Collaborating with Construction Management Consultants in Project Execution: Responsibility Delegation and Capability Integration

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Abstract: The professional consultancy services provided by construction management consultants (CMC) are important supplements to clients' management of project execution. However, CMCs' services, if not carefully managed, cannot bring salient contributions. This paper aims to empirically examine how clients' delegation to CMCs affects client–consultant capability integration in project management processes. Based on a comprehensive literature review, a conceptual capability integration model was developed. A triangulated approach was adopted to collect qualitative and quantitative data. Social network analysis (SNA) and case analysis provide exploratory evidence on the capability integration model. Partial least square based structural equation modeling (PLS-SEM) analyses tested the model hypotheses statistically. The results suggest that both clients' and CMCs' capabilities contribute to project management processes, although clients' contributions are more significant. Delegating more responsibilities to CMCs better utilizes their capabilities and at the same time does not restrict clients' contributions. Theoretically, these findings provide empirical support to the theory of temporal project organization and map the client–consultant collaboration interface. In practice, clients should better utilize CMCs' capabilities by designing appropriate responsibility delegation systems based on the revealed capability integration mechanism. **DOI: 10.1061/(ASCE)CO.1943-7862.0001312.**

Author keywords: Construction management consultant; Capability integration; Responsibility delegation; Process capability; Organizational issues.

Introduction

Recent years have witnessed the tremendous developments of construction projects in terms of project scale and technology level (Xia and Chan 2012; Wang et al. 2013). Increasing project complexity induces project organization complexity and raises the pressing demands for advanced managerial methods (Hu et al. 2015; Senescu et al. 2013). The professional managerial and technical services by construction management consultant—CMC, engineer in FIDIC (Fédération lnternationale Des lngénieurs Conseils) contract, or *Jianli* in Chinese—in project execution become indispensable underpinnings for project delivery (Shi et al. 2014; Hu et al. 2015). Thus, effectively utilizing professional consultancy services is an important issue for project clients. However, multifaceted challenges emerge in client–consultant collaboration practices (Liu et al. 2004).

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On the one hand, the organization boundary between clients and CMCs complicates the capability integration between them. Paradoxically, CMCs are involved to provide knowledge-intensive services to clients, whereas knowledge transfer across the client–consultant interface is found to be much less frequent than expected (Nesheim and Hunskaar 2015). This is ascribed to the goal incongruence problem (Ling 2004; Liu et al. 2004; Kartam et al. 2000). The ubiquitous "dichotomy between consultants' need to maximize profit and clients' need to minimize cost" induces built-in conflicts and impedes mutual trust, which is necessary for effective collaboration (Ling 2004). Even worse, problems, such as the CMC–contractor conspiracy (Sohail and Cavill 2008) and CMCs' dereliction of duty (Wang et al. 2009), also prevail in practice, reflecting a failure to integrate CMCs' capabilities in contributing to project success. From the perspective of principal–agent theory, the information asymmetry problem in client–consultant collaboration necessitates the efforts to integrate CMCs' capabilities with adequate governance mechanisms (Tufte 1988).

On the other hand, clients face the "make or buy decision" when delegating responsibilities to CMCs (Bausman et al. 2013). They can perform managerial tasks with in-house expertise or assign the tasks to CMCs (Tufte 1988; Yang et al. 2010). According to the transaction cost economics (TCE), clients should align tasks with project participants' advantages to reduce transaction cost (Reve and Levitt 1984). However, in many projects, inappropriate client–consultant responsibility allocation restricts the utilization of CMCs' capabilities. As indicated by the saying that a "management consultant is someone who steals your watch and tells you the time," many clients highly doubt the value of CMCs' contributions to projects (Wang et al. 2009). So they tend to delegate overly limited responsibilities to CMCs, and this results in the widely reported "*underusing consultant*" problem (Rona 1984; Liu et al. 2004).

In essence, these problems are attributed to the lack of an understanding on the merits of CMC services, and how clients' and CMCs' capabilities are integrated in project execution processes (Wang and Huang 2006). As evidenced by many projects, effective collaboration between CMCs and clients can contribute significantly to project success (Hardison et al. 2014). Thus, how to effectively integrate CMCs' capabilities in project execution is an important research topic of both theoretical and practical significance (Liu et al. 2004; Wang and Huang 2006; Shi et al. 2014).

Despite the abundant literature on CMCs, previous studies have predominantly focused on the ex ante selection (Kasma 1987; Ling and Tan 2001) and the ex post performance evaluation of CMCs (Chow and Ng 2007b). Little is known about how clients should manage client–consultant collaboration during project execution (Wang et al. 2009; Shi et al. 2014; Yung and Lai 2008). Informed by the aforementioned challenges, it can be argued that responsibility delegation and capability integration mechanisms need further investigation. To bridge the research gaps, this study aims to address the following key research questions:

Research Question 1: How are clients' and CMCs' capabilities integrated in project execution processes?

Research Question 2: How does responsibility delegation influence capability integration?

Literature Review and the Conceptual Model

CMCs and Their Responsibilities in Construction Projects

With their professional expertise and capabilities, CMCs have long been assuming various responsibilities in construction projects. Since Rona's (1984) seminal study on strengthening client–consultant relationships, many research efforts have been devoted to exploring the roles and responsibilities of CMCs in construction projects. This literature has been dominated by two streams of research from the perspectives of contractual arrangement and performance evaluation.

One stream of studies focused on the role of CMCs prescribed in contracts and proposed to define CMCs' responsibility by contracts. For instance, Charoenngam and Yeh (1999) compared the *FIDIC* and *Taiwanese government conditions*, and analyzed the responsibility allocation among clients, consultants, and contractors. Wang et al. (2009) combined contract document analysis with questionnaire survey to identify the critical liability risks of CMCs. A recent study by Choudhry (2016) further examined the possibility of involving the same consultant to provide consultancy services for both design and construction phases. The other stream of research, however, noted the incompleteness of contracts and analyzed the role of CMCs based on the evaluation of their contributions. Wang and Huang (2006) evaluated the link between overall project performance and CMCs' responsibilities in time and cost control, contract administration, team coordination, etc. Liu et al. (2004) conducted a questionnaire survey to identify the duties of CMCs and the factors constraining their contributions to these duties. A series of insightful studies (Ng and Chow 2004; Chow and Ng 2007a, b, 2010) further modeled CMC evaluation in terms of performing various responsibilities.

These insightful studies explored client–consultant responsibility allocation from the perspectives of CMC selection, contract design, and performance evaluation, as summarized in Table 1. However, client–consultant responsibility allocation is a dynamic system instead of a static contract document (Qiang et al. 2015; Yang et al. 2010). The allocation of responsibilities is subject to

Table 1. Client–Consultant Responsibility Allocation in China and Other Countries

