Thesis for the Degree of Doctor of Philosophy

Supply Chain Management in the Vietnamese Construction Industry

by

Nguyen Thanh Viet

Interdisciplinary Program of Construction Engineering and Management

The Graduate School

Pukyong National University

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Advisor: Prof. Soo Yong Kim

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Approved by:

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Chairman   Prof. Young Dai Lee

_____   _____

Member   Prof. Soo Yong Lee   Member   Prof. Nam Gi Lim

_____   _____

Member   Prof. Jin Kook Yang   Member   Prof. Soo Yong Kim

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Abstract

Supply Chain Management (SCM) is extremely current due to its success in other industries and therefore considered to be the future of construction. In production operation, the implementation of SCM has been proved to achieve cost saving, facilitate innovation in organizations, increase productivity and profitability, and improve organizational competitiveness. However, its application in construction is relatively new and the construction industry has been slowly developed in deploying this concept as compared with the manufacturing industry. This may be caused by barriers against its implementation. Moreover, a lack of understanding about the benefits of the SCM implementation may be one of the causes that lead to lack of active interest of the parties towards the deployment of construction supply chain management (CSCM) practices in their projects. Comparing with other industries, the construction industry is project-based temporary organization and discontinuous nature, project-unique design and material specifications with little or no repeatability. The construction supply chain is volatile, unpredictable, and the product environment is relatively unstable. Therefore, the SCM implementation in construction might be more difficult and it is impossible to use SCM principles from other industries to apply the same for the construction context.

In the world until now just limited studies and researches have been performed about SCM in construction. Therefore, the need for more studies on SCM in construction is expected. Although there are studies about CSCM however, most of the previous studies focused on other objectives rather than discovering the benefits and barriers of the CSCM implementation. Therefore, they did not aim to identify benefits, barriers and only gave some elements as an example. In summary, the benefits, barriers found from the previous studies were not enough. Moreover, there was a lack of analysis. As known, construction projects often deal with the poor performance such as schedule delayed, quality defects, and cost overruns. The main cause for the occurrence of the poor performance in the project results from the deterioration of SCM. There are few studies have addressed the impact of supply chain relationships on project performance in construction.

Based on the above, there are five objectives outlined in this study are: (1) identify and investigate the benefits of SCM implementation in construction; (2) identify and examine the barriers to the SCM implementation in construction; (3) identify and discover key factors affecting supply chain relationships in construction; (4) develop a structural model to test the influence of supply chain relationship traits on the project performance (cost, quality, and time); and (5) develop a framework for evaluating the CSC relationships.

The findings are based on literature review and the survey questionnaires that filled by the respondents from industrial practitioners. This study identified twenty benefits and twenty two barriers to the CSCM implementation. These benefits and barriers were ranked from the perspective of owners, contractors, designers, and consultants. These groups generally had a convergence of perceptions on the identified benefits and barriers. They agreed that "increase speed of project construction", "reduce project cost", "improved margins profit", "efficiency in

utilizing the resources and skills", and "improve project quality" were the most significant benefits. The four factors of benefits were extracted investigated: (1) systematic business system, (2) organization management and business strategy, (3) improved project performance, and (4) win-win outcomes among the parties. The findings showed that the implementation of SCM in the construction projects will bring the most significant gains relating to the improved project performance followed by systematic business system, and organization management and business strategy, whereas the win-win outcomes have not been emphasized by the parties. Regarding the barriers to the CSCM implementation, "lack of effective leadership", "lack of competence of the parties in SCM", "lack of understanding the supply chain concept", "passive sub-contractors and suppliers", and organizational resistance to SCM" were the five most important barriers to the CSCM implementation. The barriers were grouped into the five factors, namely, (1) lack of support and active participation from parties, (2) confronting culture and adversarial behavior, (3) inherent difficulties in the supply chain, (4) lack of knowledge and competence, and (5) deficiencies in the contract system. Among of them, factor 4, factor 1, and factor 2 are the most significant factors that require immediate attention to promote the development of the CSCM implementation.

