Partnering Mechanism in Construction: An Empirical Study on the Chinese Construction Industry

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Abstract: Partnering and its principles have increasingly been introduced to the construction industry to improve the efficiency of project delivery. However, little research outlines the mechanism behind its application. This paper presents the findings of a study that was conducted to develop and test a partnering model that reveals the relationships between the critical success factors (CSFs) of partnering and demonstrates their importance to construction. With support of data collected from the Chinese construction industry, this study has revealed strong correlations among partnering CSFs, risk management, total quality management (TQM), use of incentives, and project performance. It is concluded that project success is the outcome of the interaction between a variety of techniques, and that partnering, associated with incentives, is a basic management method through which risk management and TQM can be strongly improved.

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Introduction

Construction is a very competitive, high-risk business. In many circumstances, because of the limitations of traditional project delivery systems, the competitiveness and the perception of risks can make the relationship between participants adversarial. Existing studies tend to agree that the adversarial situations significantly affect the productivity and efficiency of the construction industry (Kadefors 2004; Scott 2001; NAO 2001; ACA 1999; Carr et al. 1999; Egan 1998; Pietroforte 1997; Li and Green 1996; Growley and Karim 1995; Hanly and Valence 1993; Cowan 1992; Contracts Working Party 1991). Most researchers in the construction industry emphasize that it is necessary to improve its performance and reduce confrontation in the construction supply chain. In the late 1980s partnering emerged as a new project delivery method which seeks to create a win/win attitude among all construction parties to change the adversarial situation. Partnering creates a trust-based environment, thus encouraging project participants to make maximum contributions to achieving the completion of a successful project to the benefit of all (CII 1991; Cowan 1992; Scott 2001). Partnering has been applied increasingly in the construction industry during the past ten years. Recently, further advancement to partnering termed alliancing has also been successfully utilized in the construction industry. Besides including key factors contained in partnering, alliancing uses a clearly defined risk allocation with gain share/pain share to manage the process. In alliancing, parties contractually commit to their contribution levels and required profit and then place these at risk in undertaking the project. This provides a powerful incentive to achieve project goals (Walker and Hampson 2003).

Despite the potential benefits to be gained by participants from the implementation of partnering, there are obstacles and barriers to successful partnering. Chan et al. (2003), Larson and Drexler (1997), Li and Green (1996), and Ng et al. (2002) conducted industry surveys to explore the barriers and problems leading to unsuccessful partnering. They revealed that the barriers and problems to successful partnering implementation cover broad themes, ranging from project environment and partnering structure to personal knowledge, skills, and attitude.

Impediments to successful partnering encountered by participants can be largely due to a lack of understanding of the deeper concepts underlying partnering. There appears to be considerable uncertainty as to how to translate general principles of partnering into any sort of concrete application, and the uncertainty is largely born of the vagueness of the partnering concept, which means many things to many people (Critchlow 1998). Bresnen and Marshall (2000a,b) highlighted the professional debate about partnering approaches, and claimed that previous research remained at a largely prescriptive level, and that empirical evidence concerning partnering in practice had largely been piecemeal and anecdotal. Fisher and Green (2001) also argue that claims regarding partnering are weakened due to a lack of rigorous verifiable evidence. The mechanism by which the benefits of partnering are actually achieved is still not clear. If the quintessential nature of partnering is understood, it is possible for participants to tailor these principles to meet their own particular requirements (Critchlow 1998). Similarly, Lazar (1997) indicates that understanding the partnering mechanism will be crucial to tailoring the partnering process for participants on an informed basis as opposed to trial and error, and this requires identification of the important components and processes in partnering. Clearly there is a need to iden-

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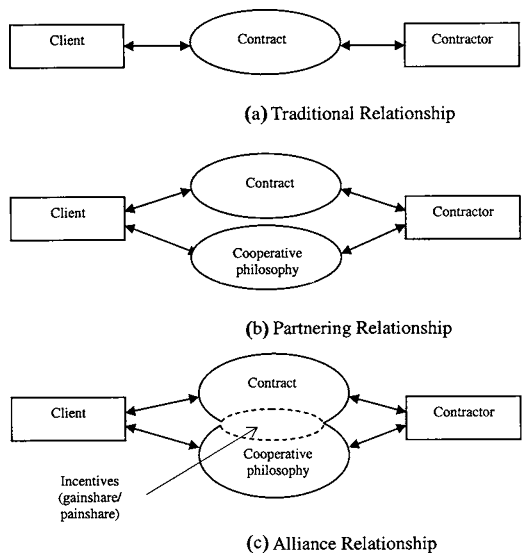

Fig. 1. Comparison of client/contractor relationships

tify critical success factors (CSFs) for partnering and to develop quantifiable models (Li et al. 2000; Lazar 2000).

The Chinese industrial culture shares many elements with partnering (Rahman and Kumaraswamy 2002; Chen and Partington 2003), and the influence of culture on partnering is well accepted, which implicitly influences the application of many CSFs of partnering in construction.

This paper reports the findings of an empirical study into the relationship between the CSFs of partnering and demonstrates their importance to construction by developing and testing a partnering model. The model testing was based on the data collected from the Chinese construction industry, which is influenced by Chinese culture particularly in respect to cooperative philosophy.

Conceptual Partnering Model

Background

A detailed explanation of the three kinds of relationships mentioned previously is required to understand the factors leading to success. In this paper the relationships are referred to as traditional relationships, partnering, and alliancing, as represented in Fig. 1.

In traditional forms of project delivery the relationship between client and contractor is based on a contract. Partnering adds a cooperative philosophy to the traditional contractual relationship. This philosophy is a trust-based relationship between project participants to facilitate the completion of a successful project to the benefit of both parties. In partnering, the cooperative philosophy resides outside the contract. However, alliancing links the ethos of partnering as a contractual requirement and uses clearly defined risk allocation with incentives to manage the process. Alliancing is "where the arrangement is underpinned by an incentive scheme, whereby the rewards of the contractor and, indeed, the owner are linked directly to actual performance during the execution phase of the project" (Scott 2001). In this case, the cooperative philosophy is tied into the contract by sharing rewards and risks among participants.

Partnering is often used to refer to both the strategies of partnering and alliancing, because they both contain a cooperative philosophy. However, if partnering is used as a generic term, use of incentives should be distinguished from other CSFs of partnering because of their strong influence on cooperative philosophy, see Figs. 1(b and c).

