Critical Success Factors for Public–Private Partnerships in Infrastructure Development

Xueqing Zhang, M.ASCE[1]

Abstract: Different types of public–private partnerships (PPPs) have been practiced in worldwide infrastructure development with diverse results and a variety of problems have been encountered. A number of factors combine to determine the success or failure of an infrastructure project in terms of its objectives. There is an urgent need for a workable and efficient procurement protocol for improved practices in future PPP projects. As an important step toward the development of such a protocol, this study identifies, analyzes, and categorizes various critical success factors (CSFs) for PPPs in general based on a public–private win–win principle and a systematic research approach that includes case studies, literature review, and interviews/correspondence with international experts. A CSF package is developed that contains five main CSFs, each including a number of success subfactors (SSFs). Relative significances of these CSFs and SSFs are examined based on the results of a questionnaire survey of international expert opinions. Agreement analysis shows that there is a good agreement in the ranking of these CSFs and SSFs between respondents from the industrial sector and those from the academic sector.

DOI: 10.1061/(ASCE)0733-9364(2005)131:1(3)

CE Database subject headings: Infrastructure; Privatization; Financial management; Partnerships; Construction industry.

Introduction

Different types of public–private partnerships (PPPs) have been practiced in infrastructure development in both developed and developing countries with diverse results. On the one hand, many projects in a broad range of sectors have been successfully developed through PPPs with significantly increased value to the outputs. These include roads, bridges, ports, airports, and railways; power, water supply, and waste disposal systems; telecommunication networks and other services of information technology; schools, hotels, hospitals, prisons, and even military facilities. For example, in the private finance initiative (PFI) program in the United Kingdom, compared with traditional public procurement routes, the average cost saving for the first eight design–build–finance–operate roads is 15%; for the Bridgend and Fazakerley prison projects 10%; for the national insurance recording system 60%; and for the Home Office's immigration casework IT project 40% (*Partnership for prosperity* 1997).

On the other hand, various problems have been encountered in PPPs in worldwide infrastructure development. One problem is the slow progress in the implementation of PPPs. Privately financed projects constitute only a very small portion of the total infrastructure projects. There are other serious problems and even failures of PPP projects. For example, the strong public opposition to some privatized projects in the Lao PDR (Pahlman 1996) and in some states in the United States (Levy 1996), the failures of two build–operate–transfer (BOT) projects in Thailand due to political instability and other reasons (Ogunlana 1997) and the failure of Malaysia's privatized national sewerage project (Abdul-Aziz 2001).

The various problems occurring worldwide are not surprising given the broad range of risks and uncertainties in long-term PPP contracts, the multiple participants involved, and the lack of PPP experience and expertise in many countries and regions. Nevertheless, the worldwide trend towards PPPs creates an urgent need for a workable and efficient procurement protocol for improved practices in future PPP projects. One critical step in the development of such a protocol is to identify, analyze, and categorize various factors that are critical to the success of PPPs in general. Consequently, the author has initiated a research to develop a suitable critical success factor (CSF) package for PPPs based on a public–private win–win principle.

A number of factors combine to determine the success or failure of an infrastructure project in terms of its objectives (i.e., cost, time, and quality). The identification of the CSFs for these objectives will enable efficient allocation of limited resources. The CSFs can be identified based either on quantitative measures (Chua et al. 1999) or on expert opinions (Chua et al. 1999). For example, Chua et al. (1999) adopts an analytical hierarchy process to survey expert opinions on CSFs for construction projects.

In this research, a systematic approach has been taken to analyze CSFs for PPPs. First, a literature review is conducted to identify CSFs as observed in previous research either from the private or the public sector's perspective. Second, experience has been drawn from successful projects and lessons learned from failing ones through case studies of different PPP scenarios in both developed and developing countries, including PFI projects in the United Kingdom, transportation projects under the Intermodal Surface Transportation Efficiency Act in the United States,

[1]Professional Engineer, Yellow River Conservancy Committee, The Ministry of Water Resources of China, 11 Jinshui Rd., Zhengzhou 450003, China.

Note. Discussion open until June 1, 2005. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on December 2, 2002; approved on June 17, 2003. This paper is part of the ***Journal of Construction Engineering and Management***, Vol. 131, No. 1, January 1, 2005. ©ASCE, ISSN 0733-9364/2005/1-3–14/$25.00.

and BOT-type projects in China (including Hong Kong), India, Malaysia, the Philippines, Sri Lanka, and Thailand. Third, interviews and correspondence have been conducted with some PPP experts and practitioners, in which they are requested to identify a list of factors that they thought are critical and then to indicate the importance of these factors. Fourth, the CSFs identified in the above steps are classified into five main aspects each including a number of success subfactors (SSFs), and a questionnaire survey has been done to solicit worldwide expert opinions on the relative significance of the CSFs and SSFs. The results of this research are presented in this paper.

Identification of Critical Success Factors

Critical Success Factors for Construction Projects in General

Chua et al. (1999) maintain that success of a construction project is determined by four aspects, namely: project characteristics, contractual arrangements, project participants, and interactive processes. Project characteristics include external (e.g., political and economical risks, impact on public efficiency of technical approval authorities, adequacy of funding, and site limitation and location) and internal characteristics (e.g., constructability, pioneering status, and project size). Project characteristics contribute to certain project risks, including financial risks and schedule delays (Diekmann and Girard 1995). The contractual arrangement contains contract type, contract award method, and risk allocation. Equitable risk allocation dictates both the content and the type of the contract (Gordon 1994; Diekmann and Girard 1995). Attributes of project participants should be considered as interorganizational conflicts in a construction project will adversely affect project performance (Mohsini and Davidson 1992). Interactive processes refer to the communication, planning, monitoring and control, and project organization to facilitate effective coordination throughout the project life. Project success can be better assured if participants work together as a team with established common objectives and defined procedures for collaborative problem solving (Larson 1995).

