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RESEARCH ARTICLE

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Project management maturity in construction consulting services: Case of Expo in China

Abstract For many years, project management maturity models (PMMM) derived from the software industry have brought immeasurable benefits. However, the adoption and investigation of PMMM in the construction field have been weak and insufficient, particularly in construction consulting services (CCS). Moreover, professionals have gradually realized the importance of non-process factors (e.g., teamwork, culture, leadership) in the evaluation of PMMM. This study describes the construction of PMMM for CCS that considers non-process factors and combines them with CCS-specific process factors. To verify the effectiveness of the proposed model, we conduct a case study on the overall project management consultancy for China's 2010 Winter Expo. The results would fill in the PMMM research gap in CCS and provide practitioners with ideas to improve their performance.

Keywords construction consulting services, project management maturity model, non-process factors, Expo

1 Introduction

Construction consulting services (CCS) are intellectual services that comprehensively apply multidisciplinary knowledge, engineering practice experiences, modern science, and management methods to provide consulting and management for the entire processes of economic and social development, investment and construction project decision-making, and implementation. CCS and construction consultants play important roles in the successful execution of an engineering project (Tamin et al., 2015). Given the development of the construction industry, CCS enterprises that provide technical support to owners have become a huge and indispensable group (Shi et al., 2014). Scholars and practitioners are increasingly focusing on the evaluation of the construction capabilities and sustainable competitive advantage of project management consultants (Chow and Ng, 2010). However, the current construction consulting industry in China remains in its infancy. Moreover, the industry lacks a basis to standardize and evaluate consulting services. Research is also lacking to promote the continuous improvement and maturity of CCS enterprises.

The earliest project management maturity model (PMMM) can be traced back to the capability maturity model (CMM) developed by the Software Engineering Institute (SEI) in Carnegie Mellon to measure capability in software development projects (Souza and Gomes, 2015). Organizations with high project management maturity (PMM) levels are considered promising in terms of project effectiveness and efficiency. The successful application of PMMM in the IT industry has resulted in its application in approximately 20 fields (Wendler, 2012), one of which is construction engineering. However, PMM in construction is not well developed compared with other industries, particularly the petrochemical and defense industries (Cooke-Davies and Arzymanow, 2003). The relevant research has a history of approximately 20 years, which is relatively short compared with over 30 years of PMM development. Furthermore, the existing maturity studies have concentrated primarily on the PMM of owners and contractors. Ren and Jia (2017) constructed a PMMM of highway construction project owners. Yimam (2011) performed a maturity assessment of contractors in Ethiopia using an improved PMMM. By contrast, the maturity research concerning construction consultancy is relatively rare and remains a research gap despite the fact that CCS

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companies, which provide owners with technical support, have become vital and indispensable to construction projects. Besides, the focus of traditional construction project management has been on maintaining a tight grip on the process to meet schedule, cost, and quality objectives; and the influence of non-process factors has seldom been considered (Pasian, 2014). When dealing with the relationship between people and process, project management often places the former in the subordinate position and only considers them the resources needed to ensure the normal operation of the process. Multiple non-process factors (e.g., trust, attitude, motivation) are related to project management capabilities.

Consequently, this study attempts to develop PMMM for CCS (CCS-PMMM) based on an appropriate cornerstone model and make a detailed investigation of PMMM used in the construction field. The maturity model to be constructed should consider non-process factors and combine them with CCS process factors. Furthermore, we conduct a case study of the overall construction project management consultancy of a megaproject for model verification. This study intends to improve the PMMM research in construction and promote the development and application of PMM in engineering construction projects.

2 Literature review on project management maturity models

This literature review has a twofold aim. The first is to highlight the main features of the existing classic maturity models. The second is to identify and elaborate on a cornerstone model used to guide the establishment of CCS-PMMM. For efficiency, our model should be based on a suitable existing maturity model that has been validated by the ongoing effort of other scholars.

Many PMMMs have been published by the turn of the new millennium. Representative models include CMM (Paulk et al., 1993), CMM Integration (CMMI) (CMMI Project Team, 2002), Kerzner PMMM (K-PMMM) (Kerzner, 2001), Portfolio, Program, and Project Management Model (P3M3) (Office of Government Commerce (OGC), 2001), PM Solutions' PMMM (PMS-PMMM) (Pennypacker, 2005), Organizational PMMM (OPM3) (Project Management Institute (PMI), 2003), and Project Management Process Maturity Model $(PM)^2$ (Kwak and Ibbs, 2002). Table 1 lists the main features of these classic models.

Construction consultants can be considered middlemen who communicate clients' requirements to contractors and deliver a final product to clients. That is, these consultants mainly provide intellectual services. Accordingly, CCS-PMMM to be built will influence the non-process factors on project management capabilities. Therefore, this study requires an existing appropriate model that comprehensively and rigorously integrates process and non-process factors. By comparing and analyzing the classic and other existing maturity models, we found that many PMMMs adopt the CMM-style, which focuses on processes, except for OPM3 and P3M3. OPM3 was the first to distinguish between process and non-process capabilities and considered organizational factors and knowledge management with P3M3 (Jia et al., 2008). Although both models consider organizational enablers, they continue to primarily emphasize processes.

After further exploration, we found that Pasian (2011) presented a collection of non-process factors that challenge the current conceptual and modularization limitations of PMM. Pasian (2011) argued that certain undefined projects need flexible project management and showed that various human, adaptable, and customer-oriented factors can satisfy this need. The aforementioned research also performed a critical analysis of existing and emergent contributing factors with respect to PMM within E-learning projects. Moreover, Pasian (2011) conducted content/textual analyses of two PMMM collections and found that multiple non-process factors can contribute to a mature project management capability. An exploratory case study of E-learning projects in two Canadian universities contributed to the development of a four-node PMM conceptual framework (see Fig. 1). This framework represents the first time that human factors are linked to PMM. The expected value of non-process factors of E-learning PMMM research matches the intention of this study and is based on various PMMM, which provides a solid foundation for our further study.