Cowan (1992), Kubal (1994), Li and Green (1996), and McGeorge and Palmer (1997) have generalized the benefits produced by partnering as: An improved ability to respond to changing project environment; improved quality and safety; reduced cost and project time; improved profit and value; and more effective utilization of resources. Based on a study of 280 construction projects, Larson (1995) reported that partnered projects achieved better results than other projects in controlling costs, in technical performance and in satisfying customer expectations. The findings of Graijek et al. (2000), Gransberg et al. (1999), Pocock et al. (1997), and Weston and Gibson (1993) have included some quantitative analysis of improvements to cost and time performance gained via partnering. Based on these four studies, preliminary benchmarks for duration and cost improvement have been developed. The average increase in duration for partnered projects was 8.99% less than for traditional projects, and the average cost overruns for partnering projects was 1.76% lower than for traditional projects. These results are consistent with the findings of Warne (1994), who concluded that in the Arizona Department of Transportation the contingency value of partnered projects was only 3% instead of the historical trend of 5%; comparable partnered projects were completed 20% earlier than traditional projects. These results give an indication of the trend of improvement achieved from partnering.

There is significantly less information available for alliancing projects than for partnering projects and the information is typically reported by way of case studies. Based on the results of 25 alliancing projects reported by Gallagher (2002), Olds (2002), Ross (2001), Clegg (2001), Scott (2001), Voordijk (2000), Barlow (2000), Shwer (1997), and the ACA (1999), the cost of alliancing projects is, on average, 8.10% lower than the target cost, and the duration of alliancing projects is on average 6.94% less than schedule.

Preliminary benchmarking of the performance of partnering and alliancing projects shows that both partnering and alliancing can improve project outcomes of project cost and duration. Both partnering and alliancing can reduce the duration of projects to a large extent, whereas partnering appears to have less of an impact on project cost than alliancing.

Model Details

Research into the important components of partnering has been undertaken by many studies through identifying the CSFs of partnering. The main CSFs identified include mutual objectives, commitment, equity, trust, attitude, openness, effective communication, teambuilding, problem resolution, timely responsiveness, and incentives (Cheng and Li 2002; Scott 2001; Black et al. 2000; Cox and Townsend 1999; ACA 1999; Bennet and Jayes 1998; Cowan 1992). Specifically, Black et al. (2000) and Cheng and Li (2002) ranked the importance of partnering CSFs according to the results of questionnaire surveys. However, the interactions between these factors are still unclear, e.g., which factors can add more value is not known, and the results do not provide guidance on how improvements are generated by these factors.

Based on the CSFs identified by the above-mentioned studies, a conceptual model has been developed. The model is shown in Fig. 2, where the relationships among various various CSFs of

J. Constr. Eng. Manage., 2006, 132(3): 217-229

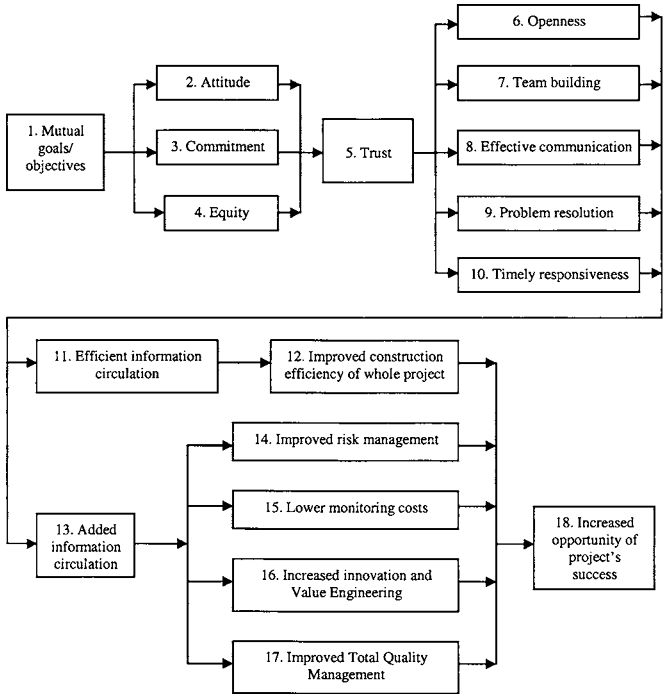

Fig. 2. Conceptual partnering model

partnering are presented. The model facilitates how improvements from partnering could be generated from these CSFs.

The 10 partnering CSFs are incorporated as components of the model from 1 to 10 (see Fig. 2). Components 11–18 of the model demonstrate the outcomes of the interactions of these CSFs. These outcomes include improved construction efficiency of the whole project, improved risk management, lower monitoring costs, increased innovation and value engineering, and improved total quality management, which are decided according to literature (Chini and Valdez 2003; Baker et al. 1999; AS 1999; Smith 1999; Carr et al. 1999; Buck 1989; Lu and Lu 1998; Pietroforte 1997; Ruskin 1995; Warne 1994; Kubal 1994; Hanly and Valence 1993; Cowan 1992). The components of the model are discussed in the following in detail to demonstrate the relationship between them and their linkages to the overall model.

Mutual Objectives, Attitude, Commitment, and Equity

The first step of partnering is to develop a partnering charter addressing mutual objectives. Joint goal formulation provides a deeper understanding of the project's overall goals and the difficulties and possibilities involved in their establishment (Kadefors 2004). In developing the mutual objectives, participants will discover that they share many common concerns and agree on much more than they may have thought. This sharing of goals will change the attitude of participants and enable them to consider the interests of others by utilizing win/win thinking. This will give participants confidence to accept commitment and equity at the beginning as they recognize that benefits can also be reached. If these principles are adhered to continually, the trust among participants will be established gradually. The factors of mutual objectives, active attitude, commitment, and equity are the precursors necessary for establishing trust between participants. The relationship between these factors and trust is shown in Components 1–4 of Fig. 2.

Trust

Many researchers have identified that partnering is a trust-based relationship which is critical to maximizing positive economic outcomes. Zaghloul and Hartman (2003) indicate that trust and contracting methods are related, and a trust relationship can be the root cause for a significant saving in construction cost. Cheung et al. (2003) also point out that trust is the pivotal attitudinal factor of partnering. This model (refer to Components 5–10 of Fig. 2) further demonstrates that the positive influence of trust is realized through facilitating open communication among participants. Trust is behavioral or attitudinal in nature (Cheung et al. 2003). Positive attitudes to people are vital to successful communication, since good communication and willing cooperation are inseparable. If trust is present, people can spontaneously engage in constructive interaction without pondering what hidden motives exchange partners might have, who are formally responsible for problems, or what are the risks in disclosing information (Kadefors 2004). By establishing trust, organizations begin to develop confidence in each other, which gradually influences them to merge their boundaries, and finally trust encourages parties to make their merged boundary more permeable, allowing active interorganizational exchange (Growley and Karim 1995). Therefore, trust is the basis of open communication among participants.

