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Selection of performance objectives and key performance indicators in public–private partnership projects to achieve value for money

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Public–private partnerships (PPPs) have been applied widely in the global construction market. During the life cycle of PPP projects, their performance could be affected by a number of factors and their interactions, which might cause the inefficiency and ineffectiveness of the projects. Previous researches on PPPs mainly concentrated on the procurement, success measurement and risk management of PPPs, but paid little attention to the process factors that can strongly influence the performance of PPPs. In order to improve process and performance management in PPPs, the performance objectives and key performance indicators (KPIs) are identified to improve the partnership outcomes. Based on the goal-setting theory, 15 performance objectives are selected. The relative significance and difference of performance objectives for different stakeholders are presented based on a structured questionnaire survey. The survey results show that all identified objectives are important. In spite of stakeholders' common opinions on the objectives of quality, costs, time and the services provided by PPPs, there are evident differences in the objectives of budget constraints of the public sector, risks, revenue and guarantees. According to the survey results, a conceptual KPIs framework is established. Furthermore, the KPIs are identified to assess PPP projects' performance. The performance objectives and the KPIs, which can be used to identify the strengths and weaknesses of PPP projects, are useful tools for effective project performance management in PPPs.

Keywords: Public–private partnership (PPP), key performance indicators (KPIs), performance management, value for money.

Introduction

PPPs are contractual relationships between the public and private sectors in infrastructure development. PPP is defined by the Canadian Council for PPPs (2001) as 'a cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards'. The mixes of responsibilities and financing instruments between public and private sectors determine the

structure of the partnership as shown by the experiences of certain European countries (Renda and Schrefler, 2006). Although PPPs are now widely used for procuring public sector infrastructure in the world, a series of problems is exposed step by step with the increasing application of PPPs because of this kind of mixture. Numerous studies to date demonstrated that problems of PPPs are caused by the interaction of multiple factors during the life cycle of the projects, including cost, quality, schedule, management ability and so forth, rather than a single factor. The critical failure factors of PPPs pointed out by Koppenjan (2005) are the lack of interaction or insufficient embedding in the broader decision-making context,

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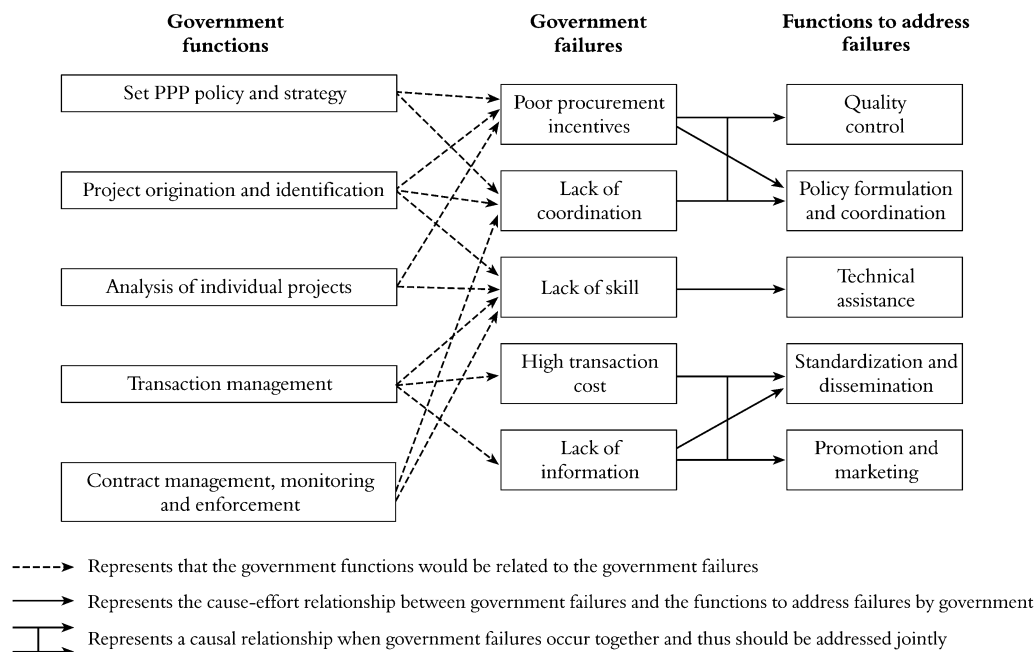


Figure 1 The problems of the PPP projects related to the public sector (Sanghi *et al.*, 2007)

ineffective process management, and the multi-faceted and capricious nature of the public sector. Figure 1 shows that the deficiencies of the public sector, such as ineffective policy and strategy, non-professional project origination and identification, can lead to problems in PPPs including poor procurement incentives, lack of coordination and high transaction costs, etc. (Sanghi *et al.*, 2007). Algarni *et al.* (2007) consider poor supply arrangement, inefficient project company formation, and high construction and operation risks as the problems related to the private sector. Therefore, how to construct a better implementation framework and how to make PPPs more efficient are of great importance, which are matters that should not be limited to the stage of preconstruction, planning or operation, but be extended to integrate the whole process aiming to grasp and manage multiple factors that can affect PPP projects.

Figure 2 shows the process of a typical PPP project and an array of factors involved, which is drawn from prior researches showing that a successful PPP project should integrate the multiple factors depicted in this figure (Li *et al.*, 2005a, 2005b; Zhang, 2005a). Owing to the changing nature of work, increasing competition and long-term risks in PPPs, a performance management method would be of increasing interest to both public and private sectors.

The objective of this research is to find the stakeholders' best-value objectives in PPPs, establish a conceptual model to evaluate the process of PPPs, and select performance indicators by a literature review and a research survey. Performance measurement and

management have been introduced to construction as they are viewed as effective tools to help manage construction projects (Bititci *et al.*, 1997; Kagioglou *et al.*, 2001). Performance objectives are the baseline for performance measurement in the process of determining how successful organizations or individuals have been in attaining these objectives (Solomon and Young, 2007). They should be set at the planning stage and be viewed as an effective motivational process to manage projects based on the goal-setting theory developed by Locke (1968). KPIs are compilations of data measures used to assess and evaluate the performance of a PPP operation (Kagioglou *et al.*, 2001). These evaluations typically compare the actual and estimated performance in terms of effectiveness, efficiency and quality. In order to measure performance or calculate the effects of any given change on the process of PPP projects, one must determine the appropriate KPIs to focus on and measure the impact. Accurate analysis of performance can be attained only after the KPIs are determined and monitored.

The remainder of this paper is organized as follows. Section 2 presents a literature review in the field of PPPs. Section 3 identifies performance objectives in PPP projects based on the findings of the literature review and a structured questionnaire survey targeting different stakeholders to seek and analyse their perceptions of the PPP project performance objectives. Section 4 proposes a conceptual performance indicator system, based upon which the KPIs are identified. Section 5 provides some concluding remarks.