3 Research methodology

The application of E-learning PMMM to the CCS context inevitably requires adjusting the factors of the model. On the one hand, we need to examine the adaptability of non-process factors of the cornerstone model to the CCS context through a comprehensive literature review. On the other hand, the process factors of our new model will be completely redetermined because the process between E-learning and construction consulting projects is completely different. Only a few studies or reports have considered what the most appropriate CCS process may be. That is, no criteria regarding the CCS process are widely accepted. We conducted interviews to identify the CCS process factors, particularly given that interviews can overcome the poor response rates and incomparability of questionnaire surveys (Barriball and While, 1994). Furthermore, semi-structured interviews are considerably adaptable to the varied professional, educational, and personal histories of the sample group (Barriball and While, 1994). A case study of the Expo in China was conducted to verify our

Table 1 Main features of the six classic maturity models

Year	Developer	Maturity models	Main features
1987	SEI	CMM	- Two-dimensional model - Includes 18 key processes and 5 maturity levels - For management of a single project - Staged model structure - Focuses on the software development process - Applicable to the software field - Lack of help for the organization to complete continuous improvement
2002	SEI	CMMI	- Two-dimensional model - CMM-style - For management of a single project - Staged and continuous model structures coexist - Extends from software development process to service and procurement - General model unrelated to the field
2001	Harold Kerzner	K-PMMM	- CMM-style - Analysis of maturity from the perspective of strategic planning of enterprises - Maturity assessment from different levels through questionnaires - General model unrelated to the field
2001	OGC	P3M3	- Two-dimensional model - CMM-style - Covers project management and project portfolio management - Includes 7 process perspectives and 5 maturity levels - Improved CMM by adding organizational culture, knowledge, technology, and other factors - General model unrelated to the field
2002	PM-Solutions	PMS-PMMM	- Two-dimensional model - CMM-style - Includes project management, 9 knowledge areas of the project management body of knowledge (PMBOK), 5 project management process groups, and 4 maturity levels - For management of a single project - General model unrelated to the field
2003	PMI	OPM3	- Three-dimensional model - Includes project management, 9 knowledge areas of the PMBOK, 5 project management process groups, and 4 maturity levels - Covers project management and project portfolio management - General model unrelated to the field
2002	Kwak and Ibbs	$(PM)^2$	- Includes project management, 9 knowledge areas of the PMBOK, 5 project management process groups - 5 maturity levels, each level contains key PM processes, organization's characteristics, and focus areas

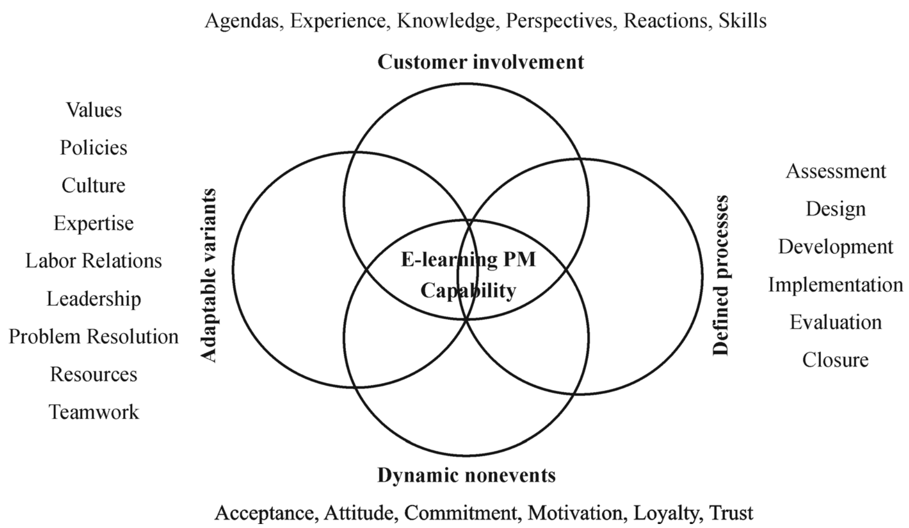

Fig. 1 Conceptual framework of PMMM in E-learning projects.

conceptual framework and improve our understanding of the application of the model. Figure 2 illustrates the research framework adopted in this study.

The interview contained questions on the CCS project phases, critical objectives, and successful standards in each phase. The main questions are as follows:

Question 1: According to your experience in CCS, what do you think are the main stages in a complete CCS project?

Question 2: In *** (as identified by experts) stage, what are the core tasks that contribute to the success of CCS?

Question 3: In these identified stages, which do you think is the most critical to the success of CCS? And why?

Questions 2 and 3 ask for additional detailed information on the essential tasks or stages to acquire an improved understanding of the divisions between stages (distinguish each stage according to its various tasks, as identified by the experts) and be taken as a basis for further research in developing metrics for CCS-PMMM.

Well-designed interviews were conducted with eight experts, who were given the following codes: E01 (i.e., Expert 01), E02, E03, E04, E05, E06, E07, and E08. We employed the following criteria (Blaikie, 1991) in choosing the experts to interview for the current research:

- Extensive experience in CCS;
- Direct involvement in the CCS practice;
- A deep understanding of or have conducted studies on the process of CCS projects.

We invited 8 experts to be interviewed and the interview sessions lasted from 25 to 45 min. Of the 8 experts, 5 have had over 10 years of experience in CCS, while 7 have worked in construction engineering for over 10 years (see Table 2).

Table 2 Work experience of experts interviewed

Time spent in the construction industry (years)		Time spent on CCS projects (years)	
(0–10]	1 (12.5%)	(0–10]	3 (37.5%)
(10–20]	6 (75%)	(10–20]	4 (50%)
above 20	1 (12.5%)	above 20	1 (12.5%)

4 Developing a conceptual CCS-PMMM framework

4.1 Non-process factors

4.1.1 Factors of customer involvement

The construction industry has come to acknowledge the importance of a client-oriented philosophy. Kärnä et al. (2009) discussed customer satisfaction in construction. A total of 831 assessments obtained from project customers with regard to the success of projects were used as bases to build a model and framework for describing the structure and factors influencing customer satisfaction in the construction industry. In the aforementioned model, factors including early customer involvement in the decision-making process and completing the contracted work in the most cost-effective manner were identified as predominant in evaluating customer satisfaction. In construction consulting, the quality of intangible services is constantly difficult to quantify and assess. Thus, whether the consulting services are successful generally depends on customers' evaluation (Othman, 2015). Moreover, the opinions of customers on the knowledge, skills, and experience of consulting teams also play vital roles in the perceived success of projects; these views have been recognized as critical factors of project planning, scheduling, and communication (Garbharran et al., 2012; Alias et al., 2014).