Project phases	Responsibility	Projects in other countries		Chinese projects	
		Client (1)	Consultant (2)	Client (3)	Consultant (4)
Inception	Feasibility study and planning	Cherns and Bryant (1984)	Ng and Chow (2004)	Wang et al. (2013) and Tang et al. (2009)	—
Design	Coordinate design process	Cherns and Bryant (1984)	Liu et al. (2004)	Wang et al. (2013)	—
	Design evaluation	Cherns and Bryant (1984)	Liu et al. (2004)	Wang et al. (2013)	—
Pre-construction	Arrange tender documents	Laryea (2012)	Liu et al. (2004)	Shen and Song (1998)	—
	Contractor qualification	Laryea (2012)	Liu et al. (2004)	Shen and Song (1998)	—
	Tender evaluation	Laryea (2012)	Ng and Chow (2004)	Shen and Song (1998)	—
Construction	Monitor quality and time	Ballard and Rybkowski (2009)	Liu et al. (2004)	Tang et al. (2009)	Yang et al. (2010) and Yung and Lai (2008)
	Cost management	Ballard and Rybkowski (2009)	Liu et al. (2004)	Yang et al. (2010)	Yang et al. (2010) and Liu et al. (2004)
	Safety management	Hardison et al. (2014)	Hardison et al. (2014)	Huang and Hinze (2006)	Wang et al. (2009)
	Monitor contract change	Ballard and Rybkowski (2009)	Liu et al. (2004)	Wang et al. (2013)	Yang et al. (2010)
	Information management	Cherns and Bryant (1984)	Liu et al. (2004)	Yang et al. (2010)	Wang et al. (2009) and Liu et al. (2004)
	Team coordination	Cherns and Bryant (1984)	Liu et al. (2004)	Yang et al. (2010)	Wang et al. (2009)
Completion	Transfer and commissioning	Cherns and Bryant (1984)	Liu et al. (2004)	Tang et al. (2009)	Wang et al. (2009)

Table 2. Milestones in the Evolution History of China's Professional Consultant Industry

Date	Milestone	Implications
1988	Notice on the professional consultant in construction projects	The adoption of professional CMCs was piloted in some major cities
1990	The Lubuge project was successfully delivered	A CMC contributed significantly to the project success, and its role won wide recognition
1995	Provisions on professional construction consultants	The scope and standard of professional consultancy services were defined
1997	Construction law	The role of CMC was legislated
1999	Law on bid invitation and bidding	The procurement of CMC service was legislated
2006	Provisions on the qualifications of professional consultants	CMCs are classified according to their qualification
2007	Provisions on consultancy fee and administration	CMCs' consultancy fees are standardized

both the contract design and the adjustments by delegation (Tufte 1988; Yung and Lai 2008; Yang et al. 2010), which is defined as authorizing specific duties (and the authorities to fulfill them) to CMCs during project execution. Thus, despite the abundant research on responsibility allocation by contracts, how clients should govern client–consultant collaboration by delegation during project execution remains largely unexplored. The analyses on delegation are further complicated by the diversity in contractual arrangements, which make delegation under one contract condition incomparable to that under another (Choudhry 2016; Bausman et al. 2013).

The recent developments in China's construction industry provide a precious opportunity to study responsibility delegation from a managerial point of view. CMCs were first introduced in the late 1980s in the Lubuge Hydropower project. With the help of a CMC under the FIDIC contract, the project achieved great success and demonstrated the value of professional project management (Wang and Huang 2006). Thereafter, the Chinese government formulated a series of laws and regulations to enforce CMCs' roles and responsibilities in construction projects (as listed in Table 2). Previous studies on client–consultant responsibility allocation in the Chinese context are reviewed and summarized in Table 1 for comparison. According to the laws and regulations in Table 2, CMCs' responsibilities are defined in a *four-two-one* paradigm, i.e., monitoring *four* objectives, managing *two* aspects, and coordinating *the whole* project team.

Construction process monitoring involves managing cost, schedule, quality, and safety with CMCs' technical expertise. Contract and information management are the two critical aspects managed by CMCs with their managerial expertise. Coordination management refers to coordinating the collective efforts of the client, designer, contractor, and other project participants. These responsibilities, with a primary focus on project execution, are also evidenced in the Columns 3 and 4 of Table 1. The Chinese government even published a model contract to standardize CMCs' responsibilities. This regulatory framework controls the diversity in contract design, so delegation individually accounts for the diversity in responsibility allocation. Thus, responsibility delegation can be directly investigated in the Chinese context and conceptualized in the *four-two-one* paradigm, as listed in the Appendix.

In practice, the responsibilities delegated to CMCs vary considerably in project execution (Yang et al. 2010). By delegating specific responsibilities to CMCs, clients define the interface in client–consultant collaboration and hence the framework of capability integration. Despite the significant influence of responsibility delegation on client–consultant capability integration, most previous studies were normative or qualitative (Wang et al. 2009; Yang et al. 2010; Yung and Lai 2008). As argued by Qiang et al. (2015), in order to allocate managerial responsibilities to the right party, the capability integration mechanism needs investigating.

Critical Capabilities in Client–Consultant Collaboration

Managing construction projects calls for multifaceted capabilities (Wang and Huang 2006; Hu et al. 2015). In view of the voluminous capability literature and the aim of this study, the literature review focuses on clients' and CMCs' capabilities that are critical to project execution (as listed in Table 3).

The seminal work by Hai et al. (2002) identified CMCs' key capabilities in construction project management and put special emphasis on the technical capability. This was echoed by Wang and Huang (2006), who underlined the importance of the technical and the coordination capabilities of CMCs. Shi et al. (2014), based on opinion survey data, further identified CMCs' roles as impartial decision makers, so their decision making capability is also important.

As for clients' capabilities, there exists more abundant literature on a broader set of capabilities. Cherns and Bryant (1984) studied the client's role in construction management and identified the organizational, professional, and contractual dimensions of capabilities. Too (2011), from the theoretical lens of dynamic capability, supplemented decision making capability as an important dimension, which is especially significant in changing project

Table 3. Clients' and Consultants' Key Capabilities in Their Collaboration

	Previous studies on the capability	
Capability	Client	Consultant
Obtain scarce resource	Wang et al. (2013)	—
Technical capability	Cherns and Bryant (1984), Too (2011), Guo et al. (2014), Wang et al. (2013) and Liu et al. (2004)	Hai et al. (2002), Wang and Huang (2006), Wang et al. (2009) and Shi et al. (2014)
Coordination capability	Cherns and Bryant (1984), Too (2011), Wang et al. (2013), Liu et al. (2004) and Guo et al. (2014)	Hai et al. (2002), Wang and Huang (2006), Wang et al. (2009) and Shi et al. (2014)
Decision making capability	Too (2011), Wang et al. (2013) and Guo et al. (2014)	Wang et al. (2009) and Shi et al. (2014)
Strategy and planning	Wang et al. (2013)	—
Organization learning	Too (2011)	—

environment. Comparative case analyses by Guo et al. (2014) further evidenced the importance of decision making by identifying two distinct governance choices of project decision making. A thorough literature review by Wang et al. (2013) on client's capabilities identified a four-dimensional capability model, which has been widely accepted in subsequent studies.

As shown in Table 3, the two sets of capabilities mainly overlap in technical, coordination, and decision management dimensions, which are the major capabilities in terms of managing the construction phase (Guo et al. 2014). This, to a large extent, originates from the overlap of their roles and responsibilities in projects (Yang et al. 2010). Therefore, the intersections of clients' and consultants' capabilities are the capabilities integrated in their collaborations and hence the subject of this study.

Technical capability includes professional skills, knowledge, and project experience (Hu et al. 2015). The technical capability enhances the understanding of project complexity and facilitates effective risk management (Dikmen et al. 2005). As Dainty et al. (2005) pointed out, managing projects calls for a grasp of the technologies used in the projects. The breadth of knowledge is more important than the depth because multidisciplinary knowledge enables cross-functional communication and resource integration (Dainty et al. 2005).

Coordination capability refers to efficient coordination of the dependencies among multiple project participants, primarily in terms of conflicts, communication, and goal alignment (Shen and Chang 2011). From the network perspective of projects, it enables clients/CMCs to hold central positions in project organizations. Acting as the coordinators of project teams, clients/CMCs are able to mobilize resources, synthesize information, and make more informed decisions (Wang et al. 2013).