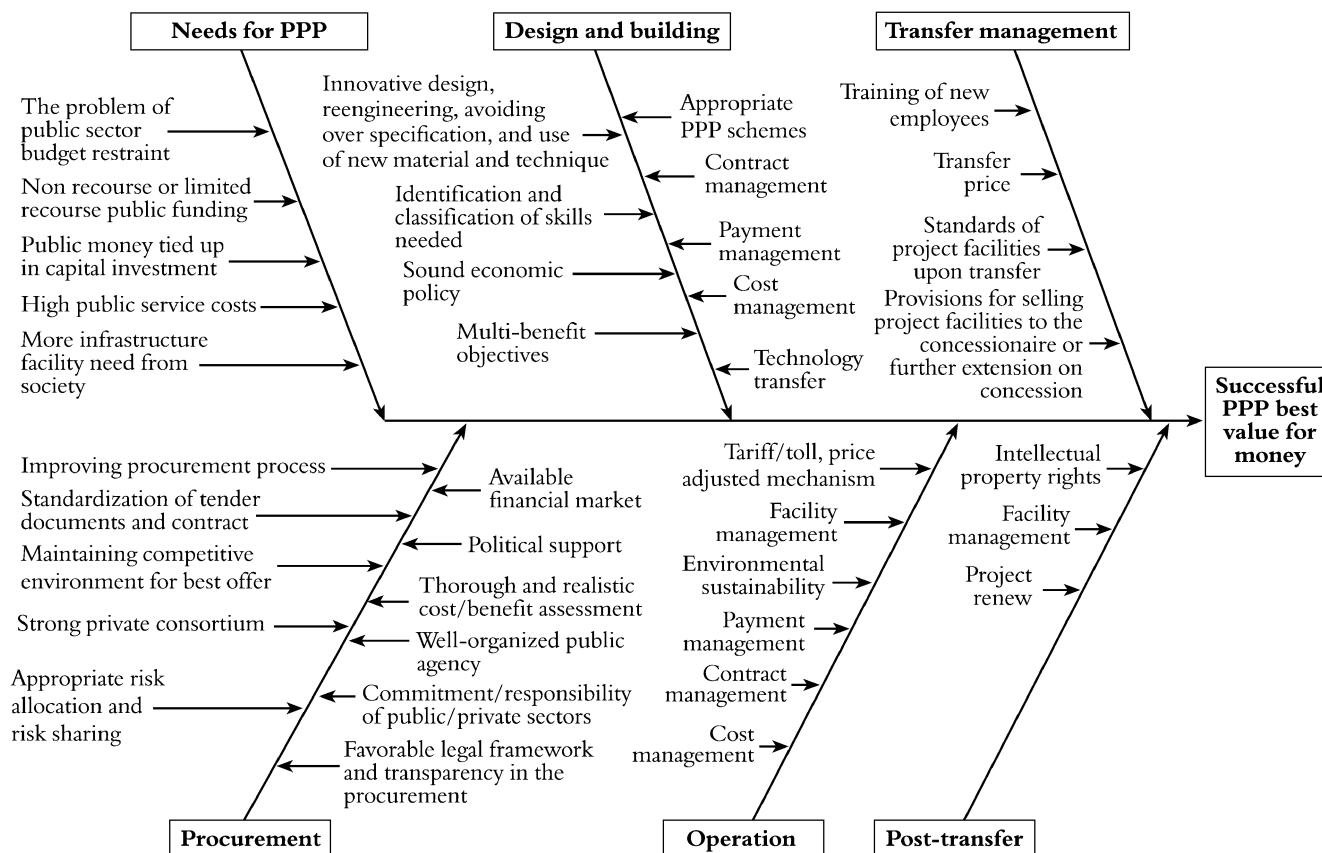


Figure 2 Processes and factors in PPP projects (Li *et al.*, 2005a, 2005b; Zhang, 2005a)

Related research on PPPs

The multiple objectives of PPPs, including promoting infrastructure development, developing local economy, reducing costs, increasing construction and operation efficiencies, and improving service quality by incorporating the private sector's knowledge, expertise and capital, have drawn increasing interest from researchers. To date, much of the extant literature has focused on examining one of the following four aspects of PPPs:

- (1) Providing an explanation for the rise in their popularity with government. The related researches mainly focus on studying the application status of PPPs in specific countries and regions (Askar and Gab-Allah, 2002; Renda and Schrefler, 2006).
- (2) Discussing the outcomes of PPP projects based on case studies. The attractiveness/benefits of PPPs (Li *et al.*, 2005b), the key challenges in governing PPPs (Algarni *et al.*, 2007) and the opportunities for the improvement of economy and technology provided by PPPs (Noble and Jones, 2006) are discussed, which can help identify the barriers for the development of PPPs and facilitate their applications.
- (3) Suggestions on how to make decisions to implement a PPP project. Many decision problems would influence the performance of projects. A well-structured and feasible decision framework is necessary to reduce the potential risks in PPPs (Zhang *et al.*, 2002). Tender/project team selection (Kumaraswamy and Anvuur, 2008), concession model (Shen *et al.*, 2002, 2006; Shen and Wu, 2005), and specific risk analysis in politics (Wang *et al.*, 2000) and financing (Wibowo and Kochendörfer, 2005; Alonso-Conde *et al.*, 2006) are investigated. However, the related researches primarily aim at resolving the decision problems in the stage of procurement without paying attention to the integration and interaction of the factors in the process of PPPs.
- (4) Examining the criteria that make for a successful PPP project. Many prior researches concentrate on critical success factors (CSFs) of PPP projects (Tiong *et al.*, 1992; Qiao *et al.*, 2001; Zhang, 2005c). The related researches influence policy development towards PPPs and can be considered as the guideline for the development of PPPs (Li *et al.*, 2005a).

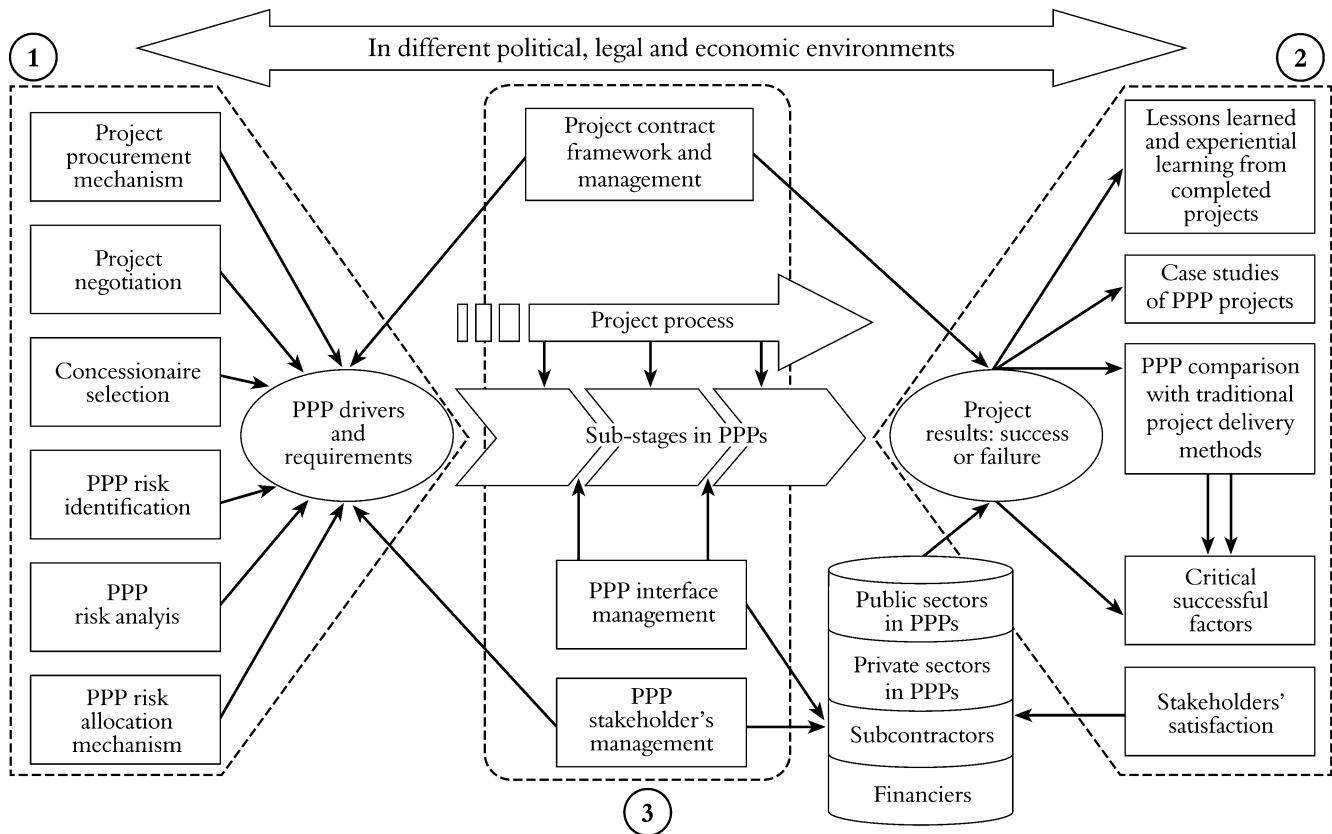


Figure 3 The landscape of PPP research to date

Unfortunately, the existing literature is generally concerned with examining PPPs at a broad social or organizational level, but provides few insights into the management of inter-organizational relationships and process control. Koppenjan (2005) suggests that the quality and effectiveness of the PPP process should be improved. This deficiency in the literature represents a significant gap in the current understanding of PPPs lacking micro-management analysis and stage-specific analysis as presented by Noble and Jones (2006).

