AN EMPIRICAL STUDY OF PARTNERS' COLLABORATION IN CONSTRUCTION JOINT VENTURE (CJV) PROJECTS AND ITS IMPACTS ON PROJECT PERFORMANCE IN HONG KONG

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CERTIFICATE OF ORGINALITY

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ABSTRACT

The Joint Venture (JV) contracting method has been widely adopted in the construction industry over the past few decades as an effective means of delivering new large-scale, technically complex building and infrastructure projects. However, the industrial practices have also recorded unfavourable project outcomes (e.g. delayed completion, cost overrun, poor quality, and intractable disputes) arising from joint venture construction projects. An extensive desktop literature review has indicated a lack of systematic empirical research focusing on the underlying motives and benefits of and difficulties in applying construction joint ventures (CJVs), so as to better understand the root causes of success or failure. Under the umbrella of relational contracting (RC) strategies, successful application of CJVs is underpinned by multi-partner collaboration, which implies the determinant role of effective collaboration behaviours in shaping the success of CJVs.

This research study aims to identify the perceived motives and benefits and potential difficulties of implementing the joint venture contracting method, and to measure the impact of collaboration amongst the joint venture partners on the overall performance of construction joint venture projects in Hong Kong. The specific research objectives are set out as follows:

(1) To identify the key motives and benefits of applying CJVs and the major

difficulties impeding CJV success, and analyse their relative importance.

(2) To solicit and compare the perceptions of CJV participants at different working levels on the assessment of the practical issues pertaining to CJV application.

(3) To develop the measurement attributes and determine the factors of collaboration for CJV projects.

(4) To determine a list of key performance indicators (KPIs) for measuring CJV project performance.

(5) To develop a model for investigating the relationships between a set of collaboration attributes of CJV partners and various performance measures of CJV projects.

In achieving the stated research objectives, mixed research methods were applied in this study. Various research data were collected through structured interviews, questionnaire surveys and case studies. The survey respondents ranked "Increasing credibility of pre-qualification during tender" and "Spreading / Sharing financial risk" as the two most significant motives for establishing CJVs, whereas "Inconsistent management styles amongst JV contracting parties" and "Incompatible organisational cultures amongst JV contracting parties" were perceived as the two most challenging difficulties associated with CJVs. These research findings have provided some valuable insights into the role of collaboration in motivating a wider use of CJVs and contributing to the success of CJVs.

Moreover, four grouped factors of collaboration attributes containing 24 behavioural aspects of CJVs were derived using exploratory factor analysis (EFA) based on t he four key processes underpinning the proposed conceptual model of collaboration in CJVs. The identified four grouped factors of collaboration attributes included: (1) Mutual trust and teamwork spirit; (2) Team skills development and mutually agreed quality, safety and health standards; (3) Proper management of financial and human resources and gain-share/pain-share mechanism; and (4) Effective communications and information sharing. A set of ten key performance indicators (KPIs) were further developed and weighted by the industrial practitioners for measuring various performance outcomes of CJV projects.

A structural equation model (SEM) was generated for examining the relationships between a set of collaboration attributes of CJV partners and various performance measures of CJV projects. The SEM results unveiled significant positive relationships between the four grouped factors of collaboration attributes and two broad categories of performance measures: generic measures and JV-specific measures. Multiple linear regression analysis was then conducted to reveal the distinct impacts of different grouped factors of collaboration attributes on individual KPIs for CJV projects. The regression results indicated the varied contributions of different grouped factors to individual KPIs.

The present study has enriched the existing knowledge base of CJVs in providing a sound platform for in-depth understanding and improvement of collaboration amongst the CJV partners. The four identified grouped factors of collaboration attributes have enabled industrial practitioners to periodically measure, evaluate and monitor the levels of collaboration behaviours amongst the CJV partners. Another practical value of the research findings is to shed light on the achievement of desirable CJV project performance through the effective collaboration amongst the CJV partners.

Although the research context is limited to Hong Kong, the research findings may also be generalised to its neighbouring countries or regions (e.g. Mainland China, Singapore, and Japan) aiming for successful application of CJVs. Similar research studies could be launched in other geographical locations, especially those western countries like the United States, United Kingdom and Australia, in order to fully understand the similarities and differences between the East and the West in terms of CJV partners' collaboration behaviours and its impact on the performance of CJV projects.

LIST OF RESEARCH PUBLICATIONS

Refereed Journal Articles (Published)

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Hong, Y.M., Chan, D.W.M. and Chan, A.P.C. (2012). "Exploring the Applicability of Construction Partnering in Mainland China: A Qualitative Study." *Facilities - Special Issue on Facilities Management Development*, Volume 30, Issue 13/14, October, 667-694.

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Hong, Y.M., Chan, D.W.M. and Chan, A.P.C. (2010). "Development of Construction Partnering in Mainland China: From Theory to Application". *Proceedings of the Second International Postgraduate Conference on Infrastructure and Environment*, 1-2 June 2010, Hong Kong, China, Volume 1, 331-338.

Chan, D.W.M., Chan, A.P.C. and Hong, Y.M. (2010). "A Comparative Study of Partnering Projects in Construction between Hong Kong and Australia". *Proceedings of the 8th International Conference on Construction and Real Estate Management (ICCREM 2010) - Leading Sustainable Development through Construction and Real Estate Management*, 1-3 December 2010, Queensland University of Technology, Brisbane, Australia, Volume 1, 236-240,

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Hong, Y.M., Chan, D.W.M. and Chan, A.P.C. (2011). "A Research Framework for Examining Collaborative Contracting and Project Performance in Mainland China". *Proceedings of the 2011 International Conference on Construction and Real Estate Management (ICCREM 2011) - Promoting Transformation of the Construction Industry*, 19-20 November 2011, Guangzhou University, Guangzhou, China, Volume 1, 174-177, ISBN 978-7-112-13701-5.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 INTRODUCTION

1.1 Introduction

This chapter introduces the research background, states the research problems and questions, determines the research aim and objectives, defines the study scope, describes the research approach for launching the study, highlights the value and significance of the research, and outlines the structure of the whole thesis.

1.2 Background of the Research

The construction industry has long been suffering from a lack of cooperation, limited trust and misalignment of objectives, often inducing a confrontational working relationship between the project participating parties, and eventually resulting in adverse project performance (e.g. Latham, 1994; Bresnen and Marshall, 2000; Chan et al., 2004). An imperative call for innovative and more collaborative procurement approaches has been advocated in many industry review reports (e.g. Latham, 1994; Egan, 1998; Construction Industry Review Committee, 2001) to rectify the deteriorating situations in the past two decades. Inter-company alliancing and collaboration within the construction industry represents a purposive initiative dedicated to promote efficiency, increase productivity, and reduce reported budgeted project costs to a considerably large extent (Bennett and Jayes, 1995, p. 7). A number of perceived benefits have been reaped for developing and establishing inter-company alliances. At the project level, Bresnen and Marshall (2000) revealed that the benefits to both clients and contractors with respect to cost, time, quality of inter-company relations and project buildability could be achieved through inter-company alliances within the construction industry. At the organisational level, enhanced technological capabilities, improved company competitiveness and sharing of financial and organisational risks and costs were amongst the major reasons for establishing inter-company alliances (Das and Teng, 2000; Ireland et al., 2002).

Construction Joint ventures (CJVs), as a collaborative contracting form under the umbrella of Relational Contracting (RC) approaches (Rahman and Kumaraswamy, 2004; Chan et al., 2010, p. 5; Yeung et al., 2012), enables the project partners to realise potential benefits through inter-partner collaboration. Badger et al. (1993, p. H-4) stated that sharing risks, gaining access to markets, political entry, and sharing of resources and technology provide the main reasons for entering into JVs. The increasingly large scale of construction projects, with their unprecedented problems and risks, makes cooperation amongst the contractors in the form of joint ventures necessary (Garb, 1988, p. 79).

The motives and benefits of applying JVs in the construction industry involve technology transfer, risk sharing/transfer, financial strengths, together with combination/pooling of general resources and specialist skills (Norwood and

Mansfield, 1999; Munns et al., 2000; Kumaraswamy and Shrestha, 2002; Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010). Other potential benefits such as bringing in outside expertise (Norwood and Mansfield, 1999) and opportunities for long-term profitable business development (Bellhouse, 1999) have also been referred to in the existing literature.

Accompanied by the increasing use of CJVs is the unsatisfactory project performance as reported from previous research studies, such as Munns et al. (2000) and Allen (2011). Therefore, there exists a strong need of research targeting for the improvement of project performance and achievement of project success in CJV projects. Successful operation of CJVs requires the dedicated mutual efforts and inputs from all involved parties, which are indispensably underpinned by inter-partner collaboration. It has been recognised that inter-company collaboration entails the requirement of mutual inter-organisational commitment and trust and willingness to cooperate in achieving the targeted mutual objectives (Low and Leong, 2000; Moran et al., 2011, p. 92). In retrospect of the reasons for the poor performance in CJV projects, lack of communication was seen as the most important factor that undermines the effectiveness of a JV in the study of Munns et al. (2000) while Allen (2011) found that a lack of understanding of CJV contracts and the partiality to one party's interests were the two major causes of the disputes in CJVs. All these factors could be classified into the scope of collaboration in CJVs, the detailed attributes of which will be derived in Chapter 7. In fact, the critical role of collaboration in the achievement of desirable project performance has been well-documented in the construction-related literature. Using a grounded approach, Phua and Rowlinson (2004) casted objective empirical light on the importance of cooperation to project success. Greenwood and Wu (2012) demonstrated the significant positive correlations between the attributes of collaborative working and the various indicators of project performance. Meng (2012) examined the association between supply chain relationships and project performance and disclosed the disparate impacts of different relationship factors on project performance.

A desktop review of previous research into CJVs revealed that the influential sources of CJV project performance/success have been spreading from issues arising from CJV formation to what emerges in CJV operation, such as partner selection, critical factors to CJV formation and operation (Mohamed, 2003), cultural distance between JV partners (Ozorhon et al., 2008a), inter-partner fit and relations (Ozorhon et al., 2008b), governance structure strategies (Lin and Ho, 2013), etc. However, the current literature base records few, if any, studies on the systematic investigation of the impact of collaboration on project performance in the specific context of CJVs, although some studies have addressed the influence of a particular collaboration aspect on JV project performance, for example, the influence of inter-partner fit and relations on international CJV performance by Ozorhon et al. (2008b). The findings from the literature review echoes the argument of Bresnen and Marshall (2000) that less attention has been paid to the systematic investigation of the actual attributes of collaboration that might account for project success.

1.3 Research Problems and Questions

The determinant role of collaboration in shaping JV project performance calls for an imperative need of understanding the practical behavioural attributes of collaboration and examining the influence of different aspects of collaboration on project performance in the specific context of CJVs, which are scarce from the existing literature base related to CJVs. In view of the research gaps identified, this research study intends to take the initiative to empirically measure and assess the importance of collaboration to the achievement of desirable CJV project performance, and make a step further to shed light on the understanding of the contributions of different collaboration factors to various performance measures. The following research questions are to be addressed throughout this study.

(1) What are the industrial practitioners' perceptions towards the motives and benefits of CJV application and the difficulties of CJV success?

(2) What are the behavioural attributes and factors of the construct 'collaboration' in the context of CJVs?

(3) What are the comprehensive and reliable measures of JV project performance?

(4) What is the extent to which collaboration factors impact on project performance in the context of CJVs?

(5) What are the differences between the impacts of the collaboration factors on the level of achievements of different KPIs for CJV projects?

1.4 Research Aim and Objectives

To address the research questions raised above, the present study aims to develop a model that explains and crystallises the underlying relationship between collaboration among JV contracting parties and JV project performance in the construction industry. Six specific objectives are set out as follows:

(1) To identify the key motives and benefits of applying CJVs and the major difficulties impeding CJV success, and analyse their relative importance.

(2) To solicit and compare the perceptions of CJV participants at different working levels on the assessment of the practical issues pertaining to CJV application.

(3) To develop the measurement attributes and determine the factors of collaboration for CJV projects.

(4) To determine a list of key performance indicators (KPIs) for measuring CJV project performance.

(5) To develop a model for investigating the relationships between a set of collaboration attributes of CJV partners and various performance measures of CJV projects.

The present study begins with an identification of the motives and benefits of CJV application and the difficulties of CJV success (Objective 1), followed by the comparison of the industrial practitioners' perceptions towards these practical issues concerning CJV application (Objective 2). Objectives 1 and 2 together could provide an enhanced understanding of the factors that facilitate the formation and successful operation of CJVs. Then a consolidated list of attributes of collaboration for CJV projects was derived and the factors of collaboration were determined (Objective 3). In addition, a list of KPIs for JV construction projects and a performance measurement model were developed for measuring JV project performance (Objective 4).

Development of the KPIs in this study adheres to the principle of comprehensiveness and conciseness for convenience and ease of practical uses. Therefore, this study tries to avoid a long list of performance indicators that may need excessive inputs and efforts from the practitioners for real-life applications. With the derived measures and factors of collaboration and the KPIs for measuring CJV project performance, a structural equation model that links collaboration factors with CJV project performance was hypothesized, tested and validated for use. Building upon the developed model, the relationships between the factors of collaboration and project performance of CJVs were examined (Objective 5). Based on the achievement of

Objective 5, some effective strategies or useful guidelines as drawn from the research findings were proposed to improve JV project performance through appropriate adjustments of the collaborative behaviours from JV partners. Figure 1.1 depicts the detailed framework of and the inter-relationship between the research objectives.

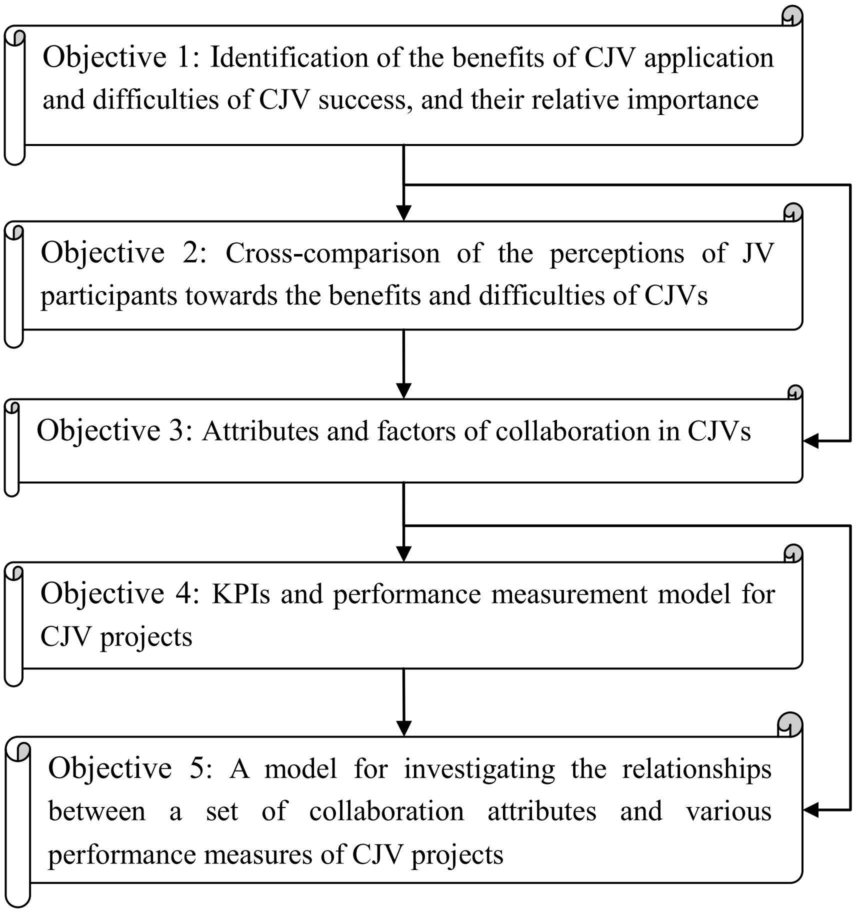

Figure 1.1 Overall framework of and relationship between the research objectives

1.5 Scope of the Study

A CJV differs from an alliance in that a JV is typically a short-term or one project agreement (Badger et al., 1993, p. F-2). A JV launched on a project basis, is sometimes called a consortium, contractual JV, or contractual alliance (Chen and

Messner, 2009). CJVs, dominantly as project-based JVs, is formed under a contractual agreement, rather than taking the form of equity JVs. The project-based JVs are temporary in nature and are the creation of separate entities through the alliance of two or more organisations for the purpose of carrying out a specific project (Sillars and Kangari, 2004). Considering the project-based nature of CJVs, the scope of CJVs, as defined in this study, is limited to the procurement/cooperative approach adopted by the architectural/engineering/construction (AEC) firms.

Although JVs may be formed by consultants or contractors in a construction project (Kumaraswamy and Palaneeswaran, 2000), contractor-JVs (JVs formed between contractors) are perceived as the mainstream in CJVs as far as the types of JV partners are concerned, which could be reflected by the fact that respondents from the industry-wide surveys in many previous studies addressing issues concerning CJVs, such as Kwok et al. (2000); Mohamed (2003); and Ozorhon et al. (2011). In addition, a CJV has been defined by Ashley (1980) as a partnership of contractors who have formed a business alliance for the purpose of undertaking a project. Therefore, the main contractors of JV construction projects were selected in this study as the target respondents for collecting empirical data for analysis.

1.6 Research Process

This research study employed a mixed research approach incorporating both qualitative and quantitative research processes. The research process started with a comprehensive review of the literature on CJVs worldwide in order to understand the various aspects (e.g. motives and benefits, and difficulties) associated with the application of CJVs, and to identify the knowledge gap pertinent to the research problems. The qualitative approaches involve structured interviews in the pilot study and case studies for the purpose of validation. An empirical questionnaire survey, as the quantitative approach, was conducted to collect empirical data from industrial practitioners on the practical issues concerning the application of CJVs with particular focus on the collaboration attributes of CJV partners and project performance. Data analysis with uses of various analytical tools was one of the main processes to achieve the research objectives. The overall flow of research depicting the whole research process for this study is portrayed in Figure 1.2.

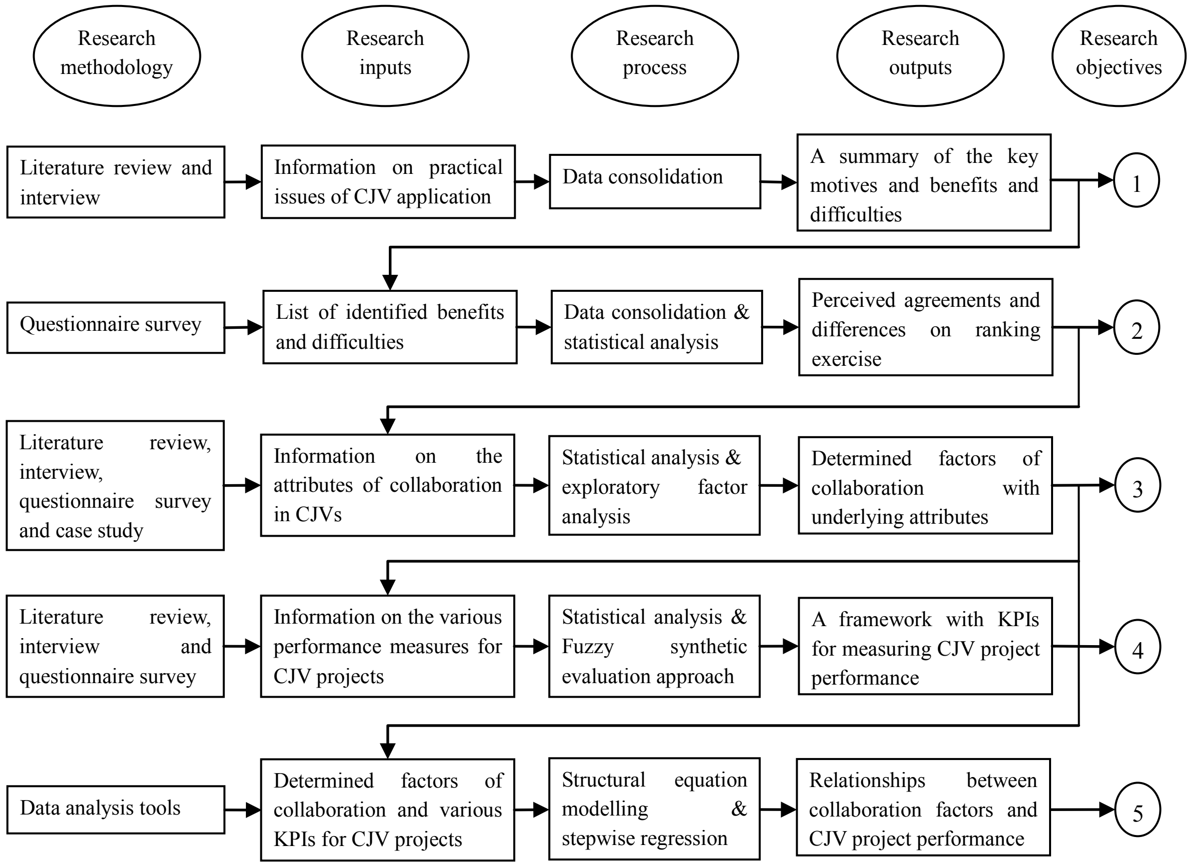

Figure 1.2 Overall flow of the research study

1.7 Significance and Value of the Research

Theoretically, this study contributes significantly to the existing knowledge base in CJVs through the development of measurement framework for partners' collaboration and project performance. The various behavioural aspects and the factors of collaboration determined in this study facilitate the understanding of collaboration amongst JV partners under a CJV contracting relationship. The tested relationship between collaboration attributes and project performance in the context of CJVs not only reinforces the crucial importance of inter-partner collaboration to the achievement of desirable JV project performance, but also sharpens the understanding of which collaborative aspects posing significant influences to a particular performance measure. All these research outcomes altogether have provided a solid platform for future researchers to examine collaboration and performance-related issues in CJVs.

Practically, the research findings are visualised to provide valuable insights for the involved JV parties into reaping mutual benefits from the achievement of desirable project performance through a performance-oriented collaborative process. Assessment of the motives and benefits of CJV application provides a basis for the industrial practitioners to consider the appropriateness of involving into a CJV contracting relationship by taking account of the expected motives/benefits at their own stances. The different levels of importance with respect to the difficulties of CJV success as identified in this study may facilitate the decision-makers in a JV relationship to adopt appropriate strategies and efficiently allocate resources to overcome the potential impediments and strive for the ultimate success of CJVs.

The determined factors of collaboration in CJVs with underlying attributes provide a platform for the industrial practitioners involved in a JV partnership to measure, evaluate and monitor the level of collaboration between JV team members. The derived performance measurement framework for CJV projects also enables the managers of JV project team to periodically assess the performance of CJV projects under construction. Based on t he research findings on t he contributions of some particular factors of collaboration to the achievement of specific performance measures (as reflected by specific KPIs), management personnel of a J V team may consider adjusting the team members' more essential collaborative behaviours so as to improve overall JV project performance.

1.8 Structure of the Thesis

In total, the whole thesis contains ten chapters.

Chapter 1 introduces the basic skeleton of the research study. The essential elements for conducting the research are clearly presented in this chapter. These elements cover the background of research, research problems and questions, research aim and objectives, scope of study, and research approaches adopted. In addition, the value and significance of this study are also highlighted, and the structure of the whole thesis outlined.

Chapter 2 provides a theoretical understanding of JV application in the construction industry. A brief introduction of the definitions and developments of JVs is made in the chapter. Three organisational theories, being organisational networks, transaction cost economics, institutionalism and resource dependence, are employed to justify the strategic meaning and importance of the uses of JVs in the construction industry. Moreover, the reason for choosing the study region as the Hong Kong construction industry is also explained.

Chapter 3 presents a comprehensive desktop review of past literature on CJVs. The scope of review mainly involves the identification of the research interests in CJVs over the past two decades. The knowledge gaps in research pertaining to CJVs are also identified through the literature review. These gaps of knowledge justify the value of the present study in contributing to the current knowledge base.

Chapter 4 illustrates the conceptual framework of collaboration, with special focus on the context of CJVs. This chapter first reviews the concepts, characteristics and forms of collaboration in construction. A definition of collaboration in CJV projects is then provided for the purpose of this study, followed by the formation and operation of CJVs.

Chapter 5 outlines the research framework and research methodology adopted throughout the study. Data collection through desktop search, structured interviews and questionnaire survey are illustrated. Various data analysis tools such as a series of non-parametric statistical tests, factor analysis, structural equation modelling and fuzzy synthetic evaluation method are described in this chapter.

Chapter 6 presents the analysis of the questionnaire survey results in terms of the motives and benefits of CJV application and the difficulties of CJV success. Four non-parametric statistical tests are conducted for analysing the survey data. These tests include: (1) the Cronbach's alpha reliability test; (2) the Kendall's concordance test; (3) the Spearman's rank correlation test; and (4) One-way ANOVA test. In addition, this chapter uses the factor analysis approach to classify and determine the underlying grouped factors in relation to individual motives, benefits and difficulties.

Chapter 7 generates a comprehensive list of attributes of collaboration and determines the factors of collaboration in CJVs. The consolidated list of collaboration attributes are derived from the literature review and structured interviews. A total of four major factors of collaboration in the specific context of CJVs are derived through exploratory factor analysis. These factors of collaboration will be used to examine the relationships between the factors of collaboration in CJV projects and CJV project performance.

Chapter 8 develops a key performance indicator (KPI) model for measuring CJV project performance. The model development involves the use of fuzzy synthetic evaluation approach to quantify the subjective assessments of the respondents on the perceived importance and level of achievement of each KPI.

Chapter 9 examines the relationships between the collaboration factors and project performance of CJVs. With solid research data and uses of appropriate research tools, the significant impact of collaboration to the achievement of desirable project performance is evidenced in JV construction projects. Moreover, contribution of specific factor of collaboration to each performance measure is examined in this chapter. The purpose of such examination is to provide valuable reference for adjusting specific behavioural aspects of collaboration and facilitating the improvement of overall JV project performance.

Chapter 10 concludes the major research findings of the study and reviews the achievement of the stipulated research objectives. Theoretical contribution of the study to the existing knowledge base and its practical value for guiding industrial practices are highlighted. Limitations of the study are also discussed, with suggestions of future research directions provided in the chapter.

1.9 Chapter Summary

This chapter introduces and outlines the overall research framework which includes: (1) background of study; (2) research problems and questions; (3) research aim and objectives; (4) scope of study; (5) research process; and (6) significance and value of the research.

CHAPTER 2 THEORETICAL UNDERSTANDING OF JOINT VENTURES IN CONSTRUCTION

2.1 Introduction

This chapter retrospects the origin and development of joint ventures (JVs) in general and presents the theories underpinning the application of JVs in the construction industry. The rationale of targeting Hong Kong as the region of study is also provided in this chapter.

2.2 Joint Ventures: Definition, History and Development

The term 'Joint Venture' originated as commercial or maritime enterprises used for trading purposes (Harrigan, 2003, p. 5). A variety of definitions of JVs have emerged in previous studies, predominantly with similar features of JVs incorporated. A JV can be defined as '*a cooperative business activity formed by two or more separate organizations that creates an independent business entity and allocates ownership, operational responsibilities, and financial risks and rewards to each partner, while preserving their separate identity/autonomy*' (Lynch, 1989). Different to some extent from the definition of Lynch (1989), the definition of Tomlinson (1970) for JV is '*an arrangement where there is commitment of funds, facilities, and services by two or more legally separated interests to an enterprise for their mutual benefits for a long period of time*'. The two types of definitions represent the general taxonomies of JVs: equity JVs and non-equity JVs. Equity JVs are formed by two or more organisations as an independent legal entity with shared resources while non-equity JVs comprise a wide array of contractual arrangements for the purpose of cooperation between two or more companies (Hennart, 1988).

JVs have been used, though not labelled as such term of 'JVs', by the ancients to conduct sizable commercial and trading operations. According to Harrigan (2003, p. 7), JVs of all types abounded in entertainment in the 1960s and the use of it within mature economies like the United States and the United Kingdom has sprung up as a result of many technological and economic changes that precipitated deregulation, globalization and increasing emphasis on the need for product innovation. Early in the 1960s, statistics of the Federal Trade Commission (FTC) showed that over half of the JVs in the United States were in the manufacturing sector. Concurrent with entry into the 1980s is the more extensive adoption of JVs in a broader range of industries, such as communications equipment, financial services, aerospace engineering, programming packaging industries, etc.

To date, there is no all-pervading positioning on the time when the JV strategy emerged in the building and construction industry after its extensive applications in other industry sectors. In retrospect of the study of Harrigan (2003, p. 8-11) on domestic JVs, the architecture / engineering / construction (AEC) industry of the

United States was not included in the list of industry sectors recording JV practices during 1970-1985. The guidance notes "*Joint Venture Tendering for Contracts in the United Kingdom*" published by the National Joint Consultative Committee (NJCC) for Building in 1985, imply the emergence of JVs in the construction industry in the 1980s. In the context of the construction industry of Singapore, Chow (1985) documented some underlying theories and local practices of JVs and provided a useful guide to the structuring of JV agreements for construction projects. The list of number of JVs (altogether 33) applied by other countries for investment in the building and construction industry in Singapore, as recorded by the study of Fisher and Ranasinghe (2001), also evidenced an increasing trend of construction joint ventures (CJVs). The existing literature in general indicates that the industrial practices and academic research of CJVs arose in the 1980s. Owing to the fact that JV is the only way, to a certain extent, for a foreign construction firm to be pre-qualified for a particular tender in the local market, research on CJVs predominantly focuses on the multinational JVs, whereas domestic CJVs are barely examined.

2.3 Theoretical Perspectives Towards the Application of Joint Ventures in the Construction Industry

A JV is conceptually a selection amongst alternative modes by which two or more firms can transact (Kogut, 1988). Hence, JV is a type of organisational behaviour, the selection of which can be explained by organisational theories. As proposed by Knoke (2001, p. 41), understanding the inter-organisational relationships could be resorted to five organisational theories: organisational ecology, organisational networks, transaction cost economics, institutionalism and resource dependence. Kogut (1988) provided explanations for JV behaviours from the transaction cost, strategic behaviour and organisational learning perspectives. By looking at the three organisational theories of institutionalism, transaction cost and resource dependence, this study explained the fundamental motives of choosing JVs over other alternatives in the construction industry. Use of construction JVs (CJVs) was further analysed from the strategic behaviour and organisational knowledge and learning perspectives.

2.3.1 Institutionalism

The institutional theory argues that organisations embedded in a field jointly construct the social realities that then guide their routine actions, therefore helping to perpetuate that social system (Knoke, 2001, p. 49). Institutionalization proceeds by the ‘elaboration of rules and requirements to which individuals must conform in order to receive support and legitimacy’ (Meyer and Scott, 1992, p. 200), wherein *legitimacy* involves normative beliefs governing the proper or acceptable exercise of power in a social situation. When looking at the perspective of institutionalization, corporations adopt similar structures and practices prevailing in their field to achieve legitimacy and environmental fitness.

Amongst the organisation's cooperative strategies, the explicit superiority of JVs over other contracting alternatives lies in its provision of the platform for structuring the integrated working team and adopting agreed working practices, which address the normative institutional requirement to secure social legitimacy (Knoke, 2001, p. 49). Narrowed down to a specific construction project, the use of JVs provides a solid platform for the partners to establish the agreed rules, mechanisms, and arrangements in correspondence with the institutionalized custom in undertaking a construction project. In other forms of inter-organisational relationships, cooperation between partners may be exposed to the threat of failure as there may be difficulty in achieving consistence in terms of the norms and standards adopted by multi-organisations and thus the partners may face a protracted struggle to gain legitimacy.

2.3.2 Transaction Cost Economics

The transaction cost theory explains variation in economic activities and organisational structures involving contracts to produce and distribute goods and services (Knoke, 2001, p. 62). Transaction costs determine which of three basic governance forms: *market*, *hierarchies*, and *hybrids*, are the most efficient for a given set of environmental conditions (Williamson, 1994, p. 102). Markets are classic economic arenas where wholly autonomous parties engage in resource exchanges while hierarchies are formal organisations that place transactions under unified ownership and hybrids involve long-term contractual relations preserving each party's autonomy (Knoke, 2001, p. 61). Under the transaction cost theory, selection of the best-fit organisational form relies on t he evaluation of three dimensions of transactions: *transaction frequency*, *uncertainty* and *asset specificity*. Asset specificity relates to the extent to which assets are specialized to support trade between a few parties (Kogut, 1988). Whenever both exchange partners' asset specificities increase, the need for adaptive cooperation increases to prevent opportunism by one of the exchange partners (Knoke, 2001, p. 62). Uncertainty is considered as involving events for which no probability distribution is discernible (Knight, 1921).

A transaction cost explanation for JVs lies in two distinctive properties of JVs: joint ownership rights and mutual commitment of resources (Kogut, 1988). Through ownership control rights and a mutual dedication of resources, a JV creates a superior monitoring mechanism and alignment of incentives to reveal information, share technologies, and guarantee performance, which ultimately decreases transaction costs under uncertainties. In brief, JVs resolve high levels of uncertainty over the behaviours of the contracting parties when the assets of one or both parties are specialized to the transaction (Kogut, 1988). Selection of JVs is favoured when there are high uncertainties over specifying and monitoring performance and there exists a high degree of asset specificity. Specified to the context of construction projects, JVs reduce transaction costs arising from project uncertainties, especially in those large-scale projects with technical complexity and planning difficulty.

2.3.3 Resource Dependence

Resource dependence theory is rooted in social exchange concepts that assume 'purposive action' which refers to the rational choices and decision making by actors who seek to gain maximum benefits from socio-economic transactions (Blau, 1964, p 91). Resource dependence theory seeks to explain how inter-organisational relations emerge from collective struggles to negotiate more advantageous terms for resource exchanges (Cook, 1977). The theory suggests that the motive behind an alliance is to acquire deficit resources from other organisations by establishing a relationship with them (Dulaimi et al., 2003).

JVs, as an extension of diversification and merge, may play a role in gathering of resources to respond to market needs (Pfeffer and Salancik, 2003, p. 152). Developing JV relationships reduces the uncertainty that a firm will not have the resources necessary to meet market demands, which in turn increases the survivability of the firm involved in the JVs (Sillars, 1998). For a construction project, the dependency theory can explain appropriately why a JV is formed to launch a construction project. JVs address the dilemma of the lack of capabilities sufficient to undertaking a single construction project by pooling the use of other partners' resources in terms of equipment, technical skills and expertise. On the other hand, in order to resist external forces, for example, the less-powerful organisations' pursuit of a diversified strategy to gain greater leverage in negotiating return rates, to reduce their dominant strength, powerful organisations, often with strong technical capabilities, could also resort to JVs as the 'bridging strategy' to maintain their advantages (Scott, 2003).

2.3.4 Strategic Behaviours and Organisational Knowledge and Learning

Kogut (1988) perceived that many JVs are motivated by strategic behaviours to erode competitors' positions. JV is also seen as a form of defensive investment by which firms hedge against strategic uncertainty, especially in industries of moderate concentration (Vernon, 1983, p. 191). Specific to the construction industry, enhancing the competitive position in the construction market has been empirically identified as the one of the major drivers of forming CJVs (Sridharan, 1995; Mclntosh and McCabe, 2003). Raftery et al. (1998) highlighted that the easiest way for foreign contractors to operate in domestic markets is through JV with local construction firms in the Asian construction industry. Likewise, Ling et al. (2008a) found that one of the most effective market entry modes for the A/E/C firms in Singapore and the broader area of Southeast Asia is to form project JVs with local firms.

When looking from the organisational knowledge and learning perspective, a JV is a vehicle by which tacit knowledge is transferred. The formation of JVs is encouraged under two conditions: one or both firms desire to acquire the other's organisational knowhow, or one firm wishes to maintain an organisational capability while benefiting from another firm's current knowledge or cost advantage (Kogut, 1988). As also mentioned by Carrillo (1996), JVs are mainly tools of convenience allowing the parties involved to exploit each other's strengths for a limited time and for a specific cause.

2.4 Study Region: The Hong Kong Construction Industry

The transfer of British sovereignty of Hong Kong in 1997, resulting in the establishment of the Special Administrative Region (SAR) of Mainland China, has tended to legitimise Hong Kong as a 'naturalistic' laboratory for examining and testing ideas pertinent to commercial and political dimensions (Johannes, 2004). The infrastructure market in Hong Kong is considered unique in that it has an 'open door' policy to international competition (Ganesan et al., 1996; Walker, 1995), which is a premise of forming project-based CJVs between local and foreign companies. Therefore, Hong Kong provides a valuable global context for understanding the influence of inter-organisational issues (e.g. inter-organisational collaboration) in facilitating the performance and success of project-based joint ventures between the main contractors (e.g. local-local or local-foreign) within the highly competitive construction and engineering industry.

The Hong Kong construction industry has been recovering from a long hibernation period within the decade since 1997. By 2006 the total construction volume in Hong Kong had been declining since reaching its peak in 1997 primarily owing to the financial crisis as Hong Kong was one of the many countries profoundly hit by the Asian economic turmoil in 1997 (CII, 2008, p. 21). The total construction output in Hong Kong shrank drastically from HK$139 billion at constant (2000) prices in 1997 to HK$96 billion in 2006 in real terms. Fewer large-scale infrastructure projects were developed within the period. Owing to the HKSAR Government's determination in revitalizing the economy by promoting infrastructure development as reflected in the Chief Executive's 2007-08 Policy Address, 10 major large-scale infrastructure projects were pushed ahead in order to lay a foundation of sustained development of Hong Kong in the future. An estimation of the added value to the local economy brought about by these projects would be more than HK$100 billion annually (CII-HK, 2008). The construction industry produced a total gross value of work of HK$159.63 billion in 2012, accounting for 7.8% of the total local GDP (Census and Statistics Department, HKSAR 2012). A significant increase in the construction volume has been recorded in Hong Kong over the recent years. For example, the increased volume of the construction output from 2011 to 2012 is HK$31 billion, with a growth rate of 24.2%. With the rising trend of the local economy and the government's huge investment on infrastructure development, a stable growth of the Hong Kong construction industry in the foreseeable future could be envisaged.

Owing to its open economy and the considerable market volume in the construction industry, Hong Kong has attracted many foreign contractors to invest and undertake construction works. Ever since the 1990s, it has been recorded that foreign contractors (with headquarters outside Hong Kong) has been gaining considerable shares in undertaking building and civil engineering projects in Hong Kong (Walker, 1995; Johannes, 2004). Notwithstanding the qualifications and technical capability to independently performing a construction project, foreign contractors may still need to collaborate with Hong Kong-based local construction firms in the form of JVs in order to improve the competitive position during prequalification. On the other hand, the need of outside expertise and required technologies necessitates the local contractors to align with foreign contractors during project construction.

Many of Hong Kong’s largest construction companies have different origins and are generally part of large corporations with headquarters outside Hong Kong, such as Dragages Hong Kong Limited, headquartered in France, Nishimatsu Construction Co. Ltd, headquartered in Japan, China Harbour Engineering Group, headquartered in Mainland China. Some other construction companies are headquartered in Hong Kong but owned by overseas corporations, for example, Leighton Contractors (Asia) Ltdwholly owned by Australia’s Leighton Holdings, Gammon Construction Ltd. jointly owned by Jardine Matheson and Belfour Beatty, China State Construction International Holdings Ltd, with parent company being China Overseas Co. Ltd. The diversified regional and cultural contexts of the main contractors provide a solid platform for studying JVs in the Hong Kong construction industry. In addition, the significant increase in the volume of Hong Kong construction output over the recent years has attracted active participation of foreign contractors in the local construction market. As stated before, foreign contractors enter the Hong Kong construction market and undertake construction projects primarily through forming JVs with local major contractors, providing valuable cases/subjects for the empirical investigation into CJV issues.

Procurement of many new large-scale government construction projects through JVs has been extensively recorded in Hong Kong, such as the Hong Kong International Airport, Tamar Development Project (New Government Complex and Legislative Council Complex at Tamar). In Hong Kong, the largest quasi-public organisation that facilitates the construction of large-scale infrastructure projects is the Mass Transit Railway (MTR) Corporation. Within the next decade, MTR Corporation has been planning to complete five new strategic rail extensions: the *West Island Line*; *Guangzhou – Shenzhen – Hong Kong Express Rail Link (Hong Kong Section)*; *Shatin to Central Link*; *Kwun Tong Line Extension*; and *South Island Line (East)*. According to the information of contracts issued by MTR on the MTR Official Website arising from the five new strategic rail extensions since 2009, 28 out of a total of 58 civil engineering contracts (including tunnels, bridges, railways) have been issued to JV main contractors. The ratio of JV contracts among all MTR contracts is 48.3% between July 2009 and March 2013.

In view of the status of Hong Kong in terms of the global context, construction market conditions and the prevalence of JV application, the Hong Kong construction industry that are much favourable to the investigation of CJV pertinent issues, is therefore identified as a suitable region for conducting a research study relevant to CJVs.

2.5 Chapter Summary

This chapter retrospected the origin of JVs and briefly reviewed its development of history. With resort to three organisational theories and the strategic behaviours and organisational knowledge and learning perspective, application of JVs in the construction industry was theoretically supported and justified. This chapter further highlighted the geographical and cultural features of Hong Kong as representative for being the selected region of study in the thesis.

CHAPTER 3 REVIEW OF JOINT VENTURE STUDIES IN CONSTRUCTION

3.1 Introduction

Although JVs have become a way of life for some industries, such as off-shore oil exploration or jet engines (Harrigan, 2003, p. 6), they are still a relatively new concept in construction today (Kazaz and Ulubeyli, 2009). However, JVs have become the principal vehicle for foreign construction firms to gain entry into the local construction market since the 1980s (Chow, 1985, p. 6). The use of a joint-venture relationship in the construction industry has become a convenient and necessary means of providing the concentration of economic resources, skills, and knowledge required to negotiate, bond and complete a new large-scale construction project (Garb, 1988, p. 76).