Owner interference, slow decision-making, and unrealistic contract duration have been identified as among the top 10 factors that trigger construction delays (Odeh and Battaineh, 2002). Aziz (2013) listed 10 owner-related causes responsible for delays in large construction projects, including delayed progress payments, changed orders, and slow decision-making by the owner. These behaviors can be attributed to the owners' perspectives on construction projects. As such, the appropriate perspectives of owners on construction, consultancy, and contractors have strong impacts on the success of projects.

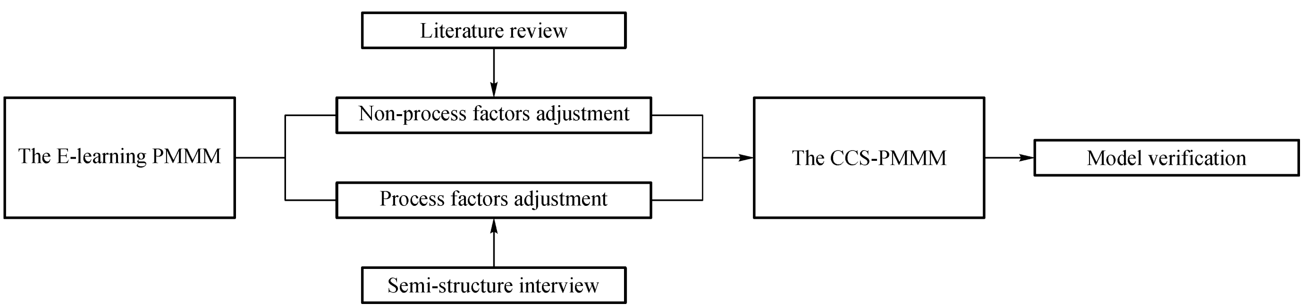

Fig. 2 Research framework adopted in this study.

4.1.2 Factors of adaptable variants

Culture, teamwork, and leadership are popular topics in organizational research and practice. Organizational culture gives an identity to an organization, the importance of which in construction organizations was recognized by Cheung et al. (2011). The aforementioned study identified seven integrated factors, in which the top two factors of the construction setting were team orientation and teamwork, which complement each other. Cultural influence has recently received significant research attention owing to its vital role in the success or failure of projects (Odusami et al., 2003; Nguyen and Watanabe, 2017). Many scholars also highlighted the positive influence of team orientation, which focuses more on the team than on individual contributions. Given that construction projects demand team effort and leadership contributes to team performance, neither can be overlooked in the construction context, particularly by external project management consultants (Nitithamyong and Tan, 2007). Studies have reported that project manager leadership styles (e.g., transformational, transactional and laissez-faire, and charismatic leadership styles) contribute substantially to internal and external project success and organizational success.

As a fundamental requirement for any construction project to achieve project completion within the estimated budget, resources have traditionally been the focus when solving construction engineering problems related to resource-leveling or resource allocation (Memon et al., 2013; Vanhoucke, 2018). At present, the successful management of construction resources is based on thorough and updated information and process utilizing a well-designed construction resources management software (Haddad, 2015). Construction problem-solving is inherent in many construction management practices and is an important research domain (Li and Love, 1998). Several concerns with poorly structured construction problem-solving have been identified, such as the many uncertainties resulting from difficulty in conceptualizing a given problem using a finite set of variables. Evidently, problem-solving in construction is a complicated issue for which no sound theories currently exist. However, the importance of this type of problem-solving is evident in ongoing attempts to address this issue using various methods, such as cognitive sciences and decision support systems (Xiang, 2015).

Policy in the construction field is a factor that has yet to be addressed by research. However, in a survey of 68 contractors, bad decisions with respect to developing company policies were identified as one of the several factors resulting in failure in construction (Al-Barak, 1993). By parity of reasoning, the behavior of CCS teams is regulated by the policies of their firm. As such, company policy should be considered a restraining factor that must be maintained.

4.1.3 Factors of dynamic nonevents

Commitment is an extensive topic when applied to diverse environments. The current study limited the meaning of this concept to employee commitment to their work organizations. Lingard and Lin (2004) found that career-related variables involving career choice commitment, satisfaction with career progression, job involvement, and supervisory support were markedly correlated with women's organizational commitment. The criticality of commitment was also recognized by Belassi and Tukel (1996), who claimed that factors related to project team members, such as technical background and determination, became most critical in construction projects. However, studies in construction engineering management are likely to discuss commitment by stakeholders (Panahi et al., 2017).

Motivation may be defined as the willingness of an individual to expend effort toward a particular set of behaviors (Tabassi and Bakar, 2009). In a survey of construction enterprises in Mashhad, Iran, the study identified several motivators of construction workers and explained that vital motivators in the construction industry include employee attitudes, achievement challenges, responsibilities, advancement possibilities, participation in decision-making, competition, and social relationships at work (Mansfield and Odeh, 1991).

Only a few published studies have expressly addressed employee loyalty and attitude in construction. However, loyalty has been noted in various human-related studies in construction. Thus, we can conclude that loyalty is a critical factor in consulting teams. In contrast to the preference of contractors for a market-based culture, construction consultants are inclined to adopt a clan-based culture, in which the fundamental norms are loyalty and tradition (Rameezdeen and Gunarathna, 2012), thereby bridging the relationship between loyalty and consultation. Some studies have explored the effect of attitude on construction waste management, safety management, and resilience management (Lingard and Rowlinson, 1997; Toh et al., 2017; Tang and Heinimann, 2018). Behavioral decisions are frequently based on attitudes (Al-Sari et al., 2012) and interact directly with performance. Compared with the events themselves, the meanings (attitude) we attach to events determine our reactions (Neenan, 2009). Besides, attitude has an immense impact on resilience management and is the internal driver of resilience (Greene et al., 2004). Peoples' attitude is important in becoming resilient and the most frequently noted internal factor professionals related to resilience was attitude. Sawalha (2015) explained that the importance of resilience has been well acknowledged in terms of managing adversity in engineering projects. Moreover, resilience arises from a combination of attitude and culture, process, and framework.