Critical Success Factors for Public–Private Partnerships Identified in Previous Studies

Research in and discussions about CSFs for PPPs have been previously conducted, for example, by Berry (1991), Tiong et al. (1992), and Morledge and Owen (1997). Tiong (1996) has identified six CSFs in winning BOT contracts: (1) entrepreneurship and leadership; (2) right project identification; (3) strength of the consortium; (4) technical solution advantage; (5) financial package differentiation; and (6) differentiation in guarantees. Tiong and Alum (1997) have further identified distinctive elements of winning proposals in competitive BOT tendering from the subfactors of the CSFs of technical solution advantage, financial package differentiation, and differentiation in guarantees. Gupta and Narasimham (1998) provide additional CSFs for promoters to win BOT contracts: ability to provide a suitable transfer package, built-in flexibility for future growth and changes, supportive and understanding community, and short construction period.

Lessons from Worldwide Public–Private Partnership Practices

The World Bank has provided reasons why many partnered infrastructure projects have been held up: (1) wide gaps between public and private sector expectations; (2) lack of clear government objectives and commitment; (3) complex decision making; (4) poorly defined sector policies; (5) inadequate legal/ regulatory frameworks; (6) poor risk management; (7) low credibility of government policies; (8) inadequate domestic capital markets; (9) lack of mechanisms to attract long-term finance from private sources at affordable rates; (10) poor transparency; and (11) lack of competition (*Asian Business* 1996).

In addition, problems in Malaysia's privatized national sewerage project reflect some of the major concerns of the public towards infrastructure privatization. In December 1993, the Malaysia government and Indah Water Konsortium (IWK) signed a United States $1.6 billion concession agreement, under which IWK would upgrade and refurbish the country's existing sewerage systems and build new multipoint sewerage systems during a 28 year concession period. A number of problems had occurred in this project, including: (1) the lack of competition and transparency in the selection of the concessionaire; (2) low equity–debt ratio; (3) overgenerous "safety nets" extended to the concessionaire by the government; (4) inefficiencies and management blunders of the concessionaire; (5) frequent change of ownership of the concession company in a short period; and (6) strong public opposition. These problems finally resulted in the government's purchase back of the project 7 years later (Abdul-Aziz 2001).

Critical Success Factors for Public–Private Partnerships under Win–Win Principle

The PPPs involve various kinds of risks (as identified by Merna and Smith 1996) that may emerge at different stages in the life cycle of a project. The PPPs are not merely a vehicle for governments to develop infrastructure projects by transferring all the risks to the private sector and thus shedding of all their responsibilities. Rather, they require appropriate allocation and management of risks. Furthermore, private finance initiatives do not automatically lead to successful infrastructure projects. The PPP schemes should be well structured. Otherwise, resources could be wasted and depleted. A PPP project procurement protocol should be based on a public–private win–win principle. It should create a favorable environment and provide necessary support for private sector participation, and establish effective measures to ensure that privatized projects and services are delivered at public-acceptable standards and quality. Governmental supports and private sector inputs should be balanced.

The systematic research approach mentioned above enables the author to identify various CSFs that are further analyzed, distilled, coded, and finally classed into five main CSFs, each CSF including a number of SSFs. The five main CSFs are: (1) favorable investment environment, (2) economic viability, (3) reliable concessionaire consortium with strong technical strength, (4) sound financial package, and (5) appropriate risk allocation via reliable contractual arrangements. Detailed information of the SSFs is presented in Table 1.

Brief Description of Critical Success Factors

Favorable Investment Environment

The willingness of private sector investors and lenders to develop public infrastructure projects depends greatly on the environment where these projects operate. For example, they are hesitant to pursue projects in an environment where local authorities are

J. Constr. Eng. Manage., 2005, 131(1): 3-14

Table 1. Critical Success Factors and Success Subfactors for Public–Private Partnership (PPP) Projects

Critical success factor	Success subfactor
Favorable investment environment	(1) Stable political system; (2) Favorable economic system; (3) Adequate local financial market; (4) Predictable currency exchange risk; (5) Predictable and reasonable legal framework; (6) Government support; (7) Supportive and understanding community; (8) The project is in public interest; (9) Predicable risk scenarios; (10) The project is well suited for privatization; and (11) Promising economy.
Economic viability	(1) Long-term demand for the products/services offered by the project; (2) Limited competition from other projects; (3) Sufficient profitability of the project to attract investors; (4) Long-term cash flow that is attractive to lender; and (5) Long-term availability of suppliers needed for the normal operation of the project.
Reliable concessionaire consortium with strong technical strength	(1) Leading role by a key enterprise or entrepreneur; (2) Effective project organization structure; (3) Strong and capable project team; (4) Good relationship with host government authorities; (5) Partnering skills; (6) Rich experience in international PPP project management; (7) Multidisciplinary participants; (8) Sound technical solution; (9) Innovative technical solution; (10) Cost-effective technical solution; (11) Low environmental impact; and (12) Public safety and health considerations.
Sound financial package	(1) Sound financial analysis; (2) Investment, payment, and drawdown schedules; (3) Sources and structure of main loans and standby facilities; (4) Stable currencies of debts and equity finance; (5) High equity/debt ratio; (6) Low financial charges; (7) Fixed and low interest rate financing; (8) Long-term debt financing that minimizes refinancing risk; (9) Abilities to deal with fluctuations in interest/exchange rates; and (10) Appropriate toll/tariff level(s) and suitable adjustment formula.
Appropriate risk allocation via reliable contractual arrangements	Appropriate and reliable risk allocation in: (1) Concession agreement; (2) Shareholder agreement; (3) Design and construct contract; (4) Loan agreement; (5) Insurance agreement; (6) Supply agreement; (7) Operation agreement; (8) Offtake agreement; and (9) Guarantees/support/comfort letters.