The first use of JVs in large construction projects could be traced back to the Hoover Dam project launched in 1931 in the United States (Rogers, 2010). The guidance notes of “Joint Venture Tendering for Contracts in the United Kingdom”, published by the National Joint Consultative Committee (NJCC) for Building in 1985, imply the emergence of JVs in the UK construction industry in the 1980s. Ozorhon et al. (2007a) stated that although establishing international construction joint ventures (ICJVs) is a widely used strategy in the construction industry, the majority of the current literature on international joint ventures (IJVs) is about the manufacturing industry and the validity of underlying theories have not been extensively and empirically investigated in the construction industry. In terms of ICJVs, Mohamed (2003) summarised that the published work on ICJVs have addressed such key issues as: (1) motivations behind ICJV formation; (2) associated advantages and disadvantages; (3) critical success factors; and (4) risk analysis and management. Ozorhon et al. (2007b and 2010) also came up with the summary that a small group of studies on IJVs are associated with the risks of IJVs in construction, the factors affecting the performance of IJVs and management issues on IJVs. Generalities alike, however, may hinder the recognition of research efforts on the study of CJVs. Thus, a systematic, holistic examination of research contributions to CJVs within the past two decades is essential for raising a convincing and well-received appreciation of the research outputs in the field, which is absent or insufficient from the pool of the contemporary literature.

As academic journal papers present the most important wealth of literature available (Fellows and Liu, 2008, p. 60), this chapter attempts to critically review the CJV literature and to investigate the research trend of JV related studies in top-tier leading journals in construction engineering and management during the past two decades.

This chapter intends to crystallise on the understanding of the coverage of CJV related studies published in construction journals and to explore the change or evolution of the themes / foci / interests of the CJV related publications within the past two decades. More importantly, it is expected that the findings from the desktop literature review could engender valuable insights to other researchers in shaping their research foci under the umbrella of CJVs to suit the demands of both the literature base and the real construction market.

3.2 Overview of Joint Ventures in Construction

3.2.1 Definition and Scope of Joint Ventures in Construction

As noted before, the term 'Joint Venture' originated as commercial or maritime enterprises used for trading purposes (Harrigan, 2003, p. 5). A JV is generally defined as an arrangement where there is commitment of funds, facilities, and services by two or more legally separated interests to an enterprise for their mutual benefits for a long period of time (Tomlinson, 1970). It involves at least two parent organisations that contribute equity and resources to a semiautonomous legally separate entity, of which they participate in the decision-making process (Geringer, 1988).

Chow (1985, p. 4) stated that there is no generally accepted statutory or legal definition of a JV, at least under common legal law systems. Garb (1988, p. 75) quoted the appropriate definition of joint-venture groupings, in the context of the construction industry, as:

> *"a business alliance of limited duration formed by two or more unrelated business or professional entities for the purpose of furnishing engineering, consulting, procurement, construction and construction management services by consolidating the skills and resources of the participants".*

The National Joint Consultative Committee (NJCC) for Building (1985) of the United Kingdom distinguished JVs from other contractual patterns by defining it as:

> *"a partnership between two or more companies covering building, mechanical and electrical engineering, or other specialist services for the purpose of tendering for, and executing a building or civil engineering contract, each of the participating companies having joint and several liability for their contractual obligations to the employer".*

Munns et al. (2000) attempted to define JVs by employing five criteria: legal agreement, duration, equality, participants and profits. Resorting to these five criteria, the study of Munns et al. (2000) is concerned with business JVs between two or more partners of comparable commitment, who create a distinct legal entity that may be of fixed or unlimited duration.

As highlighted in chapter 1, the scope of CJVs, as defined in this study, is limited to the procurement/cooperative approach adopted by the architectural/engineering/construction (AEC) firms. To distinguish the general term of “JVs” and the specific term of “CJVs”, this study makes reference to the comparative discussion of Girmscheid and Brockmann (2010), in which the marked difference between IJVs and ICJVs was stressed and pointed out by indicating that IJVs mostly take the form of equity JVs whereas ICJVs are contractual JVs. Specifically, CJV is regulated by both JV contract and construction contract signed with the client, as elaborated in Figure 3.1.

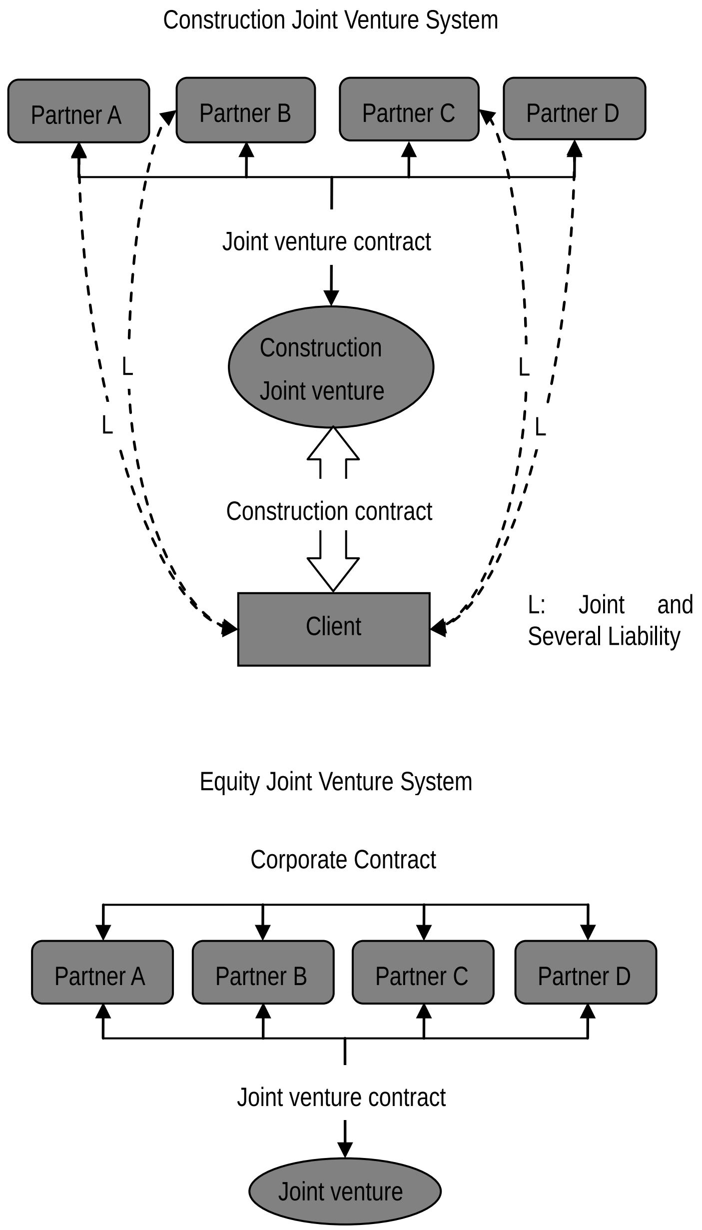

Figure 3.1 Construction joint venture and equity joint venture (adapted from Girmscheid and Brockmann, 2010)

3.2.2 Classification of Joint Ventures in Construction

Integrated and non-integrated construction joint ventures

JVs in the construction industry fall broadly into two categories: integrated and non-integrated (Norwood and Mansfield, 1999; Garb, 1988, p. 87). The integrated JVs may alternatively refer to jointly managed JVs (JMJ) (Ho et al., 2009a). Under an integrated JV agreement, the parties essentially agree to perform their work as if it were performed by a single corporation having several stakeholders (Garb, 1988, p. 87). Thus, the integrated JVs are adopted when the parties to the proposed JV intend to perform their work on an integrated basis (Garb, 1988, p. 87). The non-integrated form of JVs, being synonymous with separately managed JVs (SMJ) (Ho et al., 2009a), is often termed as item JVs (Badger et al., 1993, p. F-2), wherein the parties, for the most part, undertake their respective portions of the work separately (Garb, 1988, p. 87). The non-integrated JVs are normally used when parties to a joint venture each have discrete scopes of work and the JV is being formed merely to satisfy a particular requirement necessitating a joint bid (Garb, 1988, p. 88).

International and domestic construction joint ventures

International construction joint venture (ICJV) is a type of CJV involving multinational partners. ICJV is seen by developing countries as one of the best instruments for meeting the competing interests of national development and the prevention of the domination of the economy by foreign investors (Sornarajah, 1992; Mohamed, 2003).

Domestic construction joint venture (DCJV) is defined in this study as the type of CJVs with partners from a single country. Apart from the use by entrepreneurial firms to expand into new businesses and tap new markets, JVs are also being used voluntarily as a strategy option within mature economics (Harrigan, 2003, p. 2). Industrial studies have found some support that JVs are a form of strategy behaviour to increase market power (Kogut, 1988). From the strategic perspective, DCJV, as formed by partners from the same country, enables the share of resources of the national A/E/C firms, expedites technology transfer and adapts to the global competition.

3.3 Research Focus and Trend on CJVs

The major research interests used to classify the prior studies pertinent to CJVs are identified as: (1) theory and model development; (2) identification of motives, benefits and other strategic demands of application; (3) performance measurement or management; (4) risk assessment or management; (5) influential factors for practice; (6) problematic issues and challenges in practice; and (7) managerial practices of CJVs in the industry. Example papers for each identified research interest were shown in Table 3.1.

Table 3.1 Major research interests of relevant studies on construction joint ventures (CJVs)

Research focus	Description	Example literature
Theory and model development	Defining the scope of joint ventures in the construction field and developing models related to the formation and operation of CJVs.	Girmscheid and Brockmann (2010); Munns et al. (2000)
Motives, benefits and other strategic demands of application	Identification/investigation of motives and potential benefits of CJV application and examination of the use of C JVs for other strategic purposes, e.g. entry to overseas market, organisational learning, etc.	Norwood and Mansfield (1999); Kumaraswamy and Shrestha (2002); Girmscheid and Brockmann (2010); O'Reilly (1995); Oyegoke (2006); Ling, Ibbs and Chew (2008a); Ling and Chan (2008b)
Performance measurement or management	Development of performance measurement model and criteria and measuring CJV performance.	Luo 2001; Mohamed (2003); Ozorhon et al. (2007a and 2010)
Risk assessment or management	Development of risk assessment model/criteria and assessing risks inherent with CJVs.	Li and Tiong (1999); Li et al. (1999); Shen et al. (2001); Zhang and Zou (2007); Hsueh et al. (2007)
Exploration into influential factors/issues for practice	Identifying underlying factors/issues critical to or impacting on t he performance/success of CJVs.	Gale and Luo (2004); Adnan and Morledge (2006); Ozorhon et al. (2007b, 2008a and 2008b); Ho et al. (2009b); Girmscheid and Brochmann (2010)
Problematic issues and challenges in practice	Investigation of problematic or practical issues on CJV formation and operation.	Ozorhon et al. (2008a and 2008b); Ho et al. (2009b); Kumaraswamy and Shrestha (2002); Ofori (2000)

3.3.1 Theory and model development of CJVs

A retrospect of the observed publications on C JVs indicates a conspicuous lack of theoretical contributions to CJV study, ranging from building up theory to developing CJV practice model and framework. Defining the scope of CJVs has always been an imperative task for researchers to position the domain of studies relating to CJVs. The distinction of contractual JVs and equity JVs in the context of multinational partners, within the study of Girmscheid and Brockmann (2010), is among the rare cases concerning the differentiation of JVs and CJVs in terms of the scope of study. Similar scarce instance for providing any implications for the procedural formation of CJVs could be resorted to the cyclic model of negation developed by Munns et al. (2000) for the formation of JVs in construction, which involves five sequential elements of aspiration, information exchange, social exchange, knowledge and uncertainty. Another instance of contribution to the model development relating to CJVs is the study of Ho et al. (2009a), where a model for organisational governance choices in CJVs was proposed to decide on the use of joint managed JVs or separately managed JVs. Except for these examples of studies, the existing literature about CJVs provides few theoretical underpinnings for the formation and operation of CJVs in real practice.

3.3.2 Motives, benefits and other strategic demands of application

Research into CJVs is also concerned with the key issues in terms of the motivations for the use of CJVs and the success criteria of CJV practices. Motives and benefits underneath the application of CJVs, as identified by the previous studies, involve technology transfer (Norwood and Mansfield, 1999; Kumaraswamy and

Shrestha, 2002; Girmscheid and Brockmann, 2010), risk sharing/transfer (Norwood and Mansfield, 1999; Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010), financial strengths (Kumaraswamy and Shrestha, 2002; Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010), together with combination/pooling of general resources and specialist skills (Norwood and Mansfield, 1999; Munns et al., 2000; Kazaz and Ulubeyli, 2009). Other potential benefits such as bringing in outside expertise (Norwood and Mansfield, 1999), and opportunities for long-term profitable business development (Bellhouse, 1999) have also been referred to in the literature. Especially for the developing construction markets such as Mainland China, ICJVs could be adopted to improve local construction technology, raise project management skills and promote the development of the local construction market (Editorial, 2001).

The extensive research attention to JVs has been largely attributable to their importance as a strategic alternative in global competition (Ozorhon, 2007). Use of JVs by architectural / engineering / construction (A/E/C) firms for strategic purposes in the construction industry has been widely examined in the literature. Raftery et al. (1998) highlighted that the easiest way for foreign contractors to operate in domestic markets is through JV with local construction firms in the Asian construction industry. Ling et al. (2009a) reported from interview findings that forming JVs is perceived as one response adopted by Vietnamese A/E/C firms to the threat of foreign competition, through which the Vietnamese A/E/C firms can have fast access to up-to-date technology through their JV partners. Forming international JVs with foreign A/E/C firms has also been identified as the key strategy to overcome some of the weaknesses of the Chinese consulting firms and to reduce the competition from foreign A/E/C firms (Ling et al., 2009b). Ling et al. (2008a & 2008b) found that one of the most effective market entry modes for the A/E/C firms in Singapore and the broader area of Southeast Asia is to form project JVs with local firms.

Oyegoke (2006) advocated the organisational learning through JVs or project alliances as an essential part of operational management, which is an alternative to build a competence for managing claims in the construction industry. The use of JVs has also been proposed as the risk sharing strategy in construction contracts (O'Reilly, 1995). Case study by Chao et al. (1998) on building Taipei's mass rapid transit system implied the imperative call for strategic use of JVs in complex and most technically challenging projects as these JVs may have accumulated a high level of expertise.

3.3.3 Performance measurement or management of CJVs

Measuring JV performance has been a difficult task as efforts to identify variables associated with JV performance have been constrained by disagreements on the comparability and reliability of alternative performance measures and methods (Geringer and Hebert, 1991). A sound selection and identification of the measures of CJV project performance is critical to the validity and reliability of measurement.

With respect to the performance measurement of CJV projects, the types of CJV projects in the pool of the identified publications fall exclusively into the category of ICJV, with no record of study on DCJV.

A variety of measures for assessing CJV performance have been documented with no consensus achieved so far in the literature. Ozorhon et al. (2007a) applied three different constructs: JV structure, interpartner fit and interpartner relations, as the measures of ICJV performance. Building upon and extending the performance assessment model developed in 2007, Ozorhon et al. (2010) raised four aspects for assessing the overall IJV performance: project performance, perceived satisfaction with IJV, performance of the IJV management, and partner performance, each of which is assessed with separate measures. Mohamed (2003), from the process-based perspective, developed a research model to explore the relationships between three key processes, being partner selection, ICJV formation and ICJV operation, in the life of an ICJV and their effects on the success of the ICJV, where the ICJV's performance is measured by three items: value, profit and satisfaction. While in the context of equity JVs in construction, installation and decoration, Luo (2001) used the number of projects undertaken by the JVs, the average annual profit rate of the JVs and a subjective managerial measure to assess the performance of Sino-foreign JVs. Differing from these aforementioned studies, Sillars and Kangari (2004), with reference to the study of Warszawski (1996) on strategic planning, adopted the construct of organisation return (profitability), which is further measured by JV return, and company growth (market position change) to measure organisation success under the circumstance of project-based JV practice.

3.3.4 Risk assessment or management of CJVs

Previous research has demonstrated that despite several applications and perceived benefits, JVs frequently go awry and create problems, with dangers and risks to the success of JVs arising from anti-trust, sovereignty conflicts, lack of autonomy and control, as well as a loss of competitive advantages through strategic inflexibility (Harrigan, 2003, p. 36). Risks inherent with CJV formation and operation render it essential to develop an effective mechanism for risk management, assessment and control.

A frequently adopted classification of risks in CJVs is to incorporate three main groups of risks – internal, project-specific, and external risks – into the analysis of CJV risks, which was developed by Li *et al.* (1999a) in the context of ICJV in East Asia and was further adopted by Hsueh (2007) to develop an on-line multi-criteria risk assessment model for JVs and was also used by Zhang and Zou (2007) to evaluate risks in CJV projects in Mainland China. The study of Li *et al.* (1999a) indicated the most critical risk factors inherent with ICJVs are associated with financial strengths, government policies, project relationships, economic conditions and subcontractors' competence. Differentiated criticality of these risks in three different phases of ICJVs: *start-up*, *operation*, and *dismantle*, is further disclosed in their study. Li and Tiong (1999b) proposed a risk management model for ICJVs, where eight key measures – partner selection, agreement, subcontract, engineering contract, employment, good relationships, control and renegotiation – were used to assess the risks of ICJVs. Shen *et al.* (2001) classified the risks associated with Sino-foreign CJVs into six groups: financial, legal, management, market, policy and political, and technical risks. Their study empirically revealed that among the top 10 risks in Sino-foreign CJVs, there are 5 risks related to management, 2 related to market, 2 related to policy and 1 related to technical issue.

Overall, the general observation unveils that the system of risks in CJV has been developed systematically and identified empirically in the past studies. However, there is still a dearth of literature devoted to the development of strategies and models to avoid, mitigate or transfer risks in CJV practices. It has been observed from the study of Shen *et al.* (2001) that practical risk management strategies in ICJVs may include the co-operation with government offices, proper risk allocation within the contract, and full control of the technical risks.

3.3.5 Influential factors for CJV practices

There appears to be more similarities than differences in perceptions concerning the critical success factors for CJVs, of which commitment, co-operation, management control, agreement of JV contract, and partner selection, are widely identified from the previous studies (Gale and Luo, 2004; Morledge and Adnan, 2006). Gale and Luo (2004), focusing on the formation stage of JVs, investigated the key factors conducive to the success of JVs. Morledge and Adnan (2006), based on a literature review and semi-structured interviews, examined the critical success factors for CJV projects in Malaysia and identified the top three ones as agreement of contract, commitment and co-operation, followed by management control, inter-partner trust and financial stability. Apart from communication, partner selection and co-operation, Munns *et al.* (2000) also advocated cultural homogeneity as a critical factor to the success of CJVs.

Apart from the major critical success factors identified from the existing studies, some underlying factors influencing and contributing to the performance/success of CJVs have also been examined and explored in the literature. For instance, in the context of ICJVs, cultural differences between the CJV partners (Ozorhon *et al.*, 2008a), interpartner fit (Ozorhon *et al.*2008b), together with the host country conditions and project characteristics (Ozorhon *et al.*, 2007b), were explored to disclose their impacts on the ICJV performance. Walker and Johannes (2003) examined pertinent issues in JV design, of which JV vulnerability and risk factors, trust and commitment factors were investigated in terms of their respective influences on JV design. Ho *et al.* (2009b) studied the determining effects of four influential factors – corporate cultural difference, mutual trust, need for procurement autonomy and motivation for learning – on the selection of organisational governance structure in CJVs.

The factor of trust has also been specifically examined in the context of ICJVs by Girmscheid and Brochmann (2010), where a model of trust in ICJVs was derived and developed from three components of trust, namely trust process, objects of trust and the consequences of trust. Under the culture dimension, Fisher and Ranasinghe (2001) examined uncertainty avoidance as the most determinant cultural characteristic than cultural distance for foreign investor's choice of the entry mode of JVs.

Selection of CJV partners has also been identified as one of the critical success factors for CJVs (Gale and Luo, 2004; Morledge and Adnan, 2006). Nine criteria specifically for the selection of JV partners were raised by Williams and Lilley (1993), where strategic compatibility, complementary skills and resources, relative company size, financial capability, compatibility between operating policies, trust and commitment, compatible management teams, and mutual dependency and communications barriers should be considered for selecting the best-fit JV partners.

3.3.6 Problematic issues and challenges in CJV practices

Culture is among the frequently explored constructs in the study of CJVs. Culture is perceived as the major cause of failure in a CJV (Swierczek, 1994; Munns *et al.*, 2000). The potential for conflicts in any JVs exists because of the differences in the partners involved, which may be further increased as a result of the different cultural backgrounds that the partners possess (Munns *et al.*, 2000).

Studies into the dispute resolution in CJVs are also worthy of attention for reducing construction disputes in CJV projects. In connection with the Sino-foreign JV international projects, arbitration is identified through interviews as the preferred dispute resolution method (Chan and Suen, 2005a). The study of Chan and Suen (2005b) unfolded that the sources of construction disputes in Sino-foreign JV construction projects in Mainland China can be classified into three categories: contractual, cultural, and legal matters, which are resolved through mediation and arbitration. Allen (2011) reported that nearly one third of the JV construction projects result in disputes, where the conduct of the project managers or engineers was found to be at the heart of disputes on more than half (53%) of occasions. A lack of sound understanding of contractual procedures and a partiality to the employer's interests were further referred in the study of Allen (2011) as the two most significant mistakes that project managers or engineers have made.

Technology transfer through the use of JVs in the construction industry has been extensively identified as one major benefit of CJVs, which corresponds to the assertion that JV appears to be the most widely preferred vehicle of construction technology transfer (Kumaraswamy and Shrestha, 2002). However, it has been advocated that although the benefits have accrued in terms of technology transfer to local contractors in Singapore through JVs, the process was observed to be fraught with problems (Ofori *et al.*, 2001). Ofori (2000) asserted that JVs are not always effective as transfer vehicles as reflected by some previous studies. Ofori (2000) also concluded that research work on CJVs has not yet considered in detail the effective operation of such business entities effecting as the channels for transferring technology to local contractors, which results in an imperative to identify the factors contributing to the success of this process. Furthermore, Ofori (2000) perceived that the most important problem in technology transfer in the construction industry may be a lack of incentive from the transferors to facilitate a flow which would result in the emergence of more effective indigenous competitors. As also advocated by Carrillo (1996), the problem that most large projects are one-off and will not be repeated provides little incentive diligently to transfer technology in CJVs. Among the major barriers to technology transfer identified by Kumaraswamy and Shrestha (2002) in Hong Kong CJVs, organisational culture barriers and lack of time were rated as the top ones undermining the efficiency of technology transfer. Other main barriers included in the study of Kumaraswamy and Shrestha (2002) were capacities of individuals, attitudes of individuals, lack of clear policy, national/ethic culture differences, lack of clear agreements and lack of clear procedures.

Knowledge management and knowledge sharing in CJV projects were also found to be investigated within the CJV literature. Dulaimi (2007), using the case study methodology, uncovered a lack of clear commitment and intent to create an environment conducive to knowledge sharing and the incompatibility between the foreign and local cultures as the major barriers to effective knowledge sharing in ICJVs.

3.3.7 Managerial practices of CJVs in the industry

Other studies on CJVs, with little connection with the above identified research interests, fall exclusively into the broad category of the managerial practice of CJVs in the A/E/C industry, including CJV case reports, reporting and recording of the CJV practices.

3.4 Implications from Literature Review

With regard to the emergence of industrial practices of CJVs, the solid theoretical contributions to CJVs are essential for providing useful guidance to practitioners in avoiding barriers and achieving success throughout the formation and operation of CJVs. Assessment of risks inherent with CJVs also equips the practitioners with the knowledge about the existence of potential risks and the intention of seeking possible and effective strategies to avoid, mitigate or transfer these risks. Establishing consolidated measurement criteria and operational systems for CJV projects offers a benchmarking tool for the practitioners to monitor and meliorate the performance of CJVs. The influences on the performance and success of CJVs and the problematic issues concerning CJV practices may derive from various aspects, the identification of which is indispensable for comprehensively guaranteeing the effective operation of CJVs.

The above identified research interests enable generalising that research on CJVs overwhelmingly targets for guiding industrial practitioners on recognition of CJV issues and achievement of project success through the use of CJV approach, however, the practical value of those studies are questionable, with certain doubts from a variety of aspects, such as a lack of managerial practices of the performance measurement model or mechanism and risk assessment model or system in real-life CJV projects.

Concurrent with the extensive application of CJVs is the question of how to improve the success rate of JVs in construction projects. Prior research has articulated that the worldwide trend of using JVs has increased since the 1990s, but with very unsatisfactory results (Munns *et al.*, 2000). Nearly one-third (31%) of these JVs in place to deliver a construction project resulted in disputes (Allen, 2011). Hence, there is an imperative need to look at and explore thoroughly the reasons for the failure of CJVs.

To sum up, while a critical review of the publications on CJVs observes the increased popularity and complexity in CJV research, it also reveals the inherent limitations of the research and practices of CJVs, which may be resorted, but are not limited, to the followings:

- There is a conspicuous lack of systematic theoretical framework underpinning the formation and operation of CJVs. Building up and validating the theoretical framework involved in the process of CJV practices provides effective guidelines for industrial practitioners to implement CJVs successfully. Strategic planning of CJV application requires substantial knowledge support in terms of the theories and principles behind the success of CJVs, the literature of which needs to be imperatively enriched.

- There is a dearth of literature on identifying the appropriateness of selecting the JV approach in construction projects. The appropriateness and superiority of CJVs over other contracting approaches in construction projects have not yet been identified. JVs may not be a panacea for business, especially in the building and construction sector with increased complexity. When improperly conceived and executed, JVs can be as contentious and damaging (Wille, 1998, p. 4). Questions concerning in what context JV strategy can be the superior choice deserve substantial attention from the academic field.

- There is also an absence of research into the investigation of the barriers to CJV formation and operation and the reasons for the failure of CJVs. The increased project complexity and associated risks (especially in mega-sized projects) in the construction industry calls for the increased adoption of JVs as the desirable project delivery method. Essentially, the barriers to CJV adoption and success should be properly identified before entry into JV contracting approach. The identified barriers could be transformed into some potential strategies for avoiding or mitigating these barriers and facilitating the appropriate use of CJV approach.

- Research on the investigation into domestic CJVs issues should be enriched. The existing literature about CJVs is overwhelmingly on international CJVs. CJVs, however, as a strategic alternative, also function among local partners from a single administrative system to display its advantages and reap practical benefits. Furthermore, the possible negative impact of cultural differences among JV partners on JV performance does not exist in domestic CJVs as the JV partners share the same cultural background.

The identified research gaps are conducive to some significant perspectives towards which future research efforts can enrich and add value to the existing literature base on CJVs. Further, to strengthen the research-practice link and to make the best use of research outputs, the assessment and improvement of industrial in-take of the research efforts and products in CJVs should be consistently of significant value for future studies. This research agenda involves the identification of what products are actually filtered through to practice and which aspects of research outputs can actually demonstrate real end-user impacts (Holt, 2010).

3.5 Chapter Summary

This chapter reviewed the definition, scope and types of JVs in the construction industry, summarised the research interests and trend on CJVs, and provided implications for future research into CJVs.

Based on the observations of all CJV related studies, seven major categories of research focus on CJVs have been classified: (1) theory and model development; (2) identification of motives, benefits and other strategic demands of application; (3) performance measurement or management; (4) risk assessment or management; (5) influential factors for practice; (6) problematic issues and challenges in practice; and (7) managerial practices of CJVs in the industry.

The research findings towards the dearth of literature in several research aspects of CJVs enable the scholars to gain direct insights into the future research opportunities and values in CJVs. Future research directions for CJVs that could add significant value to the existing knowledge base are visualised as covering the following aspects: (i) establishing a theoretical framework concerning the formation and operation of CJVs; (ii) investigating the appropriateness and effectiveness of CJV contracting strategy; (iii) empirically validating the benefits and success criteria of CJVs; (iv) identifying potential barriers to the adoption and successful operation of CJVs; and (v) exploring possible strategies for improving the industrial applications in future.

In general, since the benefits and success criteria of CJVs have been well-documented in the literature, future research could be more valuable and practical when concerned about how to reduce the number of disputes in and even failures of CJVs, which in-turn renders it significantly important for researchers to develop relevant state-of-the-art criteria/framework to aid the assessment of appropriateness of selecting CJV contracting method in project procurement.

CHAPTER 4 CONCEPTUAL FRAMEWORK OF COLLABORATION IN CONSTRUCTION JOINT VENTURES

4.1 Introduction

Although construction work is constituted from the efforts of manifold organisations, each with their own resources, practices and aims, it still requires collaboration between a number of different firms and a wide range of requisite skills and specialisms to undertake the construction works (Harty, 2005). Over the past two decades, the construction industry has been seeking to improve project performance through the introduction and application of relational contracting approaches (Rahman and Kumaraswamy, 2004; Chan et al., 2010, p. 18). Notably, the two reports *Constructing the Team* by Latham (1994) and *Rethinking Construction* by Egan (1998) derived from the United Kingdom have profound effects in facilitating the reform of industrial progress towards the use of more collaborative and integrated approaches (Baiden et al., 2006). The imperative calls for collaborative strategies in construction necessitate the development of a robust research framework to study the theoretical underpinnings and effectiveness of collaboration in the construction context.

Collaboration, as an amorphous meta-concept (Barratt, 2004), has no unanimous definition or interpretation in various contexts. Collaboration occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain (Wood and Gray, 1991). Collaboration enables participants to build up capacity to complete a set of tasks that may be difficult for one single organisation to achieve (Shelbourn et al., 2007). Under a general scope of study, collaboration makes no assumptions about the number of participating stakeholders, the level of social organisation at which collaboration occurs, the time frame of the collaborative structure, the nature of intended outcome as well as the result of input efforts (Wood and Gray, 1991).

To better understand the term '*collaboration*', attention has to be paid to another synonymous term '*cooperation*', which has been used interchangeably with '*collaboration*' in many contexts. In distinguishing the two terms, Kvan (2000) referred to the definitions by Mattessich and Monsey (1992).

- *Cooperation* is characterized by informal relationships that exist without a commonly defined mission, structure or effort. In cooperation, information is shared as needed and authority is retained by each organisation such that there is virtually no risk while resources and rewards are separate.
- *Collaboration* connotes a more durable and pervasive relationship. Collaborations incorporate full commitment to a common mission. In collaboration, authority is determined by the collaborative structure and risk is much greater than

that in cooperation.

In essence, collaboration, as advocated by Mattessich and Monsey (1992), requires a greater commitment to a common goal than cooperation with an attendant increase in risk and a higher level of mutual trust is necessary to facilitate the occurrence of collaboration. As summarised by Shelbourn et al. (2012, p. 9), successful collaboration requires effectiveness in a number of areas including:

- coordination;
- negotiation;
- communication of data, information and knowledge;
- agreeing shared vision and goals;
- planning and management of activities and tasks;
- adopting common methods and procedures.

4.2 Collaboration in Construction: Concepts and Characteristics

Collaboration in the A/E/C (Architecture, Engineering, Construction) industry is different from collaboration in other fields, such as sociology, psychology, politics, science, technology, etc (Kalay, 1999). The present study broadens the context of construction as covering all relevant practices in the A/E/C industry. Such difference was further explained by Kalay (1999) from three aspects.

- Collaboration in construction involves individuals representing often fundamentally different professions holding different goals, objectives and even beliefs.
- Collaboration in construction involves 'temporary multi-organisations': a team of independent organisations joining forces to accomplish a specific, relatively short-term project.
- Collaboration in construction tends to stretch out over a prolonged time such that even when the original participants are no longer involved, their decisions and action still impact the project.

4.2.1 Definition of collaboration in the construction industry

A wide variety of definitions for collaboration have emerged in the specific context of construction in prior studies, with no consensus achieved so far. Hobbs (1996) defined collaboration in construction as:

> '*the agreement among specialists to share their abilities in a particular process, to achieve the larger objectives of the project as a whole, as defined by a client, a community, or society at large*'.

Another definition of collaboration in construction was derived by Wilkinson (2005, p. 3) as:

‘*a creative process undertaken by two or more interested individuals, sharing their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust, and mutual respect, to jointly deliver the best solution that meets their common goal*’.

Building upon the industrial practitioners’ perceptions towards collaboration in construction, Hughes et al. (2012) defined collaboration in the construction industry as (taking the contractor’s perspective for instance):

‘a non-adversarial team-based environment, where through the use of the correct contract, there is early involvement of key members and everyone understands and respects the inputs of others and their roles and responsibilities. The relationships are managed with the help of regular meetings, early warning systems, open dialogues and risk sharing to produce an atmosphere of mutual trust, where information is shared, problems can be solved together with everyone contributing towards a common aim and value engineering can be used to ensure that everyone is a “winner” motivated by a fair method of pain-share/gain-share within a long term relationship’.

As seen from the different definitions of collaboration in construction, a common aim between the collaborative parties is the pillar supporting collaboration. Sharing of abilities, skills, or expertise is the means of collaboration towards the achievement of the shared aim.

4.2.2 Elements of Collaboration in Construction

A crystallized understanding of collaboration requires the identification of its key elements. In the social science, business and management field, Wood and Gray (1991) summarised 12 common elements of collaboration (e.g. common interests/shared goals, acting constructively, shared rules/norms, temporary structure, interactive process) from its definitions in various studies in order to generate a sound definition of collaboration. Amongst the major supporting elements of collaboration identified by Barratt (2004) in the supply chain management discipline, a collaborative culture, which entails trust, mutuality, information exchange, openness and communication, is perceived as fundamental for collaboration to succeed. A comprehensive identification of the elements of collaboration has been absent or found inadequate from the construction management discipline. Drawing upon the definitions and criteria of collaboration presented by previous studies in construction, this study summarised the key elements of collaboration, which are applicable to the process of project construction. A set of 10 common key elements in previous research studies, as enumerated in Table 4.1, were derived for understanding what collaboration in construction does constitute. Shared common aim is the central element of collaboration which ties other elements together and shapes their achievements in a collaborative relationship. The role of shared common aim in integrating the key elements of collaboration is displayed in Figure 4.1.

Table 4.1 A summary of common key elements of collaboration in construction

Elements of Collaboration	Literature about Collaboration in Construction								
	Greenwood and Wu (2012)	Hugh et al. (2012)	Hobbs (1996)	Wilkinson (2005)	Ren et al. (2013)	Dietrich et al. (2010)	Son and Rojas (2011)	Shelbourn et al. (2007)	**Total number of hits for each element**
Non-adversarial environment		X			X				**2**
Shared common aim		X	X	X	X	X	X	X	**7**
Mutual understanding and respect	X	X		X		X			**4**
Early warning system		X			X				**2**
Environment for open dialogue		X		X	X	X			**4**
Risk sharing	X	X			X				**3**
Atmosphere of mutual trust	X	X		X	X	X		X	**6**
Problem resolution	X	X		X	X			X	**5**
Information sharing		X		X	X	X		X	**5**
Sharing of skills, knowledge and expertise			X	X		X	X		**4**
Total number of key elements identified from each publication	**4**	**9**	**2**	**7**	**8**	**6**	**2**	**4**	**42**

Shared common aim

Any collaborative practice is formed to achieve a specific goal which is reflected by the overall project outcome reached to the satisfaction of the collaborating partners. A shared common aim is fundamental for the collaborative practice to proceed and succeed as conflicts may arise if the aims of the collaborating parties are inconsistent.

Non-adversarial environment

The attitudes of partners in collaborating practices towards collaboration decide the way they behave within the relationship of collaboration. The transition from usual business into a collaboration-based relationship builds upon the elimination of adversarial attitude among the involved partners. A non-adversarial working environment provides a basic platform for achieving the efficiency of collaboration in the sense that agreements reached by the collaborating partners are assumed as targeting for a 'win-win' outcome for all parties.

Environment for open dialogue

The environment of open dialogue not only encourages communications between collaborating partners whenever necessary but also improves the certainty and reliability of the partners' behaviours, which further strengthens mutual trust, respect and commitment between the partners (Whipple and Frankel, 2000; Barratt, 2004). The culture of openness and honesty reduces the chance of misunderstandings between the collaborative parties which may arise in the collaborative process.

Atmosphere of mutual trust

For collaborating practices such as partnering to work, the contracting parties involved must have mutual trust toward other partners (Hellard, 1996; Chan et al., 2004). In this regard, the collaborating partners should believe the capability and reliability of their partners in fulfilling their obligations in an exchange relationship (Chan et al., 2004), and contributing to the smooth progress of overall project tasks.

Mutual understanding and respect

Mutual understanding and respect pave the way for collaboration to be performed with efficiency as they enable the involved parties to compromise and adjust their respective behaviours to be compatible with the intentions of their partners. Collaboration requires clear understanding and distribution of responsibilities, authorities and roles (Akintoye and Main, 2007). Mutual understanding between partners deals with a wide scope of aspects, such as each other's goals, cultures, strengths and weaknesses, etc.

Sharing of skills, knowledge and expertise

A major advantage of collaborative practices in construction, such as partnering and JVs, is to pool the use of skills, expertise and knowledge among the partners (Cook and Hancher, 1990; Chan et al., 2003; Munns et al., 2000; Kazaz and Ulubeyli, 2009). Participants in collaboration must be prepared to commit their resources to the team of collaboration (Barratt, 2004). Integration of the partners' strengths and expertise substantiates the collaborative process through concerted technical inputs to the work under collaboration.

Information sharing

Sharing of information is the prerequisite of successful collaboration in construction projects. Collaboration requires adequate information flows and communication of these authorities and roles among the collaborating organisations and reliable access to the latest technological and management knowledge (Yashiro, 1996, p. 135). Emphasizing the transparency and quality of information flows, information sharing and exchange ensure the symmetry of information between the partners and provide a solid basis for their timely responses to any problems emerging in the collaborative process.

Risk sharing

A collaborative arrangement can not function firmly without a mutually agreed risk sharing mechanism. The risk undertaken by each party is directly related to the financial outcome it finally achieves. Risk sharing has also been identified as one of the key motives of forming collaborative arrangements in construction, for example, JV (Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010) and partnering (Li et al., 2001; Chan et al., 2003). A fair risk sharing mechanism is therefore crucial in collaboration for the benefits of all involved parties.

Early warning system

Early warning systems for any problems should be integral to the collaborative process. Changes or conflicts, whether expected or unexpected, may occur during the project construction phase. Early warning system, being sensitive to and capable of diagnosing emergent changes or conflicts, provides a tool for the partners to make appropriate actions for the collaborative work to move on under the agreement of all involved parties.

Problem resolution

Problem may arise inevitably in any collaborative practices. Joint problem resolution mechanism looks for a mutually satisfactory solution to the collaborating parties. The problem resolution process requires a high level of participation among parties, through which a commitment to a mutually agreed solution is secured (Cheng et al., 2000).

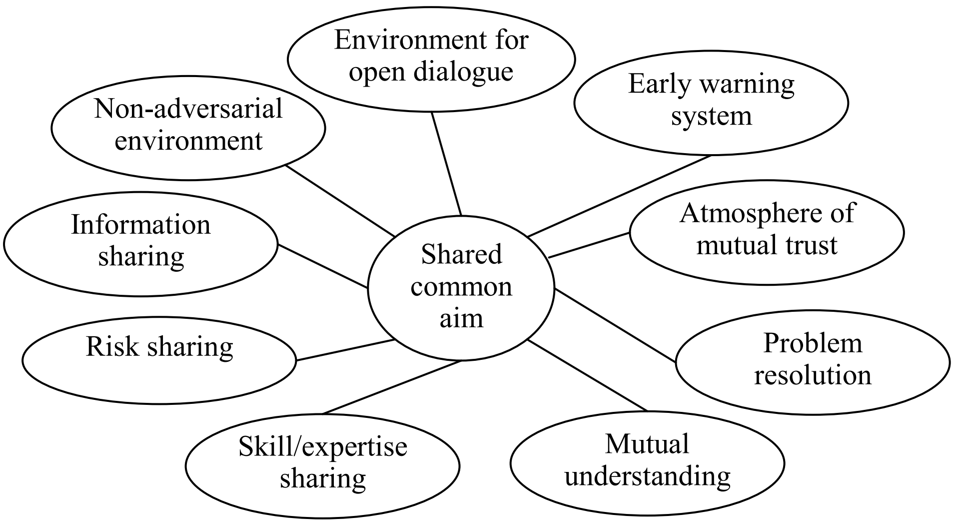

Figure 4.1 Integration of the key elements of collaboration in construction

4.2.3 Forms of collaboration in construction projects

Collaboration was used as a general term to encompass all forms of situations where different parties worked together (Hibbert et al., 2008). The term *integration* could be used to better reflect collaboration in the context of construction industry. In construction, integration is used to describe the introduction of working practices, methods and behaviours that create a culture of efficient and effective collaboration by individuals and organisations (Strategic Forum for Construction, 2003; Lennard et al., 2002; Baiden et al., 2006).

In the context of international construction, Xu et al. (2005) categorized the forms of collaboration into four types: merges and acquisitions, international joint ventures (JVs), project-based collaboration and strategic alliances. Not confined to the international construction context, Partnering, alliancing, JVs and other types of networking are all reflections of the situations underpinned by collaboration in construction (Hugh et al., 2012). The principle of these different forms of collaborative approaches is to build an integrated team or entity (virtual or physical) to work collaboratively with a common goal (Xue et al., 2010).

Figure 4.2 depicts the evolution of collaborative working (CW) approaches in construction, with the horizontal axis representing the industrial progress of collaboration and vertical axis showing the level of collaboration in different CW approaches. As seen in Figure 4.2, a low level of collaboration in the construction industry is perceived as being embraced in the Project Management (PM) delivery system, of which design-build, engineering-procurement construction (EPC) and build-operate-transfer (BOT) are the three main forms (Xue et al., 2010). A medium or high level collaboration was seen in various CW approaches succeeding the development of PM approaches.