The current research landscape in PPPs is illustrated in Figure 3, which indicates that available researches mainly focus on two sides. The research objectives of prior studies are divided into three parts based on the project phase. In Figure 3, the left side is part 1 that reflects the requirements of drivers of PPPs. Prior researches in this part focus on PPP procurement mechanism, negotiation, tender selection and risk-related problems, with the aim of resolving the problems in the pre-implementation phase. Part 2, on the right side, is relevant to the results of PPP projects, where prior researches focus on seeking and pursuing useful information by case studies based on prior experience, which are utilized to stress the successes and problems of PPPs. The connection between part 1 and part 2 is the control of project process as shown

part 3 in Figure 3. Research in this part aims to address the problems related to the project process. Currently it is composed of three important issues including project contract management (Australian Government: Dept. of Finance and Administration, 2006), project stakeholders (El-Gohary *et al.*, 2006) and interface management among the different project stages and different stakeholders (Chan *et al.*, 2005; Noble and Jones, 2006). However, research in this part mostly focuses on a single factor of the process and cannot provide micro-management analysis, which may result in neglecting the influence of other factors. Therefore, a bridge to connect part 1 and part 2 from the stage of pre-implementation to the stage of post-transfer needs to be strengthened to control and measure the whole process of a PPP project and help achieve its intended objective. In other words, all factors must be considered if they may affect the process, implementation and success of PPPs.

Research method

Using a process viewpoint, this paper extensively investigates the factors that can influence the performance of a PPP project during its life cycle. There are

four main research phases. First, the performance objectives in PPPs are identified to seek the expectations for all stakeholders based on the literature review and goal-setting theory. Second, the performance objectives are tested by investigating the opinions of the stakeholders that are divided into four groups (academia, public sector, private sector and general public). The method of stratified random sampling is used in the empirical survey. Data analysis is then conducted by using multiple statistical methods including Cronbach's alphas, Mann-Whitney *U*-test, and one-way ANOVA in order to verify the reliability of the survey and to find the different perceptions for these objectives. Furthermore, the important expectations of stakeholders in PPPs are identified and integrated in this phase based on the survey results, which provide the foundation for the next phase. Third, a conceptual model is established on the basis of stakeholders' requirements aiming to improve the efficiency and effectiveness of PPPs. An indicator system is developed to measure PPP projects' performance according to the findings of second phase. Finally, the KPIs in PPP projects are identified based on the conceptual model as well as the literature review related to the PPP application.

The performance objectives for PPP projects

In order to implement complete and effective performance management, the objective should be identified before performance planning. Achieving best value for public service and product is the ultimate objective of PPPs despite the difference of stakeholders in performance objectives (Zhang, 2006a). The best value is defined by Gransberg and Ellicott (1997) as the maximum achievable outcome from the development of an infrastructure project. In PPPs, best value emphasizes quality, efficiency/effectiveness, value for money (VfM) and performance standards (Akintoye *et al.*, 2003). The priority of these value elements depends on the business requirements of integration of stakeholders, the particular attributes of the specific project under consideration, and the achievability of the best-value elements depends on available resources (Zhang, 2006b). The best-value objective in a PPP project's delivery of a new built infrastructure project should reflect the public client's overall strategic plan and mission objectives, private sector's long-term development and payoff strategy, and the general public's requirements of quality public facilities and services. Project performance may be measured independently against the above objective, the schedule objective and requirements from stakeholders. Therefore, specification of the requirements from each stakeholder's perspective is the first principle in the

performance management system. A performance objective states the performance levels that the stakeholders expect the PPP project to achieve. It can assist the public sector to establish a clear relationship with the private sector, facilitate the private sector to develop an innovative PPP method, and make both adhere to the PPP project's budget, programme planning and performance measures.

According to goal-setting theory (Locke, 1968; Locke and Latham, 1990), the level of satisfaction can be established by gauging the discrepancies between the goal level (the level that is set) and the performance level (the level that is achieved). A value-goal-outcome model proposed by Leung and Liu (1998) and Liu and Leung (2002) on the basis of psychological value, goal-setting and process satisfaction theories reveals that value and goal could be affected by previous experience and might subsequently influence the expected goal and final outcome. Leung *et al.* (2004) consider a goal (objective) as a cognitive representation of value while decision making is a process to enable the value being transformed to a goal (objective). Therefore, the public and private sectors should have a common vision of the project under consideration and work in partnership towards shared objectives (Zhang, 2006b), which is the performance objective of PPP projects.

Therefore, a series of best-value performance objectives are selected to explore the best value and are turned into the objective. As a whole, the goal of a PPP project is to seek the feasibility, viability, success best value. Early work on the topic of the performance objectives in PPPs includes (shown in Table 1): (1) CSFs (Li *et al.*, 2005a; Tiong *et al.*, 1992); (2) best value contributing factors (BVCFs) (Zhang, 2006a); (3) the validity and feasibility factors (Salman *et al.*, 2007). Tiong *et al.* (1992) did early work on CSFs in winning BOT projects from the perspective of the private sector, by which six main CSFs and 20 sub-factors are developed. Li *et al.* (2005a) investigate many factors contributing to the success of PPP/PFI projects in the UK using an empirical survey that targets both the public and private sectors. These two researches focus on the successful procurement and implementation of PPPs respectively, which are the foundation to obtain the performance objectives. The multiple objectives of public clients in formulating partnerships with the private sector in infrastructure development are discussed by Zhang (2006a). These objectives are expressed in terms of BVCFs and necessitate the best value that can be extended for the performance objectives of all stakeholders. The key to successful implementation of a PPP project is the feasibility of the project in relation to the economy, environment, society, politics, legislation and financing. This kind