Trust has become a research hotspot in the construction engineering field and the business and management domains (Lu et al., 2016). Lau and Rowlinson (2011) examined the underlying value of trust in managing construction projects. For example, trust is a factor in the management of time, cost, and quality of a construction project. Trust that cannot be self-generated must be cultivated with rules and norms in a project team. Thus, trust between owners and contractors, which influences project success, has also been the subject of research (Jiang et al., 2016).

These factors relating to dynamic nonevents, which can also be called human factors, have mutual effects. That is, the maturity of team members will be influenced by a complex interplay of member commitment, motivation, loyalty, trust, and attitude. For example, employee attitudes can be positively affected by staff orientation programs and an overall atmosphere of trust.

4.1.4 Factors adjustment

The influences of many non-process factors have been confirmed by studies in the construction field. However, our literature review enabled us to determine that some elements have minimal or no impact on construction and others have emerged as new and important factors. Accordingly, we clarified the logic and soundness of these elements to ensure a stable foundation for a new model specifically adapted to the construction industry. We described these changes and their rationales as follows.

- Combination: Knowledge, Experience, and Skills were combined into one factor called Capability

Knowledge, experience, and skills can be considered integral components of capability. In the capability framework that was designed for evaluating and improving the capability of government employees of New South Wales in Australia, capability is defined as the underlying knowledge, skills, and experience. Chandler (1992) used knowledge, skills, and experience as criteria for assessing the capability of members in an organization. Flamholtz (1999) defined human resources as the knowledge, skills, and experience of individuals. Conceptually, the relationship between capability and knowledge, skills, and experience is inclusive. Moreover, customers will experience considerable difficulty in separately distinguishing and evaluating the knowledge, skills, and experiences of teams.

- Addition: Communication

The efficiency and effectiveness of the construction process depend heavily on the quality of communication. Good communication within and between organizations contributing to a construction project can improve motivation levels and streamline processes. Conversely, inadequate communication can result in an unmotivated workforce and construction problems (Senaratne and Ruwanpura, 2016). Thus, communication is a critical factor that cannot be disregarded.

- Elimination: Acceptance, Reaction, Value, Labor Relations, and Expertise

Acceptance: Acceptance plays a vital role when people are receiving or adopting something new. The literature has discussed and emphasized acceptance when new products or techniques are promoted, particularly in the IT and educational fields (Enevoldsen and Sovacool, 2016). In contrast to the IT and education industries, CCS requires a consulting team to provide corresponding services (intangible products) in response to identified customer needs, which can be categorized as production after ordering. The development of new technology or product belongs to the category called promotion after production. Hence, customer acceptance naturally becomes a subject of research focus.

Reaction: Reaction in E-learning projects is mainly used to investigate the responses of customers/users to E-learning (reaction to new teaching/learning/research pattern). This issue is similar to the situation with the acceptance factor, which measures the customer acceptance of E-learning. Evaluative subjects for this factor are mainly customers/users. By contrast, the consulting team (i.e., service providers) in CCS must promote its services. However, we disregarded these contrasting subjects because they make the aforementioned factor inadaptable to the current context.

Value: Culture can be regarded as a static property of a given organization and relates to a shared value. Value is also the consistent recognition by all members in an organization regarding whether certain events or behaviors are good or bad, kind or evil, right or wrong, and worth emulating. As a core part of a given culture, value is more specific than culture.

Labor Relationship: Despite the government's current legislation to protect workers, labor rights remain disregarded and poorly enforced in China. Chinese labor legislations stipulate certain individual rights of workers related to contracts and wages, among others, but fail to provide them with their collective rights (i.e., right to organize, strike, and bargain collectively in a meaningful sense) (Chen, 2007). Thus, we excluded labor unions as a factor because they have minimal impact on China.

Expertise: Subjects in E-learning projects can be categorized as either promoters or users. With respect to customer involvement, the factors of user knowledge, skills, and experience are considered. Moreover, the capability of promoters is considered by the expertise factor in adaptable variants. However, the consulting team's ability (for CCS) is assessed within the customer involvement factor. Thus, the adoption of expertise is deemed redundant.

In summary, we identified 13 out of the 21 factors (shown in Fig. 1) of the cornerstone model that have impacts on the different aspects of construction engineering, with the elimination of five factors and a combination of three factors into a new one (see Fig. 3). We also added one factor.

4.2 Process factors

The results of our interview indicated the emergence of four CCS stages: Project preparation, implementation, contract closure (external), and project closure (internal).

In the project preparation stage (E01, E06), which is also called the initialization stage (E02) and planning stage (E04, E05), the main tasks encompass tender formation (E06, E08), job responsibilities and definition of modes (E02, E03, E07), building the consulting team (E02–E05, E07), preparation of the related resources (E04, E06, E08), and CCS overall planning formulation (E01, E02, E07).

In the project implementation stage (E01–E06, E08), the experts emphasized the establishment of enforcement regulations (E02, E03, E05, E06, E08), personnel allocation and training (E01–E08), project optimization (E07, E08), emergency response (E01–E03, E05–E08), and risk assessment (E07).

The project contract closure (external) stage (E01, E02, E04–E06) can be defined as a process in which the consulting team hands over all service outcomes and related documents to the customer for their formal acceptance to terminate the contract. In this context, closure means the end of a contractual relationship. That is, the services from the customer perspective have been rendered and are completed. Moreover, obtaining full payment from customers (E02–E04, E06, E08) and dealing with problems or defects (E01, E02, E04, E08) prior to acceptance are standard practices for consulting team.

Correspondingly, the project closure stage signifies the internal closure of the CCS project from the perspective of the consulting team. A series of tasks must be performed before the consulting team is dismissed, including documentation of lessons learned from this project (E01–E03, E05, E07), knowledge management (E02, E05, E07, E08), and post-project evaluation (E02, E03).

4.3 Conceptual model

We established a conceptual CCS-PMMM with 4 dimensions and 19 factors (see Fig. 4) that were confirmed in either the literature or interviews. To name these four dimensions, we modified adaptable variants and dynamic nonevents as organizational variants and member performances, respectively. After unavoidable changes, any factors remaining in the adaptable variants category were related to organizational maturity and factors remaining in the dynamic nonevents category were issues relating to team members. Hence, we altered the name to easily differentiate and clarify the common characteristics in these dimensions.