Table 2. Summary of Responses from Industrial Sector on Significance Indexes of Success Subfactors under Respective Critical Success Factors

Success subfactors	Number of responses						Significance index	Rank
	0	1	2	3	4	5		
Economic viability								
Long-term demand for the products/ services offered by the project	0	0	0	2	15	12	86.9	1
Long-term cash flow that is attractive to lenders	0	0	0	4	12	12	85.71	2
Sufficient profitability of the project to attract investors	0	0	1	2	14	11	85	3
Long-term availability of various suppliers needed for the normal operation of the project	0	0	5	8	13	2	68.57	4
Limited competition from other projects	1	1	6	10	7	2	60	5
Appropriate risk allocation via reliable contractual arrangements								
Concession agreement	0	0	0	8	5	14	84.44	1
Guarantees/support/comfort letters	0	1	3	6	5	12	77.78	2
Loan agreement	0	0	2	9	7	9	77.04	3
Operation agreement	0	1	1	11	7	7	73.33	4
Supply agreement	0	1	4	7	8	7	71.85	5
Offtake agreement	1	2	1	6	8	7	71.2	6
Design and construct contract	0	0	4	10	9	5	70.71	7
Insurance agreement	0	1	7	5	6	8	69.63	8
Shareholder agreement	0	0	6	10	6	5	67.41	9
Sound financial package								
Appropriate toll/tariff levels and suitable adjustment formula	1	1	0	4	9	13	81.43	1
Abilities to deal with fluctuations in interest/exchange rates	0	1	1	7	12	8	77.24	2
Sound financial analysis	1	0	0	9	9	9	77.14	3
Sources and structure of main debts and standby facilities	2	0	3	6	9	8	71.43	4
Long-term debt financing that minimizes refinancing risk	0	1	4	7	10	6	71.43	4
Investment, payment and drawdown schedules	1	1	4	5	10	7	70.71	5
Stable currencies of debts and equity finance	1	0	3	14	5	5	66.43	6
Fixed and low interest rate financing	0	1	8	9	8	2	61.43	7
Low financial charges	1	2	6	11	8	1	57.93	8
High equity/debt ratio	3	1	12	5	5	2	50	9
Favorable investment environment								
Government support	0	0	1	8	8	11	80.71	1
Predicable and reasonable legal framework	0	2	1	4	10	12	80	2
Stable political system	0	1	2	6	11	8	76.43	3
Predicable risk scenarios	0	0	3	7	12	6	75	4
Favorable economic system	0	0	3	6	14	4	74.07	5
The project is well suited for privatization	1	0	5	5	11	7	71.72	6
The project is in public interest	0	0	5	7	13	4	71.03	7
Adequate local financial market	0	5	5	6	4	8	63.57	8
Supportive and understanding community	0	2	7	10	7	2	60	9
Promising economy/economic growth	1	0	9	9	8	0	57.04	10
Predictable currency exchange risk	1	3	7	9	6	2	55.71	11
Reliable concessionaire consortium with strong technical strength								
Strong and capable project team	0	0	1	8	12	8	78.62	1
Good relationship with host government authorities	0	0	3	5	15	5	75.71	2
Leading role by a key enterprise or entrepreneur	0	1	1	10	9	8	75.17	3
Effective project organization structure	0	0	3	9	10	7	74.48	4
Cost-effective technical solution	0	1	5	7	10	6	70.34	5
Sound technical solution	0	1	3	13	5	7	69.66	6
Low environmental impact	0	0	7	9	6	7	68.97	7
Partnering skills	0	0	7	10	9	3	65.52	8
Public safety and health considerations	1	0	8	6	6	6	65.19	9
Rich experience in international public private partnership project management	1	2	6	10	9	1	58.62	10
Multidisciplinary participants	1	2	8	9	6	3	57.93	11
Innovative technical solution	0	3	8	11	6	1	55.86	12

J. Constr. Eng. Manage., 2005, 131(1): 3-14

viewed as having poor credit quality and contracts are not easily enforceable. For PPP schemes to work there should be favorable political, legal, economic, and commercial environments for private sector participation. The government is in a better position than any party in creating such environments, which largely eliminate fears of the private sector concerning various risks, especially political risks such as expropriation and nationalization. Country-specific and/ or project-specific governmental guarantees and support may also be necessary to manage certain risks that can be better handled by the government, such as change in law, foreign currency convertibility, corruption, delays in approval of various permits, and certain *force majeure* risks (Fitzgerald 1998; Zhang and Kumaraswamy 2001a).

A workable legal and regulatory framework should be established to enable the formulation of effective contractual vehicles for PPPs that are compatible with a country's legal system. Such a framework needs to be updated with experience and lessons learned over time. On the other hand, over-regulation can burden and frustrate PPPs and should be avoided (Walker and Smith 1995). Competitive tendering protocols should be followed in awarding PPP contracts. Tender evaluation criteria and evaluation methods should be transparent to ensure fair competition and to avoid criticism of sponsor selection or political favoritism. Corruption may be spawned by the lack of transparency, which greatly impairs public interest.

The government's perspective needs to shift from the traditional regulatory stance to a liberal and dynamic outlook. Furthermore, infrastructure had traditionally been provided by the government for free public use. The practice of "users pay" takes time to be fully accepted by the general public, particularly when services provided by private enterprises usually cost more than those provided by public agencies due to lack of governmental subsidies (Zhang and Kumaraswamy 2001b). Appropriate public relation strategies and activities are needed to win public understanding and support (Levy 1996).

Appropriate Risk Allocation via Reliable Contractual Agreements

The contractual arrangement (i.e., contract type, contract-award method and risk allocation) is a CSF for construction projects (Sanvido et al. 1992). The identification and allocation of risks are an important issue in contractual arrangement (Gordon 1994; Diekmann and Girard 1995), which dictates both the type and content of the contract. Other important issues include the clear statement of the objectives of the contract and the obligations and rights of the contracting parties, adequacy and clarity of plans and technical specifications, a formal dispute resolution process, and motivation and incentives to the contracting parties (Chua et al. 1999).

The PPP transactions benefit from strong representation of all parties involved. A number of projects have failed to reach closures due to the inability to resolve legal issues. Strong and effective legal input at the beginning of the project cycle would have ameliorated these problems, and might have saved time, efforts, and costs in these transactions (Asian Development Bank 1997). In addition, various risks can be effectively managed by allocating them to parties best able to control them through appropriate contractual arrangements, including a concession agreement between the government and the concessionaire, and shareholder agreement, design and build contract, loan agreement, insurance agreement, supply agreement, operation agreement, and offtake agreement between the concessionaire and relevant contracting parties (Merna and Dubey 1998; Delmon 2000).