Table 1 The comparison among the BVCFs, CSFs and viability factors

BVCFs (Zhang, 2006a)	Viability factors (Salman <i>et al.</i> , 2007)	CSFs in winning BOT projects (Tiong <i>et al.</i> , 1992)	CSFs for the PPP projects (Li <i>et al.</i> , 2005a)
Transfer of risks related to construction finance and operation	Conformance to laws and regulations	Entrepreneurship	Strong private consortium
Reducing the size of public borrowing via off-balance-sheet financing	Conformance to the environmental policies	Pick the right project	Appropriate risk allocation and risk sharing
Benefits to local economy	Design flexibility	Strong team of stakeholders	Competitive procurement process
Early project completion/product or service delivery	Simplicity	Imaginative technical solution	Commitment/responsibility of public/private sectors
Acquisition of a fully completed and operational facility	Functionality	Competitive financial proposal	Thorough and realistic cost/benefit assessment
Low project life cycle cost	Accurate prediction of critical needs	Special features of bid	Project technical feasibility
Reduced public administrative costs	Forecast of future demand		Transparency in the procurement process
Reduced disputes and claims	High qualified professionals		Good governance
Low tariffs/tolls	High front-end cost		Favourable legal framework
Long project life span	Acceptable tariff level		Available financial market
Optimized resources utilization	Short construction and concession period		Political support
Additionality (acquisition of facilities that would otherwise not be built by the public sector)	Project risk management system		Multi-benefit objectives
Utilization of private managerial skills and technologies	Public acceptance of the project		Government involvement by providing guarantees
Environment friendly	Availability of resources (local/imported)		Sound economic policy
Transfer of technologies	Innovation level		Stable macro-economic environment
Increased project development and operation efficiencies	Effective and beneficial expansion		Well-organized public agency
Improved constructability and maintainability	Near monopoly advantages		Shared authority between public and private sectors
Technical innovation	High debt/equity ratio		Social support
Additional financial sources for priority projects	Low construction cost		Technology transfer
Additional facilities/services beyond client requirements	Number of bidders		
Modular and repeatable design/construction	Return on investment		

of feasibility and viability introduced by Salman *et al.* (2007) can make sure that the best value can be achieved in those given conditions. The deficiencies of these researches are lack of the viewpoints of all stakeholders, although they provide helpful references from different perspectives. Thus the performance objectives can be identified based on the aforementioned literatures, but more viewpoints of stakeholders should be thoroughly considered by using goal-setting theory. After comparing those different factors, a set of performance objectives is identified in Table 2.

These objectives integrate stakeholders' objectives, focusing on improving the quality (P1), saving time (P4) and costs (P3 and P8), and providing better public service (P2 and P6). With respect to the cost objectives, the private sector prefers to reduce the costs in the stage of construction and operation, the public sector aims to control the life cycle costs that include additional administration costs (Li *et al.*, 2005b). The public sector tends to solve the problems of budget restraints (P7), transfer high risks to the private sector (P10) (Li *et al.*, 2005b), and satisfy the need for more public

Table 2 The performance objectives in PPP projects and their scores and rankings in different groups

Performance objectives	Academia (A)			Private sector (PI)			Public sector (PII)			General public (PIII)			Overall		
	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank
P1 Acceptable quality of project	4.15	0.79	1	4.03	0.95	1	4.17	0.83	1	4.06	1.26	1	4.09	1.01	1
P2 Quality public service	3.98	0.86	2	3.65	1.05	5	3.58	0.90	4	3.73	1.23	2	3.78	1.05	2
P3 Within budget or saving money in construction and operation	3.98	0.8	3	3.71	1.1	3	4.17	0.72	1	3.44	1.09	7	3.74	1.00	3
P4 On-time or earlier project completion	3.87	0.91	4	3.71	1.32	3	3.50	0.80	6	3.52	1.07	5	3.68	1.06	4
P5 Satisfying the need for public facilities	3.67	0.84	5	3.29	1.07	10	3.42	1.08	8	3.54	1.07	4	3.52	1.00	7
P6 Provide timelier and more convenient service for society	3.65	0.92	6	3.45	0.99	7	3.50	1.17	6	3.63	1.14	3	3.58	1.03	5
P7 Solving the problem of public sector budget restraint	3.59	1.11	7	3.23	0.99	12	3.92	0.90	3	3.25	1.18	8	3.42	1.10	8
P8 Life cycle cost reduction	3.54	1.11	8	3.81	1.08	2	3.42	1.00	8	3.50	1.09	6	3.58	1.08	5
P9 Introducing business and profit-generating skills to the public sector	3.30	1.05	9	3.55	1.12	6	3.42	1.08	8	3.13	0.98	9	3.31	1.05	9
P10 Transferring risk to private sector	3.24	1.06	10	2.97	1.05	14	3.58	1.08	4	2.50	1.07	15	2.95	1.11	13
P11 Making profit from public service	3.22	1.21	11	3.45	1.21	7	2.92	1.16	12	2.94	1.04	11	3.15	1.15	10
P12 Promoting local economic development	3.15	1.03	12	3.29	1.04	10	3.17	0.94	11	3.06	0.78	10	3.15	0.94	10
P13 Improving technology level or gaining technology transfer	3.13	0.86	13	3.19	1.08	13	2.67	1.30	14	2.94	0.76	11	3.04	0.93	12
P14 Public sector can acquire additional facilities/ services beyond requirement from private sector	2.8	0.98	14	2.9	1.01	15	2.92	1.24	12	2.71	0.92	14	2.80	0.98	15
P15 Private sector can earn government sponsorship, guarantees and tax reductions	2.74	1.06	15	3.45	1.09	7	2.67	1.07	14	2.88	0.84	13	2.94	1.03	14

facilities (P5) (Chen and Subprasom, 2007; Chen and Doloi, 2008) through collaborating with the private sector. Additionally, attracting private investment in public projects could attain business and profit-generating skills (P9), promote local economic development (P12), and provide additional facilities/services by the private sector (P14), all of which might benefit the authorities and general public (Li *et al.*, 2005b; Chen and Doloi, 2008; Pessoa, 2008). For the private sector, the real attractiveness of PPP projects is their unique long-term and stable revenue stream (P11) (Li *et al.*, 2005b). They should also establish good relationships to obtain government sponsorship or guarantees to benefit themselves (P15) (Zhang, 2005c). In order to achieve most of the above objectives, innovation (P13) would be necessary (Carrillo *et al.*, 2006).

Research survey and results

In order to find the opinions of stakeholders and their differences, a structured questionnaire survey was conducted from January 2008 through March 2008. The survey targets individuals and organizations with experience or interest in PPPs. To ensure the quality of the survey, a pilot survey was presented to a group of research professionals from the University of Maryland, College Park, Nanyang Technology University of Singapore, and the International Finance Corporation of Washington, DC, USA.

The final questionnaire comprises three parts. The first part seeks background information about the respondents and general issues about PPPs. The second part deals with performance objectives about PPP projects. The third part investigates performance indicators within PPPs. In order to identify the relative significance of performance objectives for different stakeholders, Likert-style rating questions, using a five-point scale, were used to elicit respondents' opinions about the importance of each objective. Generally the level of agreement or disagreement is measured. The scale intervals are interpreted as follows: (1) Can be ignored or not important; (2)

Maybe important; (3) Important; (4) Very important; (5) Most important.

The respondents are classified into four groups in this research: academia (A), which refers to researchers and experts in the field of PPPs; private sector (PI), including general contractors, consultants/advisers and lenders, who have experience in PPP projects; public sector (PII), including government and public clients that have participated in PPPs; and the general public (PIII), an experimental group of people who have some connection to PPPs, such as end users, residents around PPP projects, and people outside groups A, PI, PII, who are interested in PPPs, etc. The survey samples are selected based on publicized information, including many academic journals (e.g. *Construction Management and Economics*) and official publications or websites of the World Bank, the National Audit Office of the UK, etc. Additionally, the contacts of many respondents are provided by several associations (e.g. the National Council for PPP of the US), among whose members are companies and government agencies. The sample of the general public is selected from the users of a non-governmental website (<http://www.unirule.org.cn>) that focuses on the application of PPPs in China. The users of this website are either end users of PPP projects or interested in the development of PPP projects.

A total of 1083 questionnaires were sent out by e-mail, among which 141 were completed and returned. The effective return rate (13.02%) was higher than prior PPP surveys with a response rate of 12% and 9.4% by Li *et al.* (2005a) and Salman *et al.* (2007), respectively. The response was therefore deemed adequate for the purposes of data analysis. The respondents were from numerous organizations in different countries and regions. Table 3 describes the roles of respondents in PPP projects. Table 4 shows the PFI/PPP project types reflected in respondents' experience. The score of each performance objective for each group is shown in Table 2.