Decision making capability involves making decisions in projects in a timely and informed manner. During project execution, clients and CMCs need to make numerous decisions, often with incomplete information and substantial uncertainty (Qiang et al. 2015). The quality and timeliness of the decisions have considerable influence on project outcomes (Guo et al. 2014; Wang et al. 2013).

Processes Capability as the Consequence of Capability Integration

According to the theory of temporary project organization, clients' and CMCs' capabilities are integrated in project management processes and collectively contribute to project performance (Lundin and Söderholm 1995). However, the overall project performance is not the immediate consequence of client–consultant capability integration because project condition factors (such as external risks) also significantly influence project outcomes (Qiang et al. 2015). Thus, a set of critical success factors (CSFs), which conduce to project success regardless of project conditions, have been frequently studied to reflect the effectiveness of capability integration (Inayat et al. 2014). Many previous studies alluded to the importance of process capabilities from the theoretical lens of organizational effectiveness (Dikmen et al. 2005), dynamic capability (Davies and Brady 2016), and project organization design (Qiang et al. 2015).

Process capability, having its root in manufacturing processes management literature, describes the quality and effectiveness of processes in terms of delivering the desired products (Kane 1986). From the perspective of business process re-engineering (BPR), high performance processes enable dramatic business growth (Hammer and Champy 1993). In the construction project setting, project process capability is a critical dimension of project organization effectiveness reflecting the ability to effectively deliver processes in various project conditions (Dikmen et al. 2005). Key aspects of process capability—process flexibility, risk allocation, and responsibility alignment—are the major concerns in project organization design (Thanh Luu et al. 2003; Mahdi and Alreshaid 2005; Qiang et al. 2015).

Process flexibility refers to the flexibility of project organization processes in adapting to complexity, coping with changes, and sharing information. It reflects the project team's capability in accommodating dynamic external project conditions (Osipova and Eriksson 2013). Flexibility is also the most pronounced advantage of project teams over traditional hierarchical organization structure (Turner and Müller 2003). Retaining process flexibility in project teams is pivotal for project success.

Responsibility alignment and risk allocation, on the other hand, mirror the internal adaptability of processes (Van Der Merwe 2003). Properly aligning tasks with participants' capability advantages clarifies the responsibilities in project processes and fully utilizes participants' capabilities. Similarly, appropriate risk allocation involves effective risk planning, allocating, and controlling to align the risks with those most capable of managing them.

Taken together, the three dimensions of process capabilities reflect how effective project teams can adapt to various project conditions and contribute to project success. Thus, following Davies and Brady (2016), this research investigates project process capability as the consequence of capability integration. Currently, empirical investigations on client–consultant capability integration and process capability are lacking in the construction project setting (Yung and Lai 2008). This induces the confusion on how clients and CMCs contribute to project process capability and, furthermore, the necessity of involving CMCs (Liu et al. 2004). In fact, project management processes embody the responsibility delegation system and formulate the framework of capability integration. So it can be expected that process capability originates from participants' capabilities. In response to the research gaps, this study tests the following hypotheses empirically.

Hypothesis 1: Clients' capabilities have a significant positive impact on project process capability.

Hypothesis 2: CMCs' capabilities have a significant positive impact on project process capability.

The governance of client–consultant collaboration is subject to the transaction cost theory (Müller and Turner 2005; Yung and Lai 2008), and clients face the "make or buy decision" when delegating responsibilities to CMCs. By delegating more responsibilities to CMCs, clients can better utilize CMCs' professional capabilities, although they have to deal with the problems of information asymmetry. On the other hand, by assuming more responsibilities themselves, clients make more direct contributions to projects, whereas they limit the utilization of CMCs' capabilities and have to invest more human resources (Yung and Lai 2008). In this light, it is reasonable to expect that responsibility delegation influences capability integration and moderates the effects of participants' capabilities on process capabilities.

Hypothesis 3: Delegating more responsibilities to CMCs negatively influences (moderates) clients' contributions to project process capability.

Hypothesis 4: Delegating more responsibilities to CMCs positively influences (moderates) CMCs' contributions to project process capability.

Fig. 1 illustrates the conceptual model and the hypotheses. By analyzing the hypothetical relationships (H1–H4) in the conceptual model, Research Questions 1 and 2 can be competently answered. So the subsequent sections focus on testing the model empirically.

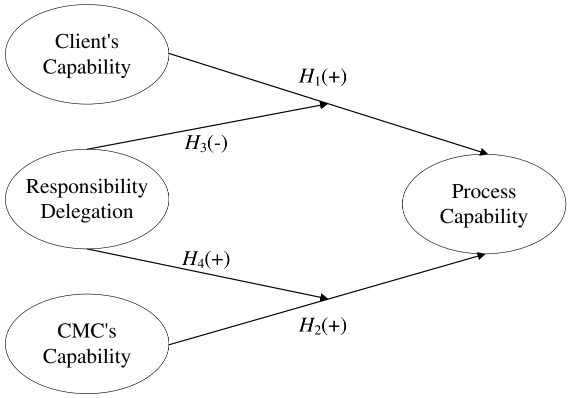


Fig. 1. Conceptual model of capability integration and responsibility delegation

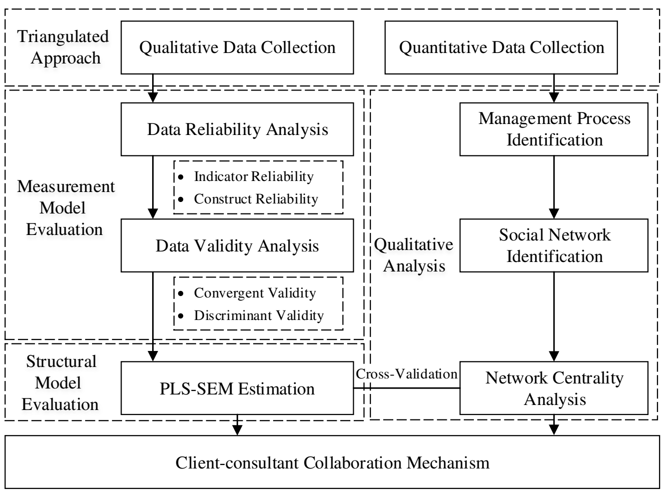


Fig. 2. Empirical analysis routine

Research Methodology

Heeding the call for combining mixed methods in construction management research (Pinto and Patanakul 2015), this study adopted both quantitative and qualitative methods, detailed as follows, to obtain robust empirical findings. Fig. 2 illustrates the routine of the empirical analysis.

Data Collection Using Triangulated Approach

To enable both qualitative and quantitative data collection, a questionnaire survey, interviews, and direct field observations were combined to achieve data triangulation.

The questionnaire survey was the principal quantitative data collection approach. Derived from the conceptual model, the questionnaire includes three parts. The first part describes the fundamental research aim and topic. In the second part, Likert scales were applied to extract data on clients' capabilities, CMCs' capabilities, responsibility delegation, and process capability. Respondents were asked to recall the last project they participated in and rate the questionnaire items (see Appendix), which were based on established measures in previous studies as elaborated previously in the literature review section. The last part asks about the questionnaire respondents' background information, such as organization positions and work experience. A pilot survey to experienced project managers was conducted, and revisions were made to ensure the applicability of the questionnaire.