While trust can be claimed to be the pivotal attitudinal factor, open communication is critical because the benefits of partnering are directly generated from it. The next part of this section illustrates why open communication in partnering is vital to add value to a project.

Open Communication in Partnering

Although participants traditionally communicate according to the contract, and information exchange is mainly at the contractual level, partnering has established complementary means of communicating information at all levels. Besides informal oral communication, partnering typically devises procedures for two other kinds of communication: meetings and written communication (Ronco and Ronco 1996):

- Meetings, which can include weekly, daily, informal, and as-needed meetings; and
- Written communications, which include formal and informal procedures for clarifying issues as they arise on the job, clarification of authority and sign-off responsibility, and informal means of access to necessary information in emergency situations.

These communication methods can be more specifically termed openness, team building, effective communication, problem resolution, and timely responsiveness (refer to Components 6–10 of Fig. 2). As all these factors are dealing with information exchange among participants, they are called open communication factors in this study. Open communication refers to the free flow of resources in terms of ideas, knowledge, skills, and technology through different effective channels (Cheng and Li 2001).

Open communication factors help to make communication more tangible and lead to information being shared freely. Thus, partnering provides methods through which it is natural to discuss and share information about new processes, innovations, improvements, and management practices, and thus makes it possible to have a level of information exchange that does not exist traditionally (Ronco and Ronco 1996). Two direct benefits are obtained from open communication: Information being circulated more efficiently and added information circulation.

J. Constr. Eng. Manage., 2006, 132(3): 217-229

Efficient Information Circulation

One benefit from open communication is information being communicated more efficiently, which can improve the construction efficiency of the whole project (refer to Components 6–12 of Fig. 2). The variety of communication methods used in partnering enables the efficient circulation of information. Most partnering efforts attempt to give project team members increased autonomy by dropping decision-making authority down to the lowest possible level. This improves the effectiveness of decisions because people with operational level information on the issues are able to deal directly with each other. When issues are raised, they can be promptly sent to the appropriate channel to be solved without delay before they have serious impacts. Timely communication and decision-making not only saves money, but also can keep a problem from growing into a dispute (Cowan 1992).

Added Information Circulation

In partnering, all parties are willing to share their knowledge and experience in a trust environment, and they are also able to contribute their ideas because sufficient communication channels are open. The outcomes of the added information circulated in partnering include improvements in risk management, lower monitoring costs, more innovation and value engineering, and improved total quality management (TQM) (see Components 13–17 of Fig. 2). Risk management and TQM are further discussed in this paper.

Improved Risk Management

A very important benefit of added information generated by partnering is the improved risk management in a partnering project (refer to Components 13 and 14 of Fig. 2). Projects contain risks arising from uncertainties. Commonly, project budgets set a contingency to cover the risk arising from uncertainties. The added information brought about by partnering can reduce some uncertainties, and therefore can reduce the risks of a project because of the value of the information. This value arises from a change in actions because of the change in understanding after the receipt of the information (Buck 1989). Information that has value reduces lost opportunity (Buck 1989), which illustrates why added information generated from open communication in partnering improves risk management.

Improved Total Quality Management

TQM has increasingly been introduced to the construction industry. Chini and Valdez (2003), Carr et al. (1999), Kubal (1994), and Hanly and Valence (1993) indicate that TQM and partnering share similar elements. “Partnering is another way of implementing quality management by attempting to improve the communication flow in a project” (Chini and Valdez 2003). The role of partnering in enhancing TQM in construction can also be largely attributed to open communication. TQM is normally implemented within one organization. Open communication enables all participants to be much more integrated, and as a result the barriers to implementation of TQM in construction can be substantially removed. Thus, it is expected that partnering can improve the implementation of TQM in construction.

Increased Opportunity of Success

Overall, the partnering mechanism model reveals how improvements can be generated by achieving open communication in partnering based on trust relationships between participants. Open communication leads to efficient information circulation which improves the efficiency of the whole construction process, and also helps to bring added information to the construction system. This results in reduced project risks, lower monitoring costs, increased value engineering, and improved implementation of TQM. These outcomes of the CSFs increase the opportunity of success for a partnering project (refer to Components 11–18 of Fig. 2).

Incentives

The preceding discussion of the conceptual partnering model has outlined why partnering can increase the opportunity for a project to succeed through open communication in an environment of trust. However, although parties recognize that they share many common objectives, the priorities of each party may still be different. For contractors, the main business objective is ultimately profit. For clients, the project objectives should be an optimum combination of time, cost and quality, which contributes to their business objectives.

The mechanism shown in Fig. 2 does not cover all problems originating from the structure of the traditional delivery systems, e.g., misalignment between the owner and the contractors (Scott 2001) and dealing with increased risk (Carr et al. 1999). The tendency toward adversarial relationships between organizations in the construction industry is attributed in part to clients placing too much emphasis on the lowest price in awarding contracts and, as a result, some contractors price work unrealistically low and then seek to recoup their profit margins through contract cost variations, e.g., design changes, and other claims leading to disputes and litigation (NAO 2001). Selection on the basis of lowest price places extreme pressure on the bidders to provide a marginally adequate bid to cover the work, with a small margin for contingency and profit, which may result in the situation where contractors feel compelled to find profit in variations and claims (Carr et al. 1999).

Recognition of the limitations of the structure of traditional delivery systems leads to the introduction of incentives or gain-share/pain-share mechanisms in alliancing. Use of the gain-share/pain-share mechanism is one of the fundamentals of equitable relationships among parties, and parties to an agreement should be aligned not only through common goals, but also through shared business interests in the project’s success (ACA 1999). Bower et al. (2002) point out that incentives create a more proactive, cooperative relationship between the contracting parties, and reinforce the cultural shift away from the traditional adversarial approach to contracting. Walker and Hampson (2003) studied an alliancing project, The National Museum of Australia, and concluded that there should be associated benefits that reward the general workforce for producing high quality results. The principal lesson from this case study is that the use of incentives for quality management should be underpinned by an incentive system, such as a gain-share/pain-share mechanism.

Incentives may create strong motivations for participants. However, they do not specify how to deal with project issues. Incentives need to exert their influences through facilitating other techniques and are expected to have overall positive impacts on the components of the conceptual partnering model.

Issues Arising from the Development of the Conceptual Partnering Model

Presentation of the conceptual partnering model combined with the use of incentives has the potential to improve project delivery and needs to be quantified and validated. An empirical approach

J. Constr. Eng. Manage., 2006, 132(3): 217-229

has been chosen to test the model and to explore how incentives can have actual impacts on the components of the model. The relevant key issues were transferred into specific questions:

- To what extent have the CSFs of partnering been achieved in construction projects?
- What is the role of CSFs of partnering in risk management in terms of risk management techniques being used by project participants?
- To what extent have participants realized the objectives of the key factors of TQM?
- How effective are incentives currently being applied?
- What is the ultimate project performance in terms of cost, duration and quality? and
- What are the relationships between all these issues?