Collaborative working (CW) approaches cover a wide spectrum of working arrangements from informal network, partnering, or alliancing to construction supply chain management (SCM). Among the forms of collaboration in construction, teamwork and partnership (general) could be perceived as embracing a certain level of collaboration. Teamwork involves the effective cooperation of a group of people in activities that are directed toward a common goal (Xue et al., 2010) while partnership in construction refers to an entity formed by the project stakeholders with collaborative relationships (Beach et al., 2005). Both terms of relationship are predominantly established voluntarily and may not be bound by a formal contract.

As also classified under the relational contracting approaches in construction, collaborative alliances (alliancing) and project partnering provide opportunities for the contracting parties to work together and create value rather than a basic commercial transaction (Bronder and Pritzl, 1992; Love et al., 2002b). Construction joint venture

(CJVs) integrates two or more companies to work collaboratively for the purpose of tendering for and executing a building or civil engineering project (NJCC, 1985). Coalition, as a project-related temporary information exchange network of actor firms governed through contractual conditions (Pryke and Pearson, 2006), requires a higher level of collaboration between the coalition members than a regular partnership does.

On top of the RC approaches, supply chain management (SCM) in construction is characterized by a relatively higher level of collaboration. SCM is a concept that originated and flourished in the manufacturing industry (Vrijhoef and Koskela, 2000). It refers to the coordination of independent enterprises in order to improve the performance of the whole supply chain by considering their individual needs (Lau et al., 2004). SCM aims to increase transparency and alignment of the supply chain's coordination and configuration, regardless of functional or corporate boundaries (Cooper and Ellram, 1993). Classified by Bennett (1998, p. 5) as third-generation partnering in the construction industry, SCM in construction is regarded as one of the emerging forms of CW (Xue et al., 2010).

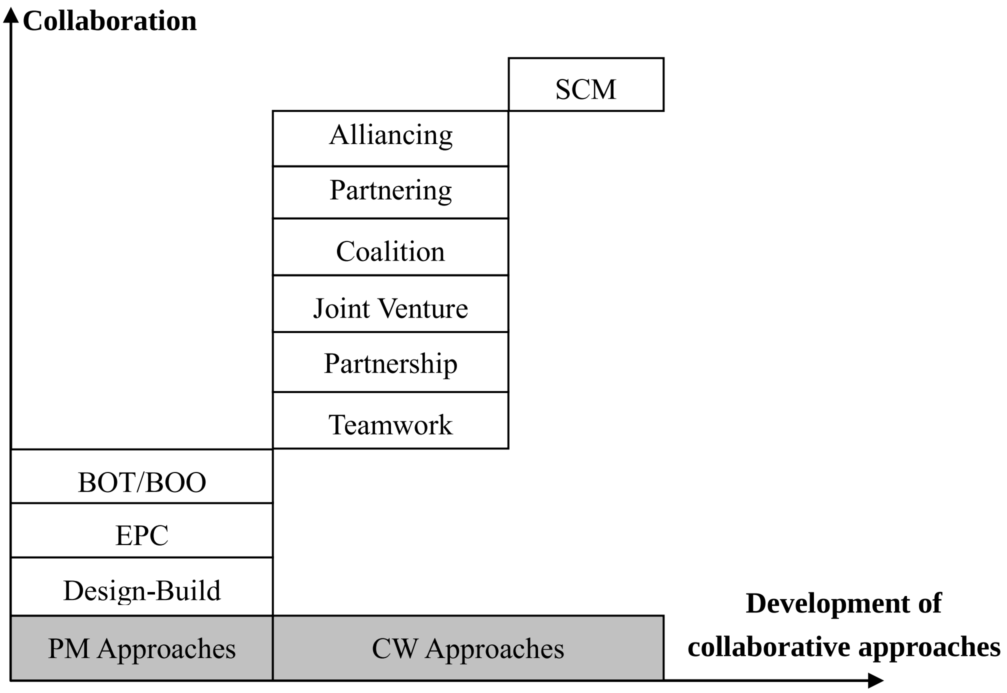

Figure 4.2 A taxonomy of collaborative working approaches in construction (Adapted from Xue et al., 2010)

4.3. Collaboration in Construction Joint Venture Projects

4.3.1 Definition of collaboration in CJV projects

As described in Chapter 3, CJVs fall broadly into two categories: integrated and non-integrated (Norwood and Mansfield, 1999; Garb, 1988, p. 87). Under the integrated CJVs, the team members essentially agree to perform their work as if it were performed by a s ingle corporation having several stakeholders (Garb, 1988, p. 87). Drawing upon t he characteristics of a full-integrated team in a construction project as referred by Baiden et al. (2006), the major features of collaboration in CJVs can be epitomized as including:

- Shared project objectives
- Operated without boundaries amongst the various organisation members
- With no-blame culture
- Freely sharing information
- Having a flexible member composition and able to respond to changes over the duration of the project
- Equity and mutual respect

Taking account of the nature of CJV operation and the generic meaning of collaboration, collaboration in a CJV project could be defined in this study, with reference to its general definition by Wilkinson (2005, p. 3), as '*a process undertaken by two or more interested organisations, sharing their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust, and mutual respect, to jointly deliver a construction product that meets their common goals*'.

As could be seen from the definition, collaboration in CJVs comprises three major dimensions: collaborative culture, collaborative behaviour and collaborative goal. The culture dimension concerns the integrated working atmosphere of openness, trust, mutual understanding and respect. Collaborative behaviours are reflected in, but not limited to, the partners' sharing of skills and expertise, establishment of problem resolution mechanism and financial and technical inputs during CJV operation. Collaborative culture and behaviours both serve for the achievement of the collaborative goal, that is, successful delivery of the construction product in which profits, knowledge and experience are gained and shared by CJV partners. These three dimensions are also integral to the formation and operation of a CJV contracting relationship.

4.3.2 Process and model of collaboration in CJV projects

Referring to the two ways suggested by Tyler and Matthews (1996) in understanding CW approaches, this study tries to understand collaboration in CJV projects from two perspectives, being the elements of collaboration and the process of collaboration.

Elements of collaboration in CJVs

As is in other collaborative practices, collaboration in CJVs is also underpinned by the elements of collaboration in the broad context of construction. Apart from the ten key elements summarised in Figure 4.1, there are other elements distinctive in the context of CJVs, such as fair pain/gain share mechanism, equity in resource and authority allocation, JV management control, etc. Therefore, a systematic examination of the elements of collaboration in CJVs is necessary for gaining an enhanced understanding of collaboration in CJV projects. The detailed process for identifying the elements/attributes of collaboration in CJVs will be presented in Chapter 7.

Process of collaboration in CJVs

An input-process-output (IPO) framework is selected to illustrate the process of collaboration in CJV projects as the construction process can be represented as IPO models hierarchically integrated into larger production systems (Bernold and AbouRizk, 2010, p. 311). The IPO framework of collaboration, as shown in Figure 4.3, divides the progress of collaboration in CJVs into four major stages, being formation of collaborative culture, collaborative inputs, collaborative process and collaborative outputs. Figure 4.3 also enumerates the behavioural aspects that are reflected in each stage of collaboration.

Collaborative Culture: shared aim, open dialogue, mutual trust, mutual understanding and respect, commitment, etc.

Collaborative Input: quality assurance, financial inputs, skill and technological inputs, etc.

Collaborative Process: joint-problem solving, communication, equitable authority distribution, etc.

Collaborative Output: fair risk allocation, fair gain/pain sharing, etc.

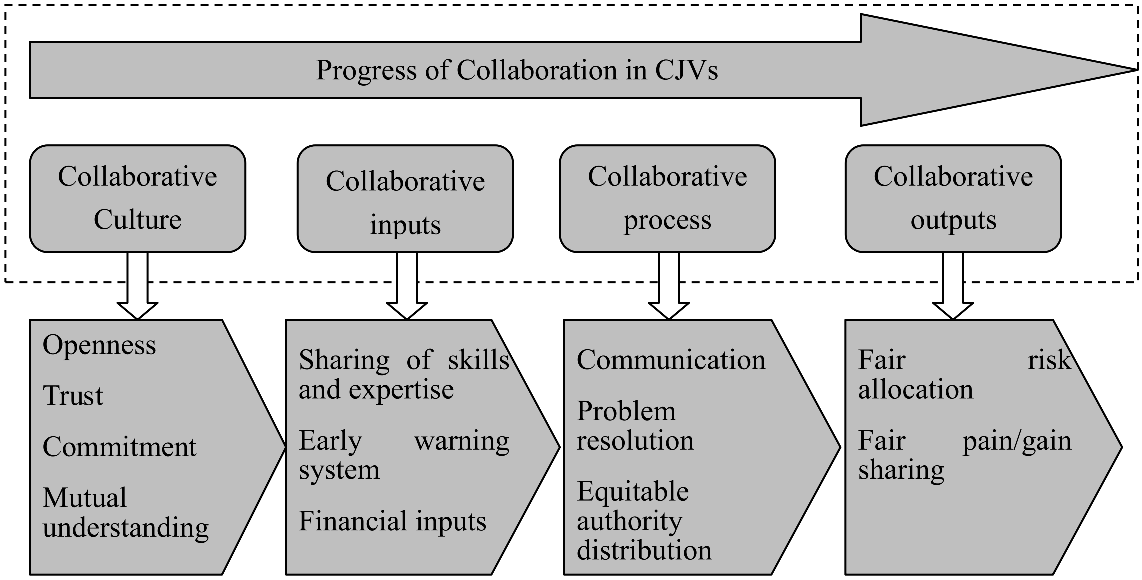

Figure 4.3 An IPO-based framework of collaboration in CJVs

Corresponding to the framework of collaboration, a model as shown in Figure 4.4 was also used to depict the process of collaboration in the context of CJVs. Within the model, the key elements of collaboration that are tailored to project objectives and lead to both short-term and long-term strategic gains are incorporated in the process of collaboration in CJVs.

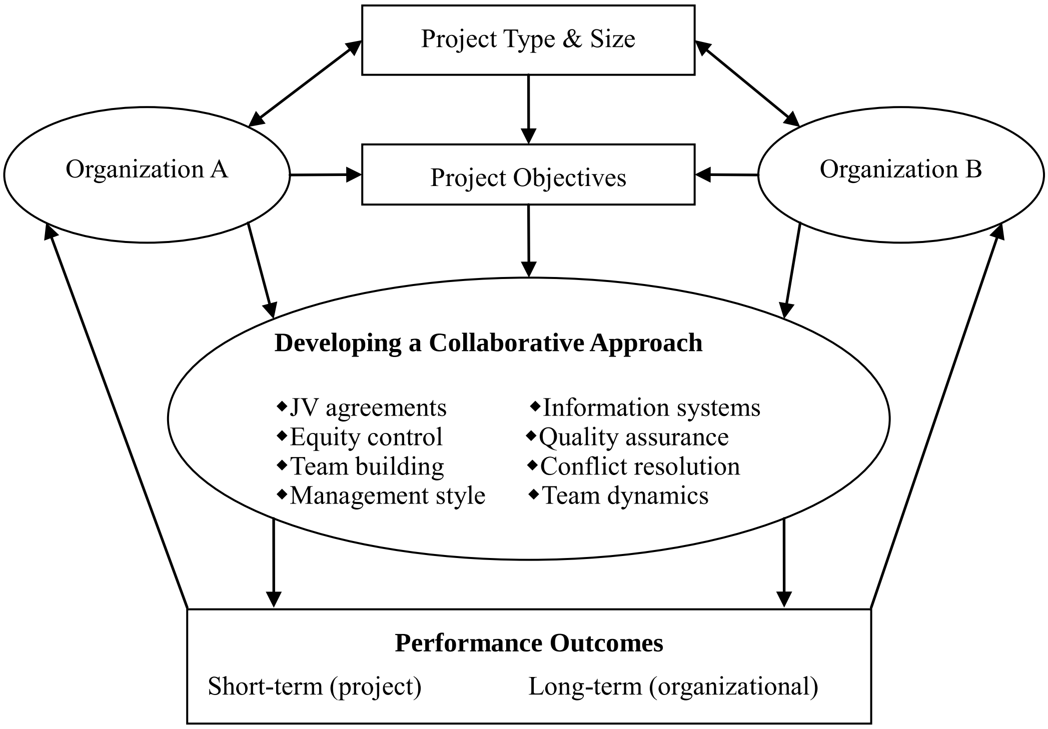

Figure 4.4 Model of inter-firm collaboration in construction joint ventures
(Adapted from Bresnen and Marshall, 2000)

4.4 Chapter Summary

This chapter elaborated the 'collaboration' construct in the construction industry from its concept, elements and forms, and further explained collaboration in JV construction projects through a particular definition of it in CJVs and a proposed process framework throughout the formation and operation of a JV contracting relationship. The process of collaboration in CJVs developed in this chapter has provided a solid basis for deriving the factors of collaboration in CJVs in Chapter 7.

CHAPTER 5 RESEARCH METHODOLOGY

5.1 Introduction

This chapter first reviews the scientific research methodologies applicable to construction management research, and then describes the proposed research framework and corresponding research design for this study. To achieve the research objectives, a series of systematic research methodologies and strategies including data collection procedures and data analysis methods are presented in this chapter.

5.2 Basic Understanding of Research Methodologies

According to Fellows and Liu (2008, p. 30), research methodology is defined as the principles and procedures of logical thought applied to a scientific investigation. As proposed by Creswell (2009, p. 5), the methodological design of a research is contingent on the three intersecting elements: the philosophical worldview assumptions, the strategy of inquiry, and the methods or procedures that operationalise the research. There are three typical types of research design generally used as described by Creswell (2009, p. 4):

(1) Qualitative research: a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem;

(2) Quantitative research: a means for testing objective theories by examining the relationship among variables; and

(3) Mixed methods: an approach or inquiry combining or associating both qualitative and quantitative forms.

A logical and coherent research procedure is essential for conducting a research. Sekaran and Roger (2009, p. 68) proposed a general model of a r esearch process which is applicable to the basic and applied research. The extensively referenced methodological process involves:

(1) identification of areas of research interest through observation;

(2) preliminary data collection through literature review and interview;

(3) definition of particular research problem;

(4) establishment of theoretical framework;

(5) formulation of research hypothesis;

(6) scientific research design of methods for data collection and analysis;

(7) data collection, analysis and interpretation of qualitative and/or statistical results; and

(8) deduction to examine the extent to which the hypothesis is substantiated or the research question is answered

Three principal research methods were presented by Leedy (2010, p. 106) as including the descriptive survey methods, the analytical method and the experimental method.

5.3 Overview of Research Methods for the Construction Management Discipline

In addressing the problems with the Construction Management (CM) research settings, a considerable debate, though subsiding gradually, exists in the literature as to which (generic) research methodology is most appropriate, such as raised by Seymour and Rooke (1995), Raftery et al. (1997), Walker (1997), Chau et al. (1998), Li and Love (1998), Holt and Faniran (2000), etc. As argued in many studies (e.g. Seymour and Rooke 1995; Seymour et al. 1997), much of CM research is close to social sciences such that the qualitative (interpretative) research approach rather than the quantitative (rationalistic) research approach should be preferred in CM research as the former is the favoured social scientific and naturalistic approach. In contrast, some researchers (e.g. Chau et al., 1998) opined that most issues in CM are of practical nature and the quantitative approach is more likely to produce a practical solution. A hybrid approach in the context of ontological (referring to the metaphysical nature of human being) and epistemological (referring to the theory of method or grounds of knowledge) research approaches has been suggested, for example by Blackwood et al. (1997) and Holt and Faniran (2000), for conducting CM research. Love et al. (2002a) suggested triangulation, which involves the use of multiple research methods and/or measures of a phenomenon, as an appropriate research approach for extending the scope of theory in CM research.

Research methods concern the techniques which are available and those which are actually employed in a research project (Fellows and Liu, 2008, p. 30). CM research is generally carried out with four typical research methods: literature review, interview, survey and case study. Selection of a suitable method for a specific research exercise is contingent on the scope and depth of the research (Fellows and Liu, 2008, p. 150). A variety of various research methods adopted in CM research has been demonstrated in the analysis of Dainty (2008, p. 6) based on the papers published in Volume 24 (Year 2006) of the journal '*Construction Management and Economics*'. The study of Dainty (2008, p. 6) examined the methodological positions and research methods used by various CM researchers and found that amongst the 107 published papers, 76 (71.0%) employed quantitative methods, followed by 12 papers (11.2%) adopting mixed methods combining qualitative and quantitative methods, 10 papers (9.4%) being primarily literature review while only 9 articles (8.4%) adopted qualitative methods exclusively.

5.3.1 Literature Review

A desktop literature review distills the existing literature in a subject field and forms as the basis of both theoretical and methodological sophistication, thereby improving the quality and usefulness of subsequent research (Mertens, 2010, p. 90). Literature review should not only report on the claims made within the existing literature but also examine critically the research methods used to better understand whether the claims are warranted. Conducting a literature review needs to draw on and evaluate a range of different types of sources including academic and professional journal articles, books, and web-based resources (Rowley and Slack, 2004).

5.3.2 Case Study

Case study refers to as 'a strategy for doing research involving an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence' (Robson, 2002). The main advantage of case study approach lies in that it allows researchers to evaluate different sources of information to test a particular concept on the basis that a consensus of the findings would yield a robust result (Proverbs and Gameson, 2008, p. 99). The existing literature has documented the extensive application of case study method in many situations to contribute into the knowledge of individual, group, organisational, social, political, and related phenomena (Yin, 2009, p. 4). To determine how to undertake a case study investigation, Proverbs and Gameson (2008, p. 100) proposed that the research should take account of the following five key issues: (1) the time available to carry out the investigation; (2) the availability of documentary information; (3) the access to people involved; (4) aim of the investigation; and (5) the number of cases required.

5.3.3 Interview

An interview can facilitate the formulation of research questions and objectives, especially when the research topic is intangible and difficult to identify. Different types of interviews are available for research and the most common typology, as related to the level of formality and structure, incorporates structured, semi-structured and unstructured interviews (Saunders et al., 2012). A structured interview is conducted on the basis of a questionnaire or a carefully designed set of questions. The questioning may start with some open-ended questions, but move towards a closed question format (Naoum, 1998, p. 57). To avoid producing worthless data, interviews should be conducted with a degree of dexterity and care (Douglas, 1985). As also recommended by Fellows and Liu (2008, p. 157), tape recording the interviews with the permission of the interviewees can be very helpful at later stage of analysis to ensure the accuracy, adequateness and objectivity in the recording responses through subsequent scrutiny. Likewise, Corbin and Strauss (2008, p. 29) suggested interview dialogues be tape-recorded, transcribed and analysed using a coding process in which the interview data are classified through qualitative methods.

5.3.4 Survey

A survey is defined by Marsh (1982) as ‘a systematic measurement made over a series of cases, yielding the data which are then analysed to see if they show any patterns’. As the purpose of a survey is to collect a body of quantitative or quantifiable data in connection with two or more variables and then to detect patterns of association (Bryman, 2004), it is widely regarded as being inherently quantitative and positivistic, and distinct from qualitative methods that involve participants' observations, unstructured interviews and case studies (De Vaus, 2002). The statistical inference based on the analysis of survey data moves from particular observations of a sample to the wider generalisations of whole population (Oppenheim, 1992, p. 5). The merits of survey are considerable in that it provides a quick, inexpensive, efficient and accurate means of assessing information about a population (Zikmund, 1991).

Questionnaire is an effective and convenient tool in survey research for observing and recording data beyond the physical reach of the observer, and for sampling the opinions of individuals in spatially diverse locations (Rahman, 2003). In conducting a questionnaire survey, the questions designed should be clear and easy to answer, with no extensive data collection by the respondents required. Each question should concern only one issue and the answer should be requested in an unthreatening manner that is appropriate to the research (Fellows and Liu, 2008, p. 155).

Notwithstanding its merits for CM research, several caveats of conducting questionnaire surveys are also noted. Only standardised data could be collected through a questionnaire survey in the sense that the data collected cannot be readily connected to other kinds of information, for example, the attitudes, feelings or reactions of respondents. The low response rate is also a major disadvantage of using questionnaire surveys such that the expected valid response rate of 25%-35% for postal questionnaires is difficult to achieve. In order to obtain prompt feedback and enhance the response rate, several aspects should be placed with greater concerns: (1) clear and courteous language; (2) questionnaire design centering around the specific research objectives; (3) simple expression and ease of understanding; (4) brevity; (5) consistency; (6) an offer of the result summary of the survey to respondents (Chan, 1998).

5.4 Research Framework and Design

5.4.1 Overall Research Framework

Specific research method(s) and analysis tools were applied to achieve each of the research objectives as stated in Chapter 1. The corresponding research methodologies for all research objectives are described in Table 5.1.

Table 5.1 Research objectives and the corresponding research methodologies

Research objectives	**Research methods**	**Analysis techniques**
1. To identify the key motives and benefits of applying CJVs and the major difficulties of impeding CJV success, and analyse their relative importance	1.Literature review 2.Structured Interview 3.Empirical questionnaire survey	1.Content analysis 2.Cronbach's alpha reliability test 3.Descriptive statistics 4.Kendall's concordance test 5.Spearman's rank correlation test 6.One-way ANOVA test 7.Exploratory factor analsysis

Table 5.1 (continued)

2. To solicit and compare the perceptions of CJV participants at different working levels on the assessment of the practical issues pertaining to CJV application	1.Literature review 2.Structured Interview 3.Empirical questionnaire survey	1.Cronbach's alpha reliability test 2.Descriptive statistics 3.Kendall's concordance test 4.Spearman's rank correlation test 5.One-way ANOVA test
3. To develop the measurement attributes and determine the factors of collaboration for CJV projects	1.Literature review 2.Structured Interview 3.Empirical 4.Questionnaire survey 5.Case study	1.Content analysis 2.Exploratory factor analysis 3.Descriptive statistics
4. To determine a list of key performance indicators (KPIs) for measuring CJV project performance	1.Literature review 2.Structured Interview 3.Empirical questionnaire survey	1.Content analysis 2.Descriptive Statistics 3.Fuzzy synthetic evaluation
5. To develop a model for investigating the relationships between a set of collaboration attributes of CJV partners and various performance measures of CJV projects	1.Empirical questionnaire survey	1.Structural equation modelling 2.Regression analysis

5.4.2 Research Methods for This Study

Literature review

A desktop literature review was conducted at the beginning of the research study. Review of literature aims to identify the gaps of knowledge existing in CJV studies through a general understanding of the prevailing research interests and research methods adopted in CJV studies. Furthermore, the associated practical issues of CJV application, such as the perceived motives/benefits of applying CJVs and the difficulties of CJV success across different countries/regions were also reviewed for designing the questionnaire survey that solicits the industrial practitioners' perceptions towards these practical aspects. For the purpose of this study, the literature review also looks at the existing key performance indicators (KPIs) for measuring CJV project performance and the measurement attributes of collaboration in CJVs. As suggested by Rowley and Slack (2004), literature review conducted in this study draws on a range of different types of sources including academic and professional journal articles, books, and web-based resources, with focus on t he articles retrieved from top-tier journals related to CM research.

Structured interview

Sekaran and Roger (2009, p. 186) pointed out that structured interviews could be applied to study the perspectives of participants at a preliminary stage and it is best used when the information needed is known at the outset. As a structured interview is perceived as a powerful tool to gather greater depth of information (Haigh, 2008, p. 113), it was used in this study to gain an in-depth perception of the industrial practitioners towards the aforementioned practical issues of CJVs under investigation. The objectives of conducting interviews in this study are threefold:

(1) To understand the level of consistency between theoretical studies and real-life practices in terms of the key issues in CJV application;

(2) To determine the appropriateness, sufficiency and clarity of the

motives/benefits of CJV application, difficulties of CJV success, KPIs for CJV projects and collaboration attributes derived from literature review; and

(3) To avoid missing items and make necessary complements to the issues raised above.

To facilitate the process and improve the efficiency of interviews, a list of open-ended questions were attached to the letter of invitation and asked the potential interviewees' views on a series of key issues concerning CJV application, including the motives/benefits of application, difficulties during implementation, success factors, key attributes of collaboration, and KPIs for CJV projects. In addition, if the target interviewees have been involved in one or more CJV projects, they were also asked to provide the background information of their real-life project cases.

To identify the potential eligible interviewees, a purposive sampling approach was applied such that only participants having satisfied the particular pre-set criteria are considered as target respondents for interview (Ng et al., 2002). To balance the theoretical understanding and practical knowledge of CJV issues, both industrial practitioners and prominent academicians were targeted as potential interviewees. When selecting the eligible practitioners, it was specified in this study that they must have gained hands-on experience in at least two large-scale JV construction projects. The chosen academicians for conducting the interviews are required as either having at least two publications addressing CJV issues (e.g. risks inherent with CJVs and technology transfer in CJVs) in top-tier international journals or offering consultancy services to at least two JV construction projects before.

As stated before, an invitation letter (see Appendix 1) describing the research background and aim was sent to 10 potential eligible respondents by electronic mails. Finally, a total of six structured interviews were conducted with all respondents having direct hands-on experience in CJV construction projects in Hong Kong or Mainland China. The interview contents cover the motives/benefits of CJV application, difficulties of CJV success, success factors of CJVs, KPIs for CJV projects and collaboration attributes in CJV projects.

Considering that the potential pool size of target interviewees was small and the limited cases of CJV projects in Hong Kong and Mainland China, six interviews were regarded as sufficient for this study. Amongst the interviewees, three were prominent academics with demonstrated research experience in CJVs and have been served as the advisory consultants for more than one JV construction project while another three were senior construction personnel with abundant hands-on experience in CJV practices. Hence, the interview findings were considered representative and valid for further analysis and application. The feedback collected through the interviews will be integrated with the findings derived from literature review to produce the empirical survey questionnaire for in-depth quantitative investigations. The major results of the interviews are summarised in Chapter 6.

Pilot questionnaire survey

Drawing on the extensive literature review and the interview findings, a pilot questionnaire survey form was developed. The pilot questionnaire survey was conducted to improve the suitability and practicality of the survey for proceeding with an empirical questionnaire survey in Hong Kong. A pilot survey form was sent to the six previously identified experts for their perusal and comments in terms of the way of setting the questions, the clarity of the questions and the suitability of the options offered. Since no adverse comments or suggested changes were received from the expert interviewees, the pilot survey questionnaire, incorporating a series of different measures for four key issues in CJV applications (i.e. motives/benefits of application, difficulties of success, key attributes of collaboration of CJV partners and KPIs for CJV projects), was taken as the final empirical questionnaire for data collection in Hong Kong.

Empirical questionnaire survey

Following the pilot questionnaire survey, an empirical questionnaire survey was launched between December 2012 and March 2013 in Hong Kong to solicit the experience-based perceptions of the key participants involved in a CJV project towards the practical issues concerning CJV application. Purposive sampling techniques, often used when the researcher wants to select a purposive sample that represents a broader group of cases as closely as possible or to set up comparisons amongst different types of cases on a certain dimension of interest (Teddlie and Yu, 2007), was adopted in this study for seeking target survey respondents. Therefore, JV project-based distribution and industrial snowball sampling were both adopted as the preferred survey sampling methods. Prerequisite was set in snowball sampling process such that the potential respondents should have acquired direct hands-on JV project experience. In the JV project-based survey, only under the circumstances that the JV project is close to completion, all JV project team members (at the project management level) were identified as valid respondents, otherwise, only those with previous experience of other JV project(s) were perceived as valid respondents.

The survey form consisted of five sections. The first section was to collect the respondents' personal profiles. The second section asked the respondents to rate their perceived levels of agreement on the 15 key motives/benefits of applying CJVs derived from desktop literature review and structured interviews. The third section collected the respondents' perceived levels of agreement on the 17 major difficulties that may impede the success of CJVs. The fourth section invited the respondents to rate the levels of agreement on each of the 38 listed collaboration attributes of JV partners in CJV projects. The fifth section solicited the survey participants' perceptions towards the importance of a list of 10 K PIs for measuring the performance of CJV projects. Answers of each question in the latter four sections (i.e. Section Two to Section Five) adopted a five-point Likert scale where 1 de notes “strongly disagree” and 5 denotes “strongly agree”. A sample of the invitation letter to the target respondents and the standard form of survey questionnaire are attached in Appendix 3 and Appendix 4 for reference.

5.4.3 Tools for Data Analysis

In order to draw meaningful conclusions from the data collected, use of various data analysis tools to turn raw data into useful information is an essential process. The empirical data collected through the questionnaire survey were first inputted into a computerised database system. Then two common statistical softwares, Statistical Packages for Social Sciences (SPSS) and AMOS, were applied to analyse the data that were collated on a standardised form.

Various statistical tools were employed to effectively analyse the survey data. The Cronbach’s alpha reliability test, descriptive statistics, Kendall’s concordance test, Spearman’s rank correlation test, and one-way ANOVA test were used to test for the consistency of the measures and to compare the perceptions of different groups of respondents on the assessment of motives/benefits of CJV application, difficulties of CJV success, and KPIs for CJV projects. Exploratory factor analysis (EFA) was applied to classify the groups of variables and extract the key factors for the motives/benefits of CJV application and the difficulties of CJV success. Confirmatory factor analysis (CFA) was employed to determine the factors of collaboration in the context of CJV projects. The fuzzy synthetic evaluation approach was used to derive the measurement model for CJV project performance. Structural equation modelling (SEM) and regression analysis were adopted to develop the model that relates factors of collaboration to project performance, and examine the relationships between the factors of collaboration and KPIs in the context of CJVs.

Cronbach's Alpha Reliability Test

The measurement of reliability that concerns the internal consistency of the measurement scale determines the validity of results derived from the questionnaire survey. The most commonly used reliability coefficient is the Cronbach's alpha value ranging from 0 to 1, with a larger value indicating a higher level of reliability (Hoxley, 2008, p. 133). The Cronbach's alpha coefficients could be used to describe the reliability of factors extracted from dichotomous (i.e. questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e. rating scale: 1 = poor and 5 = excellent) (Santos, 1999). It has been recommended that the alpha values of 0.5 for attitude/perception assessments are acceptable for evidencing the reliability of the measurement scales (Tuckman and Happer, 2012, p. 206; Yip and Poon, 2009). Research studies in CM have extensively used the Cronbach's alpha coefficient to test/confirm the reliability of the adopted measurement scale (e.g. Akintoye et al., 2000; Lam et al., 2006; Chan et al., 2010a, 2010b, 2011a, 2011b). In this study, the statistical tool was used to test the reliability of the five-point Likert scale and the variables used to examine the motives/benefits of CJV application, the difficulties of CJV success and the KPIs for CJV projects.

Descriptive Statistics

Descriptive statistics could be utilised to organise, summarise, simplify and interpret data sets effectively. Descriptive statistical techniques were applied in this study to demographic and attitudinal data for identifying the characteristics of individual groups of respondents and understanding the similarities and differences amongst the ratings on the variables. The motives and benefits of CJV application, difficulties of CJV success and KPIs for CJV projects as listed on the survey questionnaire were ranked in descending order of the mean scores. Analysis of the importance of each variable was conducted for different groups of respondents as categorized by the working level of the participants involved in JV construction projects.

Kendall's Concordance Test

The ranking exercise in a questionnaire survey with a Likert scale is based on the individual perceptions of the respondents, making the judgment subjective in nature (Chan et al., 2003). It has been recognised that such subjective judgment cannot provide any absolute value on ranking positions. Therefore, this study analysed the results of survey rankings with emphasis on the factors that were ranked as the most significant and the least significant in the ranking exercise. The Kendall's concordance analysis, as a non-parametric test, could be applied to measure the level of agreement of different respondents within an individual group on their rankings of factors based on mean scores. This statistical test aims to detect whether the respondents within an individual group respond in a consistent manner or not (Kvam and Vidakovic, 2007, p. 125). The value of the Kendall's coefficient of concordance (W) ranges from 0 to 1. A larger value of W indicates a higher level of agreement between respondents on the rankings of factors. A significant value of W (p-value < 0.05) can reject the null hypothesis that there is a complete lack of consensus amongst the respondents within one group (Chan, 1998). In other words, it can be concluded that there is a significant degree of agreement on the ranking exercise amongst the respondents within the group.

Spearman's Rank Correlation Test

The Spearman's rank correlation test is a non-parametric test for measuring the statistical significance and the strength of relationship between the rankings of two groups (El-Sayegh, 2008). The Spearman's Rank Correlation Coefficient (r_s) was applied in this study to measure the level of association between any two respondent groups on their rankings of various motives and benefits of CJV application, difficulties of CJV success and KPIs for measuring CJV project performance. The coefficient (r_s) ranges from –1 to +1, with a value of +1 indicating a perfect positive linear correlation while a value of –1 indicating a perfect negative linear correlation. The value of correlation approximate to zero implies that there is no significant relationship between the two groups on the variable under investigation (Kottegoda, 1997, p. 281). If the Spearman's rank correlation coefficient (r_s) was statistically significant at the 0.05 significance level, it can be concluded that there is no significant disagreement between the two groups on the ranking exercise.

Analysis of variance (ANOVA)

Analysis of variance (ANOVA) is a powerful statistical tool that partitions the observed variance into different components for conducting various significant tests. The ANOVA test could be used to detect if there exist any differences between more than two groups on the mean values of their survey responses. If the test result is significant at the 5% significance level, then the null hypothesis that there is no significance differences between the respondent groups on the mean values could be rejected, indicating that the mean values of the examined variables between the respondent groups are significantly different from each other at the significance level of 5%. In this study, one-way ANOVA test was conducted to explore the existence of any divergences between the different groups of respondents in perceptions towards the motives and benefits of CJV application, difficulties of CJV success and the KPIs for measuring CJV project performance. The detailed results of one-way ANOVA test are presented in Chapter 6 and Chapter 9.

Factor Analysis

Exploratory factor analysis (EFA) is a multivariate statistical technique to reduce a large number of variables into a few underlying factors, dimensions, or constructs (Hair et al., 2010, p. 94; Hoxley, 2008, p. 128). Two common methods, component factor analysis and common factor analysis, could be utilised to obtain factor solutions. The component factor model is appropriate when the study aims to examine the minimum number of factors accounting for the maximum portion of the variance in variables, and when information shows that error variance only accounts for a relatively small proportion of the total variance (Hair et al., 2010, p. 107). Factor rotation is essential for better interpretation of the factors extracted. Rotation of factor matrix redistributes the variance from earlier factors to later ones to achieve a simpler, theoretically more meaningful factor pattern. Two factor rotation methods, oblique rotation and orthogonal rotation, are used to rotate factors for achieving a simpler and theoretically more meaningful factor pattern. Orthogonal rotation (e.g. varimax, equamax, and quartimax) is used under the assumption that factors are independent of each other while the oblique rotation method (e.g. promax, oblimin, and quartimin) allows the factors to correlate with each other (Henson and Roberts, 2006). In this study, EFA was used to identify the underlying clusters of motives and benefits of applying CJVs by reducing the 15 items into a small number of underlying factors. In addition, EFA was also conducted to extract the factors of the 17 potential difficulties of CJV success for better understanding the key aspects that may impede the successful formation and operation of CJVs.

Fuzzy Synthetic Evaluation Method

Fuzzy set theory is regarded as a branch of modern mathematics to model vagueness intrinsic in human cognitive process (Chan et al., 2009). It has been adopted to tackle ill-defined and complex problems due to incomplete and imprecise information in the real world (Baloi and Price, 2003). Sadiq et al. (2004) also perceived that fuzzy set theory is an important tool for modelling uncertainty or imprecision arising from human perceptions while subjectivity should be considered in a rational manner in decision making.

Fuzzy synthetic evaluation (FSE), as an application of fuzzy set theory, has been extensively used in several CM research studies. For example, Lo (1999) adopted the fuzzy comprehensive evaluation method to develop a fire assessment system for buildings in Hong Kong. Li et al. (2013) used the same method to evaluate stakeholder satisfactions during their public participation in major infrastructure and construction projects. Xu et al. (2010) and Chan et al. (2011) applied it to develop a risk assessment model for PPP projects and a risk assessment model for guaranteed maximum price and target cost contracts, respectively.

Scrutiny into previous studies revealed that the FSE approach is most suitable for conducting assessments for multi-attributes in multi-levels. Assessment of JV project performance involves multi-participant and multi-level assessments (weighting and soccer rating) of a set of KPIs and also incorporates subjective judgments. Hence, it is perceived that FSE is an appropriate tool to develop the performance assessment model for CJV projects.

Structural Equation Modelling

SEM is a collection of statistical techniques that allow a set of relations between one or more independent variables (IVs), either continuous or discrete, and one or more dependent variables (DVs), either continuous or discrete, to be examined (Ullman, 2006). It has more flexible assumptions than multiple regression, particularly in that it a llows interpretation even in the face of multi-collinearity (Garson, 2012). SEM was selected due to its unique features over other multivariate techniques.

- It can examine a s eries of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model.
- It can take into account of latent variables, which are hypothesized and

unobserved concepts and can only be approximated by observable or measurable variables collected from survey or experiment.

- It can correct or assess measurement error by providing explicit estimates of error variance parameters.

- It takes a confirmatory rather than an exploratory approach to data analysis (Byrne, 2009, p. 3). A priori theoretical model can be tested with empirical data by using SEM. On the contrary, most other multivariate techniques are descriptive and exploratory in nature, rendering them less appropriate for model testing (Crowley and Fan, 1997).

SEM applications are prevalent in CM research. Amongst the studies using the SEM approach, examining the influences of associated factors/elements on project performance or success has been the major applications of SEM. For instance, SEM was used by Hon (2012) to explore the relationship between safety climate factors and safety performance, by Xiong et al. (2014) to examine the influence of participant performance factors on contractor satisfaction, by Doloi et al. (2011) to assess the impact of contractor's performance on project success, by Wong and Cheung (2005) to investigate the impact of trust elements on partnering project success.

For the present study, SEM enables multiple factors of collaboration in CJVs and JV project performance to be estimated simultaneously. Collaboration in CJVs is a latent variable that cannot be directly observed and measured. Since SEM can reveal the interdependencies of observed variables and latent variables simultaneously, interdependencies of collaboration factors and JV project performance can be fully modelled and tested. A full structural equation model that consists of both measurement and structural models, was tested to estimate the relationships between the collaboration attributes of CJV projects and JV project performance. The process of SEM application normally involves the following six several steps (Baumgartner, 2011), with model specification, identification, estimation and evaluation as four essential steps.

Step 1: model specification

Models can be specified graphically or algebraically, but graphical specification is perceived as more revealing (Baumgartner, 2011). In this study, a theoretically based model was formed based on the hypotheses as described in Chapter 7. Collaboration was the independent variable. Two major dimensions of CJV project performance, generic performance and JV-specific performance, were used as dependent variables to form the structural model. The factors of collaboration has been derived and validated through CFA. The attributes of collaboration were the observed variables of collaboration factors which form the measurement model.

Step 2: model identification

Model identification means that all parameters in the model are uniquely determined so that the conclusions derived from the analysis are not arbitrary (Baumgartner, 2011). An unidentified model may have more than one or even an infinite number of set(s) of parameters that can produce the same covariance matrix (Hon, 2012). Therefore no unique solution to the research problem would exist in an unidentified model. A necessary requirement for identification is that the number of parameters to be estimated should not be larger than the number of unique variances and covariances among the observed variables (Baumgartner, 2011). A check was conducted to determine whether the data points were sufficient for the structural equation model to be identified.

Step 3: model estimation

The goal of model estimation is to find values for the five types of unknown parameters, based on the observed covariance matrix, such that the covariance matrix implied by the estimated model parameters is as close as possible to the sample covariance matrix (Baumgartner, 2011). A variety of methods such as maximum likelihood (ML), generalised least squares (GLS), weighted least squares (WLS) or arbitrary distribution free (ADF) and ordinary least squares (OLS) methods can be utilised to estimate the structural equation model. ML estimation, which assumes the data follows a multivariate normal distribution, is by far the most frequently used estimation procedure in SEM (Baumgartner, 2011; Hon, 2012). As suggested by Ullman (2006), in medium to large samples, the scaled ML test statistic is a good choice with non-normality or suspected dependence among factors and errors". As the data set obtained is significantly non-normal with medium sample size, the Satorra-Bentler scaled chi-square, as also used by Hon (2012) for examining the relationship between safety climate and safety performance, was adopted in this study. This is an adjusted chi-square statistic that attempts to correct for the bias introduced when the data are markedly non-normal in distribution (Satorra and Bentler, 2001).

Step 4: model evaluation

The ratio of chi-square to the degrees of freedom and root mean square error of approximation (RMSEA) have been the commonly used basic indexes to evaluate the fitness of a SEM model. The model fit could be demonstrated if the ratio of the chi-square to the degrees of freedom is less than 2 (Ullman, 2006). RMSEA has been perceived as one of the most informative criteria in covariance structure modeling (Byrne, 2009, p. 84). RMESA values greater than 0.08 indicate reasonable errors of approximation in the population. Other commonly used fit indices include the Comparative Fit Index (CFI), Normed Fit Index (NFI) and Non-normed Fit Index (NNFI), with each index having 0.90 or greater value indicating a good fit ((Bentler and Bonett, 1980; Wen et al., 2004).

Step 5: model modification

Model modifications are usually motivated by mediocre overall fits of the initially specified model (Baumgartner, 2011). Two primary tools, modification indices (Lagrange multiplier tests) and residuals (the differences between the sample and implied covariance matrices), could be used for the purpose of model modification. In this study, modification indices for the CFA model were reviewed to detect which the parameters should be relieved or which relational link between two variables should be adjusted in order to improve the overall model fit.

Step 6: model interpretation

A comprehensive interpretation of the measurement model involves information about the estimated factor loadings and measurement error (unique) variances (including the variability of the estimates and *T*-values), evidence about measurement reliability (both for individual items and all indicators of a given construct combined), and some indication that the constructs in the model have discriminant validity.