Based on the literature review, top 12 key factors which have a significant influence on supply chain relationships were identified. This study discovered three constructs of the key factors, namely, "collaboration management in the supply chain", "support and commitment to the supply chain", and "sharing the benefits and risks". The key factors and constructs are the important elements to support the development of the structural model for testing the influence of the supply chain relationship traits on the project performance. They are also main criteria and sub criteria to establish the framework for evaluating the supply chain relationships in construction. A two-step SEM model is built to test the hypothesized relationship about the influence of supply chain relationship traits on

project performance. The results indicated that supply chain relationship traits have a significant influence on the project performance. Moreover, the construct identified in this model may help the parties to identify the factors that may result in the effective performance of projects. It can be shown that collaboration management in the supply chain, support and commitment to the supply chain, and sharing the benefits and risks play main roles to ensure the successful project performance. And the collaboration management in the supply chain plays a decisive role. An evaluation framework was developed for the evaluating the CSC relationships. The development of this framework is based on the AHP method. The proposed framework consists of main criteria, sub-criteria, and assessment matrix. The assessment criteria are organized in a hierarchy structure. Three main criteria are broken down into twelve sub-criteria. An assessment is made against sub-criteria. The evaluation framework hopes to be a useful tool for evaluating the degree of the relationship among the parties in the supply chain. The evaluating the individual relationships of each party in the supply chain facilitates to have an overview about the entire supply chain relationships.

This study contributes to the body of knowledge relating to the CSCM. The findings could be useful for similar studies in other countries for international comparison. It can be a document for construction practitioners to understand the key issues of good SCM and how they can manage supply chains better. By using the evaluation framework of CSC relationships, construction organizations and project teams can evaluate their current relationship with others in the supply chain and then to determine key areas that need to be improved better for a long-term cooperation planning in the future.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

1.1 Background and objectives

For the past 15 years, the Vietnam's economy has been really flourishing. In 1994, the per capita GDP was only USD 220, however, it tripled between the years 2002 and 2010 and reached USD 3,800 in 2013. The growth of Vietnam is maintained in international trade and foreign investment, with exports guarantee more than two-thirds of GDP in 2014. The effect of the financial crisis in Vietnam has been limited, with the country experiencing a GDP growth of 5.2% in 2012, 5.4% in 2013, and 5.5% in 2014. Some industries, for example, textiles, shoes, electronics, seafood production, and industrial production have been growing rapidly. The growth prospect in 2015 remains one of the best in Asia, at a rate of 5.6% (Santander-trade, 2015).

Along with the development of the overall economy, the construction industry in Vietnam had a strong growth rate during the review period by the stable economic conditions of Vietnam and despite the decline from 2011 to 2013 due to the slowdown of the real estate market (PRWEB, 2014). In recent years, the Vietnamese construction industry has always been expected to be a promising industry because of the increasing of the social needs. However, construction firms are still very difficult to find a business strategy for sustainable development, access to the effective management model and application of advanced technology in design and construction. Currently, only a few large domestic firms have access

to the methods of management, advanced construction technology and put themselves competing on a par with international contractors, however, they are very lonely because of lack of the assistance and support from their partner to create a truly strong enough to compete and take on an international level. Most of the small and medium remaining firms are operating as a spontaneous trend, no strategy, no strength, and using outdated construction technology.

Besides, currently the Vietnamese market has attraction to a lot of foreign investors such as South Korea, Japan, Singapore, Taiwan, China, EU, and USA. Hence, the construction industry wants to take advantage of these opportunities effectively, enterprises need to learn and grow, using modern management tools in order to increase its competitiveness. In addition, improving the quality of human resources, construction technology, and production of construction materials and fuels is also the urgent needs of the sector. The supply chain management (SCM) in construction is considered one of the best approaches to meet these requirements. To meet the challenges of global competition, the Vietnamese construction industry will have to respond to changes in demands. Since the performance of the industry has great implication to the national economy, the construction industry should be promoted to a greater echelon. Therefore, SCM is a great opportunity to improve productivity of the construction industry by mainly reducing costs and time.