In Table 2, for the 15 objectives offered to respondents, the mean response rating values range from 4.17

Table 3 Survey respondents' roles in PPP projects

Respondent	Information of questionnaires sent out		Information of questionnaires returned			Effective returned rate
	Number	Percentage	Number	Number of usable responses	Percentage	
Academia (A)	208	19.21	49	48	34.04	23.08
Private sector (PI)	327	30.19	31	31	21.99	9.48
Public sector (PII)	148	13.67	12	12	8.51	8.11
General public (PIII)	400	36.93	52	50	35.46	12.50
Total	1083	100.00	144	141	100.00	13.02

Table 4 PPP project types reflected in survey respondents' experience

Project type	Academia (n)	Per cent	Public sector (n)	Per cent	Private sector (n)	Per cent
Hospital	3	3.49	2	4.65	2	3.39
Transportation	29	33.72	9	20.93	9	15.25
Water and sanitation	10	11.63	5	11.63	4	6.78
Power and energy	8	9.30	8	18.60	7	11.86
IT & communication	3	3.49	1	2.33	1	1.69
Housing and office	14	16.28	8	18.60	10	16.95
Defence and naval	4	4.65	1	2.33	2	3.39
Police and prison	3	3.49	4	9.30	2	3.39
School and education	6	6.98	3	6.98	4	6.78
Others	6	6.98	2	4.65	18	30.51
Total	86	100	43	100	59	100

(P1 in group PII) down to 2.5 (P10 in group PIII). No factor mean value scores fell into the 'extremely important' (>4.50) and 'not important' (<1.5) categories, which indicates that all of these 15 performance objectives are important for each group. Reliability analysis is conducted to test the internal consistency of the survey variable data. Cronbach's alphas are 0.797 (F-statistic=22.222, sig.=0.000). It is much higher than the 0.70 of Nunnally's guideline (1978) and Zhang's similar research (2006b), Nunnally (1978) suggests that reliability of 0.70 or higher should suffice for the research. The results of reliability tests show that the stakeholders agreed on most of the objectives.

However, there are some disagreements reflected by the scores and rankings in different group. Herein, the score of objective P3 is more important in group PII (4.17) than in other three groups (A, 3.98; PI, 3.71; PIII, 3.44). The score of objective P7 also gets the highest score in group PII (3.92) in four groups (A,

3.59; PI, 3.23; PIII, 3.25). The score of objective P8 for group PI (3.81) is higher than other three groups (A, 3.54; PII, 3.42; PIII, 3.50). On the other hand, the ranking of objective P10 in group PI (Rank 14) is lower than in group A (Rank 10) and group PII (Rank 4), which reflects different risk attitudes. The ranking of P5 in group PIII (Rank 4) is higher than in group PI (Rank 10) and group PII (Rank 8). The disagreements between stakeholder groups can be further explained using the Mann-Whitney *U*-test and one-way ANOVA.

The Mann-Whitney *U*-test can examine the level of agreement between stakeholders in the rating of the significances of the performance objectives to determine whether the mean significance of each objective is equal between the groups (Zhang, 2006b). The null hypothesis is that the mean significance of each factor is equal between any two groups. The statistic of the Mann-Whitney *U*-test is *U*, which is compared to a

Table 5 Mann-Whitney *U*-test of survey results

Performance objectives	Asymp. Sig. (2-tailed) of Pairwise comparison					
	A and PI	A and PII	A and PIII	PI and PII	PI and PIII	PII and PIII
P1	0.642	0.975	0.524	0.752	0.4	0.787
P2	0.143	0.117	0.542	0.734	0.581	0.503
P3	0.376	0.505	0.011*	0.253	0.234	0.032*
P4	0.892	0.145	0.109	0.415	0.356	0.861
P5	0.065	0.311	0.547	0.794	0.275	0.630
P6	0.354	0.673	0.994	0.899	0.423	0.687
P7	0.147	0.374	0.166	0.037*	0.963	0.071
P8	0.304	0.69	0.897	0.250	0.222	0.715
P9	0.316	0.78	0.439	0.685	0.086	0.428
P10	0.307	0.244	0.001*	0.075	0.051	0.003*
P11	0.413	0.401	0.197	0.181	0.047*	0.908
P12	0.657	0.896	0.495	0.671	0.291	0.782
P13	0.787	0.162	0.254	0.175	0.238	0.320
P14	0.585	0.888	0.784	0.819	0.433	0.764
P15	0.004*	0.952	0.391	0.043*	0.007*	0.595

Note: * Not corrected for ties.

table of critical values based on the sample size of each group. If the value of U exceeds its critical value at some significance level (usually 0.05), there is evidence to reject the null hypothesis. In this case, the mean significance of each factor is different. The test results of pairwise comparisons are summarized in Table 5, which indicates that there are some different opinions between groups on P3, P8, P10 and P15. For example, group A and PIII have different opinions on the objective P10 ($0.001 < 0.05$), so do group PII and PIII ($0.003 < 0.05$). These differences result from different risk preferences of stakeholders. Owing to its risk-neutral nature, academia tends to seek a balance between the public and private sectors by appropriately allocating risks (sig.=0.307, 0.244). Basically, the general public doesn't understand the importance of risks in PPPs. This group tends to support the one that can bring more efficiency. Therefore, group PIII has similar opinions to those of group PI (mean value: PI, 2.97; PIII, 2.95; sig.=0.051>0.05) and has disagreements with group A and PII as shown above.

In contrast, one-way ANOVA is used to test the differences between two or more groups, thus it can help compare the mean values for the performance objectives across the different groups (Moore and McCabe, 2003). As an example, objective P10 and

P15 are tested to present the differences between the stakeholder groups. The null hypothesis is that there is no difference between the observed groups for these two objectives. The result of the test is reported in Table 6. The mean squares between groups are larger than that within groups, which shows that the means size of these two objectives are significantly different and the null hypothesis should be rejected. The least significant difference (LSD) method is to test the null hypothesis that all the population means are equal with an analysis of variance (Keppel and Wickens, 2004). The results of post hoc comparisons using LSD's method reported in Table 7 further identifies which pair of these two objectives' mean sizes is statistically different. For the objective P10, mean values of A and PII, PII and PIII are statistically different. For the objective P15, the pairs of observed groups are statistically different are (1) A and PI; (2) PI and PII; (3) PI and PIII. Compared to the results of the Mann-Whitney U -test (Table 5), LSD has the same results. Hence, more tests are not necessary.

Discussion

The survey results show that all identified objectives are important. Although the stakeholders have

Table 6 Results of the one-way ANOVA (Transferring risk to private sector and private sector can get government sponsorship, guarantee and tax reduction)

		Sum of squares	d.f.	Mean square	F	<i>p</i>
Transferring risk to private sector	Between groups	18.388	3	6.129	5.426	0.001
	Within groups	150.254	133	1.130		
	Total	168.642	136			
Private sector can get government sponsorship, guarantees and tax reductions	Between groups	11.069	3	3.690	3.705	0.013
	Within groups	132.464	133	0.996		
	Total	143.533	136			

Table 7 Results of post hoc comparisons between groups using LSD's method

Dependent variable	I	J	Mean difference (I-J)	Std. error	<i>p</i>
Transferring risk to private sector	A	PI	0.271	0.247	0.274
	A	PII	-0.344	0.345	0.320
	A	PIII	0.739*	0.219	0.001
	PI	PII	-0.616	0.361	0.091
	PI	PIII	0.468	0.245	0.058
	PII	PIII	1.083*	0.343	0.002
Private sector can get government sponsorship, guarantees and tax reductions	A	PI	-0.712*	0.232	0.003
	A	PII	0.072	0.323	0.823
	A	PIII	-0.136	0.206	0.511
	PI	PII	0.785*	0.339	0.022
	PI	PIII	0.577*	0.230	0.013
	PII	PIII	-0.208	0.322	0.519

Note: * The mean difference is significant at the 0.05 level.

common opinions on the objectives of quality, costs, time and services provided by PPPs, there are evident differences in the objectives of budget constraints of the public sector, risks, revenue and guarantees owing to the different preferences of the stakeholders.