Stepwise Regression

Stepwise regression is a method of multiple regression in which variables are entered into the model based on the semi-partial correlation with the outcome variable

(Stepwise Regression, 2006). In a stepwise regression, once a new variable is entered into the model, all variables in the model are assessed to see whether they should be removed. Stepwise regression produces a best-fit model through modifying forward selection to test the relevance of variables already in the model after each new predictor is added, and omitting predictors that no longer meet criteria for inclusion (Franke, 2010). In this study, stepwise regression was conducted to explore the contribution of different factors of collaboration to the achievement of individual performance measures for CJV projects.

5.5 Chapter Summary

This chapter presented the overall research framework and design for this study according to the research aim and five research objectives as defined in Chapter 1. Literature review, structured interviews and empirical questionnaire survey were used to collect sufficient and necessary data and information for achieving the stated research aim and objectives. The research tools used for data analysis included a series of non-parametric statistical tests (i.e. Kendall's concordance test, Spearman's rank correlation test, ANOVA test, etc), factor analysis, structural equation modelling, fuzzy synthetic evaluation and regression analysis.

CHAPTER 6 EMPIRICAL INVESTIGATION INTO THE MOTIVES, BENEFITS AND DIFFICULTIES OF CONSTRUCTION JOINT VENTURES

6.1 Introduction

The key research agendas in construction joint ventures (CJVs) are concerned with the motivations for the use of CJVs and the success criteria of CJV practices. Motives and benefits underpinning the application of CJVs, as identified by previous studies, involve technology transfer (Norwood and Mansfield, 1999; Kumaraswamy and Shrestha, 2002; Girmscheid and Brockmann, 2010), risk sharing/transfer (Norwood and Mansfield, 1999; Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010), stronger financial strengths (Kumaraswamy and Shrestha, 2002; Kazaz and Ulubeyli, 2009; Girmscheid and Brockmann, 2010), as well as the combination/pooling of general resources and specialist skills (Norwood and Mansfield, 1999; Munns et al., 2000; Kazaz and Ulubeyli, 2009). Other potential benefits such as bringing in outside expertise (Norwood and Mansfield, 1999) and opportunities for long-term profitable business development (Bellhouse, 1999) have also been referred to within the existing literature. Particularly, for developing construction markets such as in Mainland China, international construction joint ventures (ICJVs) could be adopted to improve local construction technology, raise project management skills, and promote the development of the local construction market (Editorial, 2001).

Perceptions concerning the critical success factors for CJVs in previous studies are synonymous to the extent that commitment, cooperation, management control, agreement of the JV contract, and partner selection have been commonly identified (Gale and Luo, 2004; Morledge and Adnan, 2006). Focusing on the formation stage of JVs, Gale and Luo (2004) investigated the key factors conducive to the success of JVs. Based on an extensive desktop literature review and semi-structured interviews, Morledge and Adnan (2006) examined the critical success factors for CJV projects in Malaysia and identified agreement of contract, commitment, and cooperation as the top three factors; these factors are followed by management control, inter-partner trust, and financial stability. Nine criteria specifically for the selection of JV partners were raised by Williams and Lilley (1993). In their study, strategic compatibility, complementary skills and resources, relative company size, financial capability, compatibility between operating policies, trust and commitment, compatible management teams, and mutual dependency and communications barriers should be considered to select the best-fit JV partners. Apart from communications, partner selection, and cooperation, Munns et al. (2000) also advocated cultural homogeneity as a critical factor to the success of CJVs. As seen from a comprehensive literature review, difficulties in achieving CJV success have resorted to various aspects, such as organisational cultural differences between CJV partners (Ozorhon et al., 2008a), lack of mutual trust and communications amongst contracting parties (Hung et al., 2002), and unfair gain and pain sharing (Norwood and Mansfield, 1999).

This chapter presents the research findings to achieve Objective 1 as derived in Chapter 1. The findings include the identified key benefits of CJV application, major difficulties hindering CJV success, and the results of a cross-comparison between different groups of respondents on their perceptions towards these benefits and difficulties.

6.2 Motives and benefits of CJV application

A desktop literature review was conducted to derive a list of identified motives and benefits of CJV application, together with the difficulties of CJV success. Table 6.1 depicts the perceived motives and benefits of CJV application as identified by previous literature.

Table 6.1 A summary of the perceived motives and benefits of CJV application in previous studies

No.	Motives and benefits of CJV application	Sonarajah (1992)	Kumaraswamy and Shrestha (2002)	Norwood and Mansfield (1999)	Munns et al. (2000)	Kazaz and Ulubeyli (2009)	McIntosh and McCabe (2003)	Garb (1988)	Dalle and Potts (1999)	Sridharan (1995)	Kwok et al. (2000)	Carrillo (1996)	**Total number of hits for each benefit**
1	Potential risk sharing/reduction			X	X	X	X	X	X	X	X	X	**9**
2	Pooling of general resources			X	X	X		X	X	X	X	X	**8**
3	Exchange/transfer of technology	X	X	X	X			X	X	X			**7**
4	Pooling of specialist skills/expertise			X	X	X		X	X			X	**6**
5	Stronger financial strengths		X			X				X			**3**
6	Entering into a new foreign market							X	X	X	X		**4**
7	Better communication relationships with clients		X		X								**2**
8	Increase in market share						X			X			**2**
9	Enhanced competitive position in market						X			X			**2**
10	Gaining reputation										X		**1**
11	Increase in the credibility of prequalification during tender stage			X									**1**
12	Increase in profits						X						**1**
13	Establishing long-term strategic business relationships						X						**1**
14	Maintaining an overseas presence									X			**1**
15	Meeting legal requirements of a particular country							X				X	**2**
	Total number of motives and benefits i dentified by each publication	**1**	**3**	**5**	**5**	**4**	**5**	**6**	**5**	**8**	**4**	**4**	**50**

6.2.1 Financial Benefits

Potential risk sharing/reduction

CJVs are perceived as the preferred viable project delivery approach for large-scale construction and infrastructure projects (Walker and Johannes, 2003), especially those with technical complexity. One of the predominant motives to form CJVs is to spread financial and technical risks (Norwood and Mansfield, 1999; Munns et al., 2000). In this regard, for each individual firm involved in the CJV partnership, the capital requirements for a large construction project is much less, whereas the capacity of taking on the risks during project construction is greatly enlarged. In the international construction context, political risks arising from undertaking projects in overseas construction markets could also be mitigated by engaging in a JV partnership with local construction firms. In the case when the contractor is unable or unwilling to exclusively bear the risks of a large or technically complicated project, risk reduction therefore makes JVs a more attractive option of project delivery for the contractors.

Strengthening the financial capability

The need for potential partner's assets or other financial complements has been noted as the major motivator to form JVs (Sridharan, 1995; Kumaraswamy and Shrestha, 2002; Kazaz and Ulubeyli, 2009). In a CJV relationship, each partner contributes assets to the extent that they are required to undertake the project.

Assembling of financial resources from JV partners secures sufficiency in financial capability, which is perceived as the premise of ensuring project construction progress. In the absence of strong financial support, construction progress may be delayed as a result of unguaranteed supply of necessary materials or workforce. In other cases where one of the venturers may not be capable of raising desirable financing to bid on a particular project (Garb, 1988, p. 78), teaming up with another partner with enough financial support would be a sound choice to assure the client of their qualification in the successful delivery of a desirable project. Thus, the strengthened financial capability through engagement in CJVs not only ensures the involved contractors' capability of successfully undertaking the construction project but also increases the confidence and preference of the client toward the contractors in delivering a desirable product.

Increasing profit returns

Essentially a business strategy, forming CJVs must be seen as one way of making profits. An explicable instance of profit increase could be the contractor's undertaking of a technically complex project, where sufficient technological support from multi-partners engaged in a CJV relationship is expected to improve working efficiency and save construction costs when compared with a single firm's efforts. An increase in profit is not always achieved with the first CJV project undertaken, rather in further opportunities to reach and provide services to a wider range of clients than the contractors would normally engage before entering CJVs (McIntosh and McCabe, 2003). In this regard, profit increase by engaging in CJVs is not limited to the short-term objective of the involved parties, but may also include the target gains from a long-term strategic perspective.

6.2.2 Organisational Benefits

Combination of resources, specialist skills and expertise

The technical requirements of a project may demand a combination of resources or expertise that may not be possessed by a single contractor (Chow, 1985, p. 7). Under the circumstances that a construction firm has an outstanding and recognised expertise in one or more areas of a complex construction project but needs another firm to complement its skills, working together in the form of CJVs provide the partnered organisations access to a broad market with combined business strength exceeding that of either partner alone (Garb, 1988, p. 77). From an output-based perspective, JV team functioning strength arising from the pooling of general resources and expertise greatly improves work efficiency and productivity, as well as contributes significantly to the achievement of project goals. Aside from JVs in the construction industry, the pooling of resources and expertise has been unanimously noted as a major benefit of JVs in other industrial sectors. In the broad context of international JVs (IJVs), Datta (1988) identified pooling organisational know-how to realise synergistic benefits as one major reason for JVs of multinational corporations.

Achieving technology exchange and transfer

For construction projects, technology transfer is defined as the planned conveyance and acquisition of technical knowledge and techniques from one party to another (Simkoko, 1989). CJVs are seen as a suitable vehicle to facilitate technology exchange and transfer; the rapid transfer of technology and the consequentially enhanced overall technology levels can catalyze a much faster development of the construction industry (Kumaraswamy and Shrestha, 2002). In the context of ICJVs, one of the primary reasons for local firms to form CJVs is to acquire technology (Sridharan, 1995). This condition would apply especially in countries with shortages in resources or expertise to develop technologies for themselves (Munns et al., 1999). Internal transfers of technology between domestic (local) organisations were also perceived as necessary, provided that they have distinctive strengths, weaknesses, and common objectives (Kumaraswamy and Shrestha, 2002).

6.2.3 Corporate Strategic Benefits

A conspicuous strategic benefit of CJVs to the involved partners is the improved competitive edge/competitiveness in the market. The synergic strengths with respect to technology, resources, and expertise enable CJV partners to compete with their counterparts during prequalification and gain a higher allocated market volume. The project client would also place greater concern on the JV-partnered tendering entity than a single contractor, considering the potential advantages of the CJV entity in some critical aspects such as finance and technology. The credibility of prequalification during tender may hence potentially increase when a CJV partnership is established. Better communication and relationships with clients is also asserted as one strategic benefit of CJVs (Kumaraswamy and Shrestha, 2002). Compared with a normal construction contract, in which a single contractor is involved, a CJV contract is perceived as capable of promoting the client's trust to the contractors as the CJV partnership itself requires the effective coordination and mutual monitoring among the JV partners.

Another strategic benefit of CJVs is the establishment of long-term strategic business relationships. A satisfactory CJV relationship provides great incentive for the involved partners to team up again in further projects if chances are available. Seeking further collaboration in other forms of partnership may also arise from the prior satisfactory experience of CJVs. Two participants with a longstanding relationship will presumably be able to reach an agreement quickly (Munns et al., 1999). The long-term and stable strategic relationship provides the partnered organisations with combined strengths in technology, finance, and expertise, which engenders a great opportunity for them to undertake more construction projects. Previous collaboration experience in CJVs can also nurture trust and enhance communication efficiency among the partners, thus improving the integrated working efficiency and save costs in communication and coordination.

Increasing market share is also highlighted as one benefit of CJVs from the strategic perspective. Merely considering CJV projects, such a project may be of a large scale and technically complex with considerable investment on it, which may potentially break the balance of the shares in the construction market between the involved partners and their competitors. With the new relationships established with both the partners and the clients through CJVs, the involved partners may be further invited to bid on and at times asked to negotiate for new work with the clients. This claim could be supported by the interview result presented in the study of Mclntosh and McCabe (2003). Another intangible benefit arising from the adoption of CJVs concerns the reputation gained within the industry through the project being undertaken. Public recognition of CJV partnered organisations could be promoted through the CJV projects successfully completed, provided that the project is either a local landmark or one that poses great technical challenges to the contractors. The enhanced industrial reputation, in return, not only benefits the partnered organisations in terms of market share but also sustains their long-term development in the industry.

6.2.4 International CJV specific benefits

Being able to participate in overseas projects was seen as a primary motive for forming ICJVs (Norwood and Mansfield, 1999). Entering a foreign market can be a cost-effective way for a contractor to enjoy tax and custom duty concessions (Kwok et al., 2000). Legal obstacles often hinder a contractor's progress in overseas construction markets (Norwood and Mansfield, 1999). In some cases, combining with a local co-venturer may be the only way for a foreign construction firm to prequalify for a particular tender (Garb, 1988, p. 77).

Meeting governmental requirements was also identified in the report of the Badger et al. (1993, p. 3-3) as one major motivating factor for forming ICJVs. Out of the three main reasons for forming IJVs proposed by Killing (1983), host government legislation is perceived as the fundamental concern for the entry into a JV partnership. For instance, construction and building regulation in Mainland China requires that a domestic construction corporation be a partner in any construction contract in which a foreign construction firm desires to participate. The plausible rationale for setting similar requirements by the local government may lie in the government's attempt to attract foreign construction firms to tap into the local construction market and motivate them to impart superior technology and expertise to local construction firms (Garb, 1988, p. 79).

In the context of the global economy, the expansion of the business scope to the international construction market is an important step for a construction firm to sustain corporate development. Particularly when profit margins or the project volume in the local construction market is low, maintaining an overseas presence in the form of ICJVs is strategically necessary for a contractor to seek sustained survival and development. The increase in market diversification through engaging into ICJVs strengthens the partnered organisations' capabilities of swiftly adapting to market changes.

6.2.5 Interview findings on the motives and benefits of CJV application in Hong Kong

A series of semi-structured face-to-face interviews were launched with both construction academics and industrial practitioners in Hong Kong to solicit their perceptions towards the motives and practical benefits of CJV application. Among the six interviewees, three are prominent academics with demonstrated research experience in CJVs, whereas the remaining three are senior professional practitioners with abundant hands-on experience in JV practices. Table 6.2 provides the background of the interviewees.

Table 6.2 Background of interviewees for understanding the benefits and difficulties of CJV application

Interviewee	Nature of profession	Years of working experience	Number of publications on CJVs	Number of CJV projects involved
Interviewee 1	Academia	27	0	2

Table 6.2 (continued)

Interviewee 2	Academia	25	2	0
Interviewee 3	Industry	10	0	2
Interviewee 4	Academia	29	5	0
Interviewee 5	Industry and Academia	24	0	2
Interviewee 6	Industry	7	0	3

The underlying context of the interview questions is related to CJVs in general, without specifying either domestic or ICJVs. The perceived reasons for forming CJVs fall exclusively under the broad scope of motives or benefits of CJV application identified in existing literature. Among all the motives or benefits identified, resource integration, risk sharing, and technology exchange and transfer were unanimously observed by all interviewees. Over half of the interviewees perceived improving the credibility of prequalification and responding to project technical requirements as two common motives of forming CJVs. Pooling of expertise was also agreed upon as a major benefit of CJV application.

Specifically, Interviewee 1 raised two other potential advantages of the use of CJVs: better communication relationships with clients and improving market expansion capability. The latter concerns the increase in market diversity and market share achieved through the application of CJVs. Interviewee 1 explained that before the formal issue of a CJV contract, the client normally has sufficient communication with the CJV partners to be convinced of their capability in successfully delivering the intended project. Interviewee 2 advocated cultural connection and mutual learning among CJV partners as a beneficial aspect of CJV application. Among the interviewees, two considered the establishment of long-term strategic relationships with partners as a strategic benefit of CJVs for the partnered organisations. Overall, the motive and benefits of forming CJVs perceived by the interviewees touch on the short term and long term, within and between organisational perspectives. Table 6.3 presents a summary of the interview findings on the perceived motives and benefits of CJV application.

Table 6.3 A summary of interview findings on the perceived motives and benefits of CJV application

No.	Perceived motives and benefits of CJV application	R1	R2	R3	R4	R5	R6
1	Integration of resource uses	X	X	X	X	X	X
2	Risk sharing	X	X	X	X	X	X
3	Technology exchange/transfer	X	X	X	X	X	X
4	Better communication relationships with clients	X					
5	Expanding market scope and diversity	X					
6	Responding to project requirements	X	X		X		
7	Establishment of long-term business relationships		X	X			
8	Improving the credibility of prequalification during tender stage		X	X	X	X	
9	Culture connection and integration		X				
10	Pooling of financial resources				X		X
11	Pooling of expertise				X	X	X

Note: ‘R’ denotes ‘Respondent’ of the interview.

6.2.6 Questionnaire survey on the motives and benefits of CJV application in Hong Kong

Drawing upon a comprehensive review of existing literature on JVs in the construction industry and the findings from the semi-structured interviews, a list of 15 key motives and benefits of forming CJVs was derived for a questionnaire survey.

A pilot survey questionnaire was reviewed by six selected experts before proceeding with the industry-wide empirical survey in Hong Kong. Among the six experts, three are prominent academics with demonstrated research experience in CJVs and have served as advisory consultants for JV construction projects, whereas the remaining three are senior industrial practitioners with abundant hands-on experience in JV practices. Before the review of the pilot questionnaire, semi-structured interviews were launched to acquire an entire understanding of JV issues, including the motives and difficulties of CJV application, difficulties of CJV success, features of collaboration in CJVs and importance of each KPI to measure CJV project performance. Given that no a dverse comments or suggested changes were received from the expert interviewees, the pilot survey questionnaire with the five sections was taken as the final empirical questionnaire for data collection in Hong Kong.

A structured survey predominantly targeting JV main contractors was administrated between December 2012 and February 2013 in Hong Kong. A five-point Likert scale (1 = strongly disagree, 3 = neutral or no strong view, and 5 = strongly agree) was adopted to rate the level of agreement on the identified motives and benefits of CJV application. This rating was based on recently completed or nearly completed JV construction projects in which the respondents have been involved. Sampling of the CJV context-specific survey needs cautious and rigorous determination to ensure all survey respondents were equipped with JV project experience. JV project-based distribution and industrial snowball sampling methods were both adopted in the survey sampling. Prerequisite was set in the snowball sampling process such that the potential respondents should have been involved in JV construction projects before. In the JV project-based survey, if the JV project is approaching completion, then all existing JV project team members (at the project management level) were identified as valid respondents. Otherwise, only those with previous experience of other JV project(s) were perceived as valid respondents.

Descriptive Statistics

A total of 115 completed questionnaires were returned. Given the adopted sampling approaches, the response rate is not reportable. Scrutiny into the returned questionnaires discovered that 107 completed questionnaires were deemed "valid" for further analysis. Among the respondents, 18.69% were project managers (N = 20, including senior and assistant project managers), 10.28% were contracts managers (N

= 11), 47.66% were engineers (N = 51), 16.82% were quantity surveyors (N = 18, including senior and assistant quantity surveyors), whereas the remaining 6.54% were attributed to other types of professional affiliations (N = 7) such as site sub-agents, labor officers, and safety officers. The survey respondents covered all project management members directly involved in the daily affairs of JV contracting relationships and were thus perceived as appropriate, representative and valid for data analysis.

Considering the purposive sampling approach adopted, all of the respondents have participated in one or more CJV projects and thus possessed direct hands-on experience in CJV projects with various levels of involvement in terms of the numbers of CJV projects (see Figure 6.1). Among the respondents, 81.3% (N = 87) have been involved in 1 to 3 CJV projects, 13.1% (N = 14) participated in 4 to 6 CJV projects, and 5.6 % (N = 6) had accumulated rich experience in CJV projects (10 or more).

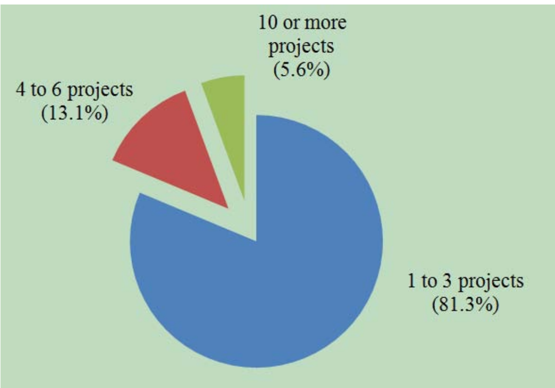

Figure 6.1 Hands-on experience of survey respondents with CJV projects (N = 107)

Methods of Data Analysis

Mean Score Ranking Technique

The respondents were divided into three main groups based on their working levels within the JV project team, being senior management group, project management group and technical/site group. Mean score was calculated to determine the relative rankings of different benefits by comparing the individual mean score for each benefit in descending order. The rankings of different motives and benefits allow cross-comparison among the three main groups of respondents. Mean score was computed by the following formula:

$$MS = \frac{\Sigma(f \times s)}{N}, \ (1 \leqslant \mathrm{MS} \leqslant 5)$$

where s = rating score of each motive/benefit

f = frequency of rating score for each motive/benefit

N = total number of responses for individual motive/benefit

Kendall's Concordance Analysis

Kendall's concordance analysis was conducted to measure the agreement of respondents within a certain group on their rankings. A reasonable degree of consensus was demonstrated if the Kendall's coefficient of concordance (W) was significant at the level of 0.05 (Chan et al. 2003).

The Kendall's coefficient of concordance (W) for the motives and benefits of CJV application was calculated by the following formula (Siegel and Castellan 1988):

$$W = \frac{\sum_{i=1}^{n}(\overline{R}_i - \overline{R})^2}{n(n^2-1)/12}$$

Where n = number of motives and benefits rated

$\overline{R_i}$ = average of rankings assigned to the ith motive/benefit

$\overline{R}$ = average of rankings assigned across all motives/benefits

The application of W has been limited as only suitable when the number of attributes to be rated is less than or equal to 7 (Siegel and Castellan 1988). If the number of attributes is greater than 7, chi-square is used as a n ear approximation instead. Statistically, if the actual computed chi-square value equals to or exceeds the critical value derived from the table for a certain level of significance and a particular value of degrees of freedom, then the null hypothesis that the respondents' sets of rankings are unrelated (independent) to each other within a survey group can be rejected. The actual calculated chi-square value with (N-1) degrees of freedom is defined as follows.

$$\Psi^2 = k(N\text{-}1)W$$

where

k is the number of respondents ranking the motives/benefits

N is the number of motives/benefits being ranked

Spearman's Rank Correlation Test

The Spearman rank correlation coefficient (r_s) for the motives and benefits was calculated by the following formula (SPSS, 2002):

$$r_s = 1 - \frac{6\sum d^2}{N(N^2 - 1)}$$

Where d = the difference in ranking of two parties

N = total number of responses for individual motives/benefits

One-way ANOVA test

One-way analysis of variance (ANOVA) for multiple samples was conducted to test if there exist any divergences between the three respondent groups on their perceptions towards the importance of a specific benefit of CJV application as reflected by the mean values of their ratings.

If the F statistics was significant at a predetermined level of 0.05, then the null hypothesis that no significant differences in the mean values between the respondents groups can be rejected, implying that the mean values of the importance of a specific benefit of CJV application between the respondent groups are significantly different from each other at the probability value $p = 0.05$ (Norusis, 2006, p. 314).

Exploratory Factor Analysis (EFA)

EFA is a multivariate statistical technique to reduce a number of variables into underlying constructs (Hair et al. 2010, p. 94), which can be used to represent relationships among sets of interrelated variables (Norusis, 1993, p. 47). In this study, EFA was used to identify the underlying clusters of motives and benefits of applying CJVs by reducing the 15 individual items into a small number of underlying grouped factors.

Principal component analysis (PCA) was used to derive the underlying factors for the motives and benefits of CJV application because of its simplicity of interpretation. Two factor rotation methods, oblique rotation and orthogonal rotation, are used to rotate factors for achieving a simpler and theoretically more meaningful factor pattern. The orthogonal rotation (e.g. varimax, equamax, quartimax) is used under the assumption that factors are independent of each other while the oblique rotation method (e.g. promax, oblimin, quartimin) allows the factors to correlate with each other (Henson and Roberts 2006). In fact, assuming the various motives/benefits of CJV application as independent of each other is unrealistic. Hence, the oblique rotation method is perceived as appropriate in this study for obtaining theoretically meaningful factors (Hair et al. 2010, p. 116).

Analysis and Discussion of Survey Results

The Cronbach's alpha coefficient for the rated motives and benefits of CJV application is 0.852 (F statistics = 11.331, p = 0.000), which is much higher than the threshold value of 0.70 according to Hair et al. (2010, p. 125). Thus, the reliability and internal consistency of the scale utilised to measure the perceived motives and benefits of CJV application were demonstrated at a 5% significance level. The means of the motives/benefits for each of the three respondent groups were calculated and ranked in descending order of level of agreement, which are shown in Table 6.4.

Table 6.4 Ranking, Kendall's coefficient of concordance and one-way ANOVA results for the perceived motives and benefits of applying CJVs

ID	Motives and benefits of applying CJVs	All respondent group		Senior management group		Project management group		Technical / site group		ANOVA result	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	F	Sig.
7	Increasing credibility of pre-qualification during tender.	4.02	1	4.00	5	4.03	1	4.00	1	0.026	0.974
1	Spreading / Sharing financial risk.	3.90	2	4.17	2	3.84	2	3.89	2	0.613	0.544
6	Improving competitive edge / competitiveness in market.	3.80	3	3.83	8	3.81	4	3.78	3	0.021	0.979
11	Increasing market share.	3.77	4	3.75	10	3.84	2	3.67	5	0.484	0.618
4	Strengthening the financial capability.	3.74	5	4.25	1	3.72	5	3.58	6	2.633	0.077
3	Pooling of skills and knowledge.	3.64	6	4.08	3	3.66	6	3.47	10	1.761	0.177
10	Establishing long-term strategic business relationships.	3.60	7	3.67	12	3.60	8	3.58	6	0.041	0.960
2	Pooling of resources.	3.59	8	4.00	5	3.62	7	3.42	12	1.616	0.204
13	Entering into a new foreign market.	3.59	8	4.08	3	3.52	10	3.56	8	2.098	0.128
15	Maintaining an overseas presence / Increasing market diversification.	3.59	8	3.92	7	3.57	9	3.53	9	1.279	0.283
14	Meeting legal requirements of a particular country.	3.51	11	3.83	8	3.47	12	3.47	10	0.902	0.409

Table 6.4 (continued)

12	Gaining reputation within the construction industry.	3.47	12	3.17	15	3.38	13	3.72	4	2.538	0.084
9	Achieving technology transfer.	3.46	13	3.75	10	3.50	11	3.31	13	1.169	0.315
8	Improving communication relationships with clients.	3.13	14	3.33	13	3.10	14	3.11	15	0.347	0.708
5	Increasing profit returns.	3.11	15	3.33	13	3.05	15	3.14	14	0.532	0.589
	Number of survey responses	106		12		58		36			
	Kendall's coefficient of concordance (*W*)	0.099		0.157		0.108		0.115			
	Actual calculated chi-square value	147.249		26.384		88.096		57.925			
	Critical value of chi-square from table	23.69		23.69		23.69		23.69			
	Degree of freedom (*df*)	14		14		14		14			
	Asymptotic level of significance	0.000		0.023		0.000		0.000			

For Kendall's coefficient concordance (W), H_0 = respondents' sets of rankings are unrelated (independent) to each other within each group.

Reject H_0 if the actual chi-square value is larger than the critical value of chi-square from table.

For one-way ANOVA test, H_0 = there is no significant differences on respondents' perceptions amongst the three groups.

Reject H_0 if actual F value is larger than the critical value of F statistics from table.

Overall ranking of the motives/benefits of applying CJVs

On the basis of the statistical result, the mean value of each motive/benefit of CJV application was exclusively above 3.0. This observation implies that the respondents generally agreed with each of the benefits reaped through the application of CJVs, although with different levels of agreement. From the range of means for the motives and benefits among the three different respondent groups, no significant difference was observed on the ratings of agreement with the motives and benefits identified. This result indicates that the relative importance of the identified motives/benefits of CJV application is generally consistent with the participants involved in a CJV relationship.

The top three benefits of applying CJVs as perceived by all respondents included "*increasing the credibility of pre-qualification during tender*" (mean = 4.02), "*spreading/sharing financial risk*" (mean = 3.90), and "*improving competitive edge/competitiveness in the market*" (mean = 3.80). This research finding supports the assertion of Kazaz and Ulubeyli (2009) that the formation of JVs by construction firms aims to enhance their competitive power and productivity, as well as share project risks with JV partners. The top three rated motives and benefits for applying CJVs were almost consistent with the research findings of Mclntosh and McCabe (2003) that the three highest ranked motives and benefits for forming ICJVs are to improve competitive positions, enter new markets, and share risks and/or profits. The only difference in the motive/benefit of "*enter new markets*" arises from the context (i.e. international or domestic) of forming CJVs, as ICJVs exclusively target overseas construction markets. Although "*improving communication relationships with clients*" (mean = 3.13) and "*increasing profit returns*" (mean = 3.11) were rated the lowest among the 15 motives/benefits, the mean values were all above the median value of 3.00. This result somewhat reveals that JV partners are more inclined to strategic benefits (e.g. improving competiveness, long-term business relationship, and technology transfer) than the increase in financial returns when forming CJVs.

Agreement of respondents within each survey group

Assessment of the perceived motives/benefits of applying CJVs was made from different perspectives of the three respondent groups. From the result of Kendall's concordance analysis, the values of Kendall's coefficient of concordance (W) for the ranking of motives/benefits were 0.099, 0.157, 0.108, and 0.115 respectively as shown in Table 6.4, all of which were statistically significant at the level of 0.05.

In this study, the chi-square value was adopted instead of the W value because the number of attributes considered exceeds seven according to Siegel and Castellan (1988). On the basis of the degree of freedom (15 − 1 = 14) and the allowable level of significance (5%), the critical value of chi-square from the table was found to be 23.69. The actual computed chi-square values for all four groups (147.249 for all respondent groups, 26.384 for the senior management group, 88.096 for the project management group, and 57.925 for the technical/site working group) were all above the critical chi-square value of 23.69. The statistical result indicates the null hypothesis that "the respondents' sets of rankings are unrelated (independent) with each other within a particular group" should be rejected. A demonstrated reasonable degree of consensus on the rankings of the motives/benefits of CJV application was thus achieved among the respondents within each survey group.

Agreement of respondents between any two survey groups

Following the verification of the internal consistency of the rankings within all respondent groups and each of the three different respondent groups, the agreement on the ranking exercise between the two different respondent groups was tested by Spearman's rank correlation. Table 6.5 shows the test results of Spearman's rank correlation coefficients (r_s) and the corresponding significance levels. For the rankings of the motives/benefits between the senior management and project management group respondents (p = 0.013) and the rankings between the project management and technical/site working group respondents (p = 0.002), the null hypothesis that no significant correlation existed in the two pairs of respondent groups has to be rejected. Hence, adequate evidence concludes that significant correlations on the rankings of the motives/benefits in the two pairs of respondent groups exist.

As shown in Table 6.5, the correlation coefficient of the rankings between the senior management group and technical/site working group was 0.298 with a significance level of 0.280, which implies that inadequate evidence cannot conclude that no significant correlation exists between the two groups of respondents. Such finding reflects the apparent different perspectives on the motives/benefits of CJV application between the senior management and technical/site working group respondents. Noticeably, the two groups of respondents rated fairly differently on item 12, "*gaining reputation within the construction industry.*" The senior management group perceived it with the lowest ranking among all the motives and benefits of applying CJVs, whereas the technical/site working group rated it as 4th out of the 15 identified motives and benefits. This disparate perception may be due to senior management personnel placing greater concerns over other approaches for promoting corporate fame (e.g. publicizing and market share increase). The technical/site working staff have limited insights into these sources from the management perspective and probably perceive the undertaking of large-scale and technically complicated projects through the formation of JV relationship as a major source for accumulating corporate reputation.

Similarly, the perceived differences between the senior management and technical/site working group respondents on the ranking of item 2, "*pooling of skills and knowledge*" (3th and 10th for the senior management group and technical/site working group, respectively), and item 3, "*pooling of resources*" (5th and 12th for the senior management group and technical/site working group, respectively), may be explained by the discrepancies of respondents' roles. The senior management staff values the combined uses of JV partners' expertise and resources more than the technical/site working staff. As frontline supervisors, the technical/site working personnel may have encountered some real difficulties or conflicts during the process of mixture and exchange of skills, knowledge, and resources from each JV party, which may lessen their values on items 2 and 3. The senior management group may not clearly see these potential difficulties or conflicts, leading to higher rankings on the two items of motives and benefits.

Table 6.5 Spearman's rank correlation test between groups of survey respondents on the perceived motives and benefits of applying CJVs

Comparison of rankings between groups of survey respondents	r_s	Significance level	Conclusion
Senior management group vs Project management group	0.622	0.013[a]	Reject H_0 at 5% significance level
Senior management group vs Technical/site group	0.298	0.280	Cannot reject H_0 at 5% significance level
Project management group vs Technical/site group	0.731	0.002	Reject H_0 at 1% significance level

H_0 = no significant correlation on the rankings between any two groups.

H_a = significant correlation on the rankings between any two groups.

Reject H_0 if the actual significance level (p-value) is less than the critical value of 5%.

[a] significant correlation at 5% significance level.

One-way ANOVA test was performed to identify any significant differences in the mean values of the responses among the senior management, project management, and technical/site working groups on the specific motives/benefits of applying CJVs. Despite the different perceptions on the ranking exercise between the senior management and technical/site working groups, the result of the one-way ANOVA test indicates that no statistical difference exists among all three groups of respondents at the 5% significance level on their perceptions of each motive/benefit as measured by the mean values. Table 6.4 shows that the lowest calculated p-value for all motives/benefits is 0.077, which is larger than 0.05. The test result supports that the three respondent groups reached a consensus on the level of agreement on each of the 15 perceived motives/benefits of CJV application as measured by the mean values.

6.2.7 Interpretation of the underlying grouped factors of the motives and benefits of CJV application

As the most commonly used oblique rotation method (Biber, 2009), the promax rotation method, which has been extensively utilised in a multitude of prior research studies in construction (Lam et al., 2008; Chan and Lee, 2009; Kärnä et al., 2009; Choi et al., 2011), was adopted in this study.

The appropriateness of applying EFA was evaluated by the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. The KMO value of the factor model was 0.820, which was higher than the threshold value of 0.50 for proceeding with EFA (Hair et al., 2010, p. 104) and indicates a "good" degree of common variance according to Field (2005, p. 640). Bartlett's test of sphericity produced an approximation of chi-square value = 512.564 (df = 105, p-value < 0.000), which implies that the population correlation matrix was not an identity matrix. Thus, the correlations between the variables were sufficiently large to conduct PCA. The Cronbach's alpha reliability coefficient was also employed to check the internal consistency (reliability) of the ratings on the motives/benefits for applying CJVs. The overall output alpha value for the motives/benefits was 0.852, which was larger than 0.70 as a rule-of-thumb for evidencing the reliability of the measurement scale (Hair et al. 2010, p. 125). Thus, a high degree of internal consistency (reliability) exists with respect to the correlations among the 15 motives/benefits, and the adopted measurement scale for these benefits/motives is reliable. Overall, the factor analysis approach was justified as appropriate for analyzing the survey data with confidence and reliability.

Four components with eigenvalues exceeding 1.0 were extracted by using PCA. The four components altogether explained a total variance of 60.411% in responses, which just meets the minimum requirement of 60% as advocated by

Malhotra (1996), with components 1 to 4 accounting for 33.160%, 11.464%, 8.101%, and 7.685% of the variance, respectively. The figure of the scree plot (Figure 6.2) confirms the sufficiency of the four-factor model for classifying the motives/benefits of applying CJVs. The factor structure for the 15 m otives and benefits of CJV application is presented in Table 6.6. The factor loading cut-off was fixed at 0.4, which has also been adopted by Hon et al. (2013). As the factor loadings of the individual motives/benefits on the four factors were all greater than 0.45, no item was removed. The factor correlations between F1 and F3, F2 and F3, and F3 and F4 were all above 0.32 as shown in Table 6.7, justifying the selection of promax rotation approach instead of the orthogonal rotation approach according to Tabachnick and Fidell (2007, p. 638).

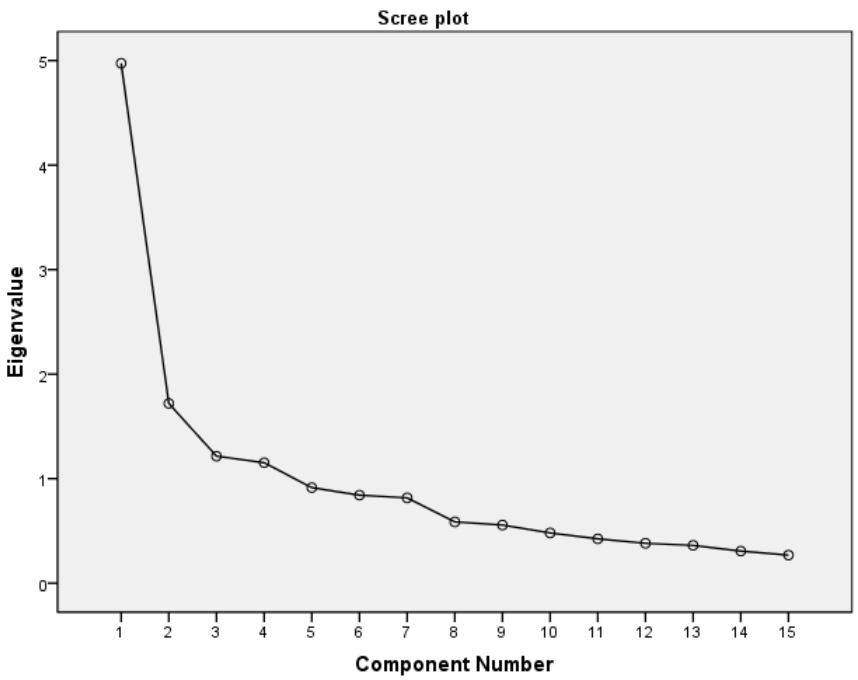

Figure 6.2 Scree plot of factor analysis for the motives/benefits of applying CJVs

Table 6.6 Factor structure of principal factor extraction and promax rotation on the 15 motives and benefits of CJV application

Motives and benefits of CJV application	Factor loading	Eigenvalue	Percentage of variance explained	Cumulative percentage of variance explained
Factor 1. Risk sharing and resource integration		4.974	33.160	33.160
1 Spreading / Sharing financial risk.	0.819			
4 Strengthening the financial capability	0.767			
2 Pooling of resources.	0.566			
Factor 2. Improvement of JV partners' competency and market strength		1.720	11.464	44.624
11 Increasing market share	0.820			
12 Gaining reputation within the construction industry	0.679			
7 Increasing credibility of pre-qualification during tender	0.554			
6 Improving competitive edge / competitiveness in market	0.489			
10 Establishing long-term strategic business relationships	0.478			
Factor 3. Technology transfer and profit gains		1.215	8.101	52.725
3 Pooling of skills and knowledge	0.770			
9 Achieving technology transfer	0.679			
5 Increasing profit returns	0.670			
8 Improving communication relationships with clients	0.563			
Factor 4. Access to the international market		1.153	7.685	60.411
15 Maintaining an overseas presence / Increasing market diversification	0.813			
13 Entering into a new foreign market	0.805			
14 Meeting legal requirements of a particular country	0.717			

Table 6.7 Factor correlation matrix of the motives/benefits of applying CJVs

Underlying grouped factors	F1	F2	F3	F4
F1: Risk sharing and resource integration	1.000	0.211	0.384	0.222
F2: Improvement of JV partners' competency and market strength	0.211	1.000	0.388	0.380
F3: Technology transfer and profit gains	0.384	0.388	1.000	0.337
F4: Access to the international market	0.222	0.380	0.337	1.000

An identifiable, collective label was assigned to the groups of individual factors highly correlated with each other to facilitate the explanation of the results of factor analysis, as each of the underlying grouped factors is inferred from a cluster of correlating variables (Sato 2010). Notably, the suggested labels adopted in the present study are employed only for the meaningful interpretation of the EFA results and distinguish them from those produced by other researchers.

- *Factor 1*: *Risk sharing and resource integration*

Factor 1 consists of three items (i.e. items 1, 2 and 4) associated with sharing of risks and resources. Items 1 and 4 are related to the sharing of financial risk and strength, whereas item 2 is concerned with the integration of resources through the application of CJVs.

- *Factor 2: Improvement of JV partners' competency and market strength*

This factor is composed of five variables that focus on the improvement of the JV partners' overall competency and market strength. Items 6 and 7 describe the overall competitiveness of JV companies, whereas items 11, 12 and 10 are related to the increase in JV companies' market strength in terms of market share, public reputation, and strategic relationships.

- *Factor 3: Technology transfer and profit gains*

Factor 3 is composed of four items mainly related to technology transfer and profit gains. Items 3 and 9 are associated with expertise integration and technology transfer. Items 5 and 8 describe the project-based benefits in terms of increase in profit returns and improvement of relationships with the clients. Although item 8 does not directly describe the profit gains through the application of CJVs, its effect towards the increase of profit gains could be achieved through enhanced working efficiency and reduced claims from the clients as a result of the improved communication relationships.

- *Factor 4: Access to the international market*

Factor 4 comprises three items concerning access to the international construction market. This factor is exclusively applicable to JV partners with headquarters in different countries. Conducting business in a new international market and increasing market diversification, which aims to broaden JV partners' market base and sustain prolonged business, could be viewed as the strategic benefits to the JV partners through forming CJVs. Meeting legal requirements of a particular country is more related to the need of forming CJVs to undertake international projects.

6.3 Difficulties in achieving CJV success

Difficulties of CJV success are concerned with, but not limited to, factors responsible for the failure of CJVs, some potential risks inherent with CJV application, and the barriers to CJV formation. Table 6.8 shows the potential difficulties of CJV success summarised from the previous studies.