Tibet was chosen as the study area for the following three reasons. First, the extreme natural environment in Tibet intensifies technical complexity and brings severe challenges to project management. These challenges need to be tackled with more effective client–consultant collaboration, so hydraulic engineering projects in Tibet better embody the importance of capability integration processes. Second, to address the shortage of management staff, CMCs were employed, and client–consultant capability integration existed in every project. Third, the water conservancy department administrates the clients of most (if not all) hydraulic engineering projects in Tibet, providing a convenient access to the majority of experienced practitioners in this area.

As indicated in previous studies, the response rate of postal questionnaire surveys in China is extremely low (Liu et al. 2004). So the survey was conducted by fieldwork. Questionnaires were distributed to the staffs in hydraulic engineering projects in Tibet with the help of the Tibet Water Conservancy Department. The authors acted as survey coordinators to directly contact with the survey respondents and assist them in completing the questionnaires. In this way, the authors ensured that the respondents understood the questions and gave responses. The first round of field survey resulted in only 70 responses because there are limited projects and practitioners in this area and some practitioners were on business trips to distant project sites. In order to enlarge the sample size and enable statistical model testing, the authors conducted a second round of questionnaire survey, which obtained another 12 responses from practitioners on project sites. Among all 82 responses, 9 responses were incomplete or obviously erroneous; 13 responses from respondents with less than 2 years' experience or not familiar with project management were also dropped to retain more valid information. As a result, a total of 60 responses were valid, achieving a valid response rate of 73.2%. Considering the number of exogenous variables and construct indicators in the model, the sample size satisfies the thresholds suggested by Hair et al. (2013) and Wong (2013). The relatively small sample size is typical in studies on hydraulic engineering projects because of the large scale and the limited number of projects (De Marco et al. 2015; Wang et al. 2013). Descriptive statistics on the questionnaire respondents were presented in Table 4. With 73% of the respondents having more than 5 years' experience and 30% of them having more than 10 years' experience, the sample is representative and can reflect current practices in the industry.

To compensate for the weakness of the limited sample size and derive robust findings, the authors conducted an in-depth case study on a megascale hydraulic engineering project. Face-to-face interviews with senior managers were conducted following the questionnaire survey to elicit their insights on the client–consultant relationship. Project documents were reviewed to facilitate direct observations and in-depth understandings. Several trips to the project site were also made to collect longitudinal data during the pre-construction and construction stages.

Social Network Analysis on Client–Consultant Collaboration Processes

Based on the relationship data of a set of actors, social network analysis (SNA) provides a holistic picture of the interactions among them and derives centrality measures indicating the importance of actors in the network (Freeman 1978). The collaboration relationships between project participants constitute a dynamic network evolving during the whole project lifecycle. Project management processes embody the collaboration relationships across

Table 4. Descriptive Statistics of the Questionnaire Respondents

Characteristic	Category	Number of respondents
Positions	Organization director	6
	Department manager	12
	Project manager	15
	Chief engineer	6
	Engineer	43
Work experience (years)	<2	12
	2–5	10
	5–10	35
	>10	25
Project management knowledge level	Mastered	26
	Proficient	35
	Familiar	15
	Not familiar	6
Role in project	Client	48
	CMC	12
	Contractor	22

organizational boundaries. Thus, SNA was performed on the collaboration relationships in project management processes with a particular focus on the collaboration between the client's functional departments and the CMC.

As elaborated previously, a megascale hydraulic engineering project was chosen as the case project (referred to as *Project L* hereinafter). The authors interviewed all the functional department managers of the client and the directors of the CMC. The interviews elicited the interviewees' responses on the following questions:

1. What are the major management processes your department participates in?
2. Which type of role does your department play in each process, a coordinator or merely a general participant?
3. What are the major difficulties in managing these processes, and how, from your perspective, should the processes be improved?

Because of the richness of the interview topics, it takes about 2 h for a typical interview, and the researchers spent 7 days at the project site to fulfill all the interviews. Based on the responses to the questions, the researchers identified the project management processes and represented them with flow charts. In order to validate the interview data, one of the researchers further stayed at the project site for a month to collect project documents, interview other project participants, and directly observe project management processes. Several seminars were also held with the directors of the client to make comments and revisions to the chart of representations of the management processes.

For each identified management process, a collaboration network tie is defined as the relationship between the process coordinator and each process participant because they directly collaborate with each other in the process. In this way, a social network reflecting the collaboration in project management processes was constructed. Based on the collaboration network, the centrality indicator was calculated for each participant to measure their relative importance in the network. In this study, the eigenvector centrality is adopted because it provides a measurement of a node's importance considering the importance of its neighbors and the weights of the network ties (Bonacich 1987).

Combined with the qualitative analyses on the interview data, SNA results constitute an exploratory examination of the conceptual model. Statistical analysis was performed in parallel to obtain more robust findings.

Partial Least Square-Based Structural Equation Model (PLS-SEM)

Structural equation modeling (SEM), a second-generation multivariate analysis method, has quickly pervaded the whole construction management field in the past decade (Xiong et al. 2015). Compared with multiple regression and other traditional statistical methods, the strengths of SEM include, but are not limited to:

1. Modeling complex causal relationships and conveniently translating the model into equations;
2. Facilitating simultaneous analyses on direct and indirect effects; and
3. Allowing for measurement errors.

In view of the model complexity and the inevitable measurement errors in the questionnaire survey data, SEM is well-suited for the research purpose. Several alternative methods can be adopted to estimate SEM, including a covariance-based method (CB-SEM), PLS-SEM (also known as the variance-based method), and other emerging estimation methods (Wong 2013). Among them, PLS-SEM has the advantages of incorporating formative and reflective constructs simultaneously, coping with non-normal data conveniently, allowing for small sample size, and being prediction- and exploration-oriented. In this study, these advantages exactly fit in with the relatively small sample size, the model specification, and the research purpose of conceptual model testing.

Exploratory Case Analysis on Project L

Research Context

We selected *Project L* as a case of client–consultant collaboration in view of its background and representativeness. *Project L* is composed of one dam, two hydropower plants, three tunnels, and four irrigation zones. The capacity of the reservoir is 291.7 million m^3, and the total irrigation area is 160.8 km^2. It is critical to the development of agriculture and in turn improving the living standard of local minorities. Because of its scale and political sensitivity, it is managed as a major hydraulic engineering development project under the direct administration of the water conservancy department and the provincial government of Tibet. An individual project corporation, *Project L Management Bureau*, was established to act as the project client. The whole project is delivered by the traditional Design–Bid–Build (DBB) method. In view of the harsh project conditions and the lack of professional staff in the client organization, a CMC was hired to assist in construction management. The CMC and the contractor were chosen by competitive bidding, except for the contract of a tunnel, which requires a special construction technique and was awarded by negotiated bidding.

Project L Management Bureau includes seven functional departments, i.e., Integration Management Department (InMD), Finance Management Department (FMD), Immigrant Management Department (ImMD), Contract Management Department (CMD), Engineering Management Department (EMD), Chief Engineer's Management Office (CEMO), and Director's Management Office (DMO). Project management processes are mainly carried out by these departments together with the three major external participants, i.e., the contractor, the CMC, and the designer. So this study took individual departments and external participants as the units of analysis. As mentioned previously, a collaboration network tie is considered to exist between the process coordinator and each process participant. Based on the collaboration relationships in all project phases, the collaboration network of *Project L* was constructed as shown in Fig. 3.