The four stages of the CCS process are not entirely separated and the interface between two adjacent stages can be ambiguous in some transitional tasks. An analogous phenomenon has been observed among non-process factors as well. These components constantly interact. In some specific instances, they may have dual relationships of belonging and belonged.

5 Case study of Expo in China

5.1 The overall construction project management consultancy (OCPMC) for Expo

The Expo site is in downtown Shanghai near the Huangpu River. This site covers 5.28 km^2 and has approximately

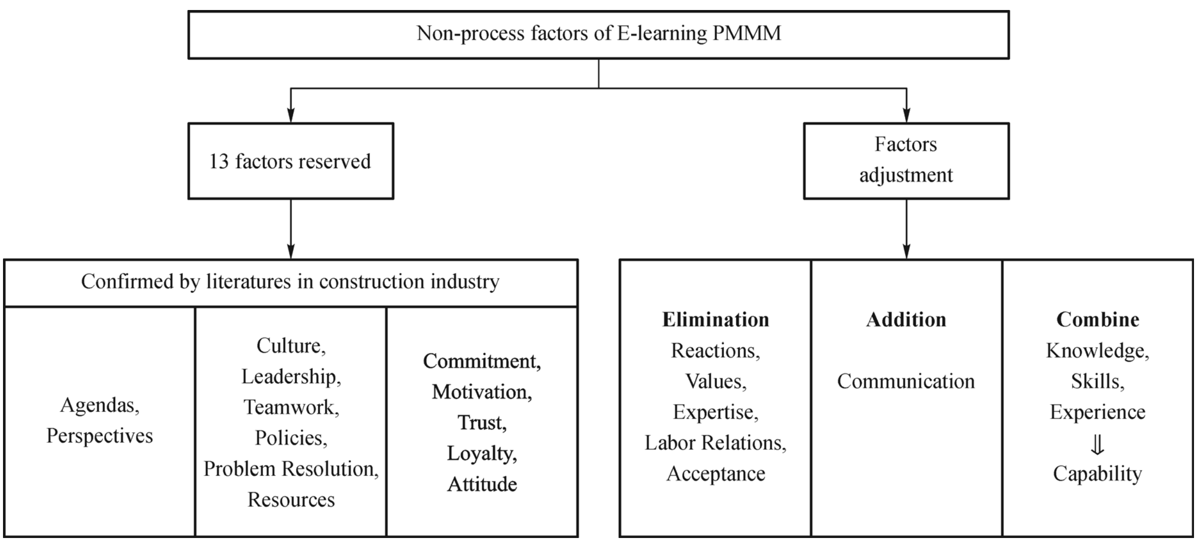

Fig. 3 Identification of the non-process factors.

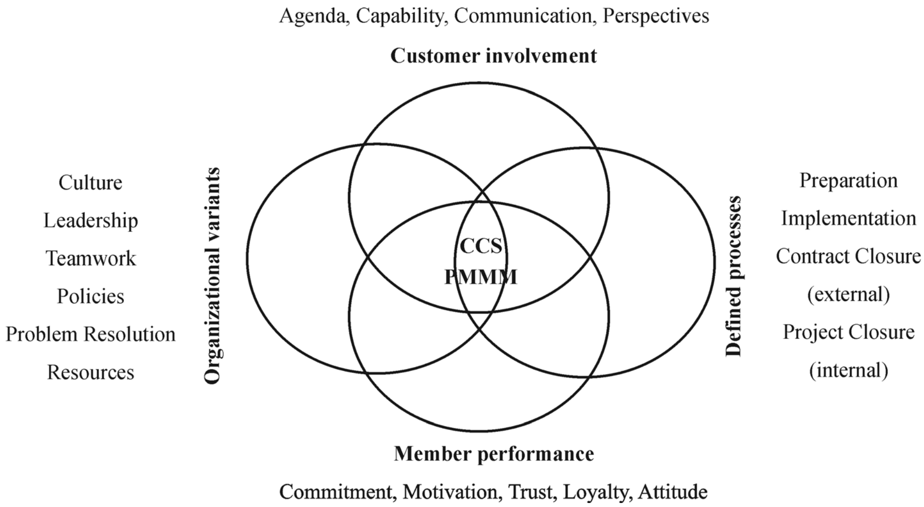

Fig. 4 Conceptual model of CCS-PMMM.

300 buildings with a total floor area of 2.4 km^2, thereby making this Expo the largest in history. The construction of the Expo site started in February 2007 and was completed in April 2010, with a total investment of approximately 18 billion yuan.

The construction headquarters of the Shanghai World Expo (CHSWE) is responsible for the overall construction management and coordination of the Expo site, which is divided into 11 sub-programs or projects. Each sub-program/project was managed by a corresponding program/project management team (PMT). CHSWE used the site program or project management as a basis to employ an overall project management team (OPMT) as its partner regarding the entire work process and a consultancy responsible for overall project management of the Expo site construction. OPMT was involved in the main development and operation of nearly all the functional management divisions (FMD) and relevant PMTs. In addition, OPMT was responsible for diagnosing and addressing potential problems in the overall program objectives, providing solutions for decisions made by the CHSWE, and supporting their optimization to establish a systematic, macro-scale, and scientific implementation of the overall construction program objectives.

During the Expo construction, OPMT comprised 30 core team members, 45 internal employees, and 75 external employees. OPMT likewise received three team honors. These honors included a Supporting Service Cup for OPMT in 2010, Shanghai Major Engineering Competition for Collective Excellence obtained by sections A&B programs of the management supporting group (MSG) in 2010, and Shanghai Expo Construction Collective Excellence obtained by the Expo Village MSG program in 2008. In addition, OPMT received the International Project Management Association (IPMA) International Project Excellence Award (IPEA) 2010 for its excellent performance.

Among the CCS teams, the OCPMC for Expo is a suitable sample that can be used to evaluate the adaptability and reliability of the proposed CCS-PMMM.