As shown in Table 2, the objective P1 has the largest score in all groups, which means this objective is the most important for all stakeholders. Likewise, the objective P14 is the least important objective. Other top five important objectives in overall ranking respectively are P2, P3, P4, P6 and P8. Compared to traditional construction activity, cost, time and quality are still important. However, quality in a PPP project is especially important, which implies that the requirements of stakeholders focus on long-term sustainable development of PPP projects. Cost reduction in PPP projects not only is emphasized in the stage of construction and operation, but also is extended to the life cycle of built facilities (Li *et al.*, 2005a; Zhang, 2005c, 2006a). In addition, providing quality service is important for all stakeholders, which is also a distinguishable characteristic of PPPs. Furthermore, PPPs stress the satisfaction of the general public, which obtains support from academic respondents. As shown in Table 8, group PI emphasizes the interior characteristics of PPP projects. Group PII considers the PPPs as the tools to solve the problem of budget restraints, reduce the high risks of public projects and improve the performance of PPP projects. Group PIII has high expectations for the quality of PPP projects and the services delivered by PPPs based on the perspectives of end users. The academia group stresses the sustainable development of the PPP method.

Establishment of performance indicators system

Conceptual model of performance indicators system

During the life cycle of PPP projects, the performance changes because of many factors. Some factors are static, i.e. fixed in the given social and economic environments since the project is initialized. These factors could influence the performance of the projects as researches about CSFs reveal that PPP projects may fail because of deficiencies at the tendering and procurement stage (Qiao *et al.*, 2001; Li *et al.*, 2005a). Other factors are dynamic in the life cycle of projects subject to external or internal conditions, so that they can further work on project performance. Additionally, as proved by many prior researches, PPPs can supply better quality than traditional construction activities (NAO, 2001; Li *et al.*, 2005a; Bloomfield, 2006) by successful process control and stressing VfM and innovation (Abdel Aziz, 2007). As a result, the factors that can influence the performance of projects in the PPP context would be more complicated than traditional construction activities because the former entails the integration of static and dynamic factors and the benefits to different stakeholders of achieving VfM.

On the basis of the aforementioned questionnaire survey and literature review, a conceptual performance indicator model can therefore be established which contains the static and dynamic factors and reflects the expectations and requirements of stakeholders. The stakeholders not only stress the quality, time and costs of PPP projects, but also have high expectations on public service and improvement provided by PPPs.

Table 8 Top five objectives in different stakeholder group

Top five objectives in each stakeholder group	Academia (A)	Private sector (PI)	Public sector (PII)	General public (PIII)
1	Acceptable quality of project	Acceptable quality of project	Acceptable quality of project	Acceptable quality of project
2	Quality public service	Life cycle cost reduction	Within budget or saving money in construction and operation	Quality public service
3	Within budget or saving money in construction and operation	On-time or earlier project completion	Solving the problem of public sector budget restraint	Provide timelier and more convenient service for society
4	On-time or earlier project completion	Within budget or saving money in construction and operation	Transferring risk to private sector	Satisfying the need for public facilities
5	Satisfying the need for public facilities	Quality public service	Quality public service	On-time or earlier project completion

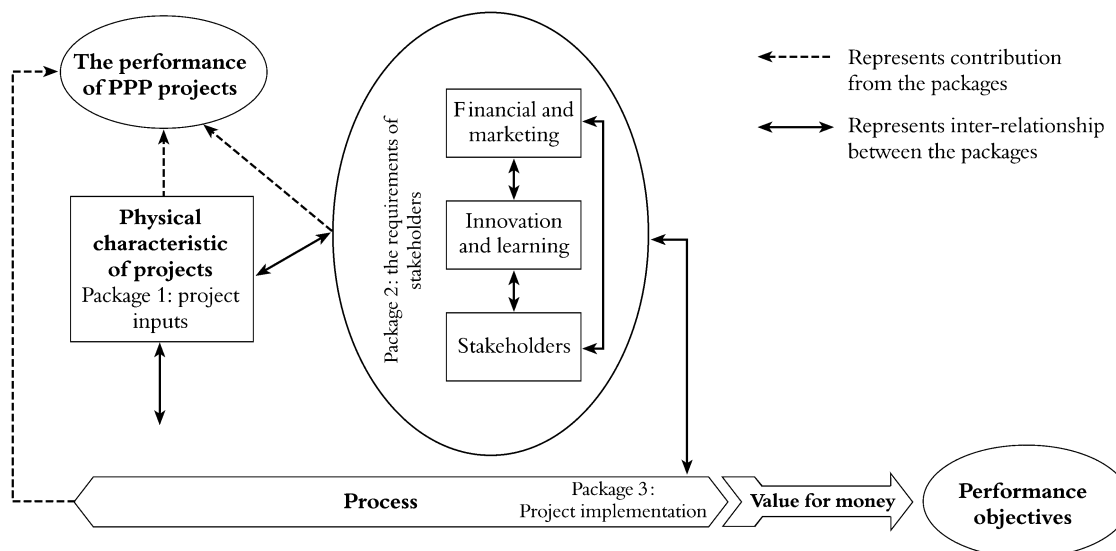


Figure 4 Conceptual model and hypothesized relationships

However, a PPP project is a non-trivial process which encompasses a series of complexities that must be represented in any model. The conceptual framework (Figure 4) is a representation of the implementation of PPP projects, and serves as the foundation for the development of a KPIs framework. The components of this framework are shown in Figure 5. There are three major packages: (1) physical characteristics of projects; (2) the requirements of stakeholders including financing and marketing, innovation and learning, and stakeholders; and (3) project process.

The physical characteristics and features of PPP projects, which also can be considered as the input of the projects, start to influence the performance of the projects in the initialization or planning stage. These static indicators usually do not change during the life cycle of PPP projects, but they could have a strong impact on the concessionaire selection, concession agreement, risk allocation and to what extent the project will achieve success in given economic, legal and political circumstances in a particular host country of the project. The second package is composed of three components including financial and marketing indicators, innovation and learning indicators, and stakeholders' indicators. It reflects specific stakeholders' requirements from the perspective of economy, innovation, culture and the benefit to the stakeholders. The survey results on finance-related objectives (P3, P8 and P11) are in line with the notion that the financing of PPP projects is a primary responsibility of the concessionaire (Xenidis and Angelides, 2005). Li *et al.* (2005b) view better project technology and economy as a positive factor influencing the attractiveness of PPP projects. Similarly, the survey results suggest that high expectations of quality (P1 and

P2), short duration (P4) and low costs (P8) of PPPs would enable the stakeholders to improve the technology level (P13) by innovation and learning, which further lead to the reduction of time and cost and improvement in service quality (P6). Moreover, because many project failures were caused by stakeholder opposition (El-Gohary *et al.*, 2006), the involvement of and effective communication between stakeholders can capture the inputs of various stakeholders to help project proponents build good relationships among the public and private sectors (P12, P14 and P15), subcontractors, suppliers and the general public (P5 and P6). Furthermore, project performance cannot be improved without effective process control. Thus, the third package consists of factors that may affect the project process. In the second and third package, all indicators should be dynamic and measurable, so that they can catch the product requirement, customer satisfaction, efficiency, business success and future potential of the projects, as well as performance change.