These questions have been used as the basis of a detailed questionnaire to obtain quantifiable answers.

Empirical Study Methodology

Choice of Chinese Construction Industry

As the concepts of the partnering model originated from the experiences of the global market, it would appropriate to test them by collecting data from world-wide markets. However, because of the limited resources it was impractical to conduct a global industries survey. It was decided to focus this study on a specific study area. Although the collected data are inevitably based on a relatively narrow area in such an approach, if the collected data are able to facilitate a deep understanding of the construction market of the area, it is expected that significant insights can still be obtained.

In terms of contractual background, recent Chinese business practices seem to incorporate significant elements of neoclassical contracting in general, in which trust played the most important role in business (Rahman and Kumaraswamy 2002). Chinese project managers have adopted concepts of negotiation, no claim, and good relationships (Chen and Partington 2003). Many features of the Chinese industrial culture are consistent with the principles of partnering. In the choice of China as a study area, this established connection between culture and partnering has been accepted. Hence, the Chinese construction industry is a suitable study area to conduct this empirical research to quantify CSFs of partnering in construction.

Six areas (Hubei, Beijing, Shanghai, Jiangsu, Heilongjiang, and Guangxi) of China were carefully chosen for sources of samples. These areas are scattered over the central, north, east, southeast, northeast, and southwest regions of China. In 2001 the overall construction production value of the six areas was $\$5.5 \times 10^9$, accounting for 29.4% of the whole construction industry in China (National Statistic Bureau of China 2002). To ensure that the collected data were able to reflect the overall picture of the industry as much as possible, it was decided to use all the principal stakeholders of the Chinese construction industry as respondents: clients, management organizations, planners, designers, superintendents, and contractors.

It was decided to select respondents from organizations that were believed to have experience in the delivery of significant projects. These projects were to be drawn from the Oil & Gas, Energy, Transportation, Industrial and Commercial Building, and Public Infrastructure industries, because of the importance of the role of these industries in construction.

In selecting these Chinese respondents and projects, it was decided that all types of project delivery strategies could be included, because partnering adopts a cooperative philosophy, the principles of which can be applied more or less in any delivery strategy. Black et al. (2000) compared the importance of 18 partnering CSFs in partnered projects and nonpartnered projects. They found that the importance of 12 CSFs had no significant differences between the two types of project, and there were significant disparities between the partnering group and the nonpartnering group for only six CSFs. This shows that the principles applied in partnered projects also exist in nonpartnered projects, with the difference being just one of degree. Schultzel and Unruh (1996) also claimed that partnering can be viewed as a matter of degree. Thompson and Sanders (1998) used a continuum to describe the different degrees of partnering, which they divided into four general stages: Competition, cooperation, collaboration, and coalescence. To reveal the general trends of the construction industry and to give this study a broader base, it was decided to investigate the extent to which the principles obtained from partnering applied in the whole construction industry, rather than to focus on a specific project delivery strategy.

Table 1. Roles of Respondents

Roles of respondents	Number of organizations	Number of respondents	Percentage of all respondents (%)
Client	8	19	16.5
Designer	3	21	18.3
Superintendent	11	20	17.4
Contractor	12	30	26.1
Designer and contractor (DB)	4	4	3.5
Contractor and owner (BOT)	1	1	0.9
Designer and superintendent	1	1	0.9
Management organization	4	10	8.7
Planning organization	1	8	7.0
Academic	1	1	0.9
Total	46	115	100

Questionnaire

Questionnaire was chosen as the survey method. A five-point Likert scale was applied in the questionnaire to permit the data to be collected in a quantitative form, and to permit different statistical techniques to be used to analyze the collected data. Postal surveys avoid the leg-work problem, but then another problem is to obtain an adequate level of response (Thomas 1996). Akintoye and Macleod (1997) argued that postal surveys can be biased if the return rate is lower than 30–40%. To avoid these limitations of postal survey, the questionnaire survey was conducted through fieldwork, with the projects and respondents being chosen and conducted in advance. The questionnaire being completed face-to-face by each respondent. Another advantage of a fieldwork survey is that it can readily be followed by an interview with the respondent after the questionnaire has been completed, which helps to test and interpret the results from the questionnaire survey.

Respondents to the questionnaire represent different roles in the construction industry, refer to Table 1. The total number of respondents is 115, and the distribution of samples is

J. Constr. Eng. Manage., 2006, 132(3): 217-229

Table 2. Application of Partnering Critical Success Factors in the Construction Industry

Critical success factors of partnering	All	Rank
Mutual objectives	3.98	1
Effective communication	3.79	2
Team building	3.68	3
Commitment	3.64	4
Openness	3.52	5
Problem resolution	3.50	6
Trust	3.50	7
Attitude	3.47	8
Equity	3.30	9
Timely responsiveness	3.24	10

as: 18 (Hubei), 38 (Beijing), 10 (Shanghai), 19 (Jiangsu), 10 (Heilongjiang), and 20 (Guangxi). 90% of the respondents held senior positions in their organizations, such as director, general manager, or project manager, and the others also had been involved in the industry for many years. These respondents were initially identified and contacted via personal relationships and reputation. Direct contact confirmed their willingness to assist this study. The fieldwork approach used in this survey enabled all sent questionnaires to be collected after interviews were held with participants. Thus, in this case, the response rate reached 100%.

Given the geographic position and economic status of these areas, and the variety of respondents, projects, and project delivery strategies, bias of selecting samples can be reasonably avoided, and the data collected can, to a large extent, be taken to be representative of the whole construction industry in China.

Data Analysis Techniques

The collected data from the industry survey were analyzed with the assistance of Statistical Package for Social Science (SPSS). The selected techniques that are appropriate to this study include:
- Estimation of the sample population mean;
- Rank cases;
- Pearson correlation; and
- Hierarchical cluster analysis.

Of these statistical techniques the Pearson correlation has been adopted for inferential analysis of the coefficients between CSFs of partnering, risk management, TQM incentives, and cost performance, and the results are tested by a significant level. The hurdle of significance in this study follows the usual level for statistical significance of 0.05, with a level of 0.01 being highly significant.

Survey Results

Application of Partnering CSFs in the Construction Industry

Respondents were given statements concerning the extent to which the ten CSFs of partnering were applied in the construction industry, and were asked to score using a five-point scale ranging from strongly disagree (1) to strongly agree (5). The results are shown in Table 2.