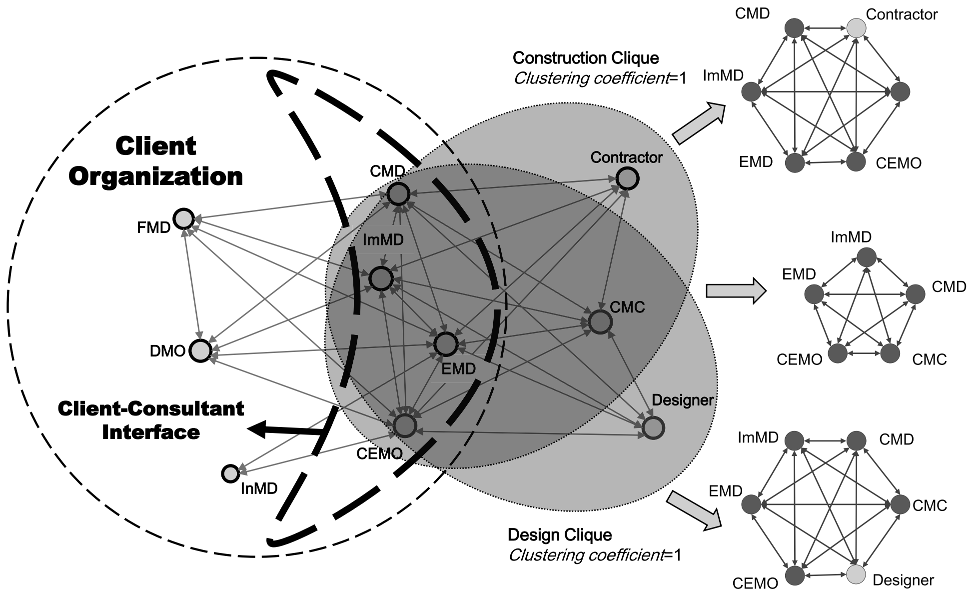


Fig. 3. Collaboration network of Project L

Collaboration Network Analysis

Fig. 3 clearly reflects the core–periphery structure in the collaboration network. ImMD, CMD, EMD, and CEMO are located at the core of the network, whereas other nodes are scattered around them, forming the project management working constellation (Winch 2014). The four core departments also completely mediate the relationship between other client departments and the external project participants, and hence constitute the interface in client–consultant collaboration. Within the client organization, all the departments, except for InMD, form a network clique (a complete subgraph, *clustering coefficient* = 1). The emergence of a clique indicates the intimate collaboration relationships among the clique members (Freeman 1978; Pauget and Wald 2013). The clique structure in the client organization coincides with the fact that InMD is a supportive department and hardly participates in construction management. So the subsequent qualitative analysis focuses on the interview data from the core departments.

The designer, the CMC, and the four core departments form another clique corresponding to the collaborations in design management (named the *design clique*). Similarly, the contractor, the CMC, and the four core departments are also fully connected with each other as the major participants in construction management (the *construction clique*). The overlap between the *design clique* and the *construction clique* is the clique including the CMC and the four core departments. This again suggests that the CMC acts as an important assistant of the client in management processes. However, the network in Fig. 3 is merely a general and intuitive picture of client–consultant collaboration considering the processes in all project phases. Dynamic network analyses should be performed to obtain an in-depth understanding of the collaboration processes in each project phase.

For each project phase, the collaboration network was derived based on the processes in that phase and calculated the eigenvector centrality of each node, as summarized in Fig. 4. Five network centrality evolution patterns can be observed. First, the centrality of EMD stays at a high level, implying its important role in coordinating the management processes in all project phases. Second, the centrality values of DMO and FMD stay at a low level in all phases. This can be attributed to the fact that they are the decision makers in the early project phases and act as the participants (administrators) of processes rather than the coordinators unless major project changes happen. The interviews with the two departments further revealed that, although they are not the coordinators in project management processes, they are the gatekeepers reporting directly to the upper administrators. Third, the centrality values of some participants only peak in a specific phase. For example, CEMO's and CMD's centrality indices peak in the pre-construction and the bidding phases respectively, corresponding to their primary obligations. Fourth, the importance of ImMD and the designer manifests a U-shaped trend. They are important coordinators of the early phases, and after that, there is a sharp decline in centrality values followed by a moderate uptrend. Fifth, the CMC and the contractor are becoming increasingly pivotal in the processes of construction and commissioning phases. This is intuitive because they are the major participants in the two phases.

The network analysis results clearly map the collaborations in the temporary project organization across the boundaries of permanent organizations. According to the social network theory (Freeman 1978), the centrality indicator reflects control and influence, which, in this context, translate to the participants' ability to make contributions to project processes. The process system reflects each participant's role as coordinator or general participant and embodies the responsibility delegation framework. Thus, the network analysis results can be understood with respect to capability integration and responsibility delegation in project execution.

As shown in Fig. 4, the centrality values of CMC and EMD are relatively high during project execution. This implies potential support to *Hypotheses 1* and *2* because with higher centrality and influence in the network they may be more able to contribute to management processes. The centrality of EMD, individually, is higher than CMC during project execution, so it can be expected that the client's capability can be integrated more efficiently, i.e., *Hypothesis 1* should be more significantly supported than *Hypothesis 2*. Moreover, if CMC is delegated with more responsibilities, it will become the coordinator of more processes and hold a more central position in the network. In this way, the CMC's network influence will grow, and as a result, its contributions to process capability may increase, whereas the client's influence and contributions may decrease. This suggests support for the moderation