The performance indicators can be used to describe the attributes of a system effectively. It is 'how good' a system is, in objectively measurable terms (Solomon and Young, 2007). The indicators should be valued by defined stakeholders and capable of being specified quantitatively. Meanwhile, these indicators are along a definable scale of measure and complex enough to contain many elementary attributes.

Indicators from the perspective of physical characteristics of projects (KPI₁)

As shown in Figure 5, the 16 indicators are selected from the perspective of regulations, administration,

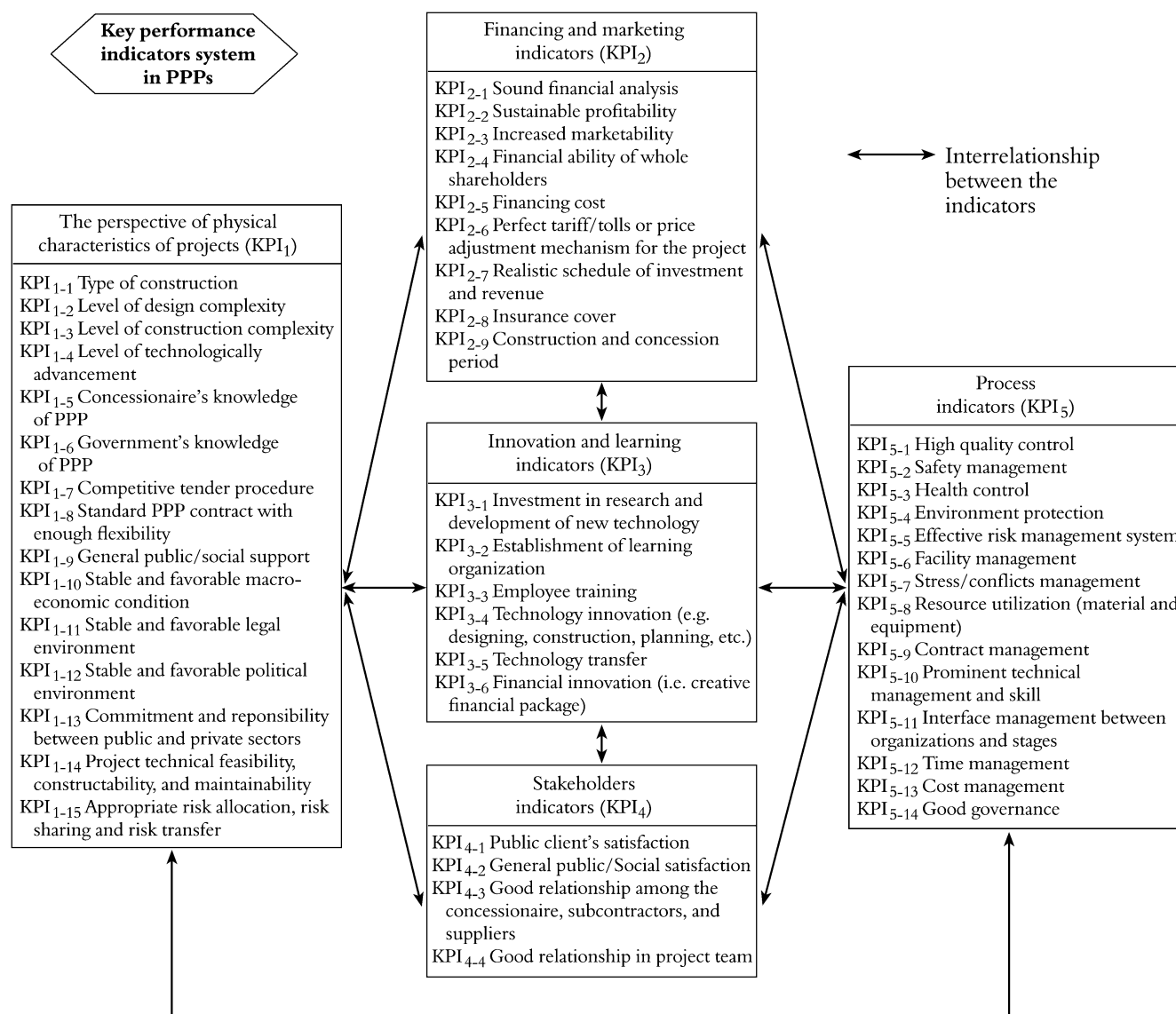


Figure 5 The framework of KPIs for the performance of PPP projects

governance, feasibility and risk-relative conditions of projects, which would not change greatly during the life cycle of projects.

The type of construction should be considered carefully because local governments embarking on long-term PPP contracts must invest in a specialized field with effective contract management and strong governance structures (Bloomfield, 2006). Furthermore, the design, construction plan and technical scheme have become especially complex since PPPs have been applied to large-scale and complicated infrastructure projects (Askar and Gab-Allah, 2002; Ling *et al.*, 2004). Particular attention should be paid to the issues relating to these factors.

In some cases, the public sector may be short of proper understanding of PPPs and thus have unreasonable

expectations of the private sector. Similarly, the private sector may lack an experienced project management team that can coordinate well with a concessionaire consortium and have the ability to deliver quality service for the price offered and the ability to identify and manage risks (Zhang, 2005a; Menches and Hanna, 2006). Efficient procurement would select the proper private sector party that can undertake the project as the best one for the contract, which is an important factor for a successful PPP project (Zhang *et al.*, 2002; Kumaraswamy and Anvuur, 2008). With regard to procurement, lack of standardization (procedure/contract) may result in a slower and more expensive procurement process than non-PPP procurement, hence time and costs overruns will happen (Akintoye *et al.*, 2003; CEPAL, 2005). Therefore, making the procure-

ment process more efficient can benefit performance tremendously.

The PPP project proponents should make an adequate and sustained marketing campaign so that the general public can understand the long-term implications and benefits of the project. This kind of support is very important for viability of the project (Salman *et al.*, 2007). On the other hand, economic, legal and political circumstances can influence the performance and have a very close relationship with local communities in PPP projects (Zhang, 2006a; Salman *et al.*, 2007). Furthermore, the commitment and responsibility of both the public and private sectors are viewed as a significant CSF in PPPs (Li *et al.*, 2005a; Akintoye *et al.*, 2003).

Technical feasibility is the key to providing an imaginative technical solution for PPPs (Zhang, 2006b). Improving constructability of PPP projects is the responsibility of all stakeholders. In addition to technical feasibility and constructability, maintainability is a necessary factor in the operation stage of PPP projects which can improve the internal value of the facility and prolong the facility's operation period (Zhang, 2006a). As an apparently crucial issue in PPPs, a good risk management mechanism, which could greatly affect the performance, should be established before the implementation of the PPP project (Alonso-Conde *et al.*, 2006).

Indicators from the perspective of financing and marketing (KPI₂)

There are extensive risks related to PPPs in the long concession period (Askar and Gab-Allah, 2002; Schaufelberger and Wipadapisut, 2003). The occurrence of one or more of these risks can lead to serious financial consequences, or even result in the failure of the projects. Furthermore, the SPV (special purpose vehicle) as a distinct legal entity uses no recourse or limited-recourse to finance, which requires appropriate financing techniques. Therefore, strong financial capability is essential to the success of a PPP project (Zhang, 2005b). Meanwhile, improving marketability can greatly help a concessionaire to deal with financial issues and obtain more revenue and profit, which can release the pressure of financial risks to make sure that the SPV can focus on construction, operation and market development. The nine indicators in financing and marketing are shown in Figure 5.

Sound financial analysis requires that important financial aspects should be analysed rigorously. Profitability means increased capability of the concessionaire to overcome financial difficulties and higher commitment to project success (Zhang, 2005b). The

survey of Salman *et al.* (2007) about viability of BOT projects shows that 'return on investment' (ROI) is the fifth most important factor out of 21 factors. Marketability shows the concessionaire's ability to succeed in the current market and develop future markets (Zhang, 2005b). Financing cost refers to low financial service charges, fixed and low interest rate financing, long-term loan financing and low costs from fluctuations of currency and exchange rates (Zhang, 2005b).