The results show that mutual objectives are well recognized, all parties endeavour to reach the objectives of projects, and communication between parties is effective in dealing with normal activities of projects. The results presented in Table 2 indicate that team building, commitment, openness, problem resolution methods, trust, and active attitude are at about average levels. The average rating of the 10 factors was 3.56. The lowest score was for timely responsiveness, i.e., when problems and issues arise, they cannot be solved quickly. This indicates that industry relationships are not as adversarial as often assumed, which could be attributed to the high rating of mutual objectives and well built communication channels. However, the overall rating is not high and the relationships still need to improve a lot, especially for timely responsiveness and equity.

Table 3. Application of Risk Management Techniques

Techniques of risk management	All	Rank
Risk identification		
Checklists	2.73	11.5
Brainstorming	3.40	3
Consulting experts	2.99	9
Risk analysis		
Qualitative analysis	3.39	4
Semiquantitative analysis	2.73	11.5
Quantitative analysis	2.60	14
Consulting experts	3.06	8
Joint evaluation of key participants	3.64	1
Use of computers and other modeling	2.10	17
Risk response		
Avoid the risk	2.98	10
Reduce the likelihood of occurrence	3.39	4
Reduce the consequences	3.41	2
Transfer the risk	3.18	6
Retain the risk	2.40	16
Risk monitoring		
Periodic document reviews	3.15	7
Periodic risk status reporting	2.71	13
Periodic trend reporting	2.53	15

Risk Management

Respondents were asked to identify the risk management techniques being used in their projects, and the chosen techniques are based on literature (Lyons and Skitmore 2003; Duffield 2001; Raz and Michael 2001; AS4 1999; Baker 1999; Baker et al. 1999, Smith 1999; Lu and Lu 1998; Kliem and Ludin 1997; Akintoye and Macleod 1997; Lei 1996; Thompson and Perry 1992). Respondents were asked to respond on a scale of 1–5, where 1=never used; 2=seldom used; 3=sometimes used; 4=often used; and 5=always used. The results are given in Table 3.

The application of risk management techniques shows that qualitative methods are most frequently used in risk management. Brainstorming for risk identification, joint evaluation for risk analysis, risk reduction for risk response, and periodic documents review for risk monitoring are the most frequently used techniques in corresponding stages.

Total Quality Management

Respondents were given statements concerning the extent to which the key factors of TQM applied in the construction industry, and the identified factors are based on literature (Hoque 2003; ISO 2000; Carr et al. 1999; Arditi and Gunaydin 1997; ECI 1996; Tam and Hui 1996; AS 1992). Respondents were asked to score

J. Constr. Eng. Manage., 2006, 132(3): 217-229

Table 4. Application of Key Factors of TQM

Key factors of TQM	All	Rank
Leadership	4.11	1
Systems/processes approach	4.07	2
Customer focus	3.97	3
Training	3.83	4
Teamwork	3.76	5
Total involvement	3.73	6
Culture	3.68	7
Measurement/improvement	3.67	8
Motivation	3.65	9
Empowerment	3.56	10

according to a five-point scale, ranging from strongly disagree (1) to strongly agree (5). The responses are shown in Table 4.

The results regarding TQM show that leadership, systems approach, customer focus, training, and teamwork have been implemented relatively well. Empowerment, motivation, measurement/improvement, culture, and total involvement have also been implemented, but to a lesser extent. Although the concepts of TQM have been accepted and applied in the industry, the overall rating is not high, suggesting that there is much room for improvement.

Incentives

Respondents were asked to identify the incentives actually being applied in their projects. They were required to respond on a scale ranging from 1 to 5, where 1=not applied and 5=always applied. The results are shown in Table 5. Incentives involving the quality of the finished project were perceived to be the incentives most frequently used in the industry, followed by incentives involving schedules, safety, cost savings, and budget savings. To investigate the effectiveness of applying these incentives, respondents were asked to give a response to the two statements in Table 6, ranging from 1=strongly disagree to 5=strongly agree. The high ratings of the two statements show that the respondents believed that incentives make risk allocation between parties fairer, and that the use of incentives is very effective in providing motivation for participants to perform better.

Project Performance

Finally, respondents were asked to rate the performance of the projects they had been involved in, regarding cost, quality, and time. Only cost performance is reported in this study, which will be used for the following model testing. Respondents were asked to describe the cost performance of their projects in terms of the ratio of actual project cost to established budget. The cost performances of 259 projects were rated ranging from 1 to 7, with the results shown in Fig. 3.

Table 5. Application of Incentives

Incentive for items	All	Rank
Quality product and service	3.85	1
Schedule meets milestone	3.78	2
Earlier completion	3.63	3
Good safety record	3.50	4
Cost savings	3.20	5
Within an established budget	3.16	6

Table 6. Perceptions on the Use of Incentives

Statements	Mean
Incentives make the project risk allocation fairer, because incentives can be seen as the sharing of rewards from good performance	3.98
Use of incentives is an effective method for better project performance	4.17

These results indicate that 70% of the projects were completed within established budgets. The mean score of cost performance was 5.3, showing that most frequently the cost of a project lay between 95 and 100% of the established budget. However, 30% of the projects exceeded their budgets, and 7% of the projects even exceeded the budgets by more than 20%. According to the ratings of the respondents, overall project performance in terms of cost was quite good. However, an appreciable number of projects were completed with cost overruns, suggesting room for improvement in the construction industry.

In general, although the delivery systems currently being applied in China are largely based on the traditional competitive tender system, which retains features that might lead to adversarial relationships between participants, the limitations of these systems are being recognized, and a variety of innovative delivery strategies is being introduced to the industry. These strategies are consistent with the principles of partnering, and the overall satisfactory performance in the construction industry in China provides a good illustration that they are effective. The implications on how these strategies could improve project performance will be explored through testing of the partnering model.

Testing the Partnering Model

To test the relationships among the components of the partnering model the CSFs were first evaluated, followed by the relationship