Table 6.8 A summary of the potential difficulties of CJV success in previous studies

No.	Difficulties of CJV success	Mansfield and Sasillo (1990)	Munns et al. (2000)	Norwood and Mansfield (1999)	Hung et al. (2002)	Dalle and Potts (1999)	Walker and Johannes (2003)	Zhang and Zou (2007)	McIntosh and McCabe (2003)	Sridharan (1995)	Carrillo (1996)	**Total number of hits for each difficulty**
1	Incompatible organisational cultures among JV contracting parties			X	X	X	X	X	X	X		**7**
2	Lack of mutual trust among JV contracting parties		X		X	X	X	X				**5**
3	Lack of communications among JV contracting parties		X		X			X	X			**4**
4	Differences in organisational policies among JV contracting parties				X		X					**2**
5	Inconsistent management styles among JV contracting parties				X					X		**2**
6	Lack of entire management control over JV partners			X		X					X	**3**
7	Inconsistent project objectives among JV team members				X					X	X	**3**
8	Lack of mutual understanding among JV team members						X					**1**
9	Lack of knowledge about fundamental JV contracting method	X										**1**
10	Organisational inflexibility				X							**1**
11	Unfair gain-share/pain-share among JV contracting parties	X							X			**2**
12	Lack of mutually agreed conflict resolution mechanism			X								**1**
13	Lack of strategic planning for JV operation				X							**1**
14	Difficulties with JV financial administration			X								**1**
15	Lack of top management support for creating right working atmosphere throughout the JV contracting process			X								**1**
16	Conflict in distribution and execution of authority						X	X			X	**3**
17	Conflict of interest between the parties outside the JV agreement					X		X	X		X	**4**
	Total number of difficulties identified by each publication	**2**	**2**	**5**	**8**	**4**	**5**	**5**	**4**	**3**	**4**	**42**

6.3.1 Lack of fundamentals of JV collaboration

Lack of knowledge about JV contracting method

Lack of knowledge about JV fundamental issues has been identified as one of the major difficulties resulting in the failure of a CJV relationship (Mansfield and

Sasillo, 1990). Sometimes, merely out of the intention of participating in a construction project, the CJV parties may not understand well how CJVs should be operated in a desirable manner. A dearth of basic knowledge of the essential elements of and necessary actions for the operation of CJVs hinders the achievement of success in a CJV relationship.

Lack of mutual understanding among JV team members

In the integrated JV, an efficient working environment is underpinned by mutual understanding among JV team members. Issues of mutual understanding may concern the sufficient recognition of the partner's team culture, working style, area of expertise, etc. Significant problems may arise when one JV partner does not understand the historical pressures (culture) influencing their partners (Walker and Johannes, 2003). A lack of mutual understanding among CJV partners thus lowers the working efficiency of the JV teams and poses a potential threat to CJV success.

Lack of mutual trust among JV contracting parties

Lack of mutual trust among JV contracting parties has been identified as one of the critical difficulties that may hinder the performance of CJVs (Dalle and Potts, 1999; Munns et al., 2000; Hung et al., 2002). In well-functioning business relationships containing CJVs, trust and commitment of parties is of crucial importance, where commitment is the physical and mental manifestation of the concept of trust (Walker and Johannes, 2003). A variety of benefits, such as facilitating the alignment of partner interests (Atkinson et al., 2006), enhancing stakeholder satisfactions (Bresnen and Marshall, 2000) and increasing further business opportunities arising from the joint work (Maurer, 2010), can be reaped through mutual trust between project partners.

Lack of communications among JV contracting parties

Intensity of communications among JV contracting parties has been demonstrated as positively related to the overall satisfaction with project-based JVs (Hung et al., 2002). The lack of communications between partners has also been perceived as the most important factor that could undermine the effectiveness of a JV (Munns et al., 2000). Only through frequent communications can necessary adjustments of CJV team functioning strategies be made via negotiation. The strategic adjustments are expected to serve for the changing demands for the venture and address managing problems arising in the operation of a CJV project.

6.3.2 Conflicts among JV partners

Conflicts of interest between the parties outside the JV agreement

Beyond the CJV relationship formed in a specific project, the parent firm engaged in the CJVs is very likely the competitor of another parent firm in the construction market. The integrated CJV team may not be fully independent of the partners' parent organisations, under which circumstances the parent firms' strategy of conducting their overall construction businesses may pose negative influences to the smooth operation of the JV formed in a specific project. The conflicts between the parent firms outside the JV agreement have been perceived as one of the profound problems that can bring great risk to the success of a CJV (Dalle and Potts, 1999).

Inconsistent project objectives among JV team members

In a JV relationship, goal incongruence causes severe conflicts between JV partners, which in turn results in the failure of JVs (Simiar, 1982). In the context of CJVs, incongruity in project objectives among CJV team members may derive from the disparity in the primary benefits expected by the parent firms. Although mutually agreed objectives are stated in the JV agreement, the process of CJV operation may still be fraught with the partners' deviations from the original agreement for the benefit of achieving their individual objectives, resulting in conflicts between CJV partners.

Lack of a mutually agreed conflict resolution mechanism among JV contracting parties

In view of the potential differences between CJV partners in many aspects (e.g. organisational culture, policy, and management style), the occurrence of conflicts may be inevitable during the operation of CJVs. A lack of a mutually agreed conflict resolution mechanism would retard, if not suspend, the proper operation of CJVs, thus leading to a dissatisfied or ultimately unsuccessful CJV relationship. A summary procedure for permitting the work in CJVs to continue is necessary when the co-venturers are unable to reach an agreement during the operation of CJVs (Garb, 1988, p. 94). Preferably, a sound conflict resolution mechanism would entail a formal procedure of negotiation and problem resolution within the partners, rather than directly resorting to arbitration or mediation.

Unfair gain-share/pain-share among JV contracting parties

Unfair risk allocation and profit distribution contributes significantly to the failure of CJVs in the sense that one party must bear unequally allocated risks while sharing unmatched benefits. This scenario could explicitly result in the dissatisfaction of the party with the CJV relationship. Sharing of gains and pains arising in the CJV project should thus be based on the partner's obligations and contributions.

Conflicts in distribution and execution of authority

Within a CJV relationship, conflicts between the partners may arise when the distribution and execution of authority is perceived as asymmetric to the joint and several shared liabilities. Adequate delegation of authority to the on-site CJV team was identified as one of the features critical to the operational success of CJVs (Garb, 1988, p. 90). Specifically, when the CJV parties hold the JV interests in more or less equal shares, the means of assigning each party with a certain level of representation and influence in the operational management of CJVs can potentially generate vigorous dissent among the parties (Chow, 1985, p. 11). Without a mutually agreed allocation and sharing scheme of authority, the commitment of JV partners may be impaired as a result of friction in resource arrangement and allocation, as well as expertise/skills contributions.

6.3.3 JV management difficulties

Inflexibility of JV organisational operations

Preservation of flexibility in JV operation is necessary to vary technical leadership and direction and accommodate the changing needs of special expertise required in projects (Garb, 1988, p. 94). Rigid partnered organisational structures that fail to accommodate midterm adjustments in project implementation as a result of their low responsiveness to the changing environment tend to lead to JV partner dissatisfaction (Hung et al., 2002). Flexible JV organisational operations enable the swift changes or actions taken to address any emergent yet unexpected needs or problems and ultimately contribute to the enhanced working efficiency of the CJV team.

Difficulties with JV financial administration

Difficulty with JV financial administration was identified as one of the disadvantages of CJVs that may engender constraints to the achievement of CJV success (Norwood and Mansfield, 1999). Thus, a solid financial administrative mechanism with functions of partners' mutual inspection and providing open and clear records of CJV partners' financial inputs and gains is necessary to avoid any obscurity in financial matters concerned with the CJV team. CJV partners should implement a clear internal financial reporting system that would inform each co-venturer the costs incurred as compared with the operating plan to alleviate the problems encountered in financial administration (Garb 1988, p. 94).

Lack of top management support for creating a proper working atmosphere throughout the JV contracting process

Friction built up within the CJV internal management, which could also be perceived as a lack of top management support, leads to an inability to create the right working philosophy throughout the CJV operation process (Norwood and Mansfield, 1999). Similar to partnering projects in which success requires the support of top management (Slater, 1998; Chan et al., 2004), the success of a CJV project relies heavily on senior management commitment to create a fully supportive working atmosphere throughout the CJV contracting process.

Lack of entire management control over JV partners

In the situation where a single party dominates a JV agreement, either by its proportion of control over the venture or its asset size, a greater risk of the venture failing or one party taking over control of the entity exists (Munns et al., 2000). A lack of total control on the JVs, both in its administration and with regard to financial matters, tends to be a disadvantage that results in the failure of CJVs (Norwood and Mansfield, 1999). Likewise, of the major problems that may improve the possibility of CJV failure, the lack of a strong and effective leadership should be well noted in CJVs (Dalle and Potts, 1999).

Lack of strategic planning for JV operation

Lack of strategic planning is one of the principal sources of potential conflicts in CJVs (Hung et al., 2002). Improper project planning was also identified as one of the management risks associated with Sino-foreign CJVs (Shen et al., 2001). Without a mutually agreed strategic plan of JV operation, the potential adverse effect of strategic incompatibility between the parent firms on JV implementation may emerge and perhaps be enlarged because the time constraints of CJVs (project-based) hardly allow for any significant corrections in conflicting strategies of parent firms.

6.3.4 Inter-organisational differences

Incompatible organisational cultures among JV contracting parties

Culture is perceived as the major cause of failure in a CJV (Swierczek, 1994; Munns et al., 2000). The effect of culture on the JV organisation is implicit and manifests its presence through conflicts in a clash of cultures (Sridharan, 1995). The potential for conflicts in any JV exists because of the differences in the partners involved, which may be further increased as a result of the different cultural backgrounds that the partners possess (Munns et al., 2000). Garb (1988, p. 82) also noted that the diversity of cultural backgrounds frequently results in a tenuous working relationship in ICJVs.

Inconsistent management styles among JV contracting parties

Conflicts and stresses in the working relationships of the participants inter se may arise if the differences between the management styles of the CJV parties are substantial (Chow, 1985, p. 9). For instance, one JV party embracing the management style leaning toward centralization may be incompatible with another with inclination toward more autonomous and decentralized operating units. Hung et al. (2002) also demonstrated through an empirical survey that inconsistencies in management styles can be a key issue of failure in project-based JVs.

Differences in organisational policies (e.g. corporate quality standards) among JV contracting parties

Differences in organisational policies among JV partners were perceived by the managers of CJVs as the second most frequently mentioned reason behind difficulties with CJV implementation (Hung et al., 2002). In the context of the UK construction industry, differences in organisational policies were also identified by local contractors as the major causes of problems in CJVs (Dalle and Potts, 1999). Such differences can be derived from the inconsistencies in corporate quality standards, project-performing criteria, and norms of managing personnel, all of which, if not properly addressed, could increase the risks of failure of CJV projects.

6.3.5 Interview findings on the difficulties of CJV success

A total of 14 difficulties of CJV success were referred to by the interviewees. Among those mentioned barriers to CJV success, organisational cultural differences and lack of mutual trust were identified by all interviewees, implying their crucial roles in shaping the success or failure of CJVs. Half of the interviewees considered conflicts in distribution of authority as a significant source of CJV failure.

Scrutiny into the fundamentals of CJV success found that lack of mutual trust, lack of problem-solving mechanism, dispute resolution mechanism, lack of mutual understanding among JV team members, and lack of effective communications, were advocated by the interviewees as the major barriers to CJV success. Specifically, a lack of staff training schemes was raised by Interviewee 4 as a hindrance to the success of CJVs. With respect to inter-organisational differences, apart from organisational cultural differences, Interviewees 2 and 5 also nominated the differences and conflicts in working procedures and corporate standards between CJV partners as affiliated with the broad category of organisational policy difference that hinders the success of CJVs. Incompatible management styles were also regarded by Interviewee 3 (a senior practitioner) as one of the inter-organisational variations contributing to the possible failure of CJVs.

As to JV management difficulties, the difficulty in the integration of JV team members was identified by Interviewee 3 as a potential barrier to the smooth operation of CJVs. Looking at the aspects of conflicts between CJV partners, inconsistent project objectives (Interviewee 6), conflicts in distribution of authority in resource allocation (Interviewees 1, 3 and 6), and unfair inputs and profit sharing

(Interviewees 4 and 5) were identified as major sources of CJV failures. Table 6.9 portrays the interview findings on the potential difficulties of CJV success.

Table 6.9 A Summary of interview findings on the potential difficulties of CJV success

No.	Potential difficulties of CJV success	R1	R2	R3	R4	R5	R6
1	Organisational cultural differences	X	X	X	X	X	X
2	Inconsistent project objectives	X			X		X
3	Lack of mutual trust	X	X	X	X	X	X
4	Conflicts in inputs and profit sharing	X					X
5	Conflicts in distribution and execution of authority	X		X		X	X
6	Incompatible management styles		X			X	
7	Corporate standards differences		X				X
8	Conflicts in working procedures		X			X	
9	Lack of effective communications			X			
10	Difficulty in the integration of JV team members			X			
11	Lack of problem-solving mechanism				X		
12	Lack of dispute resolution mechanism				X		
13	Lack of staff training schemes				X		
14	Lack of mutual understanding among JV team members				X		

Note: 'R' denotes 'Respondent' of the interview.

6.3.6 Results of questionnaire survey on the difficulties of CJV success in Hong Kong

The Cronbach's alpha coefficient for the rated difficulties of CJV success is 0.893 (*F* statistics = 7.970, *p* = 0.000), which is higher than the threshold value of 0.70 according to Hair et al. (2010, p. 125). The scale adopted to measure the potential difficulties of CJV application is reliable and internally consistent at the 5% significance level. Table 6.10 presents the rankings of the perceived difficulties of CJV success as rated by the survey respondents.

Overall ranking of the difficulties in applying CJVs

As shown in Table 6.10, the mean values of the difficulties rated by all respondents were all above 3.0 (3.17 to 3.87), indicating that the respondents were agreeable to each of the 17 difficulties that may impede the success of CJVs despite having different levels of agreement. The top three difficulties in CJV success as perceived by the respondents were "*inconsistent management styles among JV contracting parties*" (mean = 3.87), "*incompatible organisational cultures among JV contracting parties*" (mean = 3.78), "*differences in organisational policies (e.g. corporate quality standards) among JV contracting parties*" (mean = 3.70). The top three difficulties were all related to the differences in organisational issues among JV partners, which is consistent with the fact that "*incompatible organisational cultures among the contracting parties*" was most frequently cited as a key difficulty of CJV success in previous studies (e.g. Norwood and Mansfield, 1999; Hung et al., 2002; Walker and Johannes, 2003; Dalle and Potts, 1999). As articulated by Norwood and Mansfield (1999), cultural homogeneity is perceived as a critical factor in the success and duration of JVs. In any JVs, a great potential for culture-related conflicts (Hung et al., 2002) exists, especially when the partnered organisations hold different cultural backgrounds and possess different perspectives in tackling project-related affairs. Following the organisational differences among JV partners, "*lack of mutual understanding among JV team members*" was also rated as a c ritical difficulty impeding CJV success. The scope of mutual understanding covers the overall conditions (i.e. social reputation and financial capability) of the JV partners. As noted by Walker and Johannes (2003), significant problems may arise because one JV partner does not understand the political and historical pressures influencing their partners. As an example, JV partners may undertake the risk of being implicated in their partner's corruption and/or illegal activity that may be related to the JV project. Notably, the respondents perceived "*unfair gain-share/pain-share among JV contracting parties*" (mean = 3.25), "*lack of knowledge about JV contracting method*" (mean = 3.21) and "*difficulties with JV financial administration*" (mean = 3.17) as the three lowest ranked barriers to CJV success. These results may reveal that entry into a CJV relationship is mostly built upon a clear understanding of the JV approach, and the JV partners have acquired prior experience in financial administration within a JV relationship. Therefore, past involvement in a CJV partnership poses significant influence to the success of CJVs.

Agreement of respondents within each survey group

As the number of attributes examined is greater than 7, the chi-square value rather than the *W* value was adopted in this study to judge the correlation of the rankings of the perceived difficulties. According to the degree of freedom (17 − 1 = 16) and the allowable level of significance (5%), the critical value of chi-square from the table was found to be 26.30. The actual computed chi-square values for all of the four groups (111.595 for all respondent groups, 28.043 for the senior management group, 68.985 for the project management group, and 57.925 for the technical/site working group) were all above the critical chi-square value of 26.30. Thus, the null hypothesis that "the sets of rankings of the respondents on the difficulties in CJV success are unrelated (independent) with each other within a particular group" should be rejected. A reasonable degree of consensus on the ranking exercise was thus achieved among the respondents within each survey group.

Agreement of respondents between any two survey groups

Table 6.11 shows the test results of Spearman's rank correlation coefficients (r_s) and the corresponding significance levels for the rankings of the three groups of respondents. The actual significance levels (p = 0.003, 0.024, and 0.000) for the rank correlation between any two respondent groups were all lower than the critical level of 0.05. Adequate evidence concludes that significant correlations exist between any two respondent groups. For each of the three respondent groups, items 4, 7, 8 and 9 were all ranked among the top six rated difficulties. The statistical findings on the rank correlation imply that the three groups of respondents reached a significant level of consensus on the rankings of perceived difficulties in CJV success.

The result of the one-way ANOVA test also indicates no statistical differences among all three groups of respondents at the 5% significance level in terms of the mean values of each rated difficulty. As shown in Table 6.10, the lowest calculated p-value for all difficulties is 0.087 and greater than 0.05. A consistent level of agreement measured by the mean values on each of the 17 difficulties of CJV success exists among the three respondent groups.

Table 6.10 Ranking, Kendall's coefficient of concordance and one-way ANOVA result for the perceived difficulties of CJV success

ID	Potential difficulties of CJV success	All respondent group		Senior management group		Project management group		Technical / site group		ANOVA result	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	F	Sig.
8	Inconsistent management styles among JV contracting parties	3.87	1	3.92	2	3.98	1	3.68	1	1.560	0.215
7	Incompatible organisational cultures among JV contracting parties.	3.78	2	3.92	2	3.86	2	3.59	2	1.157	0.319
9	Differences in organisational policies (e.g. corporate quality standards) among JV contracting parties.	3.70	3	3.67	6	3.83	3	3.51	4	1.354	0.263
4	Lack of mutual understanding among JV team members.	3.69	4	3.75	4	3.74	5	3.59	2	0.373	0.690
3	Inconsistent project objectives among JV team members.	3.65	5	3.58	8	3.81	4	3.43	8	2.287	0.107
5	Lack of mutual trust among JV contracting parties.	3.64	6	3.75	4	3.72	6	3.49	5	0.937	0.395
6	Lack of communications among JV contracting parties.	3.58	7	4.00	1	3.60	7	3.41	9	1.963	0.146
2	Conflict of interest between the parties outside the JV agreement.	3.49	8	3.42	12	3.52	9	3.46	6	0.093	0.911
13	Lack of entire management control over JV partners.	3.47	9	3.67	6	3.57	8	3.24	13	1.443	0.241
10	Inflexibility of JV organisational operations	3.45	10	3.50	11	3.48	11	3.38	11	0.166	0.847
16	Lack of top management support for creating right working atmosphere throughout the JV contracting process.	3.44	11	3.42	12	3.43	13	3.46	6	0.012	0.988
12	Lack of mutually agreed conflict resolution mechanism among JV contracting parties.	3.43	12	3.25	15	3.48	11	3.41	9	0.340	0.713
14	Lack of strategic planning for JV operation.	3.40	13	3.17	17	3.52	9	3.30	12	0.971	0.382
17	Conflicts in distribution and execution of authority.	3.33	14	3.58	8	3.33	14	3.24	13	0.565	0.570

Table 6.10 (continued)

11	Unfair gain-share/pain-share among JV contracting parties.	3.25	15	3.42	12	3.26	15	3.19	15	0.269	0.765
1	Lack of knowledge about JV contracting method.	3.21	16	3.25	15	3.26	15	3.14	16	0.315	0.731
15	Difficulties with JV financial administration.	3.17	17	3.58	8	3.22	17	2.95	17	2.497	0.087
	Number of survey responses	107		12		58		37			
	Kendall's coefficient of concordance (*W*)	0.065		0.146		0.074		0.067			
	Actual calculated chi-square value	111.595		28.043		68.985		39.831			
	Critical value of chi-square from table	26.30		26.30		26.30		26.30			
	Degree of freedom (*df*)	16		16		16		16			
	Asymptotic level of significance	0.000		0.031		0.000		0.001			

For Kendall's coefficient concordance (W), H_0 = respondents' sets of rankings are unrelated (independent) to each other within each group.

Reject H_0 if the actual chi-square value is larger than the critical value of chi-square from table.

For one-way ANOVA test, H_0 = there is no significant differences on respondents' perceptions of each difficulty as measured by the mean values amongst the three groups.

Reject H_0 if actual F value is larger than the critical value of F statistics from table.

Table 6.11 Spearman's rank correlation test between groups of survey respondents on the perceived difficulties of CJV success

Comparison of rankings between groups of survey respondents	r_s	Significance level	Conclusion
Senior management group vs Project management group	0.678	0.003[a]	Reject H_0 at 5% significance level
Senior management group vs Technical/site group	0.543	0.024	Reject H_0 at 5% significance level
Project management group vs Technical/site group	0.848	0.000	Reject H_0 at 1% significance level

H_0 = no significant correlation on the rankings between any two groups.
H_a = significant correlation on the rankings between any two groups.
Reject H_0 if the actual significance level (p-value) is less than the critical value of 5%.
[a] significant correlation at 5% significance level.

6.3.7 Interpretation of the underlying grouped factors of the difficulties of CJV success

Similar to its use in analyzing the motives/benefits of CJV application, PCA was conducted to distinguish the factors for the perceived difficulties. The promax rotation method was also adopted to rotate the factors for better interpretation.

The KMO value of the factor model was 0.855, indicating a "good" degree of common variance according to Field (2005, p. 640). Bartlett's test of sphericity produced an approximation of chi-square value = 798.052 (df = 136, p-value < 0.000), justifying that the correlations between the variables were significant to conduct PCA. The output alpha value for the difficulties was 0.852, w hich is larger than the threshold value of 0.70 to support the reliability of the measurement scale (Hair et al., 2010, p. 125). A high degree of internal consistency (reliability) exists with respect to the correlations among the 17 di fficulties, and the scale adopted to measure the difficulties is reliable. With its demonstrated validity and reliability, the factor analysis approach was justified as appropriate to analyse the survey data.

Four components with eigenvalues exceeding 1.0 were extracted by utilising PCA. The four components explained a total variance of 63.896% in responses, which is greater than the minimum requirement of 60% as advocated by Malhotra (1996), with components 1 to 4 accounting for 38.130%, 10.453%, 9.070%, and 6.243% of the variance, respectively. The figure of the scree plot (Figure 6.3) further demonstrates the sufficiency of the four-factor model to categorize the perceived difficulties of CJV success.

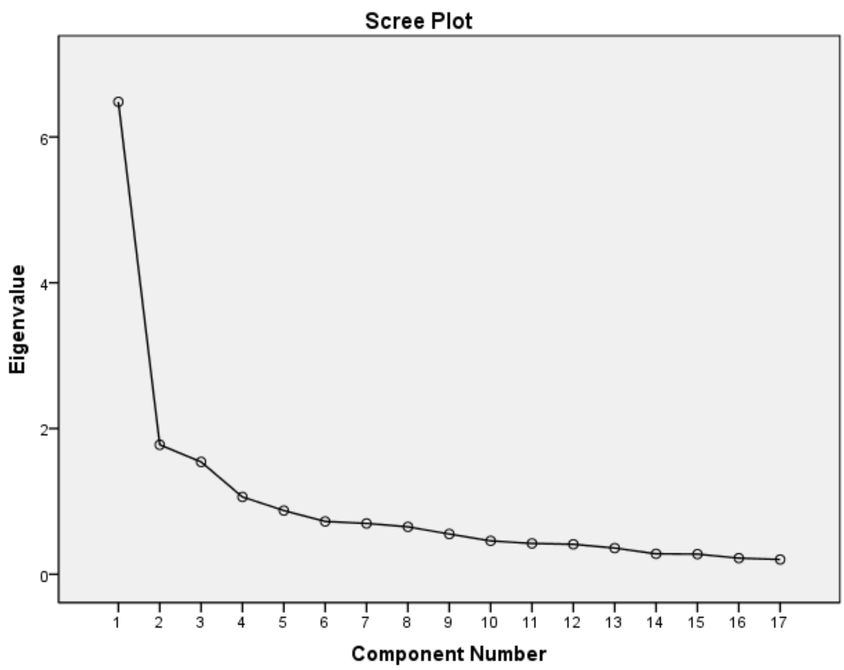

Figure 6.3 Scree plot of factor analysis for the difficulties of CJV success

The factor structure for the 17 difficulties of CJV success is presented in Table 6.12. The factor loading cut-off, which is also specified in conducting FA for the motives/benefits of CJV application, was also set at 0.4. As the factor loadings of the individual difficulties on the four factors were all greater than 0.4, all the items were retained for analysis. The factor correlations between F1 and F2, F1 and F3, and F2 and F3, were 0.448, 0.415, and 0.456, respectively (>0.32) as shown in Table 6.13. This result justifies the appropriateness of selecting the promax rotation approach instead of the orthogonal rotation approach for factor rotation according to Tabachnick and Fidell (2007, p. 638). The four factors generated are as follows.

- Factor 1: Lack of fair and effective management mechanisms for the operation and control of a CJV partnership

Seven items associated with management issues for the operation and control of CJVs were grouped into this factor. Items 13, 14, 16 and 17 predominantly focus on the lack of effective mechanisms for the planning, operation, and control of CJV relationships, whereas items 11, 12 and 15 were related to the potential conflicts and difficulties encountered in managing CJVs.

- Factor 2: Lack of mutual trust, communications and understanding

This factor is composed of five variables mainly describing the lack of mutual trust, communications and understanding between JV partners. Items 4, 5 and 6 cover the aspects of mutual trust, communications, and understanding. Although item 1 (*lack of knowledge about JV contracting method*) and item 3 (*inconsistent project objectives among JV team members*) are not directly concerned with mutual trust, communications and understanding, they have close ties with the three behavioural aspects. Little knowledge about JV formation and operation significantly weakens the partners' mutual understanding of each other, whereas inconsistent project objectives would very likely encumber the formation of mutual trust and promotion of communications between the JV partners.

- Factor 3: Differences in organisational cultures, policies and management styles

The third factor comprised four individual difficulties related to organisational differences. Items 7, 8 and 9 describe the organisational differences from the perspectives of organisational policies, cultures, and styles of management. Item 10 is more pertaining to the inefficiency of the JV operation because of rigid management procedures and/or working styles.

- Factor 4: Potential conflicts beyond the JV partnership agreement

Factor 4 was reflected alone by the individual difficulty of "*conflict of interest between the parties outside the JV agreement*" (item 2). This factor demonstrates little correlation with the other three factors because it is beyond the behavioural aspects during the formation and operation of CJVs.

Table 6.12 Factor structure of principal factor extraction and promax rotation on the 17 potential difficulties of CJV success

Difficulties in achieving CJV success	Factor loading	Eigenvalue	Percentage of variance explained	Cumulative percentage of variance explained
Factor 1. Lack of fair and effective management mechanisms for the operation and control of JV partnership		6.482	38.130	38.130
17 Conflicts in distribution and execution of authority	0.795			
16 Lack of top management support for creating right working atmosphere throughout the JV contracting process	0.785			

Table 6.12 (continued)

11 Unfair gain-share/pain-share among JV contracting parties	0.737			
13 Lack of entire management control over JV partners	0.694			
14 Lack of strategic planning for JV operation	0.691			
15 Difficulties with JV financial administration	0.654			
12 Lack of mutually agreed conflict resolution mechanism among JV contracting parties	0.613			
Factor 2. Lack of mutual trust, communications and understanding		1.777	10.453	48.583
4 Lack of mutual understanding among JV team members	0.816			
6 Lack of communications among JV contracting parties	0.775			
5 Lack of mutual trust among JV contracting parties	0.768			
1 Lack of knowledge about JV contracting method	0.557			
3 Inconsistent project objectives among JV team members	0.403			
Factor 3. Differences in organisational cultures, policies and management styles		1.542	9.070	57.653
9 Differences in organisational policies (e.g. corporate quality standards) among JV contracting parties	0.848			
10 Inflexibility of JV organisational operations	0.680			
7 Incompatible organisational cultures among JV contracting parties	0.645			
8 Inconsistent management styles among JV contracting parties	0.606			
Factor 4. Potential conflicts beyond the JV partnership agreement		1.061	6.243	63.896
2 Conflict of interest between the parties outside the JV agreement	0.922			

Table 6.13 Factor correlation matrix of the difficulties of CJV success

Underlying grouped factors	F1	F2	F3	F4
F1: Lack of fair and effective management mechanisms for operation and control of JV partnership	1.000	0.448	0.415	0.218
F2: Lack of mutual trust, communications and understanding	0.448	1.000	0.456	0.154
F3: Differences in organisational cultures, policies and management styles	0.415	0.456	1.000	0.052
F4: Potential conflicts beyond JV partnership agreement	0.218	0.154	0.052	1.000

6.4 Chapter Summary

A list of 15 perceived motives and benefits of CJV application and 17 potential difficulties of CJV success have been identified in this chapter. The results of the cross-comparison of the perceptions gleaned from different respondent groups on the motives and benefits and difficulties indicated that a general consensus was reached on the ranking exercise within a particular survey group and between different survey groups. The top three ranked motives and benefits of CJV application were found to be “increasing credibility of pre-qualification during tender,” “spreading/sharing financial risk,” and “improving competitive edge/competitiveness in the market.” The four factors determined for the group of motives and benefits were discerned as follows: Factor 1 - risk sharing and resource integration; Factor 2 - improvement of JV partners’ competency and market strength; Factor 3 - technology transfer and profit gains; and Factor 4 - access to the international market. The top three ranked difficulties of CJV success included “inconsistent management styles among JV contracting parties,” “incompatible organisational cultures among JV contracting parties,” and “differences in organisational policies (e.g. corporate quality standards) among JV contracting parties." The factors of difficulties were determined as follows: Factor 1 - lack of fair and effective management mechanisms for the operation and control of CJV partnership; Factor 2 - lack of mutual trust, communications and understanding; Factor 3 - differences in organisational cultures, policies and management styles; and Factor 4 - potential conflicts beyond the JV partnership agreement.

CHAPTER 7 DETERMINATION OF COLLABORATION FACTORS FOR CONSTRUCTION JOINT VENTURES

7.1 Introduction

This chapter presents the research findings on the factors of collaboration in the context of CJVs to achieve Objective 4 as stated in Chapter 1. The following two research questions were addressed in this chapter.

1. How can the "collaboration" construct in the specific context of CJVs be crystallised and measured?

2. How can the developed measurement framework of collaboration in CJVs be justified for use?

Determination of collaboration factors in CJVs, which has not been examined by previous studies, involves the identification and analysis of the behavioural aspects of collaboration. In this chapter, a series of attributes of collaboration were proposed, analysed, classified and verified in the development process.

7.2 Attributes of Collaboration in Construction Joint Venture Projects

So far, an unanimous definition of "collaboration" has been absent from the current construction-related literature (Hughes et al., 2012), so are the measurement criteria for collaboration in construction. Of reference value to the construction industry, measures of supply chain (consisting of two or more corporate stakeholders) collaboration in the retail industry has been developed as incorporating three major dimensions including information sharing, decision synchronisation and incentive alignment (Simatupang and Sridharan, 2005). Greenwood and Wu (2012) classified the positive attributes of collaborative working into nine measurable aspects as including mutual trust, commitment, interdependence, win-win philosophy, mutual understanding/respect, communication, problem solution, sharing of risk/benefit, and innovation/creativity. Pursuant to the interview findings, Hughes et al. (2012) developed and refined 18 essential aspects and 25 desirable aspects of collaboration in construction. In the context of project design, Ren et al. (2013) identified 25 criteria for measuring collaboration in collaborative design, with clear/common team goals, effective information sharing, shared problem solving, collaborative decision-making, ability to make compromises, cross-functional collaboration and conflict management ranked as the top seven criteria.

Collaboration in construction projects is better reflected in relational contracting (RC) approaches, which encompass partnering, alliancing, joint venture and public private partnership and other collaborative working arrangements (Chan et al., 2010, p. 5; Yeung et al., 2012). RC requires more cooperative behaviours between the involved parties than other contracting relationships. In defining RC, Yeung et al. (2012) identified five essential core elements of RC as commitment, mutual trust, cooperation and communication, common goals and objectives, and win-win philosophy, which are perceived to be integral to the spirit of collaboration. Other peripheral elements of RC approaches such as agreed problem resolution methods, equity, a joint declaration statement (partnering charter), real gain-share/pain-share, and continuous improvements, also fall exclusively into the broad category of collaboration (Chan et al., 2010, p. 38; Yeung et al., 2012) and thus are all important for gauging the level of collaboration amongst the project parties involved.

In the specific context of CJV projects, factors of collaboration could be extracted to a certain extent from the factors that are identified as critical to the success of CJVs as few of these success factors fall beyond the umbrella of collaboration. Taking the study of Morledge and Adnan (2006) for instance, most of their identified CSFs of JVs, such as mutual understanding, inter-partner trust, agreement of contract, commitment, cooperation, coordination, communication/information, etc. are the essential attributes of collaboration in CJVs. An alternative resource to generalise the collaboration factors in CJVs arises from the 'means and ends' perspective in the measurement of CJV performance. By recourse to the measures (which is perceived as the 'ends') for the performance of CJVs developed by the prior studies, the spectrum of collaboration factors (which is perceived as the 'means') could be reasonably expanded. For example, in the study of Ozorhon et al. (2011), nine variables of partner performance (e.g. sharing risks, sharing resources, and technology transfer) and three variables of performance of international JV management (i.e. strategic, operational, and organisational control) could be adapted to be the useful measures of collaboration in some aspects.

By mainly referring to the existing literature about three different perspectives, (1) the identified aspects of collaboration in construction by Hughes et al. (2012); (2) the identified CSFs of CJVs in relevant studies and the developed measures of JV partner and JV management performance by Ozorhon et al. (2011); and (3) the relevant literature about the essential elements of RC approaches in the construction industry, this study classified the factors of collaboration into 38 measurable attributes to come up with a consolidated list of various aspects of collaboration in CJVs.

7.3 Questionnaire Survey on the Perceived Attributes of Collaboration in CJVs

As stated in Chapter 5, the fourth section of the questionnaire for this study is designed to solicit the respondents' perceptions on the level of agreement with each of the 38 l isted collaboration attributes in CJV projects. Descriptive statistics of the survey respondents could refer back to the summary of respondents in Chapter 6. In addition, case-based query and survey on two JV construction projects were carried out to test and validate the developed and refined model of collaboration factors.

The set of behavioural features of collaboration in CJVs initially adopted by this study was mainly adapted from the aspects of collaboration produced by Hughes et al. (2012). A rigorous and thorough desktop review of the existing literature supports that the measures of collaboration developed by Hughes et al. (2012) are robust and comprehensive enough as these measures, specifically developed in the context of the construction industry, not only cover all essential elements of RC approaches to which JVs are attached, but also involve the success factors of JVs identified in previous studies. Integration of past literature enables generalising some 32 behavioural aspects of collaboration in CJVs which are perceived as common collaboration aspects and also inherent in RC approaches.

A specific investigation into the features of CJV contracting method on the basis of rigorous literature review further engendered several JV-specific collaboration aspects that may be useful to gauge CJV collaboration. These aspects cover the maintenance of financial stability, equity among JV contracting parties, compatibility of organisational structures, management control (e.g. strategic, operational, and structural control), human resources management, and technology transfer / exchange. A total of 38 different behavioural aspects of collaboration in CJVs were ultimately produced for conducting an industrial-wide questionnaire survey.

7.3.1 Data Analysis

Exploratory factor analysis (EFA) was used to reduce and classify the number of collaboration attributes into a smaller number of factors. In view of the potential correlation among the extracted factors, principal component analysis (PCA) using promax rotation (one of the oblique rotation methods) was selected in determining the factors of collaboration in CJVs. In conducting EFA, the predetermined minimum factor loading is used to derive a list of critical variables with substantive loadings on the corresponding factors. The condensed critical aspects of collaboration are more manageable by and more practically useful to industrial practitioners in assessing, monitoring and enhancing the level of collaboration between their JV partners.

It has been suggested that the factor loadings of 0.3-0.4 be the threshold values for extracting variables with substantive loading values (Hair et al., 2010, p. 117). By testing the significance of factor loading at the significance level of α = 0.01 (two-tailed test), Stevens (2009, p. 332) recommended using the doubled critical value for a correlation coefficient at α = 0.01 (two-tailed test) as the critical value for testing the significance of a loading. According to the critical values for a simple correlation at α = 0.01 (two-tailed test) for sample size ranging from 50 to 1,000 as shown in Table 7.1, a sample size of 100 would generate the corresponding minimum loading value of $2 \times 0.256 = 0.512$. Given that the sample size for conducting EFA in this study is 107, the cut-off value of factor loading is therefore set at 0.50.

Table 7.1 Critical value for a correlation coefficient at the significance level of $\alpha = 0.01$ for a two-tailed test

Sample size (N)	Critical value (CV)
50	0.361
80	0.286
100	0.256
140	0.217
400	0.129
600	0.105
800	0.091
1000	0.081

Kaiser's criterion, scree test, and Horn's parallel analysis could be considered to determine the number of factors to be extracted. Among these methods for determining the factor numbers, Horn's parallel analysis has been recognised as the most accurate tool whereas Kaiser's criterion and scree test tend to overestimate the number of factors to retain (Pallant, 2010, p. 1 84). Table 7.2 reveals the result of Horn's parallel analysis, from which four components were extracted, and 24 attributes of collaboration out of a total of 38 with factor loadings larger than 0.50 were retained.

Table 7.2 Comparison of the eigenvalues from the PCA and the criterion values from the Horn's parallel analysis

Component number	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	15.204	1.979	Accept
2	2.576	1.807	Accept
3	1.742	1.681	Accept
4	1.608	1.572	Accept
5	1.425	1.474	Reject

The appropriateness of applying EFA was evaluated by the Kaiser–Meyer–Olkin (KMO) test and the Bartlett's test of sphericity. The KMO value of the factor model was 0.899, which was much higher than the acceptable threshold value of 0.50 for proceeding with EFA (Hair et al., 2010, p. 104) and indicated an "excellent" degree of common variance according to Field (2005, p. 640). The Bartlett's test of sphericity produced an approximation of chi-square value = 2726.353 (df = 703, p-value < 0.000), implying that the correlations between the variables were sufficiently large to conduct PCA and the population correlation matrix is not an identity matrix. The Cronbach's alpha reliability coefficient was also used to check the internal consistency (reliability) of each factor. The overall output alpha values for each of the four underlying grouped factors, as shown in Table 7.3, were all larger than 0.70 as a rule-of-thumb for evidencing the reliability of the measurement scale (Hair et al., 2010, p. 125). Thus, a high degree of internal consistency (reliability) exists with respect to the correlations among the four clustered factors, and the adopted measurement scale for these benefits/motives is reliable. Overall speaking, the factor analysis approach was justified as appropriate for analyzing the survey data with confidence and reliability.

7.3.2 Results of Factor Analysis

The four components (i.e. underlying grouped factors) extracted from EFA altogether explained 55.602% of the total variance of in responses, which is larger than the percentage of variance explained found in many of previous research studies, for example, 43.9% in Choudhry et al. (2009), 48.20% in Hon et al. (2013), and 53.631% in Ali and Kidd (2014). Components 1 to 4 accounted for 40.009%, 6.778%, 4.584%, and 4.231% of the variance, respectively. The factor structure for the 24 attributes of collaboration in CJVs extracted is presented in Table 7.4. The full pattern matrix of all the 38 attributes of collaboration is provided in Appendix 5. Factor correlations between any two grouped factors, except for F2 and F3 (0.310) were all above 0.32 as shown in Table 7.3, justifying the selection of the promax rotation approach instead of the orthogonal rotation approach according to Tabachnick and Fidell (2007, p. 638).