Tariff/tolls or price adjustment mechanism should safeguard consumers' interests without undermining the project's viability, while maintaining a certain incentive for the private sector to develop and operate projects efficiently (Ye and Tiong, 2003). Realistic schedule of investment and revenue refers to the schedule of all financial sources and their combination in the development of the project. One highway project in Canada studied by Yeo and Tiong (2000) indicates that the debt repayment schedule structured by proactive management of risk enables the project to match the projected revenues and to meet the local government's desired toll levels—factors that reduce political risk and commercial risk. To reduce and transfer risks, insurance coverage should be examined thoroughly. A short concession period means low total costs to the public client and high operation risk to the private sector. A short construction period and a reasonable concession period are critical for PPP projects' viability (Salman *et al.*, 2007).

Indicators from the perspective of innovation and learning (KPI₃)

Innovation and learning should be considered as important factors for the performance of PPP projects. A PPP project is a long-term process with competition, uncertainty and high risks, which requires both the private and public sectors to learn advanced knowledge, experience and related useful information. Enough investment on the training programme and research can help them continually improve performance by gaining new knowledge. Innovation is the way of applying new knowledge/techniques in strategic planning, process design, creative financial packages and resource allocation in order to improve performance and sustain competitive advantage (Shen *et al.*, 2004). The SPV has to adopt new technology and management methods and to apply patents to reduce cost, time and risks. During this process, PPP projects can provide a platform for technology transfer that is viewed as an effective factor for mitigating risks and a key issue in an increasingly complex PPP environment (Carrillo *et al.*, 2006).

Indicators from the perspective of stakeholders (KPI₄)

The National Audit Office (NAO, 2001) affirms that, to secure a successful PFI project, it is important to manage the relationship. All stakeholders should commit their best resources (financial, human, etc.) to the project to achieve VfM and maintain high performance in the project. Therefore, the four indicators in Figure 5 are selected to present the performance of PPP projects to capture and address stakeholder inputs.

Clearly, the attractiveness of PPPs in addressing the problems of the public sector like budget restraint is fully recognized by stakeholders (Li *et al.*, 2005b), which drive the private sector to help its public partner to improve social welfare (e.g. convenience, opportunity for job, etc.). General contractors are continuously involved in a process of transforming inputs (i.e. materials, labour and capital) into outputs (e.g. constructed facility), during which they should keep the relationships with other firms including subcontractors, material and equipment suppliers. In the PPP context, this relationship is far more important than that in traditional construction methods (Kumaraswamy and Anvuur, 2008). Therefore, more researches support the view that contractual parties prefer to cooperate and build good relationships on longer-term contracts in PPPs (Bennett and Jayes, 1998). On the other hand, a good relationship in the project team (SPV) is mainly used to evaluate team management, organization structure and culture, which is expressed by team value and team attitude (Kumaraswamy and Anvuur, 2008).

Indicators from the perspective of project process (KPI₅)

To achieve VfM, the SPV must make sure that it has the right processes and capabilities in place. The measurement can be utilized to identify which processes and capabilities should be improved to become more competitive and which need to be maintained. Process indicators can help track whether the project process is delivering the values they were intended to and track the capabilities of processes (weaknesses and strengths) in providing value to stakeholders. Thus the 14 indicators in Figure 5 in this package can be considered.

In this package some indicators are from traditional performance management in construction. These indicators include high quality control, safety management, health control, environment protection, resource utilization (material and equipment), contract management, prominent technical management and skill, time

management and cost management. Further explanation in detail of these indicators can be found in the research of Shen *et al.* (2004), Kagioglou *et al.* (2001) and Zhang (2006b). And other indicators are selected because of their unique characteristics in PPPs including risk management systems, facility management, stress/conflicts management, interface management between organizations and stages, and governance.

Risk management involves skill and experience of various risk management methods. In the operational stage of PPP projects, various facilities management actions should be taken periodically. In the report of CEPAL (2005), facility management is a weakness in the process of many PPP projects. It involves the ability to allocate limited resources; the ability to optimize the distribution of budgets in the facility; the ability to predict the level of facility performance (Zhang, 2006c). PPPs reverse the over-fragmentation of functions in a traditional design-bid-build contract that often leads to divergence if not confrontational agendas of the multiple participants, providing a great potential for reduced disputes and claims. Hence effective stress/conflict management can supply a good work environment to improve performance. Interface management (IM) is the management of communication, coordination and responsibility across a common boundary between two organizations, phases or physical entities which are interdependent. Organizational interfaces, life cycle interfaces and physical interfaces are believed by Chan *et al.* (2005) to be important to BOT project management. Badshah (1998) emphasizes that good governance is essential to attract private sector participation in public services delivery. In UK PFI projects, most authorities and contractors consider that governance arrangements are working well to deliver VfM (NAO, 2001).

Conclusions

Aiming to address the knowledge gap identified in our research, three contributions are offered to the knowledge base in the context of PPPs. First, the performance objectives are identified in PPP projects, which are based on the previous research on critical success factors, project viability, achievement of best value in PPPs and the theory of goal-setting. The questionnaire survey was conducted to verify that all the identified performance objectives are indeed important and to find the difference between performance objectives of different stakeholders. The survey results show that all identified objectives are important. Although the stakeholders have common opinions on the objectives of quality, costs, time and services provided by PPPs,

according to the statistical analysis, there are evident differences in the objectives of budget constraints of the public sector, risks, revenue and guarantees owing to the preferences of the stakeholders. Second, a conceptual model of PPP project performance indicators is established. The model, which is built on the basis of the literature review and questionnaire survey exposing the different preferences of stakeholders and reflecting their requirements, can serve to integrate process factors that influence the performance of PPPs. These indicators are divided into static and dynamic factors, and can be used to track the performance of PPP projects. Third, the process factors that influence the performance of PPPs are defined based on the conceptual mode. These indicators can be useful for evaluating the performance of PPPs and hopefully become the foundation of performance management in PPPs. The KPIs used in performance management are identified from five components: the physical characteristics of projects, financing and marketing, innovation and learning, stakeholders and project processes. The indicators are important for allowing both public and private sectors to make appropriate decisions during the project life cycle in order to improve the value of PPP efforts. This level of sophistication is needed owing to the presence of complex macro and micro economic, financial and political conditions during the life cycle of a project. Proper understanding of these performance indicators is of equal significance for both public and private sectors.

Although the research on performance objectives and KPIs is helpful to understand performance management in PPP projects, there are some limitations. First, the performance objectives need to be quantified through mathematical modelling; the relative significance of these performance objectives has been obtained through the survey. Second, there are usually some disagreements between objectives of different stakeholders as described before. Hence it is necessary to find a way to convert conflicting objectives into a series of unique performance objectives. Third, results from statistical analysis on subjective data, which undoubtedly are affected by a 'fuzziness' bias, may be ambiguous. Thus, an appropriate algorithm to eliminate the fuzziness should be utilized for further research (e.g. based on the fuzzy set theory). Fourth, the performance objectives are dependent, which means they interact with each other. Their relationships cannot be reflected by the ranking from the research survey. How to find the relationships and how to balance and optimize the objectives, which are related to the comfortable performance objective level as presented by Locke (1968) and Locke and Latham (1990), need to be resolved in future research. Finally, the KPIs should also be tested by empirical study to

investigate their significances. Clearly, the number of KPIs should be kept low, and a consensus needs to be obtained from future work surveys, interviews and discussions with professionals in industry for effective application in project practice.

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