Construction projects include multi engineering disciplines and a network of organization to implement quality work. However, the construction industry is very fragmented with some problems such as the separation between stages of design and construction, poor communication, and lack of collaboration among the parties. These can result in the owner's dissatisfaction with final outcomes of the projects because of schedule delay, cost overruns, or poor quality. Another problem, in each construction project always contains constraints about the time,

the uncertainties and risks, so using the traditional project management techniques is really difficult to achieve the desired service parameters. However, the traditional management approaches always have a tendency to dominate in the construction industry. And the need for a solution to improve more efficiency in construction projects is important to ensure a strong health for the construction industry. SCM had been proposed as a possible measure to increase the growth and competitiveness of the construction industry (O'Brien et al. 2004).

In production operation, the implementation of SCM has been proved to achieve cost saving, facilitate innovation in organizations, increase productivity and profitability, and improve organizational competitiveness (Elumti, 2002). However, the application of SCM in construction is relatively new and the construction industry has been slowly developing in deploying this concept as compared with the manufacturing industry (Tiwari et al. 2014). Especially in Vietnam, the industry as a whole is still highly fragmented. The adversarial culture is still prevailing in the industry. Construction is encouraged to learn from manufacturing and retailing with regards to SCM. However, the supply chains in manufacturing and retailing are quite stable, regular, predictable, and standardized while the majority of supply chains in construction is still volatile, irregular, unpredictable, and differentiated. Therefore, the SCM implementation in construction might be more difficult and it is impossible to use SCM principles from other industries to apply the same for the construction context.

Additionally, in the world until now just limited studies and researches have been performed about SCM in construction (Tiwari et al. 2014). In Vietnam, there are not any researches about SCM in construction. Therefore, the need for more studies on SCM in construction is expected. Although there are studies about construction supply chain management (CSCM) however, most of the previous studies focused on other objectives rather than discovering the benefits and

barriers of the CSCM implementation. Therefore, they did not aim to identify benefits, barriers, but only gave some elements as an example. In summary, the benefits, barriers found from the previous studies were not enough. Moreover, there was a lack of analysis. SCM is regarded as the management of supply relationships (Harland, 1996). Hence, it is necessary to discover factors affecting relationships among the parties in construction supply chain (CSC). The managing relationships affect all areas of the supply chain and have a significant impact on performance (Handfield, 2003). However, the impact of supply chain relationships on project performance in construction has not been explored in most of the previous studies. In order to have success in CSCM, the relationships among the parties should be interested and continuously improved. Improvement of relationships among the parties starts with measurements of relationships among them. Therefore, a framework for measuring construction supply chain relationships among the parties is needed. Only a few researchers attempted to establish a framework for measuring the supply chain relationships. However, the existing frameworks have various weaknesses, for example, lack of evaluation criteria, lack of assigning priority weights to criteria; and may not be generalized to other geographical locations.

Based on the above discussion, the objectives of the study outlined in this thesis is to:

1. Identify and investigate the benefits of the SCM implementation in construction.

2. Identify and examine the barriers to the SCM implementation in construction.

3. Identify and discover key factors affecting supply chain relationships in construction.

4. Develop a structural model to test the impact of supply chain relationship traits on project performance (cost, quality, and time).

5. Develop a framework for evaluating the supply chain relationships in construction.

1.2 Scope and methodology of research

1. This study was conducted in Vietnam.

2. The survey questionnaires were prepared for the participants.

3. The target of questionnaire survey was practitioners who were related to the construction industry such as directorate, project managers, specialist, construction manager, designer engineer, site engineer, and other.