Economic Viability

Economic viability is critical to the success of any kind of project. For a PPP infrastructure project, it is dependent on a number of factors, particularly on: (1) long-term demand for the products/ services offered by the project; (2) limited competition from other projects; (3) sufficient profitability of the project to attract investors; (4) long-term cash flow that is attractive to the lender; and (5) long-term availability of suppliers needed for the normal operation of the project. Traditionally, four methods have been used for financial viability evaluation: payback period, discounted payback period, net present value, and internal rate of return methods. These methods are based on return of the project and on the assumption that the cash flows of the project are certain. However, PPP projects are characterized by high capital outlay, long lead time, and long operation period with a broad range of risks and uncertainties. The uncertainties bring risk into capital investment evaluation decisions and, consequently, new methods have been developed. These include risk-adjusted discount rate methods (such as capital asset pricing model, arbitrage pricing theory, and the weighted average cost of capital), and probabilistic and statistical methods (such as decision trees, mean variance, and expected return coefficient of variation methods, and cumulative distribution analysis). In addition, sensitivity analysis and simulation techniques have also been used in the economic evaluation of large infrastructure projects (Woodward 1995, Ye and Tiong 2000).

For projects that are not financially viable but of significant economic value and political and environmental objectives, the government should provide necessary flexible project-specific support and/or guarantees to make them financially viable. These include foreign exchange guarantee, arrangements against high inflation and interest rates, tax reduction and holidays, government equity, compensation for changes occurring in the current monetary laws or new regulations affecting the specific project, extension of concession period in case of *force majeure*, property development rights and the use of existing facilities, and a suitable payment adjustment mechanism.

Public affordability is also a key test for economic viability (Higher Education Funding Council for England 1998). The scope of long-term service charges must be within public budget constraints. If users pay for a service, appropriate toll/ tariff levels should be established, taking into account the users' affordability. Otherwise, strong public opposition may ruin the project, as is the case of the Tha Ngone Bridge project in the Lao PDR (Pahlman 1996).

Reliable Concessionaire Consortium with Strong Technical Strength

While the government is in a better position to create a favorable environment for private sector participation in public infrastructure development in general, private sector participants play a paramount role in the successful implementation of particular PPP projects. Significant realignment of risks among multiple project participants is a striking feature of the PPP scheme, in which the concessionaire undertakes far more commitments and assumes much broader and deeper risks than a mere contractor.

J. Constr. Eng. Manage., 2005, 131(1): 3-14

Therefore, selection of the right concessionaire is critical to the success of the project. This can be realized through a competitive tendering process.

Technical and financial strength are the most important success factors in competitive tendering for a PPP project (Tiong 1996). Technical assessment involves the evaluation of designs and the planned facilities in a life cycle scenario including environmental impacts and safety and health considerations. Value engineering techniques can be deployed to improve benefit/cost profiles of potential technical solutions, particularly in the assessment of unsolicited or alternative technical proposals. The importance of financial strength is discussed in a following section. In addition to strengths in formulating advantageous financial and technical packages, the concessionaire should also have strong managerial capabilities, including leading role by a key enterprise or entrepreneur, workable project organization structure, good relationship with host government authorities, partnering skills, rich experience in international PPP project management, multidisciplinary participants, and a strong project team.

Sound Financial Package

The PPP infrastructure projects are often financed on a nonrecourse or limited recourse basis. A number of financial instruments may be used in project finance, such as debt, equity, mezzanine finance, contractor, supplier and purchaser credit, or sureties. A sound revenue stream of the project is the basis of project finance as lenders and investors have recourse to no funds other than this revenue stream and assets of the project may or may not have any residual value (Merna and Dubey 1998). Therefore, the financial package usually has a greater impact on a PPP project's viability than the physical design or construction costs. Significant financial engineering efforts should be made to gear the great capital outlay of an infrastructure project to mesh with innovative financial instruments compatible with its projected cash flow. A sound financial package should include the following features: sound financial analysis; sensible schedules for investment, payment, and drawdown; appropriate combination of financing sources and standby facilities; stable currencies of debts and equity finance; high equity–debt ratio; low financial charges; fixed and low interest rate financing; long-term debt financing that minimizes refinancing risk; ability to deal with fluctuations in interest and exchange rates; and appropriate payment structures.

Significance Indexes of Critical Success Factors and Success Subfactors

Questionnaire Survey on Relative Significance of Critical Success Factors and Success Subfactors

It is useful to analyze the relative significance of the CSFs and SSFs. The author had conducted a questionnaire survey from December 2000 to May 2001 of worldwide expert opinions on the relative significance of these factors on a scale of 0–5 (with "0" being "not applicable," "1" being "not significant," "2" being "fairly significant," "3" being "significant," "4" being "very significant," and "5" being "extremely significant").

About 200 questionnaires were sent out. Forty-six respondents returned complete questionnaires. They are from 42 different organizations/institutions in a number of countries and regions, including Australia, Hong Kong Special Administrative Region of China, India, Japan, Peru, the Philippines, Mainland China, Malaysia, Singapore, South Africa, Thailand, the United Kingdom, and the United States. Twenty nine respondents are from the industry and 17 from the academia. Many of the respondents are from organizations that have rich experiences in PPP projects. Zhang (2004) provides the background information of these respondents including country-wise respondent breakup details and respondent breakup based on their working background (academia or industry) and organization types (public, quasigovernment, or private).