5.2 Evidence in model verification

Supported by the various awards given to OPMT and the significant success of Expo, OCPMC is considered a successful CCS characterized by mature management compared with other CCS. Therefore, we selected OCPMC to validate the appropriateness of the factors contained in the proposed CCS-PMMM and determine whether these factors accurately describe that a mature CCS is suitable or not.

The IPEA application report (denoted as Source 1) is a credible document that was confirmed by IPMA to represent the OCPMC process in a full range of aspects. Thus, we opted to use this document as the primary material for analysis. We also used other supporting materials, including the *Kerui* (the company to which OPMT belonged) *Magazine* with issues 03/2009 and 05/2009 (Source 2), and two books titled *Tongji Footprint in Expo* (Source 3) and *Huge Changes: Expo City* (Source 4).

From these existing and archived project document data, we conducted frequency statistical analysis on the relevant factors, in which data can be easily partitioned with respect to the related conceptual framework dimensions and factors (see Table 3).

01 Customer involvement

The term agenda refers to the extent to which consulting teams meet the clients' needs. For the overall construction project management of the Shanghai Expo 2010, OPMT identified the project parties involved and analyzed their demands through face-to-face exchanges and communications. Given their good understanding of customers' expectations, the project was accomplished without any delays and the investment was controlled within the

Table 3 Frequency of the CCS-PMMM factors in project documentation

Dimensions	Factors	Frequencies	Sources
01 Customer involvement	0101 Agendas	8	1
	0102 Capabilities	7	3
	0103 Communication	10	4
	0104 Perspectives	19	4
02 Organizational variants	0201 Culture	6	3
	0202 Leadership	7	1
	0203 Teamwork	3	2
	0204 Policies	1	1
	0205 Problem Resolution	5	2
	0206 Resources	4	1
03 Member performance	0301 Commitment	2	2
	0302 Motivation	8	3
	0303 Trust	5	2
	0304 Loyalty	3	2
	0305 Attitude	7	2
04 Defined processes	0401 Preparation	6	1
	0402 Implementation	13	1
	0403 Contract Closure	1	1
	0404 Project Closure	5	2

outlined objectives without any significant or dangerous safety and quality accidents.

The term Capabilities refer to the knowledge, experience, and skills of consulting teams, as evaluated by the owners. The consulting team must possess project-related experience and the necessary professional skills to flexibly respond to emergencies. With respect to the background of the Expo construction, the OPMT members were teachers, Ph.D. or Master candidates with solid theoretical backgrounds, and also professional engineers who had extensive experience in project management.

The high frequency of communication between OPMT and FMDs relatively reflects their communication status. Short meetings were held at noon every day to discuss emerging problems in the work of both groups. Given the support of CHSWE, OPMT assigned team members to participate in the daily work of every FMD. Accordingly, any construction delays or problems could be immediately identified or addressed.

The perspective of CHSWE on the construction projects was reflected in its behavior. The deputy director of CHSWE admitted that scheduling was extremely challenging with Expo that their construction plans were all made according to deadlines, some of which seemed impossible to meet.

02 Organizational variants

The OPMT culture was characterized by high efficiency, enthusiasm, unity, and mutual assistance. Nearly half of the OPMT members were young people who pursued efficiency and a sense of personal achievement. With respect to unity and mutual assistance, team members could exchange their work experiences and other matters. This free communication inspired the culture and atmosphere of OPMT and helped team leaders to obtain an improved understanding of the members in other ways.

The behavior of the consulting team managers determines the service quality and project performance. Leadership covers many aspects, including the vision and strategic perspectives, and the ability to communicate and influence. In the initial stage of project implementation, the OPMT leader proposed to realize scientific, institutionalized and standardized project management, and strived to make the Expo construction and project management a benchmark in China. However, he also believed that the concepts of “mercy and tolerance” proposed by Confucius could play a significant part in the growth of team members.

A strong team spirit was observed in the daily work of OPMT, which held a weekly internal meeting to summarize the week’s work and plan for the next stage. Team members spoke freely, learned from one another, engaged in self-reflection, and helped other members improve their work.

With respect to the policies factor, Kerui had formal policy documents but lacked explicit descriptions of the rationale behind or adaptability of these policies. We obtained indirect evidence of this factor only through the specific training and development path provided by OPMT and the high degree of employee satisfaction expressed in the annual questionnaires and interviews, which give a general view of the policy implementation.

In an excellent consulting team, the ability to resolve problems will have immense importance. A consulting team should effectively identify and define problems and propose and examine alternative solutions as well. To address the low efficiency of the control system on the objectives of the overall construction program, OPMT developed and applied several project management methods, such as the conduct of three-dimensional product breakdown structure analysis in organizational design.

To ensure the full use of these resources is a critical factor. Investment control was an essential task during the construction of the Expo because the construction funds mainly came from the government. Some members of OPMT assisted with the investment and contracted FMD to prepare a financial plan and management process. Such collaboration resulted in the establishment of six management systems. Accordingly, these measures enabled the appropriate use of financial resources.

03 Member performance

Only when team members have powerful motivation will they commit and maintain their loyalty to a consulting team. This commitment and loyalty are transformed into effective job performances.

OPMT provided its members with a clear training path and development objectives. Hence, each team member was uniquely motivated to work hard. College professors and students were provided with a continuous stream of new opportunities to apply their theories in program practice. Moreover, engineers were provided with current opportunities to absorb new theories and refine and summarize their experiences.

OPMT identified the degree of current employee satisfaction by using employee questionnaires and interviews at the end of each year. The contents of these questionnaires and interviews included the evaluation of the leadership shown by their managers and team leaders and the degree of team culture they had experienced. The results showed that all team members were proud of participating in the Expo project management and were satisfied with their self-development and contributions to Expo.

Mutual trust among the consulting team members should be established. To this end, OPMT held a weekly internal meeting, where team members shared freely, learned from one another, reflected on their work, and helped their fellow team members.

The attitude of the consulting team members toward their jobs can directly influence their job performance. To improve their initiative and creativity, team members were authorized to work independently after the objectives had been identified. Moreover, CHSWE assessed the performance of OPMT and its members and rewarded the excellent performance of team members. OPMT was twice awarded the honorary title of Advanced Collective. Four members were granted the title of Top 100 Builders.