4. The questionnaire survey was conducted by using the online system (Google Docs).

The quantitative research methodology is adopted in this study. The study starts with a review of existing literature on benefits, barriers to the implementation of SCM in construction, and factors affecting supply chain relationships. Data are collected using questionnaires. Then, statistical analysis is carried out for the quantitative data collected from questionnaire survey. The main research tools used in the research include:

- Analytic Hierarchy Process (AHP)

- Factor Analysis

- Structural Equation Modeling (SEM)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of literature on: benefits and barriers to the implementation of the CSCM, and key factors affecting CSC relationships. The main purposes of this chapter are to identify benefits, barriers and key factors affecting CSC relationships, which are used to develop the survey questionnaires in this study. Figure 2.1 presents the flowchart of this chapter.

Figure 2.1 Flowchart of chapter 2

2.2 Benefits of the implementation of construction supply chain management

SCM is an effective approach to managing construction projects (Tiwari et al., 2014). One of the earliest studies of the construction supply chain (CSC) has been reported in relation to a vision for advanced coordination, costing, and control in construction (O' Brien, 1999). The author showed that the implementation of SCM can lead to better coordination, costing and control in a construction industry. It was found that construction supply chain management (CSCM) provides strategies to reduce the project cost and increase the reliability and speed of building construction. CSCM also provides a reasonable basis to improve coordination and control on construction projects, and understanding of firms' production costs and capabilities. The principles of SCM are opposed to traditional methods of planning, controlling and contracting for projects which, are only to optimize individual benefits. The traditional methods have a tendency to support the fragmentation in construction, whereas SCM gives a promise to manage construction projects in a collaborative manner.

London et al. (1998) developed a theoretical supply chain network modelling in the building industry. In the study, they affirmed that the potential benefits of SCM include: faster response times, less waste, reduced inventory holdings, more effective information flow, increased return on investment, and less cost. Walker and Alber (1999) showed that business organizations always want to reduce production costs and lead times, the time of product development time, and to improve the product quality. Different concepts have been applied to get these targets such as business process reengineering, scheduling, materials management, and total quality management, however success, at best, has until now been partitioned. SCM has the potential to address such difficulties and problems because of its holistic nature. In fact, many organizations recognized that they

have better information, communication, and coordination when they interact with their supply chain partners. The construction companies will have advantages in long terms by using the SCM technique. Moreover, they also increase the 10% their annual turnover through this technique. Another benefit may be found to be low transaction costs (Stanford et al., 1999). Stanford et al. (1999) showed that SCM could result in low transaction costs and increased market competitiveness through collaboration among stakeholders in the supply chain.

Vrijhoef (1998) studied co-makership in construction towards CSCM. He argued that the benefits of SCM are quite obvious. In general, SCM provides a powerful theme to increase the coherence and controllability of CSCs as a whole. SCM will help to optimize the material and information flows in CSCs by ways of measurement, redesign and reengineering of the chain process. In addition, it brings opportunities to enhance operations, materials management, and strengthen cooperation and communication in the whole supply chain. Major benefits include savings and cost efficiencies, competitive advantage, and reduced uncertainty and risks. Vrijhoef and Koskela (2000) discussed four roles of SCM. The four roles aim to reduce project costs and time of project construction. These benefits are achieved by simply focusing on the relationship between the site and direct suppliers, transferring activities from the site to earlier stages of the supply chain, and managing an integrated way of the supply chain and the site production. Olsson (2000) indicated that the SCM implementation in construction can reduce costs and time, and improve revenues.

Benefits of integrating the supply chain within the construction industry have been reported by many researchers. Hall (2001) was proved that the integration of the supply chain would result in sharing problems and working together among the parties. This would bring benefits to the owner in handover of project and other benefits for themselves such as improved profit, development of no-blame

culture, development of mutual understanding, and enhanced reputations. Khalfan et al. (2004) looked into the CSC integration literature. The authors argued that one of the characteristics of the integrated CSC is that firms have to coordinate together and their relationships are always maintained for during a project and beyond. These chains aimed to minimize transaction costs, enhance, and transfer of expertise among the parties (Vrijhoef and Voordijk, 2003). Integration of the supply chain helps to streamline the goals of all the parties to achieve the common goals of improving productivity and waste minimization.