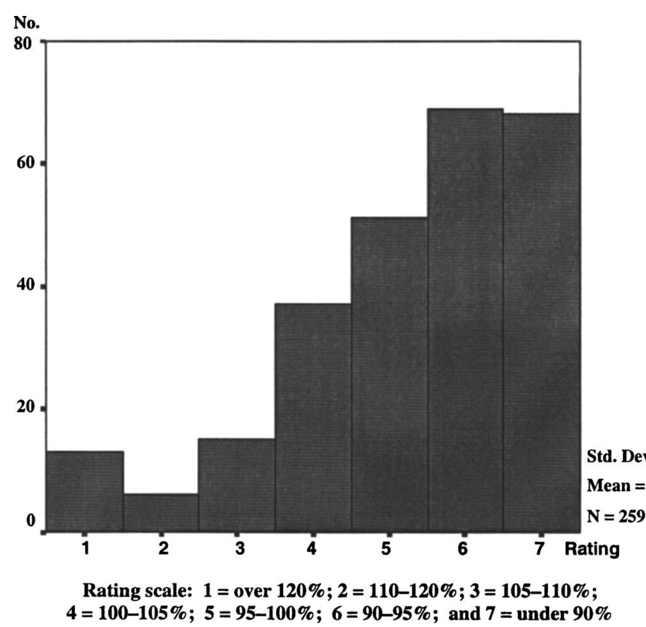

Fig. 3. Cost performance ratings of projects

J. Constr. Eng. Manage., 2006, 132(3): 217-229

Table 7. Correlations between the CSFs of Partnering

CSF	Mutual objects	Commitment	Equity	Trust	Attitude	Openness	Team building	Communication	Problem resolution	Timely responsiveness
Mutual objectives	1									
Commitment	0.409**	1								
	0.000									
Equity	0.393**	0.649**	1							
	0.000	0.000								
Trust	0.446**	0.602**	0.653**	1						
	0.000	0.000	0.000							
Attitude	0.401**	0.506**	0.602**	0.532**	1					
	0.000	0.000	0.000	0.000						
Openness	0.335**	0.332**	0.488**	0.476**	0.604**	1				
	0.000	0.001	0.000	0.000	0.006					
Team building	0.357**	0.362**	0.497**	0.410**	0.441**	0.607**	1			
	0.000	0.000	0.000	0.000	0.000	0.000				
Effective communication	0.370**	0.251**	0.444**	0.401**	0.444**	0.592**	0.484**	1		
	0.000	0.010	0.000	0.000	0.000	0.000	0.000			
Problem resolution	0.138	0.365**	0.374**	0.267**	0.288**	0.521**	0.410**	0.460**	1	
	0.160	0.000	0.000	0.006	0.003	0.000	0.000	0.000		
Timely responsiveness	0.181	0.456**	0.460**	0.221*	0.459**	0.468**	0.390**	0.418**	0.666**	1
	0.064	0.000	0.000	0.023	0.000	0.000	0.000	0.000	0.000	

Note: ** = correlation is significant at the 0.01 level (two-tailed) and * = correlation is significant at the 0.05 level (two-tailed).

between partnering (the 10 CSFs as a whole) and risk management, and finally an evaluation of the relationship between partnering and TQM.

Relationships Among the CSFs of Partnering

To test the relationships among the CSFs of partnering (see Fig. 2), a Pearson correlation analysis of the CSFs was conducted, with the results shown in Table 7. Mutual objectives are significantly correlated with commitment, equity, trust, attitude, openness, team building, and effective communication at the 0.01 level, but have no significant correlation with problem resolution methods and timely responsiveness. Commitment, equity, trust, attitude, openness, team building, effective communication, problem resolution, and timely responsiveness are significantly related with each other at the 0.01 level, except for the correlation between trust and timely responsiveness, which is significant at the 0.05 level. The strong correlations among the partnering CSFs show that partnering achievements are the outcomes of the interactions of the CSFs.

To test the distance between individual CSFs or groups of CSFs, hierarchical cluster analysis was used to analyze the application of the ten CSFs, using the average between linkages, i.e., between groups. This technique attempts to identify relatively homogeneous groups of variables based on selected characteristics, using an algorithm that starts with each variable in a separate cluster and combines clusters until only one is left (SPSS Inc. 1997). It is an appropriate technique for achieving one key objective of this study, to reveal the relationships among the CSFs of partnering. The proximity procedure of Hierarchical Cluster Analysis generates the distance or similarity scores among partnering CSFs based on the calculated Pearson correlation coefficients.

In Fig. 4, the scale 25 means the furthest distance or the weakest correlation between two factors or groups. The results were expressed as a dendrogram. Fig. 4 confirms that the ten partnering CSFs can be classified into an attitudinal factors group and an open communications factors group. The attitudinal factors group includes equity, trust, commitment, attitude, and mutual objectives, and the open communication factors group includes problem resolution, timely responsiveness, openness, team building, and effective communication. The two groups are strongly correlated ($r=0.377$ at the significance level of 0.000), suggesting that attitudinal factors can strongly facilitate open communication factors.

Within the attitudinal factors group, trust is pivotal. The other four factors can influence trust to various extents. Equity is most strongly correlated with trust, followed by commitment, attitude and mutual objectives. This confirms the relationship of the five factors in the partnering model (see Components 1–5 of Fig. 2). Notably, equity has a stronger influence on trust than commitment, and mutual objectives is the start of building trust relationships among participants, suggesting that trust needs to be built up gradually.

Among open communication factors, problem resolution and timely responsiveness have the strongest correlation ($r=0.666$ at the significance level of 0.000), suggesting these two issues are

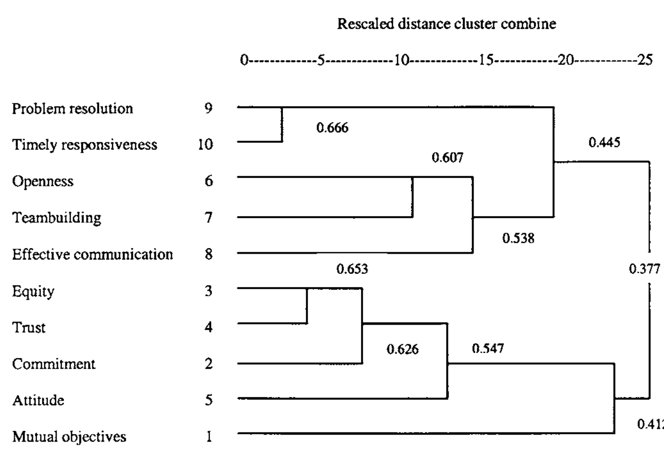

Fig. 4. Hierarchical cluster analysis of CSFs of partnering

J. Constr. Eng. Manage., 2006, 132(3): 217-229

strongly linked together. The other three factors, openness, team building, and effective communication, are further away, but are relatively close to each other. However, these three factors are also strongly correlated with problem resolution and timely responsiveness ($r=0.445$ at the significance level of 0.000), suggesting that openness, team building, and effective communication can greatly facilitate problem resolution and timely responsiveness. These results confirm the relationships between the CSFs postulated in the conceptual partnering model.

Relationship between Partnering and Risk Management

Having established the interactions between the partnering CSFs, it is now necessary to test how these factors can improve project performance by facilitating other techniques. As shown in the partnering model (see Fig. 2), partnering should be able to assist in the application of risk management. To test this, the relationship between partnering and risk management was studied.