04 Defined processes

OPMT adopted a range of measures in the preparation phase. For example, OPMT preliminarily defined the overall objective on the bases of the analysis of the project parties involved and their expectations and demands. Given the characteristics of the Expo construction program, OPMT assisted the CHSWE in compiling the "One Outline and Nine Handbooks" guide using Delphi, brainstorming, and case study methods. The PMBOK guide and other domestic and international standards and codes were used to draw from previous project management experiences in large-scale complex projects. The "One Outline and Nine Handbooks" consisted of 42 management systems and 43 standard work processes. In addition, the overall construction program objectives, function management, management system, and management process were stipulated from top management to site management.

In the implementation phase, the actual results of the consulting service are presented and delivered to the clients. Advanced planning should be made to consider how to flexibly manage possible changes or emergencies. Many processes in the project were developed by a process of continuous improvement by summarizing experiences and collecting opinions from the parties involved. As the Expo construction program developed, considering the useful contributions of other participants, the management teams and other participants should combine their effort to generate this list. After OPMT assisted CHSWE in developing these processes, some team members participated in their overall implementation and helped to optimize the processes.

The implementation phase is often followed by contract closure. In this stage, the consulting team delivers the project, deals with any deficiencies, and performs any necessary follow-up services. The contribution of this phase should not be overlooked, but few references related to it have been made in the relevant documents and materials that we collected and analyzed.

Project closure differs from contract closure because project closure demonstrates the importance of the internal summary of the consulting team, including relevant knowledge management and accumulation of experience. OPMT considered future consultancy skills and substantially focused on guiding follow-up works based on past experiences. Consequently, an information management system was established in the Enterprise Services Center Project Management Office (ESCPMO). Techniques and management information were systematically listed and documented by a special information management team.

6 Conclusions

CCS-PMMM evolved from a conceptual model of the E-learning PMMM by Beverly Pasian based on the identification of the critical role of the non-process factors of CCS. To ensure the logic and rigor of the evolution process and assess the adaptability of these factors to the CCS context, we conducted exploratory literature reviews on the factors of the E-learning PMMM. Thereafter, we modified them based on sound reasoning. In a fuzzy CCS process, we conducted interviews with eight experts in the CCS domain. Lastly, after developing CCS-PMMM, we used evidence from the literature and interviews as bases to perform a case study of the OCPMC for Expo to verify the conceptual framework of CCS-PMMM.

The results indicated that non-process factors related to customer involvement, organizational impact, and human performance are critical to CCS-PMM. The vision of the CCS team members should not be limited to the overall process experience. The consideration of such soft factors as team culture and member commitment will facilitate project success in covert or intangible ways. Through a case study of the OCPMC for Expo, we discovered that its success was due to the combined effects of the complex factors that considerably match those in CCS-PMMM. Not every factor in the model is perfectly reflected in the case materials (e.g., policies and contract closure), most of which were emphasized and applied in the project implementation phase. Consequently, we have verified that CCS-PMMM is solid, reasonable, and can be used to guide practitioners toward a mature CCS performance.

However, the relative significance of all identified factors was not quantified in this study. If CCS-PMMM is used to provide direct and practical guidance, then further research must be conducted to identify measurable indicators or metrics for each factor. Another concern is the strong interactive effects of these factors that are relatively difficult to identify. Therefore, research should be conducted to establish a concrete direction and basis for further study.

References

Al-Barak A A (1993). Causes of Contractors' Failures in Saudi Arabia. Dissertation for the Master Degree. Dhahran, Saudi Arabia: King Fahd University of Petroleum and Minerals

Al-Sari M I, Al-Khatib I A, Avraamides M, Fatta-Kassinos D (2012). A study on the attitudes and behavioural influence of construction waste management in occupied Palestinian territory. Waste Management and Research, 30(2): 122–136

Alias Z, Zawawi E M A, Yusof K, Aris N M (2014). Determining critical success factors of project management practice: A conceptual framework. Procedia: Social and Behavioral Sciences, 153: 61–69

Aziz R F (2013). Ranking of delay factors in construction projects after Egyptian revolution. Alexandria Engineering Journal, 52(3): 387–406

Barriball K L, While A (1994). Collecting data using a semi-structured interview: A discussion paper. Journal of Advanced Nursing, 19(2): 328–335

Belassi W, Tukel O I (1996). A new framework for determining critical success/failure factors in projects. International Journal of Project Management, 14(3): 141–151

Blaikie N W H (1991). A critique of the use of triangulation in social research. Quality & Quantity, 25(2): 115–136

Chandler A D (1992). Organizational capabilities and the economic history of the industrial enterprise. Journal of Economic Perspectives, 6(3): 79–100

Chen F (2007). Individual rights and collective rights: Labor's predicament in China. Communist and Post-Communist Studies, 40(1): 59–79

Cheung S O, Wong P S P, Wu A W Y (2011). Towards an organizational culture framework in construction. International Journal of Project Management, 29(1): 33–44

Chow L K, Ng S T (2010). Delineating the performance standards of engineering consultants at design stage. Construction Management and Economics, 28(1): 3–11

CMMI Product Team (2002). CMMI for systems engineering/software engineering/integrated product and process development/supplier sourcing. Version 1.1. Continuous Representation. Technical Report. CMU/SEI-2002-TR-012

Cooke-Davies T J, Arzymanow A (2003). The maturity of project management in different industries: An investigation into variations between project management models. International Journal of Project Management, 21(6): 471–478

Enevoldsen P, Sovacool B K (2016). Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France. Renewable & Sustainable Energy Reviews, 53: 178–184

Flamholtz E G (1999). Human Resource Accounting: Advances in Concepts, Methods and Applications. New York: Springer Science & Business Media

Garbharran H, Govender J, Msani T (2012). Critical success factors influencing project success in the construction industry. Acta Structilia, 19(2): 90–108

Greene R R, Galambos C, Lee Y (2004). Resilience theory: Theoretical and professional conceptualizations. Journal of Human Behavior in the Social Environment, 8(4): 75–91

Haddad E (2015). Construction resources management system for Gaza Strip building contractors. Civil and Environmental Research, 7(5): 27–35