Ahmed et al. (2002) documented the benefits of SCM in construction. They mentioned that SCM is said to have visibility and allow development of a consistent supply and demand plan from the customer to the supplier. SCM can provide better service, reduce inventories, reduce paperwork, help consolidate distribution centers, and reduce transportation costs. Handfield and Nichols (2002) performed supply chain redesign by transforming supply chains into integrated value systems. They showed that the best supply chains will solve problems, implement the best solutions, and share the benefits among their members. The effective management of information and materials across the supply chain suggests the benefits such as removing waste, reducing costs, and improving customer satisfaction.

Constructing Excellence (2004) introduced the principles of SCM for organizations. It was pointed that the construction firms provide products and services in a project supply chain that account for about 80% of the cost of the project. The benefits for personal organizations in the SCM include: reduce real costs, remove waste from the process, delivery to better underlying value to the client, more repeat business with key clients, and get a greater confidence in long-term planning. And the benefits for end-users and project owners include: meet users' needs, delivery to time and cost with minimum defects, get higher customer

satisfaction levels, and improve reputation. Wong et al. (2004) relied on literature review and pointed that deploying SCM helps to save production cost, improve the information system, facilitate effective information and facilitate risks and benefits sharing among the parties. SCM also helps the parties to develop the competitive advantage in the competence to meet customers' requirements.

Office of Government Commence (OGC) (2005) gave a guide for SCM in public sector procurement. The OGC indicated that there is the strong evidence that good practice in SCM can benefit all participants in the procurement process. This guide focused on the benefits of SCM for the public sector. It was mentioned that there are a number of clear benefits in the management of public sector supply chains such as better risk sharing, better quality, faster delivery and reduced whole life costs, better defined requirements, increased delivery times and reduced costs. Matipa and Siamuzwe (2005) looked at information and communication technology supported SCM – benefits for construction business in landlocked developing nations. From a brief overview of SCM based on literature review, it was recognized that SCM benefits are elimination of waste, greater efficiency, shared resources and capabilities, synergy, cost-base reduction, customer focus, and greater competitiveness. McDermott and Khalfan (2006) studied achieving supply chain integration within the construction industry. The authors indicated that integration issues should be considered as early as possible in any project that involves procurement. The potential advantages of integration are: better management information, greater profit, lower prices through reduced production costs, lower transaction costs, and better management of the market.

Pryke (2009) reported the concept and development of SCM in the UK construction industry and revealed that as the main objective of SCM is to enhance mutual competitive advantage through improved relationships, integrated processes and increased customer focus. SCM may help to improve poor

relationships among the parties, fragmentation of processes, and lack of customer focus in the construction industry. Similarly, Benton and Henry (2010) indicated that application of concepts of SCM will improve the competitive advantage of construction firms. Besides, it can also improve project quality, completion times, and work methods while decreasing costs, the repeating the business with project owner. Karatas (2009) conducted a survey of SCM as perceived by the US construction industry. The study detailed the results of a questionnaire survey of SCM applied to US construction industry contractors. The results revealed that some factors developing supply chain collaboration with clients and supplier are improved customer service, increased profitability, reducing bureaucracy/paper, and cost reductions within the organization.

Jalbani (2010) conducted a study on SCM in UAE construction industry. He stated that SCM can bring benefits such as bureaucracy reduction, good understanding about the tendency of the market, innovation in design, utilizing efficiently of the resources and skills, improved employee motivation and team working. Aloini et al. (2012) proposed an integrated conceptual model to enhance the implementation of CSCM from a contingent view. The study is an extensive and systematic literature review for assessing the main building elements related to SCM introduction. The authors indicated that CSCM benefits from the literature can be grouped into three concentric categories: organizational effectiveness, business performance, and financial performance. Souza and Koskela (2012) provided a discussion on improving in CSCM. The study was based on a literature review regarding the evolution of SCM theory within the construction environment and a review of the current findings of SCM in industrial engineering. The authors found that construction management is lack of integration among the parties. Therefore, integrated efforts among the parties is really necessary to

improve performance, deliver better projects to the final customers, reduce waste and promote cost reduction throughout the supply chain.

