项目组织模型？	8	应该是可以。
	4-1 该 研究设计及方法是否具有可重复性？	8	我比较赞成这个还可以到其它大项目上去实践一遍。

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