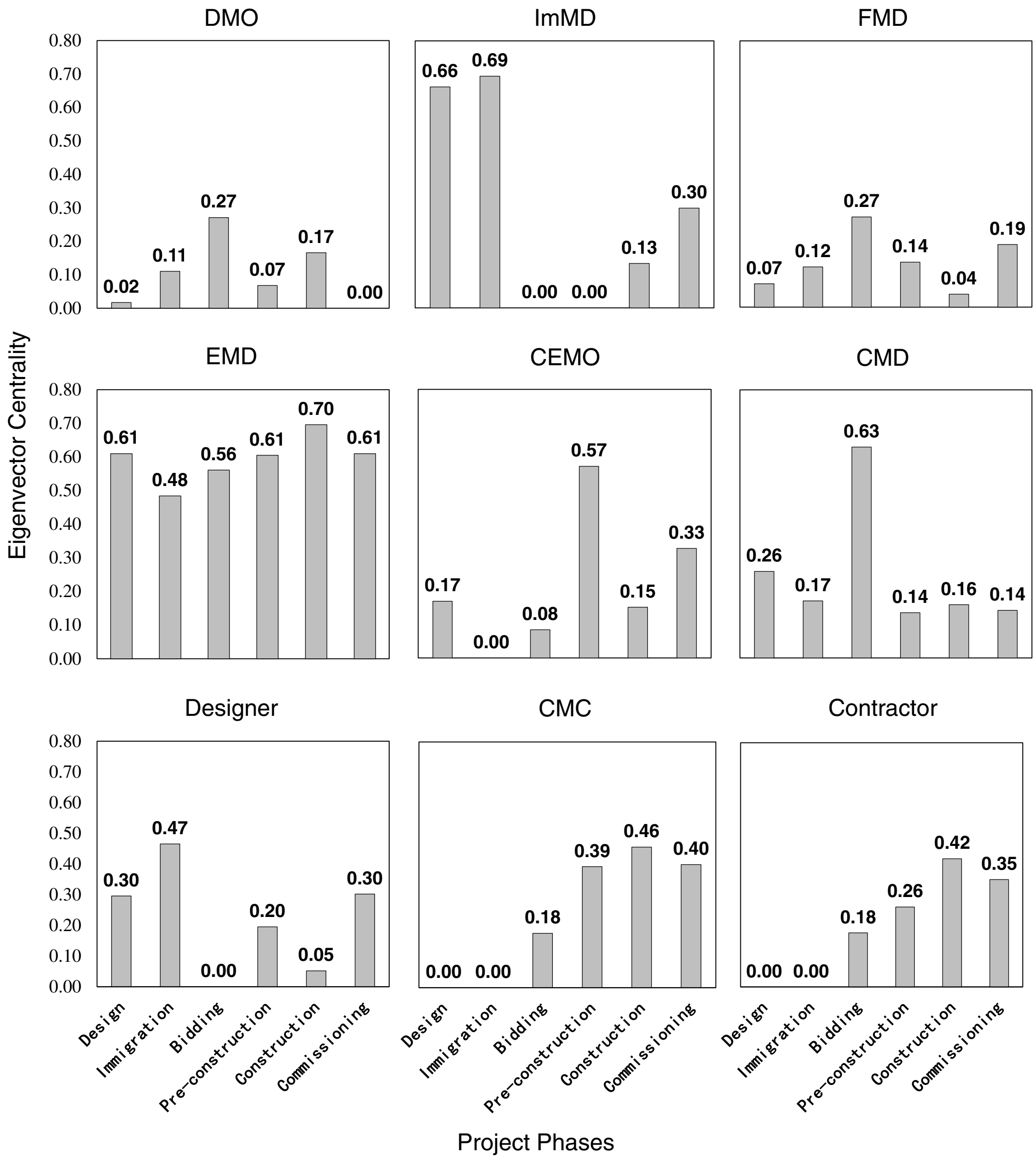


Fig. 4. Eigenvector centrality of participants in different project phases

effects in *Hypotheses 3* and *4*. Based on these implications, a preliminary judgement on the hypotheses was obtained, whereas more direct statistical examinations should be performed.

Qualitative Analysis Results

During the interviews with the managers of the client, CMC, and designer, client–consultant collaboration is the major topic attracting the interest of both the researchers and the interviewees. This enables the elicitation of insights on client–consultant capability integration, responsibility delegation, and their effects on process capability.

Hypothesis 1: Client's capability → Process capability

According to the interview data, *Hypothesis 1* is supported in that the project client's strong capability has a significant positive effect on project process capability, for example:

> Client's EMD manager: "We are in charge of nearly all aspects of project management, including project quality, cost, safety, investment, and make significant contribution to management processes … by staff training programs and employing temporary staff, our capabilities are increasing during project execution. So we are improving our management of project processes" **(strong support).**
>
> Chief CMC engineer: "The client is making adequate efforts to achieve project success and manifested sufficient expertise in this process … Their competence is the major determinant of project success within the current responsibility allocation framework" **(strong support).**
>
> Designer's on-site representative: "Client's capability is relative strong compared with the CMC, and client plays a pivotal role in improving project management efficiency. We often choose to directly contact with them to improve coordination efficiency" **(strong support).**

These statements suggest that client's capability contributes to management processes, and that increases in client's capability contribute to process capability improvements, providing strong support to Hypothesis 1.

Hypothesis 2: CMC's capability → Process capability
Because of the harsh natural environment and the underdeveloped local construction market, it is difficult to recruit experienced CMC engineers. The CMC's capability is relatively weak, and interviewees' opinions diverge in terms of CMC's contributions to management processes:

> Client's Director: "We (the client) hire them (the CMC) to assist in management processes, so we try to fully utilize their capability, however, their contributions are less significant than expected" **(weak support).**
>
> Client's EMD manager: "Because the number of staffs is limited in my department, I put every effort to involve the CMC engineers in management processes. Thus, despite the limitation in capability, they (the CMC) made some contributions indeed" **(weak support).**
>
> Chief CMC engineer: "As the professional consultant of the project, we fulfilled all the works appointed by the client and is making our own contributions to the project . . . To be honest, I admit that currently our capability is limited, especially in terms of technical capability. However, this is attributed to the insufficient management fee paid to us. In view of the harsh natural environment and the insufficient fee, experienced engineers in our company are reluctant to work here" **(strong support).**
>
> Designer's on-site representative: "The CMC engineers are surely making contribution to the project. But the lack of capability and delegation from client limit their contributions" **(weak support).**

Except for the chief engineer of CMC, other interviewees only weakly acknowledged the contributions of CMC in project management. However, there is a wide consensus that stronger CMC capability can better contribute to project processes, indicating weak support to *Hypothesis 2*.

Hypothesis 3: Responsibility delegation → The effect of client's capability on project process capability
Interview data also provide mixed evidence on this moderation effect, for example:

> Client's deputy director: "In view of the consultant's capability, I consider it risky to delegate too many responsibilities to them, and we have been restricting our delegation to them. If they fail to carry out the work as expected, it may be more difficult for us to remedy the situation" **(weak support).**
>
> Chief CMC engineer: "The client and the CMC are collaborators but not competitors. In view of the lack of staffs in the client's and our organizations, we need more collaboration to compensate each other's inabilities . . . The client can delegate more responsibilities to us and focus on more important administrative issues. Our responsibilities do NOT necessarily fully overlap!" **(no support).**

During project execution, client's delegation to CMC has been decreasing. It is not surprising that the chief CMC engineer complains about this. The effects of this responsibility delegation strategy on client's capability utilization remains to be further examined by quantitative analyses.

Hypothesis 4: Responsibility delegation → The effect of CMC's capability on project process capability
This moderation effect also provoked heated discussion during the interview. Some interviewees expressed the concern that, although delegated with more responsibilities, the incapable CMC may still fail to make more contributions. The majority of interviewees, however, underlined the necessity of better integrating CMC's capability by more delegation, collaboration, and trust.

> Client's CMD manager: "My department suffers severely from the lack of experienced staff, and we highly expect the help from some external entities. And I think if the CMC can assist in contract management, the situation will be much better" **(weak support).**
>
> Client's EMD manager: "I put every effort to involve the CMC engineers in management processes to help us. To do this, I adopt a matrix organization form in my department. I divide the whole project into subprojects managed by subproject managers. I also assign line managers responsible for schedule, safety, and quality. In this way, I use my staffs more efficiently, because CMC engineers can assist us in quality and safety management, while my staffs can focus on the administration work. By this delegation system, we can better monitor the construction processes with less effort. In the future, I think we can better utilize CMC's capability by delegating adequate responsibility to them" **(strong support).**
>
> Chief CMC engineer: "In view of the harsh natural environment and the insufficient fee, experienced engineers in our company are reluctant to work here. Also, I'm not finding excuse for our limited contributions to the project, but if delegated with more authorities, I believe, we can do much better" **(strong support).**
>
> Designer's on-site representative: "Unlike the CMC in most of the projects I have participated, the CMC in this project are delegated with overly limited responsibilities. I think that if delegated with more authority, they can do better" **(strong support).**

The limited contribution of the CMC engineers impairs the client's trust in them, reduces the client's willingness to delegate responsibilities to them, and in turn further restricts their contribution to projects. The self-enforcing less contribution–less delegation vicious cycle is the major barrier in utilizing professional consultancy services (Liu et al. 2004). This phenomenon is very common in China's construction industry, as echoed by nearly all the interviewees.

The earlier evidential examples provide varying support to the model hypotheses. However, the results are not definitive because there is a lack of counterfactuals or the counterfactuals are merely perceptual. Therefore, statistical model testing was performed to obtain more conclusive results.