Calculation of Significance Indexes

The relative significance indexes of the five CSFs and those of the SSFs under each CSF are calculated separately. The following simple formula is developed to convert linearly the 0–5 scale used in the questionnaire survey to a 0–100 scale with 0 representing the lowest and 100 the highest significance. This means that "5," "4," "3," "2," "1," and "0" have significance indexes of 100, 80, 60, 40, 20, and 0, respectively

$$\text{significance index } S_i = \frac{R_{i0} \times 0 + R_{i1} \times 20 + R_{i2} \times 40 + R_{i3} \times 60 + R_{i4} \times 80 + R_{i5} \times 100}{R_{i0} + R_{i1} + R_{i2} + R_{i3} + R_{i4} + R_{i5}} = \frac{20R_{i1} + 40R_{i2} + 60R_{i3} + 80R_{i4} + 100R_{i5}}{R_{i0} + R_{i1} + R_{i2} + R_{i3} + R_{i4} + R_{i5}}$$

where S_i=significance index for the ith factor or subfactor; R_{i0}=number of responses as "0" for the ith factor or subfactor; R_{i1}=number of responses as "1" for the ith factor or subfactor; R_{i2}=number of responses as "2" for the ith factor or subfactor; R_{i3}=number of responses as "3" for the ith factor or subfactor; R_{i4}=number of responses as "4" for the ith factor or subfactor; and R_{i5}=number of responses as "5" for the ith factor or subfactor.

Significance Indexes and Rank of Success Subfactors

A consolidated summary of the responses from the industrial sector, the significance indexes and rank of the SSFs based on industrial responses appear in Table 2. A consolidated summary of the responses from the academic sector, the significance indexes, and rank of the SSFs based on academic responses appear in Table 3. A consolidate summary of all responses, the significance indexes, and rank of the SSFs based on all responses appear in Table 4.

Based on all responses, the top five most significant of the 11 SSFs under the CSF of "favorable investment environment" are: (1) stable political system; (2) government support; (3) predicable and reasonable legal framework; (4) favorable economic system; and (5) the project is well suited for privatization. The top three most significant of the five SSFs under the CSF of "economic viability" are: (1) long-term demand for the products/ services

J. Constr. Eng. Manage., 2005, 131(1): 3-14

Table 3. Summary of Responses from Academic Sector on Significance Indexes of Success Subfactors under Respective Critical Success Factors

Success subfactors	Number of responses						Significance index	Rank
	0	1	2	3	4	5		
Economic viability								
Long-term demand for the products/services offered by the project	0	0	0	2	4	10	90	1
Sufficient profitability of the project to attract investors	0	0	0	2	8	7	85.88	2
Long-term cash flow that is attractive to lenders	0	0	0	1	12	3	82.5	3
Limited competition from other projects	0	1	0	3	7	3	75.71	4
Long-term availability of various suppliers needed for the normal operation of the project	0	1	2	4	6	3	70	5
Appropriate risk allocation via reliable contractual arrangements								
Concession agreement	0	0	0	1	5	9	90.67	1
Shareholder agreement	0	0	0	2	9	4	82.67	2
Supply agreement	0	0	1	1	10	3	80	3
Offtake agreement	0	0	0	3	8	3	80	3
Loan agreement	0	0	1	1	11	2	78.67	4
Design and construct contract	0	0	1	1	12	1	77.33	5
Operation agreement	0	0	1	2	10	2	77.33	5
Guarantees/support/comfort letters	0	0	1	3	7	3	77.14	6
Insurance agreement	0	0	1	4	7	3	76	7
Sound financial package								
Sound financial analysis	0	0	0	0	5	11	93.75	1
Appropriate toll/tariff levels and suitable adjustment formula	0	0	0	0	8	8	90	2
Abilities to deal with fluctuations in interest/exchange rates	0	0	0	3	6	7	85	3
Sources and structure of main debts and standby facilities	0	0	1	3	8	4	78.75	4
Investment, payment and drawdown schedules	0	0	0	6	6	4	77.5	5
Long-term debt financing that minimizes refinancing risk	0	0	2	2	7	4	77.33	6
Stable currencies of debts and equity finance	0	0	1	5	7	3	75	7
High equity/debt ratio	0	0	3	5	6	2	68.75	8
Fixed and low interest rate financing	0	0	2	6	8	0	67.5	9
Low financial charges	0	0	3	5	8	0	66.25	10
Favorable investment environment								
Stable political system	0	0	0	2	5	10	89.41	1
The project is well suited for privatization	0	1	0	2	6	7	82.5	2
Favorable economic system	0	0	0	1	14	2	81.18	3
Government support	0	0	0	5	6	6	81.18	3
Predicable risk scenarios	0	0	2	2	9	3	76.25	4
Promising economy/economic growth	0	0	1	4	8	3	76.25	4
Predicable and reasonable legal framework	0	0	1	5	7	3	75	5
Predictable currency exchange risk	0	0	4	4	7	2	68.24	6
The project is in public interest	0	1	1	7	6	2	68.24	6
Adequate local financial market	0	0	2	8	6	1	67.06	7
Supportive and understanding community	0	2	1	10	4	0	58.82	8
Reliable concessionaire consortium with strong technical strength								
Good relationship with host government authorities	0	0	0	2	8	6	85	1
Strong and capable project team	0	0	0	3	10	3	80	2
Effective project organization structure	0	0	0	5	7	4	78.75	3
Leading role by a key enterprise or entrepreneur	0	0	0	4	9	3	78.75	3
Sound technical solution	0	0	0	4	10	2	77.5	4
Cost-effective technical solution	0	0	0	6	7	3	76.25	5
Public safety and health considerations	0	0	0	7	4	4	76	6
Partnering skills	0	0	1	3	11	1	75	7
Rich experience in international public–private partnership project management	0	0	2	5	8	1	70	8
Low environmental impact	0	0	2	9	4	2	67.06	9
Multidisciplinary participants	0	0	2	11	3	0	61.25	10
Innovative technical solution	0	1	2	11	2	0	57.5	11

Table 4. Summary of All Responses on Significance Indexes of Success Subfactors under Respective Critical Success Factors