To do this the correlation between the application of partnering (average score of the ten partnering CSFs) and the application of risk management (average score of the seventeen risk management techniques) was calculated. It was found that partnering applications had a strong positive correlation with risk management applications ($r=0.305$ at the significance level of 0.002), strongly supporting the notion that partnering can facilitate the use of risk management techniques.

The average coefficient between the five open communication factors of partnering and risk management is 0.238 at the significance level of 0.05, but the average coefficient between the five attitudinal factors of partnering and risk management is only 0.187, and does not reach the significance level of 0.05. This suggests that open communication factors are more effective in facilitating risk management, showing their importance to risk management. However, attitudinal factors are also important to risk management because they are strongly correlated to open communication factors as shown in Fig. 2 and tested in the hierarchical cluster analysis, Fig. 4. This suggests that attitudinal factors exert their influences on risk management through facilitating the open communication factors, all of which deal directly with project implementation activities, and are strongly associated with risk management.

Relationship between Partnering and TQM

To test the assertion that partnering can improve the application of TQM, the correlation between the partnering factors (average score of the ten partnering CSFs) and the application of TQM (average score of the 10 TQM factors) was calculated. It was found that the coefficient of the correlation was 0.382 at the significance level of 0.000, thus verifying that partnering can improve TQM.

The average coefficient between the five open communication factors of partnering and TQM is 0.290 at the significance level of 0.01, and the average coefficient between the five attitudinal factors of partnering and TQM is 0.249 at the significance level of 0.05. This suggests that both groups of partnering CSFs can significantly facilitate TQM application, but it should be noted that the open communication factors play a more important role than the attitudinal factors of partnering.

Testing the Impacts of Incentives

As formerly discussed, use of incentives is expected to have an overall impact on the components of the partnering model (see Fig. 2). To test these impacts, the relationships among incentives, partnering, risk management, TQM and project cost performance are evaluated in this section.

Relationship between Incentives and Partnering

To explore how incentives as a whole facilitate partnering, the correlation between use of incentives (average score of the six incentives) and application of partnering (average score of the 10 CSFs of partnering) was calculated. The result shows that the use of incentives is strongly correlated with partnering ($r=0.268$ at the significance level of 0.007), implying that use of incentives can strongly enhance application of partnering.

The average coefficient between the use of incentives and the five open communication factors was 0.228 at the significance level of 0.05, whereas the average coefficient between the use of incentives and the five attitudinal factors was only 0.152, and this was below the significance level of 0.05. These results show that incentives have much stronger correlation with open communication factors of partnering than with the attitudinal factors.

The low correlation between use of incentives and the attitudinal factors of partnering indicates that the influence of incentives on building an environment of trust among participants is very limited. Incentives do not necessarily create trust (Bresnen and Marshall 2000a,b). Incentives are contractually binding, and an incentive arrangement can be seen as just additional clauses of a project contract, which cannot automatically create trust. Trust needs participants constantly keeping commitment, equity, and an active attitude dealing with project issues, as shown in hierarchical cluster analysis, rather than reliance on incentives.

The far stronger correlation of the open communication factors of partnering with the use of incentives than with the attitudinal factors suggests that the impacts of incentives are mainly achieved through assisting participants to directly achieve open communication, which is critical to making optimum decisions efficiently. This can be because the strong motivations from incentives encourage participants to more effectively communicate and actively resolve issues.

Relationship between Incentives and Risk Management

To test the relationship between the use of incentives and risk management, the correlation between the use of incentives (average score of the six incentives) and application of risk management (average score of the application of 17 risk management techniques) was calculated. The use of incentives was found to be strongly correlated with risk management ($r=0.465$ at significance level of 0.000), suggesting that the use of incentives can assist risk management significantly. One reason can be because the use of incentives is strongly correlated with the open communication factors of partnering that can enhance risk management as tested previously. The ways by which partnering assists risk management can also be considered to be the same as incentives. A deeper reason for incentives being able to create strong motivation can be because improving risk management incurs additional costs. Traditionally, as most contractors only have a very low margin, and to survive is the contractors' first priority, just maintaining the organization is difficult, let alone achieving con-

J. Constr. Eng. Manage., 2006, 132(3): 217-229

tinual improvement. The low efficiency of management of construction is also of world-wide concern (Forbes 2002; Egan 1998). Incentive schemes set measures to clearly specify the additional rewards from the reduced risks of a project. With incentive schemes contractors are able to greatly improve their risk management investment to reduce project risks because the expected financial rewards can greatly offset the financial burden on their risk management or could even be transferred into profit. Interviewing with some contractors also confirms that if they had possible financial support from incentives, they would have taken more measures to improve risk management, as they originally also expected to achieve successful performance.

Relationship between the Use of Incentives and TQM

To test the relationship between the use of incentives and TQM, the correlation between the use of incentives (average score of the six incentives) and TQM (average score of the 10 key factors of TQM) was calculated. The use of incentives was found to be strongly correlated with TQM ($r=0.428$ at the significance level of 0.000), showing that the use of incentives can enhance the application of TQM.

The reasons for the strong correlation between application of incentives and TQM can also be considered in two ways. First, the use of incentives can enhance TQM application through facilitating partnering, and how partnering can assist TQM can largely be seen as the way incentives enhance TQM. Second, as with risk management, improvement of TQM needs resources, and incentives can supply additional financial support for TQM, which can greatly assist in its application.

Incentives and Project Cost Performance

To test how incentives actually assist in improving project cost performance, the relationship between the use of incentives and cost performance was calculated. Cost performance was selected as a study indicator of project performance because all incentives and their impacts on project performance will be ultimately reflected in the final project cost. The results showed that the use of incentives was strongly correlated with cost performance ($r=0.152$ at the significance level of 0.016), suggesting that incentives can help projects to achieve better cost performance, and that the benefits from incentives outweigh their cost.

The quantified relationships among partnering, risk management, TQM, incentives, and cost performance are shown in Fig. 5. Fig. 5 shows that partnering, especially when associated with incentives, can effectively facilitate risk management and TQM, and ultimately achieve better cost performance.