Explanatory PLS-SEM Analysis

Measurement Model Evaluation

As shown in Fig. 2, the reliability and validity of the measurement model were evaluated with *SmartPLS* and *Statistical Product and Service Solutions* (*SPSS*). First, because the items were aggregated to derive the indicators, the internal consistency reliability of the items should be tested to justify item aggregation. The Cronbach's α of each construct was calculated. As listed in Table 5, the results indicate satisfactory reliability above the threshold level of 0.7. Second, the composite reliability (CR) of reflective constructs is a measurement of construct reliability specific to PLS-SEM (Hair et al. 2013). *Processes capability*, the only reflective construct in the model, has a composite reliability of 0.892, well above the 0.7 threshold. Third, the convergent validity of reflective and formative constructs are typically tested with average variance extracted

Table 5. Construct Reliability and Validity Test

Constructs	α	Composite reliability	Redundancy	Average variance extracted	1	2	3	4
Client's capability	0.761	—	0.791	—	—	—	—	—
CMC's capability	0.854	—	0.878	—	0.296	—	—	—
Responsibility delegation	0.837	—	0.769	—	0.317	0.057	—	—
Processes capability	0.817	0.892	—	0.733	0.697	0.423	0.294	0.856

(AVE) and redundancy analysis, respectively. The results listed in Table 5 indicate strong validity with redundancy and AVE values above 0.7 (Hair et al. 2013). Fourth, the discriminant validity of reflective constructs is tested by the Fornell–Larcker criterion (Fornell and Larcker 1981), which compares the square root of the AVE values with the latent variable correlations. As shown in Table 5, the largest correlation between *Process capability* and other constructs is smaller than the square root of its AVE (0.697 < 0.856), which indicates satisfactory discriminant validity. Fifth, because formative constructs are estimated as the linear combination of their indicators, the collinearity problem should be tested. The variance inflation factors (VIFs) of the indicators range from 1.408 to 3.457, below the threshold level of 5.000 (Wong 2013). Thus, the collinearity problem is not a concern.

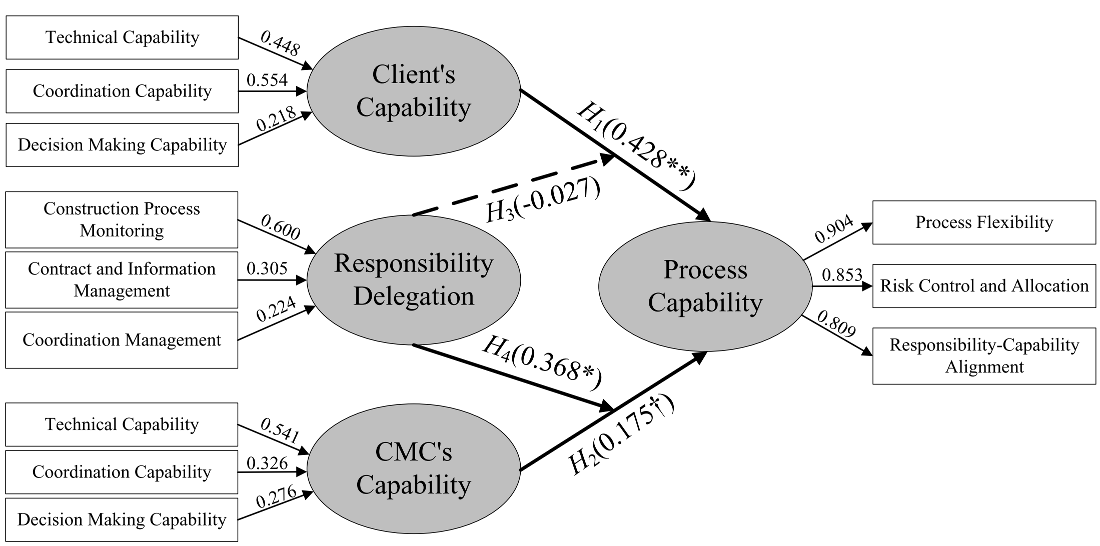
Taken together, these results indicate that the measurement model of the PLS-SEM is reliable, valid, and eligible for further structural model estimation (Hair et al. 2013).

Structural Model Estimation

By the Bootstrapping PLS algorithm in *SmartPLS*, the structural model was estimated, and the obtained results are presented in Fig. 5. Unlike CB-SEM, which provides various overall goodness-of-fit (GoF) indices, PLS-SEM analysis results are assessed on the basis of heuristic criteria.

First, similar to the formative measurement models, the collinearity problem of the predictor constructs was examined by VIF values for each endogenous construct (*Process capability* in this model). The VIF values range from 1.164 to 1.765, indicating no significant collinearity problem. Second, because of its predictive orientation, PLS-SEM should have sufficient predictive ability. The predictive accuracy of the model in terms of the endogenous construct was evaluated by the coefficient of determination (R^2). The R^2 value of the model is 0.609, and according to Hair et al. (2013), this result is satisfactory with moderate predictive accuracy. Third, in addition to predictive accuracy, predictive relevance is another indicator measuring predictive ability in terms of endogenous indicators. By the cross-validated redundancy blindfolding approach, the Stone–Geisser's Q^2 values were calculated. With a Q^2 value of 0.395, the structural model has a large predictive relevance (Hair et al. 2013). In this light, the PLS-SEM results achieved satisfactory overall model fit, and hence, the interpretations of the path coefficients are meaningful.

According to the model results illustrated in Fig. 3, *Hypothesis 1* is supported in that client's capability has a significant positive effect on project process capability. *Hypothesis 2* is only weakly supported with a marginally significant coefficient at the 0.1 level. This suggests that clients contribute much more directly and significantly to process capability than CMCs, coinciding with the findings of the case study. It is interesting to find that *Hypothesis 3* is not supported. It means that delegating responsibilities to consultants does not significantly restrict clients' contributions to process capability. Based on the quantitative results and the majority of the qualitative results, *Hypothesis 3* is not supported empirically. So appropriate responsibility delegation can better utilize the CMCs' capability while not reducing clients' contributions. *Hypothesis 4* is supported with a significant positive moderation effect. So when delegated with more responsibility, CMCs can contribute more significantly to process capability. By comparing the indicator weights of the constructs, it can be found that coordination capability is the most important for clients with the highest weight, CMCs' technical capability is the most prominent, and construction process



Note:†*denotes significance level p<0.1*; **denotes p<0.01*; ***denotes p<0.001.*

Fig. 5. PLS-SEM estimation results

monitoring is the most important aspect of responsibility delegation. This corroborates the qualitative analysis results.

Discussions

Implications for the Research Questions

Based on the qualitative and quantitative analysis results, the two key research questions can be answered.

First, as for how capabilities are integrated in client–consultant collaboration (*RQ1*), the network analysis implied the high potential for clients and CMCs to contribute to process capability with central network positions. The PLS-SEM results substantiate this and further suggest that clients' contributions are more direct and significant in project execution. The interview data also corroborate this with strong support. Theoretically, the conceptual model, verified by empirical data, substantiates the theory of temporary organization in terms of client–consultant capability integration. It is also interesting to find that several client's departments constitute the interface in client–consultant collaboration and hold central positions in the project organization (Winch 2014). These findings clearly illustrate the capability integration mechanisms and are in line with previous studies that indicate project teams' capabilities originate from project participants' capabilities (Lundin and Söderholm 1995; Turner and Müller 2003; Pauget and Wald 2013). This responds to the call for investigation on project organizing as a temporary configuration of permanent organizations (Winch 2014).