Success subfactors	Number of responses 0	1	2	3	4	5	Significance index	Rank
Economic viability								
Long-term demand for the products/services offered by the project	0	0	0	4	19	22	88	1
Sufficient profitability of the project to attract investors	0	0	1	4	22	18	85.33	2
Long-term cash flow that is attractive to lenders	0	0	0	5	24	15	84.55	3
Long-term availability of various suppliers needed for the normal operation of the project	0	1	7	12	19	5	69.09	4
Limited competition from other projects	1	2	6	13	14	5	65.37	5
Appropriate risk allocation via reliable contractual arrangements								
Concession agreement	0	0	0	9	10	23	86.67	1
Loan agreement	0	0	3	10	18	11	77.62	2
Guarantees/support/comfort letters	0	1	4	9	12	15	77.56	3
Supply agreement	0	1	5	8	18	10	74.76	4
Operation agreement	0	1	2	13	17	9	74.76	4
Offtake agreement	1	2	1	9	16	10	74.36	5
Design and construct contract	0	0	5	11	21	6	73.02	6
Shareholder agreement	0	0	6	12	15	9	72.86	7
Insurance agreement	0	1	8	9	13	11	71.9	8
Sound financial package								
Appropriate toll/tariff levels and suitable adjustment formula	1	1	0	4	17	21	84.55	1
Sound financial analysis	1	0	0	9	14	20	83.18	2
Abilities to deal with fluctuations in interest/exchange rates	0	1	1	10	18	15	80	3
Sources and structure of main debts and standby facilities	2	0	4	9	17	12	74.09	4
Long-term debt financing that minimizes refinancing risk	0	1	6	9	17	10	73.49	5
Investment, payment and drawdown schedules	1	1	4	11	16	11	73.18	6
Stable currencies of debts and equity finance	1	0	4	19	12	8	69.55	7
Fixed and low interest rate financing	0	1	10	15	16	2	63.64	8
Low financial charges	1	2	9	16	16	1	60.89	9
High equity/debt ratio	3	1	15	10	11	4	56.82	10
Favorable investment environment								
Stable political system	0	1	2	8	16	18	81.33	1
Government support	0	0	1	13	14	17	80.89	2
Predicable and reasonable legal framework	0	2	2	9	17	15	78.22	3
Favorable economic system	0	0	3	7	28	6	76.82	4
The project is well suited for privatization	1	1	5	7	17	14	75.56	5
Predicable risk scenarios	0	0	5	9	21	9	75.45	6
The project is in public interest	0	1	6	14	19	6	70	7
Adequate local financial market	0	5	7	14	10	9	64.89	8
Promising economy/economic growth	1	0	10	13	16	3	64.19	9
Predictable currency exchange risk	1	3	11	13	13	4	60.44	10
Supportive and understanding community	0	4	8	20	11	2	59.56	11
Reliable concessionaire consortium with strong technical strength								
Strong and capable project team	0	0	1	11	22	11	79.11	1
Good relationship with host government authorities	0	0	3	7	23	11	79.09	2
Leading role by a key enterprise or entrepreneur	0	1	1	14	18	11	76.44	3
Effective project organization structure	0	0	3	14	17	11	76.00	4
Sound technical solution	0	1	3	17	15	9	72.44	5
Cost-effective technical solution	0	1	5	13	17	9	72.44	5
Public safety and health considerations	1	0	8	13	10	10	69.05	6
Partnering skills	0	0	8	13	20	4	68.89	7
Low environmental impact	0	0	9	18	10	9	68.26	8
Rich experience in international build–operate–transfer project management	1	2	8	15	17	2	62.67	9
Multidisciplinary participants	1	2	10	20	9	3	59.11	10
Innovative technical solution	0	4	10	22	8	1	56.44	11

Table 5. Summary of Responses from Industrial Sector on Significance Indexes of Critical Success Factors

Critical successful factors	Number of responses 0	1	2	3	4	5	Significance index	Rank
Economic viability	0	0	0	2	12	14	88.57	1
Appropriate risk allocation via reliable contractual arrangements	0	0	0	4	11	14	86.9	2
Sound financial package	0	0	0	9	7	13	82.76	3
Reliable concessionaire consortium with strong technical strength	0	0	2	7	14	6	76.55	4
Favorable investment environment	0	0	3	14	3	8	71.43	5

Table 6. Summary of Responses from Academic Sector on Significance Indexes of Critical Success Factors

Critical successful factors	Number of responses 0	1	2	3	4	5	Significance index	Rank
Economic viability	0	0	1	0	4	11	91.25	1
Appropriate risk allocation via reliable contractual arrangements	0	0	0	2	5	9	88.75	2
Sound financial package	0	0	0	0	11	5	86.25	3
Favorable investment environment	0	0	0	2	9	5	83.75	4
Reliable concessionaire consortium with strong technical strength	0	0	0	4	7	5	81.25	5

Table 7. Summary of All Responses on Significance Indexes of Critical Success Factors

Critical successful factors	Number of responses 0	1	2	3	4	5	Significance index	Rank
Economic viability	0	0	1	2	16	25	89.55	1
Appropriate risk allocation via reliable contractual arrangements	0	0	0	6	16	23	87.56	2
Sound financial package	0	0	0	9	18	18	84	3
Reliable concessionaire consortium with strong technical strength	0	0	2	11	21	11	78.22	4
Favorable investment environment	0	0	3	16	12	13	75.91	5

offered by the project; (2) sufficient profitability of the project to attract investors; and (3) long-term cash flow that is attractive to lenders. The top five most significant of the 12 SSFs under the CSF of "reliable concessionaire consortium with strong technical strength" are: (1) strong and capable project team; (2) good relationship with host government authorities; (3) leading role by a key enterprise or entrepreneur; (4) effective project organization structure; and (5) sound technical solution/cost-effective technical solution. The top five most significant of the ten SSFs under the CSF of "sound financial package" are: (1) appropriate toll/tariff levels and suitable adjustment formula; (2) sound financial analysis; (3) abilities to deal with fluctuations in interest/exchange rates; (4) sources and structure of main debts and standby facilities; and (5) long-term debt financing that minimizes refinancing risks. The top five most significant of the nine SSFs under the CSF of "appropriate risk allocation via reliable contractual arrangements" are: (1) concession agreement; (2) loan agreement; (3) guarantees/support/comfort letters; (4) supply agreement; and (5) operation agreement.

Significance Indexes and Rank of Critical Success Factors

The significance indexes and rank of the five main CSFs are shown in Table 5 (based on responses from the industrial sector), Table 6 (based on responses from the academic sector), and Table 7 (based on all responses).