Table 7.3 Factor correlation matrix of collaboration attributes in CJVs

Factor of Collaboration in CJVs	F1	F2	F3	F4	Cronbach's alpha
F1: Mutual trust and teamwork spirit	1.000				0.906
F2: Team skills development and mutually agreed quality, safety and health standards	0.355	1.000			0.806
F3: Proper management of financial and human resources and gain-share/pain-share mechanism	0.475	0.312	1.000		0.883
F4: Effective communications and information sharing	0.405	0.363	0.370	1.000	0.807

Table 7.4 Factor structure of principal factor extraction and promax rotation on the 24 attributes of collaboration in CJVs

Attributes of collaboration in CJVs	Factor loading	Percentage of variance explained	Cumulative percentage of variance explained
Factor 1. Mutual trust and teamwork spirit		**40.009**	**40.009**
6. An environment of mutual trust was developed between JV contracting parties in the project.	0.716		
5. JV relationship was operated under a non-adversarial environment.	0.712		
3. Collaboration created a joint problem-solving environment.	0.669		
7. JV team members contributed to the project (i.e. commitment).	0.620		
8. Teamwork spirit existed between JV team members involved in the project.	0.580		

Table 7.4 (continued)

1. An environment of open dialogues existed between JV contracting parties in the project.	0.567		
2. A common aim was shared by the JV contracting parties to the project.	0.556		
9. JV team members understood the roles and responsibilities of other team members in the project (i.e. mutual understanding).	0.547		
11. JV team members respected the input from other team members in the project.	0.515		
Factor 2. Team skills development and mutually agreed quality, safety and health standards		**6.778**	**46.787**
20. JV team members were allowed to develop their skills and extend their inputs beyond the traditional role.	0.733		
23. A formal quality assurance mechanism formed part of the project.	0.727		
29. JV contracting parties set higher safety and health standards in the project	0.696		
4. Early warning system for any problems was integral to the project.	0.594		
28. JV contracting parties encouraged greater innovations	0.520		
Factor 3. Proper management of financial and human resources and gain-share/pain-share mechanism		**4.584**	**51.371**
33. Financial stability was maintained among JV contracting parties.	0.788		
37. Effective human resources management was achieved among JV contracting parties.	0.768		
34. Equity among JV contracting parties was well-observed.	0.714		
14. Relationships between the JV contracting parties were well-managed.	0.655		
13. The gain-share / pain-share mechanism is fair to JV contracting parties in the project.	0.648		
36. Effective management control (e.g. strategic, operational, and structural control) was achieved among JV contracting parties.	0.632		
Factor 4. Effective communications and information sharing		**4.231**	**55.602**
16. Various natures of workshops were held involving JV contracting parties.	0.844		
15. There were regular meetings between the JV contracting parties.	0.734		

Table 7.4 (continued)

10. JV team members fully understood the different cultures of their JV partners.	0.679
27. JV contracting parties encouraged more effective information sharing in the project.	0.648

7.4 Factors of Collaboration in Construction Joint Ventures

The four clustered factors of collaboration in CJVs and their underlying measures are as follows:

- Factor 1—Mutual trust and teamwork spirit: This factor contains nine behavioural aspects of collaboration, with V1, V2, V3, V5, V7, V9 and V11 related to teamwork environment, covering shared aim, open dialogues, mutual respect, commitment, joint-problem solving and teamwork. V6 is concerned with the prerequisite of team working: mutual trust between JV partners.
- Factor 2—Team skills development and mutually agreed quality, safety and health standards: This factor consists of five variables, with V20 in relation to project team skills development while V4, V23, V28, and V29 pertinent to the efforts devoted for project quality, safety and health assurance.
- Factor 3—Proper management of financial and human resources and gain-share/pain-share mechanism: This factor is composed of six variables. V14, V33, V36 and V37 are associated with the management of financial and human resources while V13 and V34 mainly pertain to the assurance of equity among JV partners (e.g. gain-share/pain/share mechanism).
- Factor 4—Effective communications and information sharing: Four behavioural attributes of collaboration are incorporated in this factor. V15 and V16

focus on the platform for communication among JV partners while V10 and V27 are more relevant to the attitudinal aspects of inter-partner communications and information sharing.

It was noted that the four extracted factors of collaboration in CJVs cover the most essential aspects/attributes critical to the success of JVs and other approaches under RC umbrella as identified by previous studies (e.g. Morledge and Adnan 2006; Famakin et al. 2012; Yeung et al. 2012). However, there do exist some attributes distinct in JV contracting method. For example, V9 (Mutual understanding of the roles and responsibilities of other team members in the project), V34 (Equity among JV contracting parties) and V11 (Mutual respect from other project team members) may be more likely stressed in JVs than other RC approaches, while V20 (Allowing JV team members to develop their skills and extend their inputs) and V33 (Maintenance of financial stability among JV contracting parties) are particularly favoured by JV contractor partners as they share the same role in the project which requires mutually dedicated inputs (including financial and human resource inputs) to the project.

The derived factors of collaboration echoes the input-process-output (IPO) framework of collaboration as proposed in Chapter 4. With reference to the four stages of collaboration: incorporating collaborative culture, collaborative inputs, collaborative process and collaborative outputs, the behavioural aspects at each stage are enumerated in Figure 7.1.

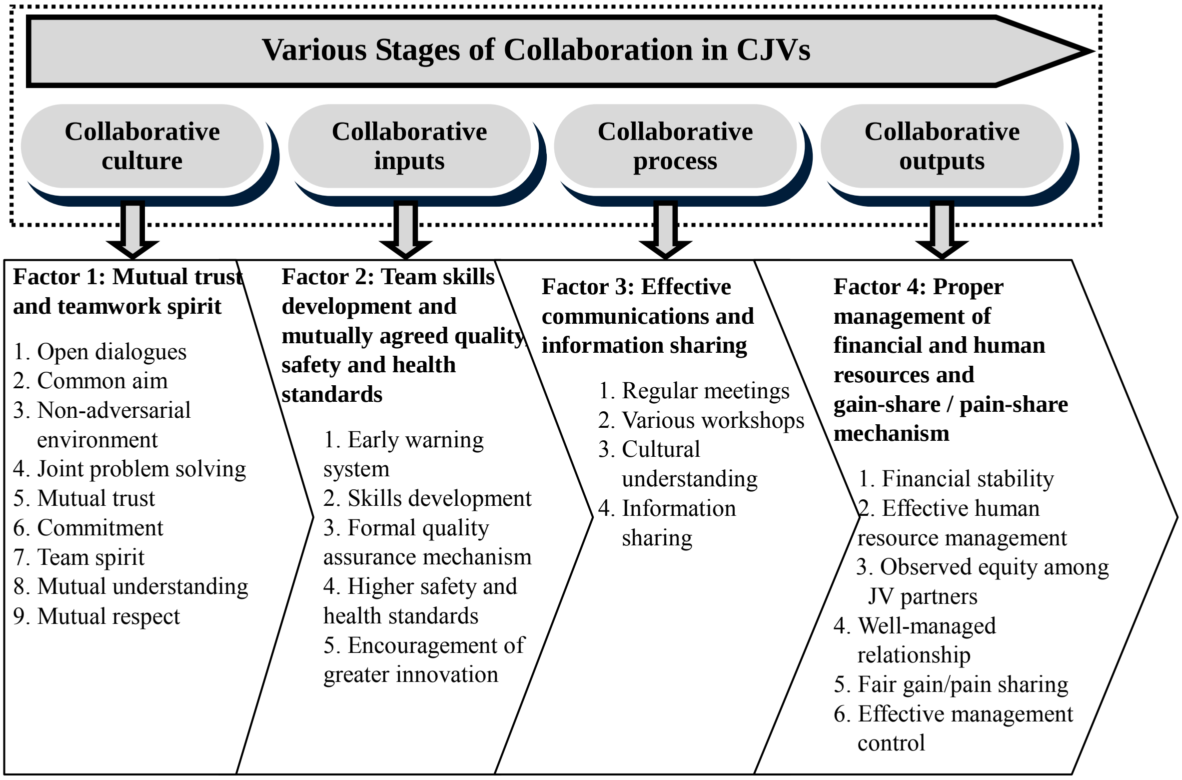

Figure 7.1 Conceptual model for collaboration in CJVs

In view of the determined factors of collaboration, prime concerns over how to improve the level of collaboration between JV partners could be addressed by virtue of imposing serious attentions and actions to the identified aspects of collaboration. To place greater concerns about Factor 1, it calls for the senior managers from all JV contracting parties not only to create a joint working culture for the team members but also nurture a shared spirit of teamwork under a new single entity without organisational boundary. As for the improvement of the level of Factor 2, JV parties should take the initiative to negotiate and come up with effective strategies on the shared inputs for achieving desired or superior project productivity, quality and safety performance. To ensure the sound achievement on Factor 3, the prerequisite rests on the clear statement of and agreement on the contract documenting financial issues and human resource deployment as well as equitable gain/pain sharing. Furthermore, extra efforts may be needed to negotiate any possible changes in the initially agreed terms of the gain-share/pain-share mechanism to maintain equity among JV partners throughout JV operation. Factor 4 requires the JV parties frequently communicate with each other and purposively seek platforms and chances to share and exchange information/resource acquired by any one of the JV partners.

7.5 Testing the Practicality and Reliability of the Determined Factors of Collaboration in CJVs

Although the factors of collaboration in CJVs were derived empirically from the industrial practitioners' perceptions, the practical value and the reliability of the four extracted factors are subject to further verifications. As an effective means to examine the practicality, reliability and generalisability of the determined four-factor model of collaboration, the explanatory power of the four factors of collaboration for the achievement of inter-partner collaboration among JV contracting parties was investigated in this study. To this end, the respondents were further invited to indicate their perceptions according to a five-point Likert scale (1 = strong disagree; 3 = neutral or no strong view; and 5 = strongly agree) on the extent to which they were satisfied with the JV overall collaboration experience. Based on the feedback on the ratings of the level of achievements of a series of collaboration attributes, a total of 107 valid responses were received with respect to the assessment on the level of '*satisfaction with the overall JV collaboration experience*'. Only a significant percentage of variance in this item explained by the four factors of collaboration could demonstrate the practical value and reliability of the derived factors of collaboration in CJVs.

A multiple linear regression model was therefore hypothesised with '*satisfaction with the overall JV collaboration experience*' as the dependent variable and the four extracted factors of collaboration in CJVs being the independent variables. Ordinary least square (OLS) regression was performed via *SPSS* software package to test the reliability of the hypothesised regression model.

Table 7.5 Results of multiple linear regression analysis

Independent variable	Unstandardised coefficient (*B*)	Standardised coefficient (β)	Standard error	*t*-statistic	*p* value
Constant	-0.035	—	0.216	-0.160	0.873
Factor 1	0.192	0.270	0.044	4.351**	0.000
Factor 2	0.245	0.303	0.046	5.343**	0.000
Factor 3	0.287	0.382	0.046	6.291**	0.000
Factor 4	0.164	0.219	0.046	3.612**	0.000

Sample size = 104 (outlier excluded)
Adjusted R^2 = 0.722
Model *F*-statistic= 67.807**

Note: Dependent variable: *satisfaction with the overall JV collaboration experience*.
* Significant at the 0.05 level; ** Significant at the 0.01 level.

Table 5 presents the detailed regression results including the standardised coefficient (β), unstandardised coefficient (B), t statistics, model F statistics, significance level (*p-value*), and adjusted coefficient of determination (adjusted R^2). As revealed in Table 5, all of the correlation coefficients in the regression model were significant at the 0.01 significance level, implying that the four extracted factors significantly correlate to the dependent variable, which is '*satisfaction with the JV overall collaboration experience*'. The adjusted R^2 value of 0.722 demonstrated that the four factors of collaboration altogether could explain significantly at least 72% of the variance in the construct reflecting on the level of satisfaction with inter-partner collaboration in CJVs. The percentage of variance explained in the hypothesised regression model is comparable with and larger than that of Greenwood and Wu

(2012)'s study, in which the collaborative working attributes explained 68.6% of variance in the construct '*service satisfaction*' under the context of construction projects. The regression results in general revealed the determinant roles of the four extracted factors of collaboration in reflecting on the overall performance of inter-partner collaboration between JV partners. Hence, the determined four factored model of collaboration in CJVs via EFA is perceived as practically useful and reliable to gauge the level of inter-partner collaboration among JV parties achieved in a specific CJV project.

7.6 Chapter Summary

This chapter illustrated the research findings to achieve objective 3. EFA was used to derive four factors of collaboration with underlying behavioural aspects in the context of CJVs. The finally determined grouped factors included: (1) Mutual trust and teamwork spirit; (2) Team skills development and mutually agreed quality, safety and health standards; (3) Proper management of financial and human resources and gain-share/pain-share mechanism; and (4) Effective communications and information sharing. The four factors of collaboration supported the model of collaboration in CJVs derived from the input-process-output (IPO) framework as proposed in Chapter 4. Regarding the level of satisfaction with the current JV contracting experience and the willingness of future JV collaboration, the practicality and validity of the four-factor measurement model of collaboration were demonstrated through multiple linear regression analysis which revealed the predictive power of the four extracted factors of collaboration for explaining the perceived level of satisfaction with JV collaboration experience. The derived CJV collaboration model helps to set a benchmark for measuring the level of collaboration in CJVs.

CHAPTER 8 PERFORMANCE MEASUREMENT OF JOINT VENTURE PROJECTS IN CONSTRUCTION

8.1 Introduction

With the merits that CJVs derive, research into the evaluation of the success of CJV projects becomes more important because it can help develop a benchmark to measure the performance of CJV projects. Strong emphasis has been placed by many researchers on the adoption of performance measurement methods to improve the current status of the construction industry (Yang et al. 2010). Measures of project performance enable the practitioners to gauge the extent to which project success is achieved, intuitively understand their competitive status, and purposively enhance future project performance.

Measuring JV project performance has been a difficult task because efforts to identify variables associated with JV performance have been constrained by the disagreements on the comparability and reliability of alternative performance measures and methods (Geringer and Hebert, 1991; Luo, 2001). Given its complexity and multidimensional attributes, the validity of the possible measures for JV performance is still questionable (Ozorhon et al., 2010). In the context of the construction industry, various measures to assess JV project performance have been documented with no c onsensus achieved so far from the existing literature. The evaluation could be centered either on the performance of the project itself or on the performance of the JV organisation, but preferably on bot h aspects. Most of the developed measures of performance in CJVs are for IJVs, with the example studies of Ozorhon et al. (2011) and Mohamed (2003). Few studies, if any, proposed all-encompassing performance measures for both ICJVs and domestic CJVs.

Concerns over the necessity in developing appropriate measures of CJV project performance could be grouped into three facts: (1) the existing performance measurement criteria are either too redundant or insufficient; (2) the existing measures are predominantly developed for ICJVs and few are applicable for domestic CJVs; (3) few of the existing measures are derived based on strong theoretical support.

Management of CJV performance is vital to achieve success in CJV projects. An effective performance management system greatly depends on the performance metrics to define the performance of the organisation from a number of perspectives (Kagioglou et al., 2001). Therefore, a sound selection and identification of the measures of CJV project performance, with justified validity and reliability, is of paramount importance in achieving CJV success. This chapter presents the development process of a practical framework for CJV performance measurement. Conciseness, comprehensiveness, and practicality of the measurement criteria could be assured to achieve objectives 4 and 5.

8.2 Key Performance Indicators for Measuring Construction Project Performance

Among the prevalent frameworks for measuring project performance in construction, the key performance indicators (KPIs) model was most favoured according to the statistics on the utilisation of performance measurement frameworks by leading construction firms in the United Kingdom (Robinson et al., 2002). A variety of performance measures in construction have been resorted to many perspectives that are distinctive among studies. Kagioglou et al. (2001) argued that the methods employed to measure construction project performance fall into three main categories of the balance scorecard (BSC): financial perspective, internal business process perspective, and customer perspective. Yang et al. (2010) epitomized that performance measurement in construction has focused on three levels, namely, project level, organisational level, and stakeholder level. Mcleod and MacDonell (2012) expanded the dimensions of project success criteria as incorporating process, product, and organisation levels, with focus on pr oject management, project objectives, and organisational objectives, respectively. Most research studies, such as Chan and Chan (2004), Lai and Lam (2010), and Toor and Ogunlana (2010), have incorporated both objective and subjective measures in the evaluation of project performance. Referring to the KPIs presented in the *Construction Best Practice Programme* from the United Kingdom, KPIs at the project level cover construction cost, construction time, predictability cost, predictability time, defects, and client satisfaction (product and service), whereas the company-level indicators involve safety, profitability, and productivity (Yang et al., 2010).

Factors constituting the success criteria are commonly referred to as KPIs (Toor and Ogunlana, 2010). Traditionally, KPIs for construction projects are represented by the "Iron Triangle" of project success criteria: cost, time, and quality (Atkinson, 1999). Safety criterion has been added to the three measures in many succeeding studies, such as White and Fortune (2002), Cox et al. (2003), Lam and Wong (2009), and Yang et al. (2012). Some studies also extended the criteria for measuring the overall project performance to incorporating client satisfaction (Pinto and Slevin, 1988; Wit, 1988; Jugdev and Müller, 2005).

Although these measures provide an indication of the extent to which project success is achieved, they do not provide a balanced view of the performance of a project. Some further studies responded to the drawbacks of those limited measures of project performance by integrating more performance indicators to the performance measurement framework. For instance, within the set of KPIs identified by Chan and Chan (2004), time, cost, quality and functionality, safety, profitability, users' satisfaction, participants' satisfaction, and environmental performance, were integrated to measure the performance of a construction project. Lai and Lam (2010) used nine specific performance criteria (i.e. profit, time, claims or disputes, job satisfaction, quality, safety, environment, generation of innovative ideas, and effectiveness) to assess performance outcomes in a construction project. While measuring the performance of partnering projects, Yeung et al. (2007) classified the performance measures into four categories: result-oriented objective and subjective measures, together with relationship-oriented objective and subjective measures. Sohail and Baldwin (2004) developed three groups of performance indicators: *general performance indicators*, *inter-organisational, cooperation, and partnership indicators*, and *socio-economic indicators*, to measure the performance of micro-projects.

8.3 Literature Review of KPIs for CJVs

In measuring project performance, different performance criteria are relevant to different types of projects and in different degrees of importance (Wateridge, 1998; Shenhar et al., 2001). The specific set of KPIs that are most suitable to gauge the performance of CJV projects should thus be distinctive from the KPIs developed to measure the performance of other types of projects [e.g. partnering projects or public-private-partnership (PPP) projects]. Predominantly labeled as project-based

JVs, JVs in the construction industry are formed to perform a project and are temporary in nature (Sillars and Kangari, 2004). In the case of project-based JVs, the conventional proxy to evaluate JVs in general: *duration and survival rates of JVs*, seem to be less relevant in view of the limited life span of such partnerships ((Hung et al., 2002).

A variety of measures for assessing CJV performance have been developed with no consensus achieved so far from the existing literature. According to previous studies, the common factors that reflect JV performance may include client satisfaction, budget, schedule, and quality (Mohamed, 2003; Ozorhon et al., 2008a, 2008b, 2010). "*Client satisfaction with the JV contracting method*" was adopted by Lin and Ho (2013) as the major proxy for the performance of CJVs. Ozorhon et al. (2011) defined IJV performance as incorporating project performance, partner performance, performance of IJV management, and perceived satisfaction with IJVs. In the study of Mohamed (2003), ICJV performance was measured by three items: value, profit, and satisfaction. In the context of equity JVs in construction, installation, and decoration, Luo (2001) advocated the number of projects undertaken by the JVs, the average annual profit rate of the JVs, and a subjective managerial measure to assess the performance of Sino-foreign JVs. In contrast, Sillars and Kangari (2004) adopted the construct of organisation return (profitability), which is further measured by JV return, and company growth (market position change) to measure organisation success in the practice of project-based JVs.

According to Mcleod and MacDonell (2012), project success may even be extended further to include the accomplishment of more strategic objectives and benefits, such as effects on m arkets and competitors, business development or expansion, and ability to react to future opportunities or challenges (Jugdev and Muller, 2005; Shenhar et al., 2001; Toor and Ogunlana, 2010). Therefore, a comprehensive set of performance measures for CJV projects should also look at the strategic benefits reaped through a CJV contracting relationship. Typical strategic benefits in the application of CJVs may include technology transfer (Norwood and Mansfield, 1999; Kumaraswamy and Shrestha, 2002; Girmscheid and Brockmann, 2010), increase in market share/competitive position (Mohamed, 2003; Sillars and Kangari, 2004), and improvement in JV management skills (Luo, 2001; Ozorhon et al., 2011).

8.4 Selected KPIs to Measure CJV Projects: The Contractor's Perspective

Given that project success is considered an intangible perceptive feeling that varies with different management expectations, among persons, and with project phases (Pariff and Sanvido, 1993), different project stakeholders (e.g. clients, contractors, and consultants) may have different project objectives and perceived performance criteria to measure the success of CJV projects. Thus, a selected perceptive stance is necessary to develop consistent measures for performance evaluation. Although JVs may be formed by consultants or contractors in a construction project (Kumaraswamy and Palaneeswaran, 2000), contractor-JVs (JVs formed between contractors) are perceived as the mainstream in CJVs as far as the types of JV partners are concerned. This scenario is reflected by the fact that respondents for the industry-wide surveys from many previous studies addressing issues concerning CJVs (e.g. Kwok et al., 2000; Mohamed, 2003; Ozorhon et al., 2011) have been exclusively aimed at the contractors. Throughout the development of the KPIs to measure CJV projects, this study focuses on the contractor's perspective.

In developing a consolidated and comprehensive list of KPIs to measure CJV project performance, the following principles are adopted:

(i) The developed KPIs should incorporate both objective and subjective measures.

(ii) The developed KPIs do not only measure performance at the project level but also extend to measurement at the organisational level, such as business development.

(iii) Both generic KPIs (G-KPIs) to measure project performance in general and JV-specific KPIs (S-KPIs) to measure CJV project performance in particular, are included.

The major references in extracting a consolidated list of KPIs for CJV projects were resorted to the following perspectives to maximally secure the validity and reliability of the performance measures:

(i) Repeated measures in the existing literature;

(ii) In accordance with the key motives/benefits of CJV formation;

(iii) Aligning the measures with the strategic or business objectives of the JV partners.

The rationale of referring to the key motives/benefits of CJV formation to develop the KPIs lies in their determinant roles in the formation of CJVs. The project performance/success of CJVs is greatly consistent with the realisation of the key motives/benefits of forming CJVs. The third perspective was in response to the argument that KPIs have conventionally been seen as external to the business needs of many organisations despite being generic and relevant to nearly all companies (Beatham et al., 2004). White and Fortune (2002) noted that yielding business and other benefits was ranked by the industrial practitioners as one of the five most important criteria for the evaluation of project success.

Based on the above criteria, this study reviewed and classified the KPIs for CJVs into two broad categories: G-KPIs and S-KPIs. The two groups of KPIs incorporate both subjective and objective measures for CJV project performance; In particular, the latter group of KPIs was adopted to measure the various performance aspects exclusively derived from the use of CJVs. Repeated KPIs sought from the existing literature on CJV literature have been reviewed and initially considered appropriate measures of CJV project performance. Those performance indicators adopted at least in two of the previous studies on CJVs are enumerated in Table 8.1. A total of ten KPIs were derived to measure CJV project performance, with KPI-1 to KPI-6 measuring the general project performance and KPI-7 to KPI-10 measuring JV-specific project performance aspects.

Table 8.1 Review of various performance measures in Construction Joint Ventures

Performance Indicators	Ozorhon et al. (2011)	Ozorhon et al. (2007a)	Ozorhon et al. (2008a)	Mohamed (2003)	Hung et al. (2002)	Luo (2001)	Kwok et al. (2000)	Lin and Ho (2013)	Sillars and Kangari (2004)	**Total number of hits**
1. Project cost performance	X		X				X			**3**
2. Project time performance	X		X				X			**3**
3. Achieving required project quality	X		X				X			**3**
4. Project safety performance							X		X	**2**
5. Satisfying the client's requirements / expectations	X		X			X	X	X		**5**

Table 8.1 (continued)

6. Making profits				X	X	X			X	**4**
7. Overall satisfaction with JV experience		X		X	X		X			**4**
8. Increase in market share/position				X					X	**2**
9. Improvement of JV management skills	X					X				**2**
10. Achievement of technology transfer	X				X					**2**
Total number of performance indicators identified by each publication	**6**	**1**	**4**	**3**	**3**	**3**	**6**	**1**	**3**	**30**

Further to the extensive desktop literature review, the development of KPIs for CJVs has also been referred to the perspective of strategic gains. Strategic Return On Investment (STROI), as described by Lynch (1993) as an appropriate measure of strategic gains, was employed to judge the comprehensiveness of and make possible complements to the initially identified 10 KPIs for CJVs. Assessment of the strategic success of any business alliances or ventures hinges on the evaluation of the five key dimensions of STROI:

(1) Market strength (e.g. market share, sales level, expansion into new markets);

(2) Organisational capability (e.g. human resources, learning, skills);

(3) Innovative capacity (e.g. perceived improvements in innovative capabilities);

(4) Competitive advantage (e.g. strategic gains relative to competitors);

(5) Financial gain (e.g. cost cutting, revenue or profitability gains).

The STROI measure is applicable to CJVs while considering CJV to be a type of project-based alliance (Sillars and Kangari, 2004). Scrutiny into the contents of the 10 generalised KPIs indicates that all five key dimensions of STROI were covered in the list of KPIs. KPI-7 in the labeled name of "increase in market share/position" echoes the dimension of market strength, KPI-8 entitled "technology transfer" consists of the dimensions of innovative capacity and competitive advantage, KPI-9 described as "improvement of JV management skills" highly relates to the STROI dimension of organisational capacity, while KPI-6 expressed as "making profits" is identical to the dimension of financial gain.

In summary, the key dimensions of STROI for measuring strategic success were incorporated into the ten identified KPIs for CJVs. The proposed KPIs for CJV projects also comply with the expanded dimensions of project success criteria raised by Mcleod and MacDonell (2012), where the dimension of organisational success focuses on organisational objectives as reflected by business benefits and strategic benefits. Thus, these KPIs are generally sufficient and appropriate for measuring CJV project performance as a whole.

8.4.1 General Measures of Project Performance

As seen from the comprehensive review of the measures of project performance in construction management research, the conventional measures of project performance/success fall exclusively under five dimensions, namely, time, cost, quality, safety, and client satisfaction (Chan and Chan, 2004; Yeung et al., 2007). Profit gains could be perceived as another performance dimension that corresponds to cost saving from the perspective of the contractor.

KPI-1: Project Time Performance

Project time performance has been an indispensable measure of project success throughout the evolving progress of project performance measurement criteria. Time refers to the duration for completing a project, and project time performance can be measured by construction time, speed of construction, and time variation (time overrun/underrun) (Chan and Chan, 2004; Yeung, 2009). The evaluation of CJV project time performance could be based on the perception toward one or more of these three aspects.

KPI-2: Project Cost Performance

Project cost performance has also been persistently incorporated into the necessary criterion to gauge the level of project success. Cost is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubshait and Almohawis, 1994) and can be measured in terms of unit cost and percentage of net variance over the final cost (Chan and Chan, 2004). The latter measure could be adjusted as the percentage of variance of actual progress cost over estimated progress cost in an ongoing project. Assessment of CJV cost performance accords to the perceived extent of variance of actual project cost over estimated project cost.

KPI-3: Project Quality Performance

Project quality, time, and cost are viewed as the "Iron Triangle" of project success criteria (Atkinson, 1999). Project quality has been a fundamental measure of project performance repeatedly cited in almost all studies involving project performance/success. Quality in a construction project is defined as the degree to which the general conditions promote meeting the project's established requirements of materials or workmanship (Bubshait and Almohawis, 1994). Quality could also be perceived as a measure of how well the work is completed in accordance with the design work (Cheung et al., 2003) and can be scored based on the average number of non-conformance reports generated per month (Yeung, 2009). Project quality performance, as measured in CJV projects from the contractor's perspective, reflects the extent to which the project requirements from the designers, clients, and consultants are satisfied.

KPI-4: Project Safety Performance

Health and safety are defined as the degrees to which the general conditions promote the completion of a project without major accidents or injuries (Bubshait and Almohawis, 1994). Safety has been the primary concern in measure of success of all types of construction projects, and CJV projects are no exceptions (Kwok et al., 2000). Project safety performance could be evaluated by comparing the accident rate of the specific project with the industry's annual average accident rate. For the purpose of research in this study, the assessment of project safety performance is based on the respondents' intuitive understanding of the project accident rate.

KPI-5: Client's Satisfaction

Client's satisfaction has been added to the conventional project success criteria of time, quality, and cost by many studies (e.g. Pinto and Slevin, 1988; Wit, 1988; Jugdev and Müller, 2005) and has also evolved as an indispensable measure of CJV project performance (Luo, 2001; Ozorhon et al., 2008a, 2011; Lin and Ho, 2012). The level of client's satisfaction is associated with the fulfillment of the requirements/expectations as set by the client. In a CJV project, client's satisfaction may also be extended to the level and area of collaboration among the partnered contractors. Appraising the level of client's satisfaction in a CJV project from the perspective of the contractor is based on the feedback and responses of the client to the overall performance of contractors engaged in the JV contracting relationship.

KPI-6: Profit Gains

Profit is one of the most vital measures of project success from the contractor's perspective. The pursuit of profits and other financial gains is the foremost concern of construction firms in undertaking a construction project. Profit could be measured as the increment by which revenues exceed cost (Norris, 1990). Alternatively, profit as a financial achievement could be reflected by the net present value of revenues deducted by cost (Chan and Chan, 2004). In this study, perceptions toward performance in terms of profit gains in the CJV project are conceptually contingent on the variance between the actual revenues gained and the financial investment on project construction.

8.4.2 Additional Measures of JV Operation

KPI-7: Technology Transfer

As defined by Hulin and Roznowski (1985, p. 47), *Technology* refers to "the physical combined with the intellectual or knowledge processes by which materials in some form are transformed into outputs". It is mostly perceived that technology includes not only the hardware used in performing work but also the skills and knowledge of workers, and even the characteristics of the objects on which work is performed (Scott, 2003, p. 231) . As also advocated by Scott (2003, p. 232), most organisations do not themselves invent their technologies but import them from the organisations' environment which is not only the source of inputs and the recipient of outputs but also the major source of technical knowledge, work techniques, and tools employed by the organisation. Hence, for the organisations to adopt and improve the technology transferred from their business partners, dedicated inputs of any hardware, skills and knowledge are essential as technology transfer is a reciprocal process.

Technology transfer is generally defined by Dichter et al. (1988, p. 1) as "the process whereby knowledge in some form is transferred from a person or organisation that possesses it (the transferor) to another person or organisation that arranges to receive it (the transferee)." In the context of construction projects, Simkoko (1989) adjusted the definition of technology transfer as the planned conveyance and acquisition of technical knowledge and techniques; this process highlights the effective use of technical knowledge by the receiver as the essential constituent in achieving technology transfer. JV appears to be the most widely preferred vehicle of construction technology transfer (Ofori, 1994; Kumaraswamy and Shrestha, 2002) because JV allows the parties involved to exploit each other's strengths for a limited time and for a specific cause (Carrillo, 1996). Technology transfer has been extensively identified as one major benefit of CJVs (Norwood and Mansfield, 1999; Kumaraswamy and Shrestha, 2002; Girmscheid and Brockmann, 2010). Measurement of CJV project performance has also been resorted to the aspect of technology transfer in previous studies (Ozorhon et al., 2011). The extent to which technology transfer is achieved in a CJV project is grounded on the perception of the contractors toward the lessons learned from and/or the acquisition of the technical knowledge and expertise of their JV partners.

KPI-8: Increase in Market Share

Creation of a large market share has been identified as the measure of business success out of the four dimensions of project success (Shenhar et al., 2001). An increased market share could be viewed as the immediate and direct effect that a CJV project may have on the organisation. Increase in market share is also perceived as one of the business benefits reaped through the application of CJVs; its synonymous terms have been adopted as an important measure of CJV project performance (e.g. "value" in the study of Mohamed (2003); and "market position change" in the study of Sillars and Kangari (2004). Increase in market share/market position change is considered both the operational and post-operational success criteria of CJV project in this study when soliciting the JV contractors' perceptions on the achievement of this KPI.

KPI-9: Improvement of JV Management Skills

The experience of being involved in a CJV project equips the JV partners with the potential to improve their JV management performance in future CJV projects. JV management skills cover all possible aspects of management control over JV operation and have been adopted as measures of CJV project performance by Luo (2001) and Ozorhon et al. (2011). From the strategic perspective, this KPI could be considered one of the organisational strategic business benefits reaped through the application of CJVs. Improvement of JV management was thus adopted as an essential KPI for CJV projects in this study and was perceived as integral to the process of JV formation, operation, and future collaboration.

KPI-10: Satisfaction with JV Collaboration Experience

This KPI concerns with job satisfaction, which refers to the extent to which participants gain enjoyment or satisfaction from their efforts at work (Fogarty, 1994). In a CJV project, the contractors' job satisfaction is reflected by the satisfaction with the experience of collaboration with their JV partners. Overall satisfaction with CJV experience has been identified by many studies as a key measure of CJV project performance (Kwok et al., 2000; Hung et al., 2002; Mohamed, 2003; Ozorhon et al., 2007a). In this study, satisfaction with JV collaboration experience measures the extent to which the JV contractors are satisfied with both the JV collaborative process and collaborative outcomes.

8.5 Determining the Weightings of CJV Project Performance Measures

As described in Chapter 5, Section E of the survey questionnaire was designed to solicit the survey participants' perceptions toward the importance of the 10 KPIs to measure the performance of CJV projects. Descriptive statistics of the survey respondents were presented in Chapter 6.

8.5.1 Overall ranking of the weightings of KPIs for CJV projects

The KPIs for CJV projects were ranked in the descending order of mean scores for their perceived importance as shown in Table 8.2. The Cronbach's α coefficient for the weightings of KPIs for CJV projects is 0.763 (F statistics = 24.749, p = 0.000), which is larger than the recommended acceptable value of 0.5 for attitude/perception assessment (Tuckman and Happer, 2012, p. 206; Yip and Poon, 2009), implying that the five-point measurement scale adopted to rate the levels of importance on all KPIs (i.e. 1 = least important; 3 = important; and 5 = most important) is internally consistent and reliable at the 5% significance level.

Table 8.2 illustrates that the six general measures of project performance (from KPI-1 to KPI-6) were ranked among the six most important KPIs for CJV projects. This result further evidenced that these measures are fundamental and integral to the performance measurement system for all types of construction projects from the perspective of construction firms. With no exception, the performance criteria of CJV projects incorporate these general measures of project performance first and foremost. Among these top six KPIs, time performance (mean = 4.18, SD = 0.698), safety performance (mean = 4.11, SD = 0.805), and cost performance (mean = 4.10, SD = 0.672) were ranked as the three most important KPIs to measure the performance of CJV projects. Distinct from previous research findings on KPIs for projects implementing other types of relational contracting approaches (e.g. partnering and PPPs), safety performance was ranked very high (2nd) in measuring CJV project performance. However, this factor was ranked relatively low (10th out of 30 initial KPIs) for partnering projects (Yeung et al., 2007) and even lower (13th out of 48 performance indicators) for projects procured with the PPP approach (Yuan et al., 2012). Given that the survey respondents participating in this study are primarily from main contractors, such disparate perception on the importance of safety performance may be attributable to the emphasis of contractors on project site safety and they value safety performance as the basis of project success. The occurrence of accidents in construction projects may not only engender considerable compensation costs but also impair the firm’s overall reputation and impression within the industry and community.

Among the four KPIs (from KPI-7 to KPI-10) specific for CJV projects, “improvement of JV management skills” (mean = 3.54, SD = 0.743) was ranked higher than “JV partners’ satisfaction with JV contracting experience” (mean = 3.47, SD = 0.744) and “increase of market share” (mean = 3.45, SD = 0.815). This observation implies that the contractors involved in a CJV project place greater concerns about the long-term strategic benefits reaped through the CJV practices because the improvement of JV management skills provides a solid basis for the success of future JV projects. Although technology transfer has been identified as one of the major benefits of applying CJVs (Norwood and Mansfield, 1999; Kumaraswamy and Shrestha, 2002; Girmscheid and Brockmann, 2010), it was ranked the lowest among the 10 KPIs. This divergence may be explained by the conflict between the pursuit of and recognised difficulty in achieving technology transfer between the JV contracting parties. As referred in previous studies, JV is not a universally successful vehicle for technology transfer because it may be difficult to match the partner's commitment to technology transfer with its suitability for the project and to monitor the transfer process (Chow, 1985; Ofori, 1994).

Table 8.2 Ranking of the relative importance of KPIs for CJV Projects

ID	KPIs for CJV projects	All respondent group		
		Mean	S.D.	Rank
1	The time performance of this JV project was good (i.e. completed within schedule).	4.18	0.698	1
4	The project achieved good safety performance.	4.11	0.805	2
2	The cost performance of this JV project was good (i.e. completed within budget).	4.10	0.672	3
5	The client's requirements / expectations were satisfied in the project.	4.03	0.758	4
3	The required project quality was achieved.	4.01	0.637	5
6	JV contracting parties made reasonable profits from the project.	3.83	0.733	6
9	JV management skills were improved through the JV contracting experience.	3.54	0.743	7
10	JV contracting parties were satisfied with the JV overall contracting experience.	3.47	0.744	8
8	Market share was increased via the JV contracting approach.	3.45	0.815	9
7	Technology transfer was achieved in the project.	3.42	0.813	10

8.5.2 Calculation of Weightings of KPIs for CJV Projects

As previously adopted by Chow (2005), Yeung et al. (2007), Chan et al. (2011), and Chan and Chan (2012), the weighting for each of the ten KPIs for CJV projects was computed using the following equation:

$$W_{KPI_a} = \frac{M_{KPI_a}}{\sum_g M_{KPI_g}} \tag{1}$$

where:

W_{KPI_a} represents the weighting of a particular KPI;

M_{KPI_a} represents the mean ratings of a particular KPI;

$\sum_g M_{KPI_g}$ represents the summation of mean ratings of all the ten KPIs.

The matrix of weightings for all KPIs for CJV projects was therefore calculated as being (0.110, 0.107, 0.105, 0.108, 0.106, 0.100, 0.090, 0. 090, 0.093, 0.091).

8.6 Fuzzy Synthetic Evaluation of CJV Project Performance

Fuzzy synthetic evaluation (FSE) addresses the issues concerning multi-criteria decision making (Xu et al., 2010). According to Meng et al. (2009), Wei et al. (2010), Xu et al. (2010), and Li et al. (2013), FSE involves five essential steps:

(1) Identify a set of basic criteria $U = \{u_1, u_2,\ldots,u_m\}$, where u_i (i = 1, 2,……,m) denotes the ith evaluation index. For example in the present study, u_1 = KPI$_1$, u_2 = KPI$_2$, u_3 = KPI$_3$, u_4 = KPI$_4$, u_5 = KPI$_5$, u_6 = KPI$_6$, u_7 = KPI$_7$, u_8 = KPI$_8$, u_9 = KPI$_9$, u_{10} = KPI$_{10}$.

(2) Form a set of grade alternatives for the evaluation criteria $V = \{v_1, v_2,\ldots,v_n\}$, where v_j (j = 1, 2,… ,n) denotes the evaluation grade *j*. In this study, for instance, v_1 = strongly disagree, v_2 = disagree, v_3 = neutral / no strong view, v_4 = agree, v_5 = strongly agree.

(3) Determine the weight vectors of the evaluation criteria $W = \{w_1, w_2,\ldots,w_m\}$, where w_i denotes the weighting of the *i*th evaluation index and $\sum_{i=1}^{m} w_i = 1$.

(4) Set up an evaluation matrix R $= \left(r_{ij}\right)_{m\times n}$, where r_{ij} denotes the degree to which the grade alternatives v_j satisfies the evaluation index u_i.

(5) Normalize the fuzzy evaluation matrix and compute the fuzzy evaluation result $B = A \times R = \{b_1, b_2,\ldots,b_n\}$.

8.6.1 Establishment of a fuzzy comprehensive evaluation model for CJV project performance

Establishment of the evaluation index system

The set of ten KPIs for CJV projects, as derived from the literature review, formed as the evaluation index system for assessing CJV project performance. It is believed that these ten KPIs are comprehensive enough to reflect the performance measures of a CJV project. Therefore, the set of criteria for FCE is $U = \{u_1, u_2,\ldots, u_{10}\}$ = {KPI_1, KPI_2,…, KPI_{10}}.

Development of appropriate weightings for KPIs for CJV projects

As described before, the development of respective weightings for each KPI for CJV projects were based on the mean ratings of the importance of the ten KPIs for

CJV projects. To develop the weightings of all KPIs for a specific respondent group, summation of mean ratings of all KPIs was only conducted within the specific group of respondents. Using Eq. (1), the weighting matrix for the ten KPIs as rated by the a specific respondent group could be derived and expressed as $W = \{w_1, w_2, ..., w_k, ...\}$, where w_k is the weighting of the *k*th KPI rated by the respondents.

Determination of the membership function for each KPI

With reference to the study of Xu et al. (2010) and Li et al. (2013), the grades for selection by respondents were defined as L = {1, 2, 3, 4, 5}, w here 1 = strongly disagree, 2 = disagree, 3 = neutral / no strong view, 4 = agree, 5 = strongly agree. The membership function of a specific KPI u_{ik} can be derived by the following equation.

$$MF_{u_k} = \frac{P1_{u_k}}{\text{strongly disagree}} + \frac{P2_{u_k}}{\text{disagree}} + \frac{P3_{u_k}}{\text{neutral}} + \frac{P4_{u_k}}{\text{agree}} + \frac{P5_{u_k}}{\text{strongly agree}} = \frac{P1_{u_k}}{1} + \frac{P2_{u_k}}{2} + \frac{P3_{u_k}}{3} + \frac{P4_{u_k}}{4} + \frac{P5_{u_k}}{5} \quad (2)$$

where u_k denotes the *k*th KPI as rated by the respondents; MF_{u_k} is the membership function of the KPI u_k and Pm_{u_k} (m = 1, 2,…,5) is the proportion of the respondents who choose m for the level of agreement concerning the KPI u_{ik}. The membership function of u_k can also be written as $(P1_{u_k}, P2_{u_k}, P3_{u_k}, P4_{u_k}, P5_{u_k})$, where $0 \le Pm_{u_k} (m = 1,\ 2,\ 3,\ 4,\ 5) \le 1$ and $\sum_{m=1}^{5} Pm_{u_k} = 1$.

8.6.2 Developing a fuzzy comprehensive evaluation model for performance of CJV projects

The overall performance of CJV projects was assessed by integrating the performance score as rated by the three different respondent groups through fuzzy comprehensive evaluation. The performance of a CJV project rated by a s pecific respondent group was depicted in the form of a fuzzy evaluation matrix:

$$R = \begin{bmatrix} MF_{u_1} \\ MF_{u_2} \\ \ldots \\ MF_{u_k} \\ \ldots \end{bmatrix}$$

where u_k denotes the kth KPI evaluated by the respondents and MF_{u_k} represents the membership function of the kth KPI.

The performance matrix was derived and normalized by integrating the fuzzy performance evaluation matrix with the weighting matrix for all KPIs produces the following equation:

$$PM = W \times R = \{w_1, w_2, \ldots, w_{10}\} \times \begin{bmatrix} MF_{u_1} \\ MF_{u_2} \\ \ldots \\ MF_{u_{10}} \end{bmatrix} \qquad (3)$$

where PM is the performance matrix, W is the weighting matrix, R is the fuzzy evaluation matrix.