Second, as for how responsibility delegation influences capability integration (*RQ2*), the PLS-SEM results suggest that if delegated with more responsibilities, CMCs can contribute more to process capability. When delegated with more responsibilities, CMCs will coordinate more processes and hold more central positions in the collaboration network. Therefore, they can exercise more control and influence in the project team, and better utilize their capabilities. Surprisingly, clients' contributions to process capability do not significantly decrease with more responsibilities delegated to CMCs. This implies that clients can better utilize CMCs' professional consultancy services by delegating more responsibilities and, at the same time, not affect the utilization of their own capabilities. Although it is counterintuitive, it can be understood with respect to the status quo of China's construction industry. The *big client–small consultant* culture is prevailing and makes clients unwilling to delegate responsibilities to CMCs, even though some processes can be coordinated more efficiently by CMCs (Qiang et al. 2015). Thus, this study substantiates the proposition to better utilize CMCs' capabilities by more delegation (Liu et al. 2004; Kartam et al. 2000). It responds to Peled and Dvir's (2012) call for a contingent theoretical perspective to capture the effects of responsibility delegation as a moderator of capability integration. By identifying delegation as a channel to motivate CMCs, the findings supplement Adam's equity theory of motivation, which suggests enhancing motivation by rewards (Ling 2004). In this light, merely increasing the consultancy fee does not necessarily translate to higher consultancy service quality, although adequate delegation is also essential.

Practical Implications and Exploitation

The major practical implication is that proper responsibility delegation can better utilize CMCs' capabilities without restricting clients' capability utilization. The researchers exploited it in the management processes of *Project L*.

Based on the empirical findings and on-site observations, the researchers redesigned the project management process system for *Project L* to improve client–consultant collaboration. Given the lack of staff in the client organization, the researchers proposed to delegate more responsibilities to the CMC (known as the *big consultant–small client* mode, Yang et al. 2010), especially in the subprojects with less complexity. On the other hand, considering the limitations in the CMC's technical capability, it was suggested that the most important subproject (the dam construction project) should still be directly managed by the client (known as the *big client–small consultant* mode, Yang et al. 2010). With the help from the CMC in those less complex subprojects, the client can concentrate on managing the most important subprojects and put its own capability to the best use. The researchers wrote two reports to elucidate the problems in current management practices and describe the proposed management process system. The reports were submitted to the director of *Project L Management Bureau*. The director highly appreciated them. One of the researchers was invited to work with him as his secretary to help embed the process system in the daily management practices of *Project L Management Bureau* and make necessary revisions. During the second trip to the project site, the researchers observed salient improvements in management practices, especially the performance of CMCs.

The management process re-engineering of *Project L* acts as a quasi-experiment to examine the research findings. The improvements in the client–consultant collaboration of *Project L* demonstrate the applicability of the implications in project management practices.

Conclusions and Future Studies

Effectively managing and utilizing CMCs' capabilities underpin the success of project execution processes and, furthermore, promote the development of the professional consultant industry. This study derives a better understanding of capability integration and responsibility delegation in client–consultant collaboration. Based on the mixed methods, the empirical findings suggest that both clients' and CMCs' capabilities contribute to project process capability, whereas clients' contributions are more direct and significant; delegating more responsibilities to CMCs makes CMCs' capabilities contribute more significantly to process capability and does not significantly affect clients' contributions. By answering the two research questions empirically, the findings of this study clarify the mechanisms of capability integration and responsibility delegation in client–consultant collaboration.

The major theoretical contribution of this study is that it sets the agenda for developing a process-based model of client–consultant governance. First, future studies can utilize the empirical analysis paradigm, based on the combination of mixed methods, to study more fine-grained client–consultant collaboration processes and capability integration in the processes. Second, informed by the moderation effect of delegation on capability integration, actionable rules can be developed in future research to decide which participant best undertakes specific responsibilities. Third, the analysis of capability integration mechanisms can also be extended to incorporate other participants (e.g., contractors and suppliers), who also contribute to project success.

In practice, the findings suggest that clients, especially Chinese clients, should abandon the *big client culture*, and better utilize CMCs' professional consultancy services by delegating more responsibilities to CMCs. In this way, CMCs can make more substantial contributions to project management processes not necessarily at the cost of limiting clients' contributions. However, this by no means suggests that clients should lose control of projects. In contrast, what is suggested for clients is not to give up their salient roles in projects, but to switch their roles and focus on more important issues. The switch of the client's role is a feasible solution to breaking the aforementioned *less contribution–less delegation vicious cycle* as demonstrated by the management process re-engineering of *Project L*.

The findings and implications of this study should be viewed with respect to its limitations. First, because of the research context, the empirical analysis is only based on a small sample from Tibet hydraulic engineering projects. This makes the study a unique contribution to project management under harsh project conditions, but also limits the generalizability of the findings. For example, in countries where the *big consultant–small client* culture prevails, more clients' participation may be appreciated (*Hypothesis 3* may be supported). So caution should be taken when applying the findings to projects in other contexts. Subsequent studies are surely needed to test the capability integration model with empirical evidence in other contexts, especially where consultants already play a very central role in megaprojects. Second, specific to the scope of Chinese CMCs' responsibilities, this study focuses on CMCs' contributions to project execution. Capability integration mechanism in other aspects of project management can also be investigated for consultants undertaking a broader set of responsibilities. Third, this study only analyzed the collaboration relationships formally prescribed in management processes and does not consider the informal interactions among project participants. Future studies can obtain a more holistic picture of formal and informal relationships, and better understand the capability integration processes in temporary project teams.

Appendix: Indicators of Constructs and Their Sources

Constructs	Indicator items	Reference
Client's technical capability	Abundant project experience	Wang et al. (2013)
	Abundant technical knowledge	Wang et al. (2013)
Client's coordination capability	Effective conflict arbitration	Wang et al. (2013)
	Communication and information sharing	Wang et al. (2013)
	Aligning the goal of the project team	Wang et al. (2013)
Client's decision making capability	Informed risk decision making	Too (2011)
	Timely decision making	Too (2011)
CMC's technical capability	Abundant project experience	Hai et al. (2002)
	Abundant technical knowledge	Hai et al. (2002)
CMC's coordination capability	Effective conflict arbitration	Wang et al. (2009)
	Communication and information sharing	Wang et al. (2009)
	Aligning the goal of the project team	Wang et al. (2009)
CMC's decision making capability	Informed risk decision making	Shi et al. (2014)
	Timely decision making	Shi et al. (2014)
CMC's responsibilities in construction process monitoring	Cost and schedule management	Yang et al. (2010)
	Quality management	Yang et al. (2010)
	Safety management	Yang et al. (2010)
CMC's responsibilities in contract and information management	Contract management	Yang et al. (2010)
	Information management	Yang et al. (2010)
CMC's responsibilities in coordination management	Coordination with contractor	Wang et al. (2009)
	Coordination with client	Wang et al. (2009)
	Coordination with designer	Wang et al. (2009)
Process flexibility (process capability)	Flexibility to project change	Qiang et al. (2015)
	Flexibility to project complexity	Qiang et al. (2015)
	Flexible information sharing structure	Qiang et al. (2015)
Risk control and allocation (process capability)	Effective project risk planning	Mahdi and Alreshaid (2005)
	Effective risk allocation	Mahdi and Alreshaid (2005)
	Effective risk control	Mahdi and Alreshaid (2005)
Responsibility–capability alignment (process capability)	Clearly defined responsibility	Qiang et al. (2015)
	Utilization of participants' capabilities	Qiang et al. (2015)

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