Agreement Analysis

In previous sections, the significance indexes and rank of the CSFs and SSFs have been calculated separately according to responses from the academic sector and the industrial sector. It is useful to measure the agreement in the ranking of these factors between the two groups of responses. Okpala and Aniekwu (1988) provides a quantitative method for rank agreement analysis. In this method, the "rank agreement factor" (RAF) is used. The RAF shows the average absolute difference in the ranking of the factors between two groups. For any two groups, let the rank of the ith item in group 1 be R_{i1} and in group 2 be R_{i2}, N be the number of items, and $j=N-i+1$.

The RAF is defined as

$$\mathrm{RAF} = \frac{\sum_{i=1}^{N} |R_{i1} - R_{i2}|}{N}$$

The maximum rank agreement factor ($\mathrm{RAF}_{\max}$) is defined as

J. Constr. Eng. Manage., 2005, 131(1): 3-14

Table 8. Agreement Analysis of Ranking of Success Subfactors

	Academia		Industry		
Success subfactors	Significance index	Rank	Significance index	Rank	Agreement analysis
Economic viability					
Long-term demand for the products/ services to be offered by the project	90	1	86.9	1	RAF=0.8
Sufficient profitability of the project to attract investors	85.88	2	85	3	RAF_{mzx}=2.4
Long-term cash flow that is attractive to lenders	82.5	3	85.71	2	PA=66.67%
Limited competition from other projects	75.71	4	60	5	
Long-term availability of various suppliers needed for the normal operation of the project	70	5	68.57	4	
Appropriate risk allocation via reliable contractual arrangements					
Concession agreement	90.67	1	84.44	1	RAF=2.33
Shareholder agreement	82.67	2	67.41	9	RAF_{max}=4.44
Supply agreement	80	3	71.85	5	PA=47.5%
Offtake agreement	80	3	71.2	6	
Loan agreement	78.67	4	77.04	3	
Design and construct contract	77.33	5	70.71	7	
Operation agreement	77.33	5	73.33	4	
Guarantees/ support/ comfort letters	77.14	6	77.78	2	
Insurance agreement	76	7	69.63	8	
Sound financial package					
Sound financial analysis	93.75	1	77.14	3	RAF=1.2
Appropriate toll/ tariff levels and suitable adjustment formula	90	2	81.43	1	RAF_{max}=5
Abilities to deal with fluctuations in interest/ exchange rates	85	3	77.24	2	PA=76%
Sources and structure of main debts and standby facilities	78.75	4	71.43	4	
Investment, payment and drawdown schedules	77.5	5	70.71	5	
Long-term debt financing that minimizes refinancing risk	77.33	6	71.43	4	
Stable currencies of debts and equity finance	75	7	66.43	6	
High equity/ debt ratio	68.75	8	50	9	
Fixed and low interest rate financing	67.5	9	61.43	7	
Low financial charges	66.25	10	57.93	8	
Favorable investment environment					
Stable political system	89.41	1	76.43	3	RAF=2.45
The project is well suited for privatization	82.5	2	71.72	6	RAF_{max}=5.45
Favorable economic system	81.18	3	74.07	5	PA=55%
Government support	81.18	3	80.71	1	
Predicable risk scenarios	76.25	4	75	4	
Promising economy/ economic growth	76.25	4	57.04	10	
Predicable and reasonable legal framework	75	5	80	2	
Predictable currency exchange risk	68.24	6	55.71	11	
The project is in public interest	68.24	6	71.03	7	
Adequate local financial market	67.06	7	63.57	8	
Supportive and understanding community	58.82	8	60	9	
Reliable concessionaire consortium with strong technical strength					
Good relationship with host government authorities	85	1	75.71	2	RAF=1.25
Strong and capable project team	80	2	78.62	1	RAF_{max}=6
Effective project organization structure	78.75	3	72.67	4	PA=79.17%
Leading role by a key enterprise or entrepreneur	78.75	3	75.17	3	
Sound technical solution	77.5	4	69.66	6	
Cost-effective technical solution	76.25	5	70.34	5	
Public safety and health considerations	76	6	65.19	9	
Partnering skills	75	7	65.52	8	
Rich experience in international Public–Private Partnership project management	70	8	58.62	10	
Low environmental impact	67.06	9	67.33	7	
Multidisciplinary participants	61.25	10	57.33	11	
Innovative technical solution	57.5	11	55.86	12	

Table 9. Agreement Analysis of Ranking of Critical Success Factors

	Academia		Industry		
Critical successful factors	Significance index	Rank	Significance index	Rank	Agreement analysis
Economic viability	91.25	1	88.57	1	
Appropriate risk allocation via reliable contractual arrangements	88.75	2	86.9	2	RAF = 0.4
Sound financial package	86.25	3	82.76	3	$RAF_{max} = 2.4$
Favorable investment environment	83.75	4	71.43	5	PA = 83.33%
Reliable concessionaire consortium with strong technical strength	81.25	5	76.55	4	

$$RAF_{max} = \frac{\sum_{i=1}^{N} |R_{i1} - R_{j2}|}{N}$$

The percentage disagreement (PD) is defined as

$$PD = \frac{\sum_{i=1}^{N} |R_{i1} - R_{i2}|}{\sum_{i=1}^{N} |R_{i1} - R_{j2}|} \times 100$$

The percentage agreement (PA) is defined as

$$PA = 100 - PD$$

The higher the value of RAF is, the lower the agreement between the two groups. A RAF of zero means perfect agreement. The RAFs, $RAFs_{max}$, and PAs for SSFs and CSFs are shown in Tables 8 and 9. It can be seen that the PAs for SSFs range from 47.5 to 80%. Except for the PA for the SSFs under the CSF of "appropriate risk allocation via reliable contractual arrangements," the PAs for other SSFs are all greater than 55%. The PA for the CSFs is 83.3%. Therefore, there is a good agreement in the ranking between the industrial and academic sectors.