Calculation of overall performance score for CJV projects

The performance score rated by each respondent was quantified using Eq. (4).

$$PS = PM \times L^T = W \times R \times L^T \qquad (4)$$

where

PS is the overall performance score of CJV projects from the viewpoint of all survey respondents.

PM is the performance matrix

L is the matrix of linguistic variable where 1 = strongly disagree, 2 = disagree, 3 = neutral / no strong view, 4 = agree, 5 = strongly agree.

8.6.3 Practical application of the measurement model for evaluating CJV project performance

To validate the usefulness of the performance measurement framework based on the FSE approach, a case-based survey was conducted in a real-life JV project. The project for case study is an on-going JV railway service construction project, with the client being the Mass Transit Railway (MTR) Corporation (a major railway service provided in Hong Kong) and the main contractors as Chun Wo-Hip Hing JV, where Chun Wo Construction and Engineering Company Limited and Hip Hing Construction Company Limited were the two partnered JV organisations. The project scope is to construct a railway station and an overrun tunnel. Detailed information about the JV project is shown in Table 8.3. A total of 20 JV project team members (i.e. management staff and technical personnel) from the main contractor participated in the case-based survey.

Table 8.3 An illustrative project for measuring the performance of CJV projects

Background	Project information
Project name	MTR Kwun Tong Line Extension-Whampoa Station and Overrun Tunnel
Nature of project	Railway Service
Client of project	MTR Corporation Limited
Tendering method	Selective tendering
Type of contract	Lump sum contract
JV contractor partners	Chun Wo - Hip Hing Joint Venture
Contract period	May 2011-May 2015
Total contract sum	Around US$ 110 million (HK$ 856,152,032)

Determining the membership function of each KPI for CJV projects

The membership function of each KPI assessed by different survey respondent groups was derived according to Eq. (2). For instance, for the first KPI 'time performance', there are 20 respondents altogether indicating their ratings of performance for the selected CJV project. Specifically for the level of agreement on the achievement of KPI_1, 1 (5%) respondent selected 'strongly disagree', 6 (30%) indicated 'disagree', 1 (5%) selected 'neutral', 7 (35%) chose 'agree', and 5 (25%) selected 'strongly agree'. Therefore, the membership function for KPI_1 evaluated by the respondents could be obtained through Eq. (2).

$$MF_{u_1} = \frac{0.050}{\text{strongly disagree}} + \frac{0.300}{\text{disagree}} + \frac{0.050}{\text{neutral}} + \frac{0.350}{\text{agree}} + \frac{0.250}{\text{strongly agree}} = \frac{0.050}{1} + \frac{0.300}{2} + \frac{0.050}{3} + \frac{0.350}{4} + \frac{0.250}{5}$$

Likewise, the membership functions for other KPIs could be obtained. The membership functions for each KPI were calculated and presented in Table 8.4.

Table 8.4 Weighting and membership function of each KPI

KPI	Weighting for KPI	Membership function for each KPI
KPI_1	0.110	(0.050, 0.300, 0.050, 0.350, 0.250)
KPI_2	0.107	(0.000, 0.250, 0.450, 0.200, 0.100)
KPI_3	0.105	(0.000, 0.150, 0.400, 0.350, 0.100)
KPI_4	0.108	(0.000, 0.050, 0.200, 0.600, 0.150)
KPI_5	0.106	(0.000, 0.150, 0.250, 0.450, 0.150)
KPI_6	0.100	(0.000, 0.100, 0.550, 0.200, 0.150)
KPI_7	0.090	(0.000, 0.250, 0.400, 0.300, 0.050)
KPI_8	0.090	(0.000, 0.250, 0.350, 0.350, 0.050)
KPI_9	0.093	(0.000, 0.250, 0.350, 0.300, 0.100)
KPI_{10}	0.091	(0.050, 0.050, 0.500, 0.350, 0.050)

Evaluating the performance of the CJV project from the viewpoint of each survey group

A fuzzy evaluation matrix for quantifying JV project performance could be derived by integrating the membership function of each KPI.

$$R = \begin{bmatrix} MF_{u_1} \\ MF_{u_2} \\ \ldots \\ MF_{u_k} \\ \ldots \end{bmatrix}$$

where u_k denotes the kth KPI evaluated by the respondents and MF_{u_k} represents the membership function of the kth KPI.

The fuzzy evaluation matrix for the selected CJV project could be obtained through Eq. (3).

$$R = \begin{bmatrix} 0.050 & 0.300 & 0.050 & 0.350 & 0.250 \\ 0.000 & 0.250 & 0.450 & 0.200 & 0.100 \\ 0.000 & 0.150 & 0.400 & 0.350 & 0.100 \\ 0.000 & 0.050 & 0.200 & 0.600 & 0.150 \\ 0.000 & 0.150 & 0.250 & 0.450 & 0.150 \\ 0.000 & 0.100 & 0.550 & 0.200 & 0.150 \\ 0.000 & 0.250 & 0.400 & 0.300 & 0.050 \\ 0.000 & 0.250 & 0.350 & 0.350 & 0.050 \\ 0.000 & 0.250 & 0.350 & 0.300 & 0.100 \\ 0.050 & 0.050 & 0.500 & 0.350 & 0.050 \end{bmatrix}$$

The performance matrix for each respondent group could be derived by normalizing the fuzzy evaluation matrixes with consideration of the weightings of each KPI. For example, the performance matrixes for the respondents were:

$$PM = W \times R = \{w_1, w_2, ..., w_{10}\} \times \begin{bmatrix} MF_{u_1} \\ MF_{u_2} \\ ... \\ MF_{u_{10}} \end{bmatrix}$$

$$= (0.110,\ 0.107,\ 0.105,\ 0.108,\ 0.106,\ 0.100, 0.090,\ 0.090,\ 0.093,\ 0.091) \times \begin{bmatrix} 0.050 & 0.300 & 0.050 & 0.350 & 0.250 \\ 0.000 & 0.250 & 0.450 & 0.200 & 0.100 \\ 0.000 & 0.150 & 0.400 & 0.350 & 0.100 \\ 0.000 & 0.050 & 0.200 & 0.600 & 0.150 \\ 0.000 & 0.150 & 0.250 & 0.450 & 0.150 \\ 0.000 & 0.100 & 0.550 & 0.200 & 0.150 \\ 0.000 & 0.250 & 0.400 & 0.300 & 0.050 \\ 0.000 & 0.250 & 0.350 & 0.350 & 0.050 \\ 0.000 & 0.250 & 0.350 & 0.300 & 0.100 \\ 0.050 & 0.050 & 0.500 & 0.350 & 0.050 \end{bmatrix}$$

= (0.010, 0.180, 0.344, 0.347, 0.119)

Evaluating and interpreting the overall performance of the CJV project

The oveall performance score (PS) obtained from the ratings of the respondents could be calculated using Eq. (4).

$$PS = PM \times L^T = (0.010, 0.180, 0.344, 0.347, 0.119) \times (1,\ 2,\ 3,\ 4,\ 5)^T = 3.49$$

Therefore, the performance score of the project is above the median value of 3 out of a five-point measurement scale, which can lead to a conclusion that the project performance is generally good and above average at the current stage but with great potential to be improved in future.

8.7 Chapter Summary

This chapter reported on the research findings to achieve objective 4. A list of 10 KPIs was derived to comprehensively and concisely measure the performance of CJV projects. The list of KPIs includes the general measures of project performance and specific measures of JV operational performance. Based on the derived KPIs and its weightings rated by the respondents, this chapter further presented an assessment framework for calculating the quantitative level of CJV project performance, which incorporates a fuzzy synthetic evaluation process. The performance score of a particular JV construction project derived from the assessment model could be used to measure and evaluate the performance level achieved in the project.

CHAPTER 9 RELATIONSHIPS BETWEEN COLLABORATION FACTORS AND PROJECT PERFORMANCE FOR CONSTRUCTION JOINT VENTURES

9.1 Introduction

This chapter examines the relationships between inter-partner collaboration and project performance in the context of CJVs to achieve objective 6 as stated in Chapter 1. Questions concerning which attributes of collaboration influence which measures of project performance for CJVs will be addressed in this chapter. An in-depth understanding of the contributions of different collaboration factors to various performance measures will be gained.

9.2 Research Hypotheses and Framework

Drawing upon previous research into CJVs with specific focus on project performance and various influential factors to CJV practice, this chapter aims to establish the link between inter-partner collaboration and project performance in the context of CJVs. Apart from the general association, the effects of different collaboration factors on the individual performance measures for CJV projects were further examined.

In accordance with the assertion stated in a stream of previous research studies, collaboration (in the context of CJVs) was hypothesized to be significantly influential on CJV project performance. Assumption was also made with regard to the varied effects of different collaboration factors (as depicted by different sets of measurable attributes) on individual performance measures, which were measured by a set of

KPIs. After combining these assumptions with the research questions raised, the following research hypotheses are proposed in this study.

H1: *Joint venture collaboration (JVC) has a significant positive influence on the generic performance of CJV projects.*

H2: *JVC has a significant positive influence on JV-specific performance of CJV projects.*

H3: *Different collaboration attributes, grouped into several collaboration factors, have distinguished effects on each KPI of CJVs.*

The hypothesized model for the relationship between JV collaboration and project performance is illustrated in Figure 9.1. The model was proposed based on the four determined factors of collaboration in Chapter 7 and the 10 KPIs to measure CJV project performance in Chapter 8. The three hypotheses would be empirically tested throughout the study.

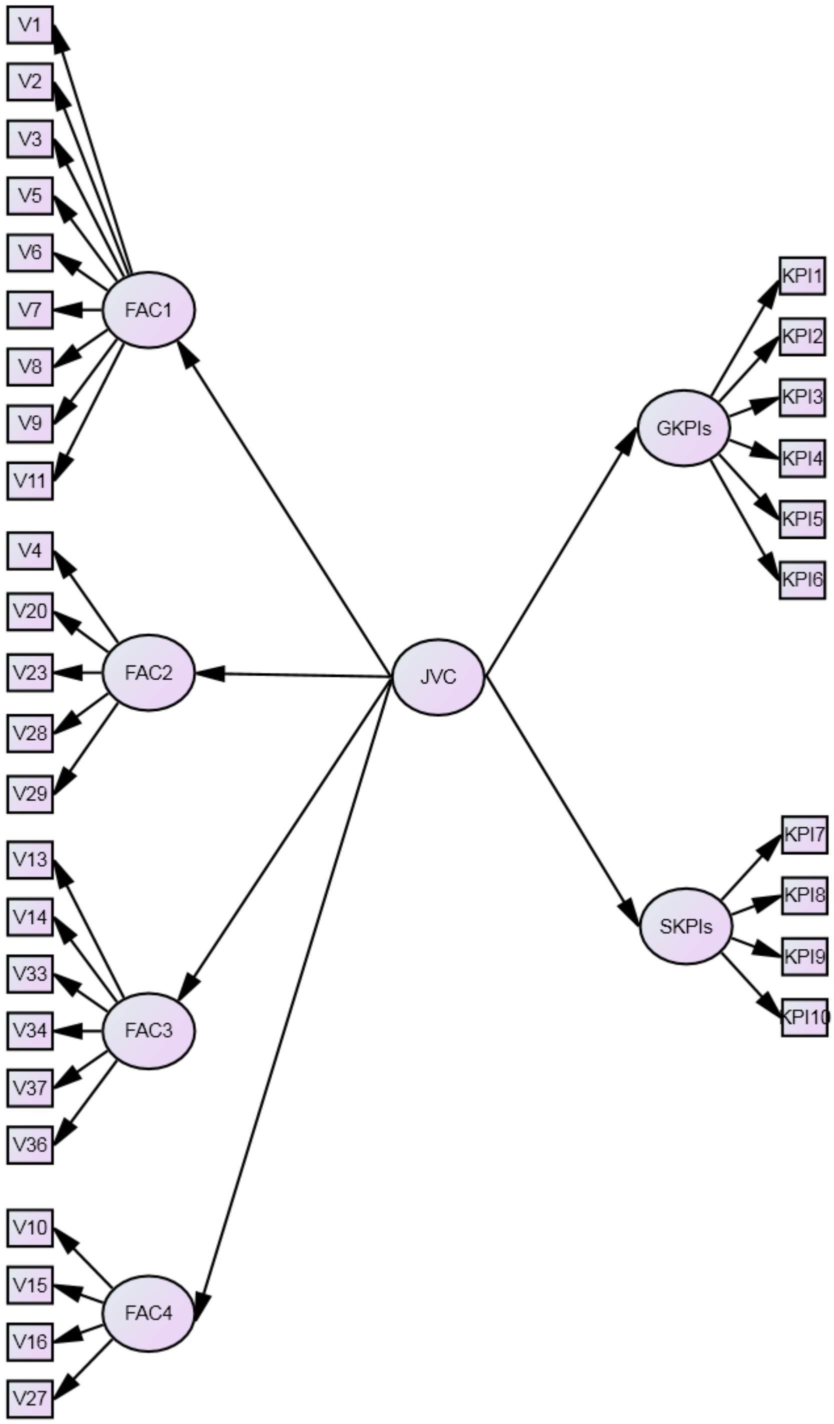

Figure 9.1 Hypothesized relationship model between factors of collaboration and project performance in construction joint ventures

Note: 'FAC1', 'FAC2', 'FAC3', and 'FAC4' represent the four determined factors of collaboration in CJVs.

'JVC' represents the latent variable of '*collaboration in CJVs*'.

'GKPIs' and 'SKPIs' represent '*generic performance of CJV projects*' and '*JV-specific performance of CJV projects*' respectively.

9.3 Analysis of Questionnaire Survey Results

9.3.1 Structural equation modeling

Structural equation modeling (SEM) was adopted in this study because it takes into account the latent variables that are unobserved concepts of prime interest to researchers and can only be approximated by observable or measurable variables (Ullman, 2006). SEM can also correct or assess measurement errors by providing explicit estimates of error variance parameters (Molenaar et al., 2000). SEM was performed in *AMOS 20.0* to test and evaluate the significance of the relationships between inter-partner collaboration and project performance in CJVs. Common goodness-of-fit indexes (GFIs) were employed to evaluate the adequacy of the hypothesized CFA and SEM models. The adopted GFIs were the ratio between the chi-square and degrees of freedom (χ^2/df), comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and non-normed fit index (NNFI). Standard error and critical ratio (*t* value) were incorporated into the assessment criteria for model fit because the estimation of factor loadings and errors could be problematic even if the overall good fit is observed (Yuan et al., 2012).

As a rule of thumb, the model fits the data when χ^2/df is less than 2, the RMSEA value is less than 0.080 (Browne and Cudeck, 1993, p. 136), and the CFI and NNFI (TLI) values are greater than 0.90 (Wen et al., 2004; Bentler and Bonett, 1980). These recommended benchmarks for GFIs and the statistics of significance levels, which were also adopted by other studies (Molenaar et al., 2000; Ozorhon et al., 2011), are enumerated in Table 9.1.

Table 9.1 Reliability values and Fit Indices for the SEM model

Goodness of Fit Indices	Recommended values	SEM output values
χ^2/Df	The lower, the better; $1 < \chi^2/Df <= 5$	χ^2 (650.4) / Df (520) = 1.25
CFI	CFI >= 0.90	**<u>0.939</u>** > 0.90
TLI (NNFI)	TLI >= 0.90	**<u>0.931</u>**> 0.90
RMSEA	<= 0.05: good model fit; <=0.08: acceptable	**<u>0.048</u>**
SE	0.008 ～0.36	All within recommended range
P value	< 0.05	All loadings are significant at **<u>0.001</u>** or below level

Before looking into the overall model fitness, the internal reliability and validity of the data and models were assessed. The construct-reliability (CR) index was computed with a value of over 0.7 indicating good reliability (Hair et al., 2010, p. 687). Average variance extracted (AVE) was calculated to assess the discriminant validity of the SEM model, where the AVE of a factor should be preferably greater than its squared correlations with other factors (Hon et al., 2013). The exception to this condition is when the value of 1 is not included within the 95% confidence interval of factor correlation, where that pair of factors is still perceived as having discriminant reliability (Bagozzi and Phillips, 1982).

9.3.2 Stepwise multiple regression analysis

Stepwise multiple regression analysis was conducted via the SPSS statistical package to explore the effects of different collaboration factors on individual KPIs in CJVs. A stepwise regression procedure can produce a best-fit model in which the variables that can significantly increase the amount of variance accounted for are added, whereas less significant variables are removed (Pallant, 2010, p. 150). In each regression equation, the independent variables were the collaboration factors, and the dependent variables were the individual KPIs. The score of each collaboration factor was calculated according to factor score weights on each collaboration attribute. For example, the equation for computing the score of Factor 1 is indicated as follows:

Factor 1 = 0.134*V1 + 0.127*V2 + 0.154*V3 + 0.045*V4 + 0.179*V5 + 0.175*V6 + 0.14*V7 + 0.124*V8 + 0.119*V9 + 0.004*V10 + 0.115*V11 + 0.01*V12 + 0.069*V13 + 0.072*V14 – 0.054*V15 – 0.064*V16 + 0.038*V17 + 0.03*V18 – 0.016*V19 – 0.027*V20 + 0.014*V21 + 0.052*V22 – 0.011*V23 + 0.09*V24 + 0.058*V25 + 0.029*V26 – 0.02*V27 – 0.097*V28 – 0.026*V29 – 0.054*V30 – 0.086*V31 – 0.038*V32 – 0.083*V33 – 0.014*V34 + 0.005*V35 + 0.005*V36 – 0.048*V37 – 0.063*V38

where each independent variable is a collaboration attribute in CJVs.

A rule of thumb suggests that the sample size should be a minimum of 10 times the number of independent variables (Greenwood and Wu, 2012), which is well satisfied by the 107 r esponses obtained. This study specifies that outliers with standardised residuals greater than 2.5 were excluded from the analysis. Statistics of the regression results, including the related standardised regression coefficients (β), the corresponding coefficients of determination (R^2), the adjusted R-square value (adjusted R^2) and level of significance, were extracted and adopted to analyse the relationships between factors of collaboration and each KPI for CJVs.

9.4 Results of SEM and Regression Analysis

9.4.1 Reliability and validity of SEM model

Construct reliability (CR) measures the internal consistency of the latent variables in a model. In the SEM model, the values of CR (Table 9.2) were all above the recommended level of 0.7 (Hair et al., 2010, p. 719), implying that all endogenous factors achieved good internal consistency. Construct validity is the extent to which an observation measures the concept it is intended to measure (Bagozzi and Phillips, 1982). Two broad criteria for construct validation, convergent validity and discriminant validity, were proposed by Campbell and Donald (1959) and have been pervasively utilised to evaluate construct validity. Convergent validity can be assessed via the significance of the factor loadings of the observable variables on their respective latent factors (Anderson and Gerbing, 1988). As shown in Figure 9.2, all path coefficients in the SEM model were significant. Thus, convergent validity was achieved in the model. The results of the discriminant validity test as portrayed in Table 9.2 also demonstrated the discriminant validity of the six latent variables because the 95% confidence interval of the correlation between each pair of latent variables does not include the value of 1.

Table 9.2 Construct reliability, discriminant validity, and squared correlation of latent variables in the SEM model

Latent variables	Factor 1	Factor 2	Factor 3	Factor 4	G-KPIs	S-KPIs	Construct Reliability
Factor 1	0.523[a]						0.906
Factor 2	0.392[b]	0.482					0.806
Factor 3	0.442 (0.605, 0.710)	0.111	0.522				0.883
Factor 4	0.494 (0.656, 0.750)[c]	0.433 (0.608, 0.710)	0.187	0.533			0.807

Table 9.2 (continued)

G-KPIs	0.522		0.896
S-KPIs	0.618 (0.738, 0.836)	0.451	0.839

[a]Average variance extracted along diagonal

[b]Squared factor correlation

[c] The 95% confidence interval of factor correlation

9.4.2 SEM results

Before exporting the estimates in the hypothesized SEM model, the modification indices (MIs) were reviewed to diagnose the model deficiency. It was found that MI for the covariance between the residues of Variable 36 and Variable 37 is very high (33.3) in comparison with other MIs. After rigorous review and analysis of the two observed variables, it was therefore extrapolated that collinearity exists between the two variables, implying that the two variables to a large extent measures the same aspect of collaboration (Freund et al., 2010). Therefore, the initial SEM model was adjusted by correlating the residues of V36 with those of V37. The factor structure and factor loadings of the adjusted SEM model, along with standardised parameters estimates, are discerned in Figure 9.2. All standardised path coefficients were statistically significant ($p < 0.001$) and were above 0.5, justifying the adequacy of estimation (Hair et al., 2010). When compared with the recommended benchmarks, the actual GFI results indicated that the SEM model fits the empirical data well: χ^2/df =; RMSEA = 0.048; CFI = 0.939; and NNFI = 0.931. As shown in Table 9.3, the standard error and critical ratio (all greater than 1.96) of the standardised coefficient estimates also supported the model fitness.

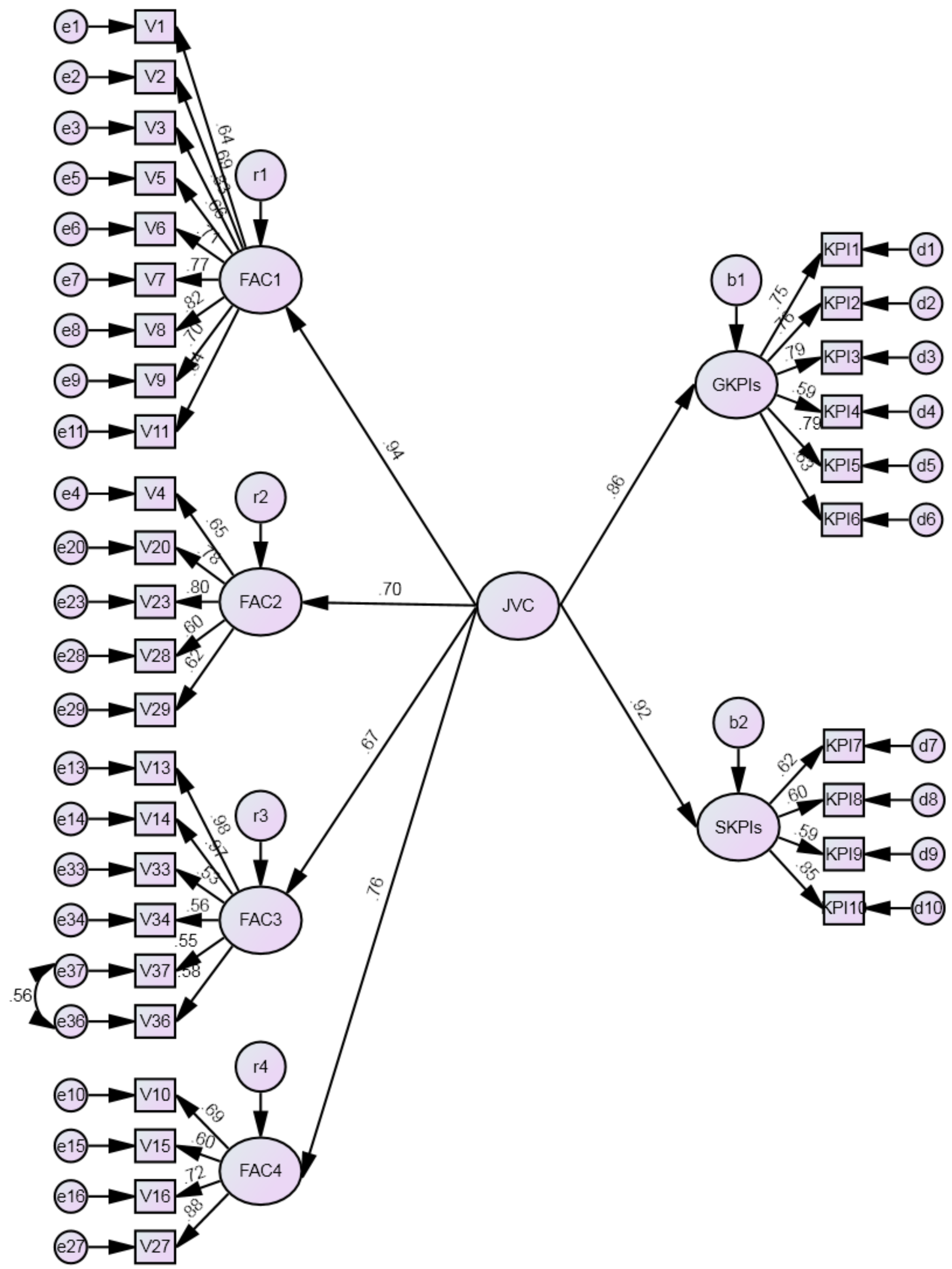

Figure 9.2 Structural equation model for factors of collaboration and project performance in construction joint ventures

Table 9.3 Standardised parameter estimate, standard error and critical ratio for the Structural Equation Model

			Estimate	Standard error (S.E.)	Critical ratio (C.R.)
FAC1	<---	JVC	.937		
FAC2	<---	JVC	.699	.181	4.670
FAC3	<---	JVC	.666	.237	5.773
FAC4	<---	JVC	.756	.247	5.047
GKPIs	<---	JVC	.858	.258	5.811
SKPIs	<---	JVC	.924	.190	5.181
V11	<---	FAC1	.643	.210	5.892
V9	<---	FAC1	.704	.221	6.287
V8	<---	FAC1	.819	.226	7.090
V7	<---	FAC1	.774	.232	6.833
V6	<---	FAC1	.711	.221	6.395
V5	<---	FAC1	.664	.219	6.045
V3	<---	FAC1	.829	.235	7.225
V2	<---	FAC1	.693	.208	6.314
V1	<---	FAC1	.643		
V4	<---	FAC2	.652		
V20	<---	FAC2	.776	.175	6.515
V23	<---	FAC2	.803	.156	6.671
V28	<---	FAC2	.595	.209	5.161
V29	<---	FAC2	.619	.157	5.346
V37	<---	FAC3	.553	.092	6.635
V36	<---	FAC3	.576	.076	7.079
V34	<---	FAC3	.557	.072	6.733
V33	<---	FAC3	.529	.072	6.273
V14	<---	FAC3	.974	.035	29.492
V13	<---	FAC3	.979		
V27	<---	FAC4	.885	.130	7.548
V16	<---	FAC4	.718	.130	6.510
V15	<---	FAC4	.600	.106	5.541
V10	<---	FAC4	.687		
KPI1	<---	GKPIs	.754		
KPI2	<---	GKPIs	.756	.125	7.834
KPI3	<---	GKPIs	.791	.116	7.989
KPI4	<---	GKPIs	.588	.115	5.841
KPI5	<---	GKPIs	.787	.114	8.120
KPI6	<---	GKPIs	.634	.116	6.448
KPI7	<---	SKPIs	.618		
KPI8	<---	SKPIs	.598	.180	5.252
KPI9	<---	SKPIs	.588	.198	5.028
KPI10	<---	SKPIs	.847	.233	6.568

Note: (1) All factors loadings are statistically significant at 0.001 level.

(2) FAC1, V1, V4, V10, V13, K1, K7 are the specified standardised parameters in SEM.

Based on the standardised path coefficients in the SEM model output, the relationship between JVC and G-KPIs is significantly positive as the standardised path coefficient from JVC to G-KPIs was 0.86 and statistically significant at the level of below 0.001. Thus, H1 was supported. JVC accounted for approximately 73.6% (R^2 = 0.736) of the variance in G-KPIs. The explanatory power of JVC to the level of achievement of G-KPIs is considerably large such that a one-unit increase of collaboration level in CJVs leads to an enhancement of approximately 0.7 unit on the level of general indicators of project performance. Similarly, the standardised path coefficient from JVC to S-KPIs was 0.92, indicating the significant positive relationship between JVC and S-KPIs. H2 was well supported because JVC accounted for approximately 85.4% (R^2 = 0.854) of the variance in S-KPIs. Therefore, inter-partner collaboration in CJVs has a profound effect on the achievement of the performance measures specific for CJV projects. In the estimation of the relationships between JVC and KPIs, JVC was found to have stronger explanatory power ($R^2 = 0.924^2 = 0.854$) for S-KPIs than G-KPIs ($R^2 = 0.858^2 = 0.736$) for JV construction projects.

An in-depth examination into the indirect effects of the four clustered factors of collaboration under the two categories of KPIs for CJVs reveals that the indirect effect of Factor 1 (mutual trust and teamwork spirit) on S-KPIs was highest among the effects of each collaboration factor on either of the two groups of KPIs for CJV projects, with the aggregated effect coefficient of 0.865 (0.94 × 0.92). The lowest indirect effect (0.67 × 0.86 = 0.576) was between Factor 3 (proper management of financial and human resources and gain-share/pain-share mechanism) and G-KPIs. This statistical finding implies the determinant role of mutual trust and teamwork spirit in shaping the achievement of JV-specific performance measures (i.e. technology transfer, improvement of JV management skills, increase in market share, and overall satisfaction with JV contracting experience).

9.4.3 Regression results

As revealed from Table 9.4, except for KPI-8 (increase of market share), the other nine KPIs with the adjusted R^2 values are all greater than the minimum acceptable value of 0.5 as advocated by Barreto and Howland (2006) (ranging from 0.618 to 0.878) after excluding some "outlier" cases. This result indicates that almost all individual KPIs, as the dependent variables in the regression models, could be largely explained by the four clustered factors of collaboration, which are the independent variables in the regression equations. The explanatory power of the independent variables in most regression models for the 10 KPIs were perceived as significant when referring to the value of R^2 (adjusted R^2) in other studies to assert the significance of the explanatory power of independent variables for the dependent variable. Recent examples include the adjusted R^2 value of 0.58 in Windapo (2013) for examining the relationship between the level of compliance to occupational health and safety regulations and the degree of risk and cost in construction, the adjusted R^2 value of 0.45 in Mir and Pinnington (2013) for predicting project success utilising project management performance variables, and the R^2 value lower than 0.7 in Greenwood and Wu (2012) for examining the association between the attributes of collaborative working and indicators of project performance.

Table 9.4 Results of stepwise multiple regression analysis

Independent variable	Unstandardised coefficient (*B*)	Standardised coefficient (β)	R^2	Adjusted R^2	t value	*p* value
KPI-1: The project was completed within schedule (*N*=102)						
Constant	0.843	---	---	---	3.559	0.001
Factor 1	0.529	0.654	0.583	0.579	9.422	0.000
Factor 3	0.196	0.234	0.626	0.618	3.376	0.001
KPI-2: The project was completed within budget (*N*=104)						
Constant	-0.256	---	---	---	-1.082	0.282
Factor 1	0.516	0.546	0.568	0.564	9.216	0.000
Factor 3	0.438	0.445	0.723	0.717	7.511	0.000
KPI-3: The required project quality was achieved (*N*=101)						
Constant	-0.939	---	---	---	-5.727	0.000
Factor 2	0.711	0.685	0.670	0.667	18.844	0.000
Factor 1	0.445	0.478	0.881	0.878	13.164	0.000
KPI-4: The project achieved good safety performance (*N*=102)						
Constant	-0.287	---	---	---	-1.124	0.264
Factor 2	0.676	0.616	0.558	0.554	10.918	0.000
Factor 1	0.378	0.418	0.716	0.710	7.406	0.000
KPI-5: The client's requirements/expectations were satisfied in the project (*N*=103)						
Constant	0.174	---	---	---	0.815	0.417
Factor 3	0.398	0.499	0.542	0.537	8.528	0.000
Factor 2	0.296	0.342	0.688	0.682	6.307	0.000
Factor 1	0.218	0.285	0.747	0.739	4.802	0.000
KPI-6: JV contracting parties made reasonable profits from the project (*N*=101)						
Constant	0.243	---	---	---	1.186	0.238
Factor 1	0.436	0.518	0.555	0.550	8.873	0.000
Factor 3	0.419	0.485	0.738	0.733	8.294	0.000
KPI-7: Technology transfer was achieved in the project (*N*=103)						
Constant	-0.813	---	---	---	-4.793	0.000
Factor 1	0.469	0.547	0.629	0.626	13.304	0.000
Factor 2	0.420	0.419	0.834	0.830	10.243	0.000
Factor 4	0.203	0.221	0.870	0.866	5.249	0.000
KPI-8: Market share was increased via the JV contracting approach (*N*=105)						
Constant	1,251	---	---	---	4.065	0.000
Factor 1	0.280	0.365	0.234	0.227	4.313	0.000
Factor 2	0.313	0.359	0.349	0.336	4.242	0.000
KPI-9: JV management skills was improved through the JV contracting experience (*N*=103)						
Constant	0.049	---	---	---	0.258	0.797
Factor 3	0.640	0.719	0.717	0.714	13.374	0.000
Factor 1	0.228	0.271	0.774	0.770	5.042	0.000
KPI-10: JV contracting parties were satisfied with the JV overall contracting experience (*N*=104)						
Constant	-0.123	---	---	---	-0.557	0.579

Table 9.4 (continued)

Factor 1	0.431	0.515	0.594	0.590	8.443	0.000
Factor 3	0.277	0.319	0.699	0.693	5.418	0.000
Factor 4	0.206	0.237	0.742	0.734	4.097	0.000

Note:
Factor 1: Mutual trust and teamwork spirit

Factor 2: Team skills development and mutually agreed quality, safety and health standards

Factor 3: Proper management of financial and human resources and gain-share/pain-share mechanism

Factor 4: Effective communications and information sharing

The specific KPI with the highest percentage of variance being explained by collaboration factors is KPI-3, with an R^2 value of 0.878. In the regression model of KPI-3, Factor 2 (Team skills development and mutually agreed quality, safety and health standards) and Factor 1 (mutual trust and teamwork environment) were the explanatory variables that had significant contributions (both with significance level of 0.000) to the achievement of required project quality. In the 10 regression models, the collaboration factors as explanatory variables are different for individual KPIs. For instance, the contributing variables for the performance of KPI-1 was Factor 1 (mutual trust and teamwork spirit) and Factor 3 (proper management of financial and human resources and gain-share/pain-share mechanism), whereas Factors 1 (mutual trust and teamwork spirit), Factor 2 (team skills development and mutually agreed quality, safety and health standards) and Factor 4 (effective communications and information sharing) were the explanatory variables in the regression model best fit for the dependent variable KPI-7. Interestingly, Factor 1 significantly contributed to each of the 10 KPIs, though explaining varied degrees of variances across different KPIs.

Overall, Factor 2 has significant influence on KPIs-3, 4, 5, 7 and 8. Factor 3 significantly affects KPIs-1, 2, 5, 6, 9 and 10. Factor 4 significantly affects only KPIs-7 and 10. Although Factor 1 and Factor 2 have significant relationships with KPI-8 (increase of market share), only a small part of the variance in KPI-8 (adjusted R^2 = 0.333) can be explained by the two factors. This condition implies that other external variables not covered in this study (e.g. corporate development strategy) may exert profound influences on the increase of market share. On the basis of the observed different effects of collaboration factors on the individual KPIs for CJVs, H3 is accepted.

In particular, the regression results showed that Factor 1 (mutual trust and teamwork spirit) and Factor 3 (proper management of financial and human resources and gain-share/pain-share mechanism) both significantly affect the performance measures of project time performance KPI-1 (adjusted R^2 = 0.602), project cost performance KPI-2 (adjusted R^2 = 0.703), and making profits KPI-6 (adjusted R^2 = 0.540). For these three performance measures, the effects from the other three collaboration factors may be limited as time and cost savings, as well as profit maximisation, are intuitively attributable to the collaborative working and relationship management efficiency of the JV contracting parties based on teamwork spirit, mutual trust and proper management of various resources while not so much affected by team skills development and mutually agreed quality, safety and health standards, together with frequent communications and information sharing. The significant contribution of Factor 2 to KPI-3 and KPI-4, with the variances of 67.0% and 55.8% explained respectively, supports the intuitive effect of concerted efforts in setting stringent quality, safety and health standards on the achievement of desirable project quality and safety performance. Another noteworthy point is that the regression result for

KPI-10 reflects JV partners' overall consideration of the four factors of collaboration in judging their satisfactions with JV collaborating experience as there are three factors (Factors 1, 3 and 4) significantly affecting the level of achievement of KPI-10. Factor 3 and Factor 1 affect KPI-9 in the sense that lessons on JV management styles could be learned from the process of creating a collaborative working environment and effective relationship management via mutual trust and teamwork spirit in terms of proper resource control and allocation.

9.5 Insights and Implications from Research Findings

Although the apparent positive influences of inter-partner collaboration on project performance in CJVs were observed, mostly only two factors of collaboration contribute significantly to the achievement of each performance measure (KPI) of CJVs. This observation evidenced the diversified scope of different factors of collaboration in CJVs as reflected by a wide spectrum of collaboration attributes. The observation also arouses the need of considering specific collaboration factors and their underlying attributes to make improvements to the target performance measures and to achieve overall desirable performance in CJV projects.

As revealed by the research findings, regarding the improvements to the general project performance measures (e.g. time, cost, quality and safety) in CJVs, attributes of collaboration under Factors 1 and 2 s hould be placed with greater concerns. Teamwork spirit enables the improvement of the collaborative working efficiency of the JV team that results in time and cost savings. By comparison, the mutual contributions of JV partners to project quality and safety facilitate the delivery of high-standard products and better constructed facilities. In the pursuit of solid achievements in JV-specific performance measures (e.g. technology transfer, increase in market share and partners' satisfaction), apart from Factor 1, JV partners should look particularly into Factors 3 and 4. Unlike other contracting relationships where partners may play distinctive roles in projects, CJVs are mostly formed by two or more parallel parties (e.g. two or more main contractors) with similar functioning mechanisms to work as an integrated team on a construction project. Under this relationship context, the effective relationship management and proper resource input and allocation are the factors of particular importance to sustain a satisfactory and well-functioning CJV relationship. Effective communications and information sharing would strengthen the connection and commitment between JV partners that determines the subjective assessments of JV partners on their satisfactions with JV overall contracting experience. From a s trategic perspective, general project performance measures almost exclusively pertain to short-term gains reaped through CJV practices, whereas long-term strategic benefits are associated with JV-specific performance measures. In view of the influences of different collaboration factors on the two categorized groups of performance measures, the JV parties involved may adjust their collaborative behaviours to realise their expected financial and/or strategic returns (short-term oriented or long-term oriented) throughout the CJV operation.

The comparatively limited contribution of collaboration to the performance measure of increase in market share suggests the need of probing into other behavioural aspects or management strategies beyond inter-partner collaboration to seek market share increase by engaging in a CJV contracting relationship. Previous research studies have highlighted the complement and combination of technology/specialist skills as a major impetus of forming CJVs (e.g. Norwood and

Mansfield, 1999; Munns et al., 2000), especially for contractors without special equipment/expertise to be capable of undertaking technically complex infrastructure projects. In this regard, the superiority of CJVs in the integration of technology also improves the contractors' qualifications in winning the biddings of construction projects, thus enhancing their market competency and competitiveness. Apart from the partners' collaboration in a CJV relationship, landmark stances and technical complexity of the projects undertaken by CJV parties are also perceived to significantly account for the increase of corporate share in the construction market.

Technology transfer throughout CJVs has also been extensively raised in prior studies. JV appears to be the most widely preferred vehicle for construction technology transfer (Kumaraswamy and Shrestha, 2002). Although the benefits of technology transfer to local contractors through JVs have been well observed, the process was observed to be fraught with problems (Ofori et al., 2001). As implied by the research findings of this study, nurturing an integrated working environment with strong team spirit and dedicated inputs to deliver quality products and better constructed facilities are perceived as the most viable measures to facilitate technology exchange and transfer between CJV partners.

9.6 Chapter Summary

This chapter explored the relationships between inter-partner collaboration and project performance for CJVs at two levels. The first level is associated with the effect of collaboration on two broad categories of performance measures (i.e. G-KPIs and S-KPIs). The second level of analysis addressed the influence of different factors of inter-partner collaboration on individual KPIs for CJV projects. The research findings supported the three proposed hypotheses. An apparent association between inter-partner collaboration and KPIs for CJVs, as well as the different impacts of collaboration factors on individual KPIs, were observed and demonstrated.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

This chapter presents a summary of the key research findings tailored to the proposed research aim and objectives. The significance of research and contributions of this study are also highlighted in this chapter. Finally, the limitations of the research and suggestions for future research directions are provided.

10.2 Summary of Major Research Findings

This study aims to develop a model that explains and crystallises the relationships between collaboration factors among JV contracting parties and JV project performance in the construction industry. The specific research objectives are: (1) To identify the key benefits of applying CJVs and the major difficulties impeding CJV success, and analyse their relative importance; (2) To solicit and compare the perceptions of CJV participants at different working levels on the assessment of the practical issues concerning CJV application; (3) To develop the measurement attributes and determine the factors of collaboration for CJV projects; (4) To determine a list of key performance indicators (KPIs) for measuring CJV project performance; and (5) To develop a model for investigating the relationships between a set of collaboration attributes of CJV partners and various performance measures of CJV projects.

10.2.1 Identification and classification of the motives and benefits of CJV application and difficulties of CJV success

A list of 15 perceived motives and benefits of CJV application has been derived from the systematic desktop literature review and structured interviews. These motives and benefits cover but are not limited to the financial (e.g. potential risk sharing/reduction, strengthening the financial capability), organisational (e.g. combination of resources, specialist skills and expertise, achievement of technology exchange and transfer), corporate strategic (e.g. establishment of long-term strategic business relationships, increasing market share), and international CJV specific (e.g. entering into a foreign market, meeting governmental requirements) aspects. The motives and benefits have been further classified into four clustered factors using factor analysis, being ‘risk sharing and resource integration’ (Factor 1), ‘improvement of JV partners’ competency and market strength’ (Factor 2), ‘technology transfer and profit gains’ (Factor 3), and ‘access to the international market’ (Factor 4).