Deshmukh et al. (2014) have studied SCM in the residential construction sector. The authors concluded that residential construction firm use CSCM to maintain the relationship among the parties and improve the project performance relating to cost, quality and time as well. Bureaucracy reduction in residential construction firm through the SCM implementation can bring better understanding about market data, innovation in design, the economy in utilization of resources and skills, increased safety and after-sales service to the customer, improved worker motivation and team-working. By using the SCM process, the parties can integrate in the overall distribution channel to provide better service, reduce inventories, reduce paperwork and reduce transportation costs. Mulla et al. (2015) have just conducted a review of the overview of SCM in the construction industry. They indicated that the implementation of SCM in construction can bring benefits as follows: transparency, trust and efficiency in the management of the supply chain; increased value for money and efficiency; better communications among the parties, increased market competitiveness, and assurance of continuity in business with key clients.

A summary of reference sources for the benefits of the CSCM implementation is presented in Table 2.1. Each of the previous studies listed the different benefits of the CSCM implementation. Review of the literature indicates that "reduce project cost", "improved margin profit", "improve project quality", "enhanced reputations and increased market competitiveness", and "better information, communication and coordination" are the benefits that are the most mentioned. Most of the previous studies focused on other objectives instead of identifying the benefits so the benefits found were insufficient and lacked analysis. This study

attempts to fill these gaps. As a result of the literature review, twenty benefits of the CSCM implementation were identified.

Table 2.1 Summary of reference sources for benefits of the CSCM implementation

Benefits of the CSCM implementation	London et al (1998)	O' Brien (1999)	Walker & Alber (1999)	Stanford et al (1999)	Vrijhoef (1998)	Vrijhoef & Koskela (2000)	Olsson (2000)	Hall (2001)	Ahmed et al (2002)
Reduce project cost	√	√		√	√	√	√		√
Repeat business with key clients									
Sharing problems and working together		√		√				√	
Increase speed of project construction	√	√				√	√		
Improved margin profit	√		√				√	√	
Improve project quality		√						√	
Remove waste from project process	√								
Reduce paperwork									√
Development of mutual understanding		√						√	
Benefit allocation among the parties									
Development of no-blame culture								√	
Enhanced reputations and increased market competitiveness				√	√			√	
Increase customer satisfaction level									
Greater confidence in long-term planning									
Bureaucracy reduction in organization									
Risk sharing among the parties					√				
Better information, communication and coordination	√	√	√	√	√				
Shared resources, data and knowledge									
Efficiency in utilizing the resources and skills					√				
Improved worker motivation and team-working								√	

Table 2.1 Summary of reference sources for benefits of the CSCM implementation (cont.)

Benefits of the CSCM implementation	Handfield & Nichols (2002)	Vrijhoef & Voordijk (2003)	Khalfan et al (2004)	Constructing Excellence (2004)	Wong et al. (2004)	Office of Government Commence (2005)	Matipa & Siamuzwe (2005)
Reduce project cost	√	√	√	√	√	√	√
Repeat business with key clients			√	√			
Sharing problems and working together	√						√
Increase speed of project construction						√	
Improved margin profit				√			
Improve project quality			√	√		√	√
Remove waste from project process	√		√	√			√
Reduce paperwork							
Development of mutual understanding							
Benefit allocation among the parties	√				√		
Development of no-blame culture							
Enhanced reputations and increased market competitiveness				√	√		√
Increase customer satisfaction level	√			√	√		√
Greater confidence in long-term planning				√			
Bureaucracy reduction in organization							
Risk sharing among the parties					√	√	
Better information, communication and coordination			√		√		
Shared resources, data and knowledge		√	√				√
Efficiency in utilizing the resources and skills					√		
Improved worker motivation and team-working							

Table 2.1 Summary of reference sources for benefits of the CSCM implementation (cont.)