Conclusions

Diverse results have occurred in international infrastructure PPPs, with both successes and failures. There is an urgent need to develop an appropriate procurement protocol for constructive partnerships, in which private sector funds, managerial skills, and operational efficiencies will be brought into full play for enhanced values that benefit both public and private interests. This prompted the identification and analysis of CSFs for PPPs. Success means public–private win–win results.

Various success factors have been identified through case studies, literature review, and interviews/correspondence with worldwide PPP experts and practitioners. These success factors are further analyzed, distilled, coded, and finally classed into five main CSF aspects: (1) economic viability, (2) appropriate risk allocation via reliable contractual arrangements, (3) sound financial package, (4) reliable concessionaire consortium with strong technical strength, and (5) favorable investment environment.

The relative significance and ranking of the CSFs and SSFs have been determined based on a questionnaire survey of international expert opinions. Agreement analysis shows that there is a good agreement in the ranking of the CSFs and SSFs between respondents from the industrial sector and those from the academic sector.

References

Abdul-Aziz, A. R. (2001). "Unraveling of BOT scheme: Malaysia's Indah Water Konsortium." *J. Constr. Eng. Manage.*, 127(6), 457–460.

Asian Business. (1996). Special Report on Asia's Infrastructure Boom, March, 60–69.

Asian Development Bank. (1997). "Technical assistance for legal training in BOT/BOOT infrastructure development." *TAR: TRA 30150*, Metro Manila, Philippines.

Berry, C. (1991). "Criteria for successful project financing." *Project finance yearbook 1991/1992*, Bedfordshire, U.K., 15–20.

Chua, D. K. H., Kog, Y. C., and Loh, P. K. (1999). "Critical success factor for different project objectives." *J. Constr. Eng. Manage.*, 125(3), 142–150.

Delmon, J. (2000). *BOO/BOT projects: a commercial and contractual guide*, Sweet & Maxwell Limited, London.

Diekmann, J. E., and Girard, M. J. (1995). "Are contract disputes predictable?" *J. Constr. Eng. Manage.*, 121(4), 355–363.

Fitzgerald, P. F. (1998). "International project financing: an overview." *Project financing 1998—Building infrastructure projects in developing markets*, Practicing Law Institute, New York.

Gordon, C. M. (1994). "Choosing appropriate construction contracting method." *J. Constr. Eng. Manage.*, 120(1), 196–210.

Gupta, M. C., and Narasimham, S. V. (1998). "Discussion of 'CSFs in competitive tendering and negotiation model for BOT projects' by R. L. K. Tiong." *J. Constr. Eng. Manage.*, 124(5), 430.

Higher Education Funding Council for England (1998). *Practical guide to PFI for higher education institutions*, Bristol, U.K.

Larson, E. (1995). "Project partnering: Results of study of 280 construction projects." *J. Manage. Eng.*, 11(2), 30–35.

Levy, S. M. (1996). *Build, operate, transfer*, Wiley, New York.

Merna and Dubey (1998). *Financial engineering in the procurement of projects*, Asia Law & Practice, Hong Kong.

Merna, A., and Smith, N. J. (1996). *Guide to the preparation and evaluation of build–own–operate–transfer (BOOT) project tenders*, Asia Law and Practice, Hong Kong.

Mohsini, R. A., and Davidson, C. H. (1992). "Determinants of performance in the traditional building process." *Constr. Manage. Econom.*, 10(4), 343–359.

Morledge, R., and Owen, K. (1997). "Developing a methodological approach to the identification of factors critical to success in privatized infrastructure projects in the UK." *Proc., CIB W92 and CIB TG 23 Joint Symp.: Profitable Partnering in Construction Procurement*, 487–498.

Ogunlana, S. O. (1997). "Build operate transfer procurement traps: examples from transportation projects in Thailand." *Proc., CIB W92 Symp. on Procurement*, IF Research Corporation, Montréal, 585–594.

Okpala, D. C., and Aniekwu, A. N. (1988). "Causes of high construction costs in Nigeria." *J. Constr. Eng. Manage.*, 114(2), 233–244.

Pahlman, C. (1996). "Build–operate–transfer (BOT)–private investment in public projects or just more public subsidies for the private sector?" *Watershed*, Vol. 2, Towards Ecological Recovery and Regional Alliance, Bangkok, Thailand.

J. Constr. Eng. Manage., 2005, 131(1): 3-14

Partnership for prosperity: The private finance initiative. (1997). HM Treasury, London.
Sanvido, V., Grobler, F., Parfitt, K., Guveris, M., and Coyle, M. (1992). "Critical success factors for construction projects." *J. Constr. Eng. Manage.*, 118(1), 94–111.
Tiong, R. L. K. (1996). "CSFs in competitive tendering and negotiation model for BOT projects." *J. Constr. Eng. Manage.*, 122(3), 205–211.
Tiong, R. L. K., and Alum, J. (1997). "Distinctive winning elements in BOT tender." *Eng., Constr., Archit. Manage.*, 4/2, 83–94.
Tiong, R. L. K., Yeo, K. T., and McCarthy S. C. (1992). "Critical success factors in winning BOT contracts." *J. Constr. Eng. Manage.*, 118 (2), 217–228.
Walker, C., and Smith, A. J. (1995). *Privatized infrastructure: The BOT approach*, Thomas Telford, London.
Woodward, D. G. (1995). "Use of sensitivity analysis in build-own-operate-transfer project evaluation." *Int. J. Proj. Manage.*, 13(4), 239–246.
Ye, S. D., and Tiong, R. L. K. (2000). "NPV-at-risk method in infrastructure project investment evaluation." *J. Constr. Eng. Manage.*, 126(3), 227–233.
Zhang, X. Q. (2004). "Concessionaire selection: methods and criteria." *J. Constr. Eng. Manage.*, 130(2), 235–244
Zhang, X. Q., and Kumaraswamy, M. M. (2001a). "Paving the way for private finance in public infrastructure projects." *Proc., Int. Conf. on Construction*, Hong Kong.
Zhang, X. Q., and Kumaraswamy, M. M. (2001b). "Procurement protocols for public-private partnered projects." *J. Constr. Eng. Manage.*, 127(5), 351–358.

J. Constr. Eng. Manage., 2005, 131(1): 3-14