Similarly, a list of 17 potential difficulties of CJV success was identified in this study. These impediments to the success of CJVs are related to the lack of fundamentals of JV collaboration (e.g. lack of knowledge about JV contracting method, lack of mutual understanding among JV team members), conflicts among JV partners (e.g. conflict of interest between the parties outside the JV agreement, inconsistent project objectives among JV team members), JV management difficulties (e.g. inflexibility of JV organisational operations, difficulties with JV financial administration), and inter-organisational differences (e.g. incompatible organisational cultures among JV contracting parties, differences in organisational policies). Four clustered factors of the difficulties were also derived through factor analysis. These factors are F1—lack of fair and effective management mechanisms for the operation and control of CJV partnership, F2—lack of mutual trust, communications and understanding, F3—differences in organisational cultures, policies and management styles, and F4—potential conflicts beyond JV partnership. With these difficulties effectively addressed, a successful operation of CJVs leading to more desirable project performance could be anticipated.

10.2.2 Cross-comparison between CJV participants at different working levels on the assessment of practical issues concerning CJV application

The identified relative importance of the motives and benefits of CJV application and the level of existence of the difficulties impeding CJV success are of practical value to guide the JV industrial practitioners in rational selection of CJVs and avoidance or resolution of the impediments to successful operation of CJVs. The Kendall's concordance analysis, together with the Chi-square test, revealed that a reasonable degree of consensus on the rankings of the motives and benefits of CJV application and the difficulties of CJV success was achieved among the respondents within each of the three respondent groups: senior management group, project management group and technical/site working group. The spearman's rank correlation test implied a significant difference between senior management and technical/site working group respondents on their perceptions towards the relative importance of the motives and benefits of CJV application, whereas for the assessment of difficulties of CJV success, the three groups of respondents reached a significant level of consensus on the ranking exercise. The result of one-way ANOVA test disclosed that the three respondent groups reached a significant level of consensus on the level of agreement on each of the elicited motives/benefits and difficulties as measured by the mean values.

10.2.3 Measurement attributes and factors of collaboration in CJVs

The factors of collaboration were derived from a list of 38 measurable attributes of collaboration in CJVs. Exploratory factor analysis (EFA) enables to extract four factors of collaboration including Factor 1—mutual trust and teamwork spirit, Factor 2—team skills development and mutually agreed quality, safety and health standards, Factor 3—proper management of financial and human resources and gain-share/pain-share mechanism, and Factor 4—effective communications and information sharing. These factors of collaboration in CJVs reflect the behavioural aspects of inter-partner collaboration in the specific context of CJV projects.

10.2.4 KPIs for measuring JV project performance

Drawing upon an extensive desktop literature review and some structured interviews, a list of ten key performance indicators (KPIs) was developed to comprehensively and concisely measure JV project performance from the perspectives of the JV contracting parties. These KPIs encompassed project time performance, project cost performance, project quality performance, project safety performance, client's satisfaction, profit gains, technology transfer, increase in market share, improvement of JV management skills, and satisfaction with JV collaboration experience. A fuzzy synthetic evaluation model was established to quantitatively measure CJV project performance based on the KPIs derived. A real-life JV project case was used to validate the practicality of the measurement framework.

10.2.5 Relationships between collaboration factors and project performance in CJVs

As highlighted in Chapter 1, this study aims to explore the relationships between collaboration factors and project performance for CJVs at two levels. The first level is associated with the impact of collaboration on two broad categories of performance measures (generic measures and JV-specific measures) while the second level of analysis addresses the influence of different factors of collaboration on individual KPIs for CJV projects. Based on the developed structural equation model, the relationships between factors of collaboration and project performance in CJVs were identified and interpreted. The research hypotheses were tested and supported. Significant contributions of collaboration attributes to the generic project performance and JV-specific performance were revealed. Furthermore, the results of stepwise regression demonstrated disparate influences of different factors of collaboration on the achievement of different KPIs for CJV projects.

10.3 Significance and Contributions of Research

10.3.1 Contributions to existing knowledge

Firstly, the present study has contributed to the literature of CJVs through a systematic examination of the motives and benefits of application and the difficulties in achieving success during implementation. The derived list of motives and benefits of CJV application and the list of obstacles to CJV success integrated the outputs and findings from previous studies and formed valuable references for future studies to explore similar issues concerning CJV application.

In addition, the existing literature on collaboration in construction only fragmentarily referred to some elements of it without full reflection or coverage of its behavioural aspects especially in CJV projects. The present study conceptualized a series of behavioural attributes of JV partners into the 'collaboration in CJVs' framework and systematically explored its impact on JV project performance. With the development of the measurement model for collaboration in CJVs, this study has enriched the current knowledge base on the understanding of collaborative aspects in CJVs, which could provide industrial practitioners with some useful insights into the effective management and assessment of collaboration in CJV projects.

Thirdly, a multi-faceted performance measurement framework for CJV projects has been developed in this study. By doing this, the study contributed to the literature with a solid reference for future research to consider and/or incorporate the various performance aspects for measuring the overall performance of CJV projects. The FSE-based measurement model also enriched the literature by providing an effective tool to quantify, assess, and monitor the overall performance of CJV projects.

As the main contribution of the study to the literature of CJVs, the predictive power of collaboration in CJVs for explaining the level of achievement of JV project performance was validated by the statistically significant relationships between JV collaboration factors and two groups of performance measures (generic KPIs and JV-specific KPIs) of CJV projects. The result has also reinforced that collaboration between JV partners is a significant determinant indicator for JV project performance. Varied impacts of different factors of collaboration on the level of achievements of different KPIs for CJV projects were explored by using stepwise multiple regression analysis. These diversified influences could enhance the understanding about the contributions of specific collaboration aspects to the improvement of a specific performance aspect for CJV projects and could also provide valuable insights for JV project managers to enhance specific collaborative behaviours of JV partners for improving the overall JV project performance.

10.3.2 Practical values for industrial application

First of all, the assessment of the motives and benefits of CJV application in the study provided a solid basis for the industrial practitioners to make sensible decisions for entering into a CJV contracting relationship by taking account of their expected motives/benefits. The different levels of importance with respect to the difficulties of CJV success enable the decision-makers to contemplate and adopt appropriate effective strategies and efficient resource allocation schemes to overcome the potential impediments and strive for the ultimate success of CJVs.

The derived CJV collaboration factor model has also served as a benchmarking tool for measuring the level of collaboration among JV partners in CJVs. Taking advantage of the determined factors of collaboration, JV project managers could periodically measure, monitor and enhance the level of collaboration within the integrated JV project team. The developed performance measurement framework consisting of ten KPIs and FSE-based model have provided a reliable platform for JV project managers to periodically assess, monitor and improve CJV project performance.

Furthermore, the significant relationships between JV collaboration factors and the two sets of performance measures for CJV projects have further demonstrated the importance of various behavioural aspects of collaboration between JV partners in order to improve the performance of CJV projects by the JV project managers. The diversified influences of different factors of collaboration on t he level of achievements of individual KPIs for CJV projects have generated useful pointers for JV project managers to strengthen specific collaborative behaviours of JV partners for raising the performance of CJV projects from the specific performance aspect (as reflected by specific KPI) and ultimately to improve the overall JV project performance.

10.3.3 Generalisation of research findings to other countries or regions

Although this study was mainly conducted in Hong Kong, the research findings may also be generalised to other countries or regions, such as Mainland China, Singapore, Japan, the United Kingdom, Australia, etc where JVs have been adopted extensively in the construction industry. The identical operational process of project-based JVs, coupled with their shared characteristics such as the presence of predetermined, limited life span and its activities oriented towards well-defined project objectives (Hung et al., 2002), has provided the theoretical basis for the generalisability of research findings based in Hong Kong. With this in mind, future research studies could also employ the derived measurement model to measure and assess the levels of collaboration in CJVs, gauge and evaluate JV project performance, and examine the impact of partner’s collaboration on project performance for CJV projects in other countries (regions), such as Singapore and the United Kingdom where the practices of JVs in construction projects have been well-documented in the existing literature (e.g. Chow, 1985; Carrillo, 1996). Specifically, the case of Singapore greatly resembles Hong Kong, where public infrastructure and utilities services are compact as a result of the limited land size. In such countries/regions, JVs sufficiently address the requirement of specialized skills or technologies sometimes not possessed by local contractors (Kwok et al., 2000).

10.4 Limitations of the Study

Notwithstanding the perceived theoretical and practical values of the study, it is also noted that the research findings are subject to several potential limitations. First, although the ratio of sample size to observed variables in this study approximates to 5:1, which is the favoured threshold value for conducting factor analysis (Lingard and Rowlinson, 2006; Gagne and Hancock, 2006), it is suggested that the sample size be enlarged (e.g. 200 or more) in order to capture wider responses and further reduce sampling errors, though unable to be fully avoided in reality. Similarly, although there is no rule of thumb on the ratio of sample size to observed variables under investigation when conducting SEM analysis, it would be preferable if a larger sample size could be obtained in order to secure the reliability of SEM test results. Future research studies may specifically target more JV-based construction projects to obtain more valid responses for subsequent statistical analysis.

In addition, the distribution of senior management, project management and technical/site working groups are not exactly balanced (the number of valid respondents for the three groups being 12, 58 and 37 respectively), it would be more representative to solicit more samples from the senior management group in the survey, although reasonable levels of agreement have been reached among the three groups of respondents in rating some practical issues of CJV application (e.g. motives and benefits of adopting CJVs, and KPIs for CJV projects).

Another limitation of this study concerns the adoption of perceptual measures for measuring JV project performance. Composite measures of JV project performance and JV inter-partner collaboration are based on r espondents' own perceptions rather than actual observations. For measuring some project performance measures such as time, cost, quality, safety, subjective measures are rarely used. However, attitudinal measurement was still adopted in this study for evaluating these performance measures after considering the difficulty in collecting sufficient and necessary objective data and the consistency with the measurement of inter-partner collaboration in CJVs using attitudinal evaluations (i.e. five-point Likert scale).

Last but not least, this study was launched based in Hong Kong and the value of research to other regions or countries is subject to further verifications, although it may be agreed that CJVs are underpinned by common essential elements irrespective of the locations where the contracting relationship was established and executed. Hence, it is still recommended for conducting future similar research investigations in other regions or countries for cross-comparisons and generalisation of common research findings for practical implementation.

10.5 Future Research Directions

Apart from the cross-sectional questionnaire survey, future studies on inter-partner collaboration in CJVs could be launched with use of different research methods that could better reflect the behavioural aspects of collaboration, such as case study and documentation analysis. In addition, future investigations could attempt to generate a mixed measurement framework incorporating both subjective and objective measures to assess partner's collaboration in CJVs and JV project performance.

Considering this study is regional in nature, further research could be undertaken in other regions (countries), such as Mainland China, Singapore, Japan, the United Kingdom, Australia, etc where JVs have been widely applied in the construction industry. With the research findings presented in this study based in Hong Kong and future studies based in other regions (countries), cross-comparisons can be made in order to detect any similarities and differences on the practical issues concerning CJV application. Finally, a benchmarking tool for measuring inter-partner collaboration could be established for use after combining the survey results on the assessment of collaboration attributes in Hong Kong and other places.

Another possible direction of future research could target on identifying other potential factors and explore their impacts on CJV project performance. For example, JV partner selection, the type of projects involved, and governmental policies in CJVs, may pose significant influences on the partners' behaviours and ultimately impact on JV project performance. A spectrum of such research studies, including the present one, are useful in providing comprehensive and practical guidelines, at the behavioural level, for achieving overall desirable performance of CJV projects.

10.6 Chapter Summary

As a conclusion of the whole thesis, this chapter presented a summary of the major research findings, highlighted the significance and contributions of the study, and described the limitations of the present study. In addition, future research directions were proposed to enrich the current knowledge base on CJVs. Some valuable insights into the improvement of collaboration among JV partners and the overall CJV project performance should be gained based on the research outcomes generated from this study.

APPENDICES

APPENDIX 1: Sample of Invitation Letter for Structured Interviews

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF BUILDING & REAL ESTATE
建築及房地產學系
INTERNATIONAL • COLLABORATIVE • CONSTRUCTION

25 September 2012

Dear *Sir/Madam*,

Request for an Interview on "An Investigation of Inter-partner Collaboration in Construction Joint Venture Projects and Its Impacts on Project Performance in Hong Kong

We are currently undertaking a doctoral research project entitled "*An Investigation of Inter-partner Collaboration in Construction Joint Venture Projects and Its Impacts on Project Performance in Hong Kong*". The main objective of this project is to identify the benefits and difficulties of implementing joint venture contracting method and measure the impacts of collaboration among joint venture parties on the performance of joint venture projects in Hong Kong.

As an experienced academic in the construction field, you are cordially invited to participate in our research study **as an expert advisor to our research team**. We would like to request from your kind permission to conduct an interview to discuss the benefits of joint venture application, difficulties of joint venture success, collaboration features in construction joint venture projects and performance indicators of joint venture projects. The interview period lasts for approximately one hour and we wish to launch the interview **near the middle of October of 2012**. All the information you provide will be kept in strict confidence and it will be used solely for research purposes. A list of questions for the interview is enclosed herewith for your reference and preview.

We strongly believe that your hands-on experience and professional advice are highly valuable to our research study and construction community at large. If you have come up with convenient timing for the interview, please contact me by email: hym.bre@ , or by phone: -2766-5827.

Apart from the interview, we wish to solicit, if possible, some basic information and data about construction projects adopting joint venture contracting method, i.e., contractors JV, subcontractors JV, for our reference and perusal.

Thank you for your kind consideration and generous assistance with our research in anticipation. We are looking forward to seeing you soon.

Yours sincerely,
Mr Hong Yuming
PhD Candidate
Department of Building and Real Estate
The Hong Kong Polytechnic University

APPENDIX 2: Research Interview Questions and Summary of Interview Dialogues

A. Motives / Benefits of Adopting CJVs

1. *What are the motives / benefits of using the CJV approach in construction projects (e.g. resource integration, risk sharing, technology transfer)*

All of the six interviewees considered ‘integrated uses of resources’, ‘risk sharing’, and ‘technology exchange/transfer among JV partners’ as three of the various motives/benefits of CJV application. Over half of the interviewees (Interviewee 2, 3, 4 and 5) perceived ‘improving the credibility of prequalification’ as one of the major motives/benefits and half of them mentioned ‘responding to project technical requirements’ and ‘pooling of expertise’ as two common motives of forming CJVs.

Specifically, Interviewee 1 raised another two potential advantages in the use of CJVs, being better communication relationships with client and improving market expansion capability. The latter motive/benefit concerns the increase of market diversity and market share achieved through the application of CJVs. It is explained by Interviewee 1 that before formal issue of CJV contract, the client normally has sufficient communication with the CJV partners in order to be convinced of their capability in successfully delivering the intended project. Interviewee 2 advocated cultural connection and mutual learning among CJV partners as an important benefit of CJV application that may be gradually achieved throughout the JV operation process. Among the interviewees, two considered (Interview 2 a nd 3) ‘establishment of long-term strategic relationships with partners’ as a strategic benefit of CJVs for the partnered organisations. Overall, the motive and benefits of forming CJVs perceived by the interviewees touch on t he short term and long term, within and between organisational perspectives.

B. Difficulties in CJV Success

2. ***What are the major barriers to adopting CJVs in construction contracts?***

A total of ten perceived impediments to the adoption of CJV approach were raised by the interviewees. 'Organisational culture difference' is the barrier that was perceived by all interviewees. Five of the six interviewees perceived 'lack of mutual trust among CJV partners' as the critical barrier to the entry into a CJV partnership. Three interviewees raised 'inconsistent objectives/interests' and 'conflict in distribution and execution of authority' as the common barriers to collaborating in the form of CJVs. Two of them also referred to 'conflict in input and profit sharing', 'incompatible management style', 'corporate standards difference' and 'disagreement on contract provisions' as the major barriers to adopting CJVs. Specifically, 'difficulty in partner selection' was raised by Interviewee 1 and 'governmental restrictions' was mentioned by Interviewee 2 as another two major barriers to forming CJVs.

3. ***What are the major difficulties encountered for the successful application of CJVs?***

The perceived difficulties of CJV success incorporate most barriers to adopting CJVs. A total of 14 difficulties of CJV success were identified by the interviewees. Among those barriers to CJV success, organisational cultural differences and lack of mutual trust were mentioned by all interviewees. Half of the interviewees (Interviewee 1, 3 and 6) considered conflict in distribution of authority as a significant source of CJV failure.

As the fundamental elements of CJV success, lack of mutual trust, lack of problem-solving and dispute resolution mechanism, lack of mutual understandings among JV team members, and lack of effective communication were perceived by the interviewees as the major barriers to CJV success. Specifically, a lack of a s taff training scheme was raised by Interviewee 4 as disadvantageous to the success of CJVs.

With respect to inter-organisational differences, apart from the organisational cultural differences, Interviewees 2 a nd 5 a lso nominated the differences and conflict in working procedures and corporate standards between CJV partners as the barriers to CJV success. Incompatible management style was also regarded by Interviewee 3 (a senior practitioner) as one of the inter-organisational variations contributing to the possible failure of CJVs.

As to JV management difficulties, the difficulty in the integration of JV team members was identified by Interviewee 3 as a potential barrier to the smooth operation of CJVs. Looking at the aspects of conflicts between CJV partners, inconsistent objectives (Interviewee 6), conflict in distribution of authority in resource allocation (Interviewees 1, 3, and 6), and unfair input and profit sharing (Interviewees 4 and 5) were identified as major sources of CJV failures.

C. Collaboration Features in CJV Projects

4. *What are the typical collaboration features in CJV projects?*

A total of 18 be haviour features of collaboration between CJV partners were identified by the interviewees. Almost all interviewees (5 out of 6) perceived 'frequent, open and effective communication', 'frequent project meetings/workshops', 'mutual trust', 'integration of JV team members', 'achievement of technology exchange/transfer' as the basic features of inter-partner collaboration in a CJV relationship. Over two interviewees have also reached consensus regarding the features of 'solving problems effectively together', 'top management support and communication', 'opening account to JV partners', 'establishment of conflict/dispute resolution and avoidance mechanism' and 'fair risk sharing' as the reflections of collaboration between JV partners.

Some specific features of collaboration were also raised by different interviewees. Interviewee 4 enumerated 'sharing of resources' and 'work monitoring scheme' as the essential elements of collaboration in CJV projects. Interviewee 2 added 'agreement in provision of staff training scheme' as an essential feature of collaboration. Interviewee 3 valued 'compatible organisational culture' as a r eflection of collaboration between CJV partners. Interviewee 5 i ndicated that 'JV management flexibility', 'regular progress review' and 'clear working distribution' are some typical attributes of collaboration in CJVs while ‘efficient information sharing among JV parties’ was raised by Interviewee 6 as indispensable in a good collaborative relationship between CJV partners.

5. ***What are the critical success factors for CJVs?***

‘Mutual trust’ and ‘frequent, open and effective communication’ were perceived by all interviewees as the two most critical success factors of CJVs. Following these two factors, ‘compatiblity of organisational culture’ and ‘fair risk sharing’ were identified by three interviewees as critical to the success of CJVs. Other factors that were perceived by individual interviewees as critical to CJV success were ‘exchange/transfer of technology’ (Interviewee 1), ‘establishment of efficient JV team structure’ (Interviewee 3), ‘sharing resources effectively’ (Interviewee 4), ‘integration of team members’ (Interviewee 4), ‘work monitoring scheme’ (Interviewee 4), ‘dispute resolution and avoidance scheme’ (Interviewee 4) and ‘integration of expertise’ (Interviewee 5).

D. Perceived Performance Indicators for CJVs

6. ***What are the key performance indicators for CJVs to assess the success of CJV projects?***

The scope of perceived key performance indicators (KPIs) for CJV projects were initially confined to the contractor’s perspective before asking the interview question. A list of ten KPIs was obtained from the interviewees. Three traditional performance measures, i.e. time (completing project within schedule), cost (gaining profits) and quality (achieving required quality) were perceived by each interviewee as the basic KPIs for assess the performance of CJV projects. In addition, safety performance was also identified by each interviewee as essential KPI to measure CJV project performance. Most interviewees (5 out of 6) raised ‘client satisfaction’ as an important measure of CJV project performance. Interview 2 and 4 incorporated ‘establishment of long-term collaborative relationship’ into the KPI group for measuring CJV project performance from the perspective of JV partnered contractors.

Specifically, Interviewee 1 pr oposed ‘improvement of technological capability’ and ‘expansion of market’ as additional KPIs to assess the success of CJV projects. Interviewee 2 i ncluded ‘improvement of JV management skill’ and Interview 4 highlighted ‘satisfaction of JV teamwork’ and ‘mutual learning and benefit’ as the important criteria to assess CJV success.

E. JV projects information

7. ***According to your hands-on working experience, please name some JV projects in which you have been involved over the recent years. If possible, can you provide some detailed information of these case study projects for our reference?***

Four JV construction projects, with three completed and one under construction, were nominated and elaborated by the interviewees. The type of JV form for each project was contractor-JV, i.e. JV formed by contractors. The detailed information of the JV projects are shown in the following table.

Table AX.1 JV project information provided by interviewees

Background	Project Case 1	Project Case 2	Project Case 3	Project Case 4
Project name	Hong Kong Conventional Exhibition Centre (second phase)	MTR West Island Line, SYP & HKU stations, SYD to KET tunnels	Shanghai World Financial Center	Guangzhou International Financial Centre (West Tower)
Location of project	Hong Kong, China	Hong Kong, China	Shanghai, China	Guangzhou, China
Nature of project	Government Exhibition Building	Railway Tunnel	Commercial Office Building	Commercial Office Building
Procurement method	N/A	N/A	Management Contracting	Management Contracting
Form of contract	Lump sum contract	Target Cost Contract	Guaranteed Maximum Price	Guaranteed Maximum Price
JV partners	Dragages (50%) and Hip Hing Construction (50%) JV	Gammon Construction and Nishimatsu WIL JV	China State Construction Engineering Corporation (70%) and Shanghai Construction Corporation (30%)	China State Construction Engineering Corporation and Guangzhou Municipal Construction Group Corporation JV
Contract period	June 1994 ~ June 1997	Mar 2010 ~ Jun 2014	Feb 2003 ~ Aug 2008	Jan 2007 ~ Nov 2009
Total contract sum	HK$ 4.80 billion	HK4.80 billion	HK$ 9.36 (7.3 Billion RMB)	HK$ 1.73 (1.35 Billion RMB)

APPENDIX 3: Sample of Invitation Letter for Questionnaire Survey

January 2013

Dear *Sir/Madam*,

<u>Re: Invitation for Participating in a Research Survey</u>

I am currently undertaking my full-time doctoral research project entitled "***An Investigation of Inter-partner Collaboration in Construction Joint Venture (CJV) Projects and Its Impacts on Project Performance***" under the direct supervision of Associate Professor Dr Daniel Chan and Professor Albert Chan. The main objectives of this project are to identify the perceived benefits and potential difficulties of implementing the joint venture contracting method, and to measure the impacts of collaboration amongst the joint venture partners on the performance of construction joint venture projects in Hong Kong.

As an experienced practitioner in the construction management sector, you are cordially invited to give your views on this collaborative contracting method by completing this survey questionnaire. All the information and data you provide will be kept in strictest confidence and it will be used solely for research purposes. A blank sample form is enclosed herewith for your perusal and responses. I strongly believe that your hands-on experience and professional advice are highly valuable to my research study and construction community at large.

Please kindly return your completed survey questionnaire by your preferred choice: (a) by post to Mr HONG Yuming using the attached stamped self-addressed return envelope; OR (b) by fax to 2764-5131 for the attention of "Mr HONG Yuming"; OR (c) via email to "<u>hym.bre@</u>______________", **<u>on or before 1 February 2013 (Friday)</u>**.
Should you have further enquires, please feel free to contact me by phone at 2766-5827. Thank you in advance for your generous assistance with my research study.

Yours sincerely,

Mr HONG Yuming (洪羽明), PhD Candidate

Department of Building and Real Estate

The Hong Kong Polytechnic University

APPENDIX 4: Blank Questionnaire Survey Form

Project Title: An Investigation of Inter-partner Collaboration in Construction Joint Venture Projects and its Impacts on Project Performance

This questionnaire survey aims to investigate the contribution of Joint Venture (JV) contracting method to project performance within the construction industry. It will take about 15 minutes to complete this questionnaire. Respondents are assured that this survey is completely anonymous and responses will be treated with the strictest confidentiality.

*** Joint venture contracting method in this study refers to "a partnership arrangement between two or more contracting companies covering building, mechanical and electrical engineering, or other specialist services for the purpose of tendering for, and executing a new building or civil engineering contract, each of the participating companies having joint and several liabilities for their contractual obligations to the employer".**

*** Joint venture partners in this study refer to "the firms (dominantly the main contractors) jointly tendering for a new building or civil engineering contract".**

Section A – Background of Respondent

1. **Region where you work:** ☐ Hong Kong (China) ☐ Mainland China ☐ United Kingdom
   ☐ Other (please specify): ____

2. **Current position in your organisation:** ___________________________________

3. **Professional affiliation (you may select more than one option):**

   ☐ Architect ☐ Engineer ☐ Quantity Surveyor

   ☐ Builder ☐ Project Manager ☐ Contracts Manager

   ☐ Other (please specify): _____________________________________

4. **Years of working experience in the construction industry:**

   ☐ Less than 5 years ☐ 5-10 years ☐ 11-15 years

   ☐ 16-20 years ☐ More than 20 years

5. **Working level within your organisation (please select the most relevant option):**

   ☐ Technical / Site level ☐ Project management level ☐ Senior management level

   ☐ Other (please specify): ____________________________________

6. **Number of joint venture project(s) involved (including on-going projects):**

   ☐ 0 (Please answer Sections B and C only) ☐ 1-3 ☐ 4-6 ☐ 7-9 ☐ 10 or more

Section B – Motives and Benefits of Establishing Construction Joint Ventures (CJVs)

Please indicate your level of agreement on the following statements by using the scoring system listed below:

1 = Strongly disagree; 2 = Disagree; 3 = Neutral / No strong view; 4 = Agree; 5 = Strongly agree

No.	Motives and Benefits of Establishing Construction Joint Ventures (CJVs)	Level of Agreement					Not Applicable
		1	2	3	4	5	
		Strongly disagree ↔ Strongly agree					
1	Spreading / Sharing financial risk.	☐	☐	☐	☐	☐	☐
2	Pooling of resources.	☐	☐	☐	☐	☐	☐
3	Pooling of skills and knowledge.	☐	☐	☐	☐	☐	☐
4	Strengthening the financial capability.	☐	☐	☐	☐	☐	☐
5	Increasing profit returns.	☐	☐	☐	☐	☐	☐
6	Improving competitive edge / competitiveness in market.	☐	☐	☐	☐	☐	☐
7	Increasing credibility of pre-qualification during tender.	☐	☐	☐	☐	☐	☐
8	Improving communication relationships with clients.	☐	☐	☐	☐	☐	☐
9	Achieving technology transfer.	☐	☐	☐	☐	☐	☐
10	Establishing long-term strategic business relationships.	☐	☐	☐	☐	☐	☐
11	Increasing market share.	☐	☐	☐	☐	☐	☐
12	Gaining reputation within the construction industry.	☐	☐	☐	☐	☐	☐
13	Entering into a new foreign market.	☐	☐	☐	☐	☐	☐
14	Meeting legal requirements of a particular country	☐	☐	☐	☐	☐	☐
15	Maintaining an overseas presence / Increasing market diversification.	☐	☐	☐	☐	☐	☐
16	Other:	☐	☐	☐	☐	☐	☐

Section C – Difficulties in Achieving Joint Venture (JV) Success

Please indicate your level of agreement on the following statements by using the scoring system listed below:

1 = Strongly disagree; 2 = Disagree; 3 = Neutral / No strongly view; 4 = Agree; 5 = Strongly agree

No.	Difficulties in Achieving Joint Venture (JV) Success	Level of Agreement					Not Applicable
		1	2	3	4	5	
		Strongly disagree ↔ Strongly agree					
1	Lack of knowledge about JV contracting method.	☐	☐	☐	☐	☐	☐
2	Conflict of interest between the parties outside the JV agreement.	☐	☐	☐	☐	☐	☐
3	Inconsistent project objectives among JV team members.	☐	☐	☐	☐	☐	☐
4	Lack of mutual understanding among JV team members.	☐	☐	☐	☐	☐	☐
5	Lack of mutual trust among JV contracting parties.	☐	☐	☐	☐	☐	☐
6	Lack of communications among JV contracting parties.	☐	☐	☐	☐	☐	☐
7	Incompatible organisational cultures among JV contracting parties.	☐	☐	☐	☐	☐	☐
8	Inconsistent management style among JV contracting parties	☐	☐	☐	☐	☐	☐
9	Differences in organisational policies (e.g. corporate quality standards) among JV contracting parties.	☐	☐	☐	☐	☐	☐
10	Inflexibility of JV organisational operations	☐	☐	☐	☐	☐	☐
11	Unfair gain-share/pain-share among JV contracting parties.	☐	☐	☐	☐	☐	☐
12	Lack of mutually agreed conflict resolution mechanism among JV contracting parties.	☐	☐	☐	☐	☐	☐
13	Lack of entire management control over JV partners.	☐	☐	☐	☐	☐	☐
14	Lack of strategic planning for JV operation.	☐	☐	☐	☐	☐	☐
15	Difficulties with JV financial administration.	☐	☐	☐	☐	☐	☐
16	Lack of top management support for creating right working atmosphere throughout the JV contracting process.	☐	☐	☐	☐	☐	☐
17	Conflicts in distribution and execution of authority.	☐	☐	☐	☐	☐	☐
18	Other:	☐	☐	☐	☐	☐	☐

Section D – Inter-partner Collaboration Achieved in Joint Venture (JV) Projects

Please name a recently completed or nearly completed JV construction project on which your responses are based:

____

Number of JV partners involved (including your company): ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

1. **Which sector is the JV project representing?**

☐ Public sector ☐ Private sector ☐ Quasi-public sector

☐ Other (please specify): ____________________________________

2. **Which work type does the JV project belong to?**

☐ Office building ☐ Residential building ☐ School building

☐ Highway ☐ Railway ☐ Bridge

☐ Roadwork ☐ Reclamation ☐ Drainage / Sewage / Water

☐ Other (please specify): ____

3. **Major role of your organisation in the JV project (please select the most relevant option):**

☐ Client organisation ☐ Main contractor ☐ Quantity surveying firm

☐ Project consultant ☐ Supervisor ☐ Specialist subcontractor

☐ Supplier ☐ Other (please specify):____________________________________

4. **Please indicate your level of agreement on the following attributes of collaboration achieved in the above nominated JV construction project by using the scoring system listed below:**

1 = Strongly disagree; 2 = Agree; 3 = Neutral / No strongly view; 4 = Agree; 5 = Strongly Agree

No.	Attributes of Collaboration in Joint Venture (JV) Projects	Level of Agreement				
		1	2	3	4	5
		Strongly disagree ⟷ Strongly agree				
1	An environment of open dialogues existed between JV contracting parties (i.e. open communications) in the project.	☐	☐	☐	☐	☐
2	A common aim was shared by the JV contracting parties to the project.	☐	☐	☐	☐	☐
3	Collaboration created a joint problem-solving environment.	☐	☐	☐	☐	☐
4	Early warning system for any problems was integral to the project.	☐	☐	☐	☐	☐
5	JV relationship was operated under a non-adversarial environment.	☐	☐	☐	☐	☐
6	An environment of mutual trust was developed between JV contracting parties in the project.	☐	☐	☐	☐	☐
7	JV team members contributed to the project (i.e. commitment).	☐	☐	☐	☐	☐
8	Teamwork spirit existed between JV team members involved in the project.	☐	☐	☐	☐	☐
9	JV team members understood the roles and responsibilities of other team members in the project (i.e. mutual understanding).	☐	☐	☐	☐	☐
10	JV team members fully understood the different cultures of their JV partners.	☐	☐	☐	☐	☐
11	JV team members respected the input from other team members in the project.	☐	☐	☐	☐	☐
12	Risks were allocated fairly to the JV contracting parties in the project.	☐	☐	☐	☐	☐
13	The gain-share / pain-share mechanism is fair to JV contracting parties in the project.	☐	☐	☐	☐	☐
14	Relationships between the JV contracting parties were well-managed.	☐	☐	☐	☐	☐

No.	Attributes of Collaboration in Joint Venture Projects	Level of Agreement				
		1	2	3	4	5
		Strongly disagree ⟷ Strongly agree				
15	There were regular meetings between the JV contracting parties.	☐	☐	☐	☐	☐
16	Various natures of workshops were held involving JV contracting parties.	☐	☐	☐	☐	☐
17	Value engineering (management) was an integral part of the project.	☐	☐	☐	☐	☐
18	Collaborations promoted long-term business relationships.	☐	☐	☐	☐	☐
19	Financial accounts and reports are accessible to JV contracting parties in the project.	☐	☐	☐	☐	☐
20	JV team members were allowed to develop their skills and extend their inputs beyond the traditional role.	☐	☐	☐	☐	☐
21	Work performance was measured by using some key performance indicators (KPIs) in the project.	☐	☐	☐	☐	☐
22	The JV project provided ample opportunities for repeated business in future.	☐	☐	☐	☐	☐
23	A formal quality assurance mechanism formed part of the project.	☐	☐	☐	☐	☐
24	Conflict resolution mechanism was established in the JV project.	☐	☐	☐	☐	☐
25	The JV project streamlined the administrative process.	☐	☐	☐	☐	☐
26	The flexibility of management was observed in the JV project.	☐	☐	☐	☐	☐
27	JV contracting parties encouraged more effective information sharing in the project.	☐	☐	☐	☐	☐
28	JV contracting parties encouraged greater innovations.	☐	☐	☐	☐	☐
29	JV contracting parties set higher safety and health standards in the project.	☐	☐	☐	☐	☐
30	JV contracting parties devoted more collaborative efforts to reduce construction waste in the project.	☐	☐	☐	☐	☐
31	JV contracting parties placed greater concerns over sustainability in the project.	☐	☐	☐	☐	☐
32	JV team members demonstrated a track record of collaboration in previous projects.	☐	☐	☐	☐	☐
33	Financial stability was maintained among JV contracting parties.	☐	☐	☐	☐	☐
34	Equity among JV contracting parties was well-observed.	☐	☐	☐	☐	☐
35	Organisational structures of JV contracting parties were found compatible to each other in the project.	☐	☐	☐	☐	☐
36	Effective management control (e.g. strategic, operational, structural, etc) was achieved among JV contracting parties.	☐	☐	☐	☐	☐
37	Effective human resources management was achieved among JV contracting parties.	☐	☐	☐	☐	☐
38	JV contracting parties encouraged technology transfer / exchange between each other in the project.	☐	☐	☐	☐	☐
39	Other:	☐	☐	☐	☐	☐

Section E – Perceptions on the Performance of Joint Venture Projects

Please rate the **"level of importance"** on the following key performance indicators (KPIs) for joint venture construction projects by using the scoring system listed below. Please also rate the extent to which the following key performance indicators (KPIs) were achieved ("**level of agreement**") **based on your nominated JV construction project in Section D**, by using the scoring system listed below.

*** Level of Importance:**
1 = Least important; 2 = Fairly important; 3 = Important; 4 = Very important; 5 = Most important

*** Level of Agreement:**
1 = Strongly disagree; 2 = Disagree; 3 = Neutral / No strong view; 4 = Agree; 5 = Strongly agree

Example: If you perceive the **importance** of the first KPI "Time Performance" to be "very important", and the JV project was completed ahead of schedule, then please tick **4** under "Level of Importance" and **5** under "Level of Agreement".

	Key Performance Indicators	Level of Importance					Level of Agreement				
		1	2	3	4	5	1	2	3	4	5
		Least imp. ⟷ Most imp.					Str. disagree ⟷ Str. agree				
1	The time performance of this JV project was good (i.e. completed within schedule).	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	The cost performance of this JV project was good (i.e. completed within budget).	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	The required project quality was achieved.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	The project achieved good safety performance.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	The client's requirements / expectations were satisfied in the project.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6	JV contracting parties made reasonable profits from the project.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7	Technology transfer was achieved in the project.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8	Market share was increased via the JV contracting approach.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9	JV management skills were improved through the JV contracting experience	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10	JV contracting parties were satisfied with the JV overall contracting experience.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11	Other:	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Section F – Personal Views on Collaboration in Future Joint Venture (JV) Projects

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am willing to team up with the same partnered organisation(s) as another JV to bid for future construction projects if appropriate.	☐	☐	☐	☐	☐

End of the questionnaire. Thank you for your kind participation

Please kindly return your completed survey questionnaire by your preferred choice: (a) by post to Mr HONG Yuming using the attached stamped self-addressed return envelope; OR (b) by fax to 2764-5131 for the attention of "Mr HONG Yuming"; OR (c) via email to "hym.bre@   ", **on or before 12 January 2013 (Saturday).**

Reply Slip (Optional)

Those who wish to receive a summary of the research findings, please enter the details below:

Name:__________________________________

Organisation:__________________________________

Email:__________________________________

APPENDIX 5: Full Pattern Matrix of 38 Attributes of Collaboration in CJVs

Table AX.2 Pattern matrix for PCA and promax rotation of the attributes of collaboration in CJVs

Attribute number	Attribute of Collaboration in CJVs	Pattern Coefficients				Communalities
		C1	C2	C3	C4	
V6	An environment of mutual trust was developed between JV contracting parties in the project.	**0.716**	0.058	0.063	0.024	0.611
V5	JV relationship was operated under a non-adversarial environment.	**0.712**	0.287	0.032	-0.195	0.643
V3	Collaboration created a joint problem-solving environment.	**0.669**	-0.015	0.117	0.191	0.681
V7	JV team members contributed to the project (i.e. commitment).	**0.620**	-0.031	0.128	0.216	0.631
V8	Teamwork spirit existed between JV team members involved in the project.	**0.580**	0.110	0.135	0.204	0.669
V1	An environment of open dialogues existed between JV contracting parties (i.e. open communications) in the project.	**0.567**	0.157	0.123	-0.062	0.465
V2	A common aim was shared by the JV contracting parties to the project.	**0.556**	-0.094	0.227	0.107	0.509
V9	JV team members understood the roles and responsibilities of other team members in the project (i.e. mutual understanding).	**0.547**	-0.083	0.131	0.291	0.576
V11	JV team members respected the input from other team members in the project.	**0.515**	0.214	0.007	0.117	0.475
V24	Conflict resolution mechanism was established in the JV project.	0.431	0.405	-0.176	0.226	0.556
V20	JV team members were allowed to develop their skills and extend their inputs beyond the traditional role.	0.048	**0.733**	-0.011	0.132	0.651
V23	A formal quality assurance mechanism formed part of the project.	0.108	**0.727**	-0.021	0.125	0.675
V29	JV contracting parties set higher safety and health standards in the project.	0.034	**0.696**	0.048	0.021	0.539
V4	Early warning system for any problems was integral to the project.	0.249	**0.594**	0.015	-0.151	0.454
V28	JV contracting parties encouraged greater innovations.	-0.185	**0.520**	0.289	0.160	0.459
V25	The JV project streamlined the administrative process.	0.349	0.477	0.105	0.071	0.600
V21	Work performance was measured by using some key performance indicators (KPIs) in the project.	0.191	0.326	0.061	0.294	0.428
V33	Financial stability was maintained among JV contracting parties.	-0.121	0.083	**0.788**	-0.003	0.583
V37	Effective human resources management was achieved among JV contracting parties.	0.009	-0.011	**0.768**	0.068	0.635
V34	Equity among JV contracting parties was well-observed.	0.100	0.077	**0.714**	-0.126	0.566
V14	Relationships between the JV contracting parties were well-managed.	0.395	-0.180	**0.655**	-0.059	0.704
V13	The gain-share / pain-share mechanism is fair to JV contracting parties in the project.	0.387	-0.186	**0.648**	-0.022	0.702

Table AX. 2 (continued)

V36	Effective management control (e.g. strategic, operational, structural, etc) was achieved among JV contracting parties.	0.189	-0.034	**0.632**	0.102	0.603
V32	JV team members demonstrated a track record of collaboration in previous projects.	0.012	0.315	0.485	-0.132	0.468
V35	Organisational structures of JV contracting parties were found compatible to each other in the project.	0.197	0.032	0.476	0.199	0.583
V31	JV contracting parties placed greater concerns over sustainability in the project.	-0.115	0.356	0.471	0.191	0.532
V12	Risks were allocated fairly to the JV contracting parties in the project.	0.201	-0.063	0.469	0.268	0.523
V19	Financial accounts and reports are accessible to JV contracting parties in the project.	0.088	-0.080	0.457	0.247	0.382
V26	The flexibility of management was observed in the JV project.	0.256	0.263	0.400	0.002	0.508
V16	Various natures of workshops were held involving JV contracting parties.	-0.061	0.067	-0.062	**0.844**	0.683
V15	There were regular meetings between the JV contracting parties.	-0.042	-0.034	0.034	**0.734**	0.517
V10	JV team members fully understood the different cultures of their JV partners.	0.170	-0.055	0.046	**0.679**	0.584
V27	JV contracting parties encouraged more effective information sharing in the project.	0.123	0.168	0.108	**0.648**	0.708
V17	Value engineering (management) was an integral part of the project.	0.253	0.265	-0.184	0.462	0.476
V18	Collaborations promoted long-term business relationships.	0.253	0.113	0.084	0.434	0.470
V22	The JV project provided ample opportunities for repeated business in future.	0.336	0.022	0.187	0.365	0.504
V30	JV contracting parties devoted more collaborative efforts to reduce construction waste in the project.	-0.029	0.300	0.246	0.313	0.401
V38	JV contracting parties encouraged technology transfer / exchange between each other in the project.	-0.064	0.263	0.292	0.300	0.373

Note: C1, C2, C3, C4 denote Components 1, 2, 3, and 4.

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