Jia G S, Cao L, Chen J G, Zhou S S, Wang J (2008). Application of organizational project management maturity model (OPM3) to construction in China: An empirical study. In: 2008 International Conference on Information Management, Innovation Management and Industrial Engineering. IEEE, 2: 56–62

Jiang W, Lu Y, Le Y (2016). Trust and project success: A twofold perspective between owners and contractors. Journal of Management Engineering, 32(6): 04016022

Kärnä S, Junnonen J M, Sorvala V M (2009). Modelling structure of customer satisfaction with construction. Journal of Facilities Management, 7(2): 111–127

Kerzner H (2001). Strategic Planning for Project Management Using a Project Management Maturity Model. New York: John Wiley & Sons

Kwak Y H, Ibbs C W (2002). Project management process maturity $(PM)^2$ model. Journal of Management Engineering, 18(3): 150–155

Lau E, Rowlinson S (2011). The implications of trust in relationships in managing construction projects. International Journal of Managing Projects in Business, 4(4): 633–659

Li H, Love P E D (1998). Developing a theory of construction problem solving. Construction Management and Economics, 16(6): 721–727

Lingard H, Lin J (2004). Career, family and work environment determinants of organizational commitment among women in the Australian construction industry. Construction Management and Economics, 22(4): 409–420

Lingard H, Rowlinson S (1997). Behavior-based safety management in Hong Kong's construction industry. Journal of Safety Research, 28 (4): 243–256

Lu P, Qian L, Chu Z, Xu X (2016). Role of opportunism and trust in construction projects: Empirical evidence from China. Journal of Management Engineering, 32(2): 05015007

Mansfield N, Odeh N (1991). Issues affecting motivation on construction projects. International Journal of Project Management, 9(2): 93–98

Memon A H, Abdul Rahman I A, Abdul A A A (2013). Assessing causal relationships between construction resources and cost overrun using PLS path modelling focusing in southern and central region of Malaysia material resource. Journal of Engineering Technology, 4(1): 67–78

Neenan M (2009). Developing Resilience: A Cognitive-Behavioural Approach. London: Routledge

Nguyen L H, Watanabe T (2017). The impact of project organizational culture on the performance of construction projects. Sustainability, 9 (5): 781

Nitithamyong P, Tan Z (2007). Determinants for effective performance of external project management consultants in Malaysia. Engineering, Construction, and Architectural Management, 14(5): 463–478

Odeh A M, Battaineh H T (2002). Causes of construction delay: Traditional contracts. International Journal of Project Management, 20(1): 67–73

Odusami K T, Iyagba R R O, Omirin M M (2003). The relationship between project leadership, team composition and construction project performance in Nigeria. International Journal of Project Management, 21(7): 519–527

Office of Government Commerce (OGC) (2001). Portfolio, Programme and Project Management Maturity Model (P3M3). Available at: gov.uk/government/publications

Othman A A E (2015). An international index for customer satisfaction in the construction industry. International Journal of Construction Management, 15(1): 33–58

Panahi B, Moezzi E, Preece C N, Wan Zakaria W N (2017). Value conflicts and organizational commitment of internal construction stakeholders. Engineering, Construction, and Architectural Management, 24(4): 554–574

Pasian B (2011). Project Management Maturity: A Critical Analysis of Existing and Emergent Contributing Factors. Dissertation for the Doctoral Degree. Sydney: University of Technology Sydney

Pasian B (2014). Extending the concept and modularization of project management maturity with adaptable, human and customer factors. International Journal of Managing Projects in Business, 7(2): 186–214

Paulk M C, Curtis B, Chrissis M B, Weber C V (1993). Capability maturity model, version 1.1. IEEE Software, 10(4): 18–27

Pennypacker J S (2005). PM solutions' project portfolio management maturity model. Havertown, USA: Center for Business Practices

Project Management Institute (PMI) (2003). Organizational Project Management Maturity Model (OPM3): Knowledge foundation. Newtown Square, Pennsylvania: Project Management Institute

Rameezdeen R, Gunarathna N (2012). Organisational culture in construction: An employee perspective. Construction Economics and Building, 3(1): 19–30

Ren Y, Jia Y (2017). Research on owner project management maturity model of highway construction project. In: 5th International Conference on Mechatronics, Materials, Chemistry and Computer Engineering (ICMMCCE 2017). Atlantis Press

Sawalha I H S (2015). Managing adversity: Understanding some dimensions of organizational resilience. Management Research Review, 38(4): 346–366

Senaratne S, Ruwanpura M (2016). Communication in construction: A management perspective through case studies in Sri Lanka. Architectural Engineering and Design Management, 12(1): 3–18

Shi L, Ye K, Lu W, Hu X (2014). Improving the competence of construction management consultants to underpin sustainable construction in China. Habitat International, 41: 236–242

Souza T F, Gomes C F S (2015). Assessment of maturity in project management: A bibliometric study of main models. Procedia Computer Science, 55: 92–101

Tabassi A A, Bakar A H A (2009). Training, motivation, and performance: The case of human resource management in construction projects in Mashhad, Iran. International Journal of Project Management, 27(5): 471–480

Tamin R Z, Tamin P F, Shahab F, Widiasanti I, Oktavianus A (2015). Improving Indonesian construction consulting services. Journal of Engineering and Technological Sciences, 47(2): 189–200

Tang J, Heinimann H R (2018). A resilience-oriented approach for quantitatively assessing recurrent spatial-temporal congestion on urban roads. PLoS One, 13(1): e0190616

Toh Y Z, Goh Y M, Guo B H W (2017). Knowledge, attitude, and practice of design for safety: Multiple stakeholders in the Singapore construction industry. Journal of Construction Engineering and Management, 143(5): 04016131

Vanhoucke M (2018). Planning projects with scarce resources: Yesterday, today and tomorrow's research challenges. Frontiers of Engineering Management, 5(2): 133–149

Wendler R (2012). The maturity of maturity model research: A systematic mapping study. Information and Software Technology, 54(12): 1317–1339

Xiang Q (2015). Discussion on problem-based engineering management system. Frontiers of Engineering Management, 2(3): 249–260

Yimam A H (2011). Project Management Maturity in the Construction Industry of Developing Countries (The Case of Ethiopian Contractors). Dissertation for the Master Degree. College Park, Maryland: University of Maryland, College Park