As shown in the hierarchical cluster analysis of Fig. 4, the 10 CSFs can be divided into two groups of attitudinal factors and open communication factors. The relationships among these two groups of partnering CSFs, incentives, risk management, and TQM are further presented in Fig. 6. Fig. 6 shows that the open communication factors are strongly correlated with incentives, risk management, and TQM, suggesting the crucial roles of the open communication factors in partnering. However, the attitudinal factors are also important because they not only can strongly facilitate the open communication factors, but also are correlated with TQM (although not as strongly as with the open communication factors). This figure also shows that although partnering alone can improve both risk management and TQM, the combination of partnering with incentives to form alliancing makes the

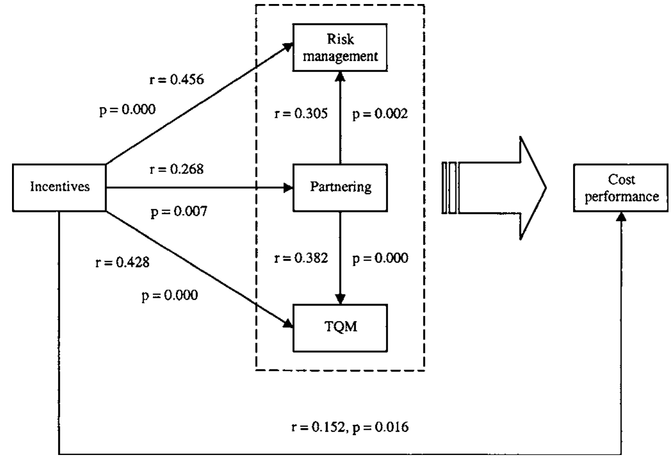

Fig. 5. Relationships between incentives, partnering, risk management, TQM, and cost performance

connection far stronger, which illustrates why alliancing appears to have stronger impact on project cost than partnering.

Conclusions and Proposals

Overall, the relationships demonstrated in the partnering model (see Fig. 2), associated with the incentives' positive impacts on the components of the model, have been largely tested and confirmed based on the data collected from the Chinese construction industry. The CSFs of partnering are strongly correlated with each other, indicating that the benefits of partnering are the outcomes of the interactions of these CSFs. Hierarchical cluster analysis revealed that the 10 CSFs included in the partnering model can be divided into two groups according to the correlation distance between them, namely, attitudinal factors and open communication factors (see Fig. 4). It was found that trust was the core factor among the attitudinal group, with the other four factors being able to influence it to different extents. Equity is most strongly correlated with trust, followed by commitment, attitude, and mutual objectives. The attitudinal factors can strongly reinforce the open communications factors of openness, team building, effective

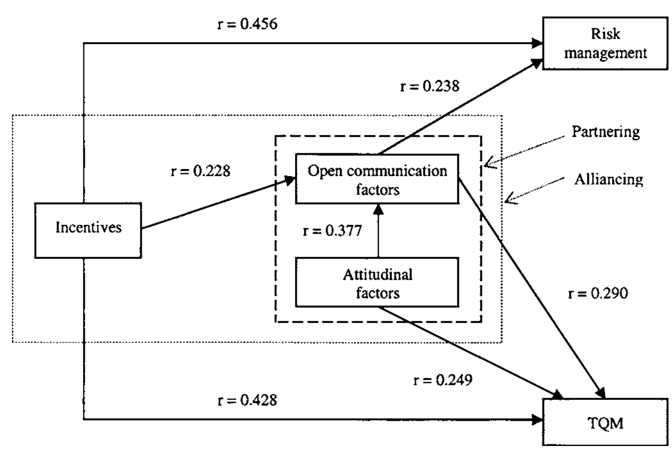

Fig. 6. Relationship between incentives, open communication and attitudinal factors of partnering, risk management, and TQM

J. Constr. Eng. Manage., 2006, 132(3): 217-229

communication, problem resolution, and timely responsiveness, which are directly dealing with project issues.

As a whole the CSFs of partnering are strongly correlated with both risk management and TQM, suggesting that partnering is a basic management technique and that the benefits of partnering are largely achieved by facilitating other management techniques such as risk management and TQM. This illustrates the point that it is very difficult to distinguish at times between partnering and other management techniques such as TQM (Fisher and Green 2001). Use of incentives is strongly correlated with partnering, risk management, TQM, and cost performance, indicating that incentives can provide not only strong motivations but also substantial financial support to facilitate the application of other management techniques, and ultimately to improve project performance.

Open communication factors were found to be strongly correlated with use of incentives, while attitudinal factors are only weakly correlated with it, suggesting that incentives can largely play the role of attitudinal factors and directly assist participants to achieve open communication. The open communication factors are also much more strongly correlated with risk management than the attitudinal factors, indicating that it is the additional information brought in by partnering that is critical to risk management. Although the open communications factors of partnering are more strongly correlated with TQM than the attitudinal factors, the attitudinal factors do have a strong correlation with TQM, suggesting that both groups of partnering CSFs have an overall impact on TQM.

In general, the partnering model development and testing have revealed how partnering brings improvements to construction by quantitatively studying the relationships among CSFs of partnering, risk management, TQM, incentives, and project cost performance. The insights obtained suggest some potential strategies for future application in the construction industry.

- As open communication factors of partnering can strongly facilitate risk management, it is necessary to build a mechanism to permit the corporate experience of all participants as well as their personal knowledge and judgement to be effectively utilized in risk management;
- The two groups of partnering CSFs are both able to effectively facilitate TQM, suggesting that future TQM should be developed for inter-organizational considerations. Implementation of TQM should be based on overall project requirements, weaknesses from measuring own performance and identified gaps from benchmarking between organizations. This requires an environment of trust and in-depth information exchange between all project participants;
- As shown in Fig. 4, trust needs to be built up gradually, suggesting that organizations should foster a cooperative culture to change an individual's behavior and habits gradually in facilitating application of the attitudinal factors;
- Because open communication factors are crucial components in the partnering model, and are strongly correlated with all other techniques included in the model, future developments in partnering should emphasize factors related to open communication (building of communication infrastructure and development of communication methods) which focus on how to achieve faster decision making, optimum decision making, and more innovation;
- As incentives make risk allocation between parties fairer, and are cost effective, incentive schemes should appropriately be designed and introduced into project delivery; and
- This study has revealed that project success is the outcome of the interactions of a variety of techniques, and partnering, associated with incentives, is a basic management method that can effectively facilitate other techniques such as TQM and risk management. Future project management strategies could combine the principles of these various techniques to make a maximum contribution to the improvement of the construction industry.

Future Research Directions

Further work is required to develop the above-mentioned strategies and enhance their applications in the construction industry. The conclusions of this study were mainly obtained from the empirical study conducted into the Chinese construction industry. However, the theory building derived from this study incorporated experience from different areas via literature; thus, it appears that the insights obtained are transferable to industries elsewhere in the world. Further study investigations would be required to test this.

This study has focused on only 10 CSFs of partnering. It is left to future studies to add other identified important factors to the partnering model and to draw a broader picture of the relationships between them. This study has detailed the interactions between partnering and the CSFs of improved risk management and total quality management. Industry would benefit from further investigation of the relationships between partnering CSFs and other outcomes, such as lower monitoring costs, increased innovation and value engineering, improved efficiency of construction, and other identified important components, to reveal in-depth mechanism on how improvements may be obtained from partnering.

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J. Constr. Eng. Manage., 2006, 132(3): 217-229