Benefits of the CSCM implementation	McDermott & Khalfan (2012)	Pryke (2009)	Benton & Henry (2010)	Karatas (2009)	Jalbani (2010)	Davide Aloini et al (2012)	Souza & Koskela (2012)	Deshmukh et al. (2014)	Mulla et al. (2015)
Reduce project cost	√		√	√			√	√	√
Repeat business with key clients			√						√
Sharing problems and working together									
Increase speed of project construction			√						√
Improved margin profit	√			√	√	√			√
Improve project quality			√			√	√	√	
Remove waste from project process							√		
Reduce paperwork				√				√	
Development of mutual understanding									
Benefit allocation among the parties									√
Development of no-blame culture									
Enhanced reputations and increased market competitiveness	√	√	√		√			√	√
Increase customer satisfaction level		√		√	√			√	
Greater confidence in long-term planning									
Bureaucracy reduction in organization				√	√			√	
Risk sharing among the parties									
Better information, communication and coordination	√					√			√
Shared resources, data and knowledge									
Efficiency in utilizing the resources and skills					√	√		√	
Improved worker motivation and team-working					√			√	

2.3 Barriers to the implementation of construction supply chain management

The SCM concept has been developed in the construction industry since the early of 1990s. However, the construction industry has slowly developed to adopt SCM although its concept has gained a lot of efficiency in the business process (Hai, 2012). The implementation of CSCM may deal with a number of challenges and barriers (Mulla, 2015). Hence, the potential benefits suggested by adopting CSCM may not be materialized if barriers of its implementation are not removed. An effort to identify problems in construction supply chains was done by Vrijhoef (1998). From literature review, he identified 10 basic problems in contemporary CSCs, including: inconsistency of the supply chain, non-transparency of the supply chain process, lack of communication and information exchange, lack of genuine collaboration and good working relations, non-involvement among supply chain participants, confrontation culture within the supply chain, non-commitment to the supply chain, inadequate management of the supply chain, bad controllability of the supply chain, and absence of accurate performance data and effective measurement methods. Akintoye et al. (2000) performed a survey of supply chain collaboration and management in the UK construction industry. It was concluded that CSCM is still in its infancy, but some awareness of the philosophy is evident. The authors identified the key barriers to the integration which include: culture at the workplace, lack of commitment from senior managers, inappropriate support structure and a lack of knowledge of SCM philosophy. Hence, it is necessary to train and educate at all levels in the industry to overcome these barriers. Olsson (2000) discovered a number of obstacles for SCM approaches in the construction industry such as the poor level of logistical competence, the partly limited competition, the strong project focus, and the attitudes and traditions in the construction industry.

Harnan (2000) demonstrated the different challenges that industry facing to adopt the value chain management. He pointed out the major obstacles in the value chain management, which needs to be removed for achieving more benefit from it. The findings showed that technology incompatibility is the least factor of concern, while price pressures are main challenges. Other factors considered in the survey are lack of trust, lack of knowledge/ training, lack of leadership, poor communication. Tan (2001) developed a framework of SCM literature and identified the key drivers towards fully integrated supply chain such as changes in the corporate cultures, trust and communication, mutual objectives, information/knowledge sharing among the parties. In order to get higher levels of supply chain integration, it is necessary to facilitate relationships among the parties in the supply chain to achieve mutual benefits, and build trust among them. It is also important to remove the deep-rooted hindrances of traditional relationships and the adversarial culture in construction by introducing a management framework to facilitate the SCM implementation at the operational level (Dainty et al., 2001). Dainty et al. (2001) suggested that subcontractors and suppliers should be involved early in the project stages. This would allow them to establish closer relationships and also improve communication among the parties. Ahmed et al. (2002) studied on SCM in construction relating scope, benefits and barriers. Some barriers, which might affect the application of the SCM concept in the construction industry, were listed. The researchers concluded the following reasons hindering the development of SCM in construction: lack of guidance to create alliances with partners in the supply chain, failure to develop measures for monitoring alliances, inability to broaden the supply chain vision, inability to integrate the company's internal procedures, lack of trust, organizational resistance to the SCM concept, lack of integrated information systems, and lack of suitable organizational setup.

According to Jones and Saad (2003), there are some difficulties in deploying CSCM such as short-termism, lack of trust and adversarial relationships, the transient nature of construction projects and the considerable number of infrequent clients. Khalfan (2004) supposed key barriers to greater integration are due to fragmentation of project delivery system, lack of trust, and adversarial contractual relationship. Barratt (2004) researched about understanding the meaning of collaboration management in the supply chain in detail. He reported some of the SCM implementation problems, including: lack of collaboration, over-reliance on technology, lack of understanding customer requirements, and lack of trust among the parties. Wong et al. (2004 and 2005) conducted a study on the CSCM in Hong Kong. In their study, a questionnaire survey was used to discover the major problem hindering the CSCM implementation. It was found that the unfair allocation of risks and benefits hinder the effective use of SCM in construction. And anticipated rewards unclear and inappropriate tendering method are two next significant problems.

Albaloushi and Skitmore (2008) conducted a study on the implementation of SCM in the UAE construction industry. They mentioned obstacles to CSC implementation found from previous studies. CSCM is difficult to implement because of involvement of controlling a complex and active group of institutions relating to numerous different and incompatible business purposes. The major problems caused by myopic and independent control of the CSC among the parties or stages involved in the CSC. Another difficulty is the highly fragmented characteristics of the construction industry. CSC can be revealed some weak links as follows: adversarial relationships between clients and contractors, lack of risks and benefits sharing, fragmented approaches, win-lose attitudes and short-term focus, power domination and frequent contractual non-commitments, inadequate

information exchange and limited communication, minimal or no direct interactions.

Benton and Henry (2010) pointed out SCM gives promise for the construction industry, however it encounters a number of barriers. One barrier is that the individualistic and adversarial characteristic existing in the industry makes it difficult to create collaborative relationships among the parties. SCM requires sharing of information, strategy, planning and goals, and so on among the parties, however, most construction companies do not want to do such with other companies due to fearing loss of management. Moreover, the cooperation among the parties requires each party to create a high level of awareness of both themselves and their partners, and such cognition is often difficult to accomplish effectively. Another problem is that chain members only focus on their individual objectives instead of mutual objectives with other members. Other significant obstructs to the deployment of SCM include a lack of understanding of the project owner, communication gaps, a lack of understanding about SC, the enormous size of many supply chains, a lack of effective leadership, egocentrism, and finally, a deficiency of mutuality. In the literature review relating barriers to implementation of SCM, Jalbani (2010) revealed that the SCM implementation is always difficult if organizations do not have a proper structural organization. Other barriers that have great impact on implementation are misunderstanding of the requirements, coordination among the team members, distributed information between the different stakeholders.

Hai (2012) carried out a study to investigate the challenges of CSC and its strategic management in CSCM. They identified six critical challenges in implementing the SCM as the complexity and harshness of supply chain processes, multi trades supply chain members, inefficient of information sharing, temporary or short-term supply chain network, competitive nature of supply chain, and

separation between stages of the design and construction. Deshmukh et al. (2014) have indicated that SCM brings benefits to the residential construction field, however, its application deals with some difficulties of the SCM implementation in residential projects such as failure to communicate project information, fear of losing management, lack of self-knowledge, lack of communication among the parties, unknown complexity of the project, poor define of project goals, lack of understanding customer requirement, lack of understanding SC concept, and lack of mutuality. Mulla et al. (2015) realized that SCM principles seem to have much strength to smoothen and integrate the construction processes. However, there are some obstacles for the SCM implementation such as poor competence in logistic, lack of guidance for creating strategic alliances, the incompetence of integrating the company's internal procedures, strong project focus and the attitudes and traditions in the construction industry. Olaniyi et al (2015) have used a questionnaire survey to investigate SCM practices in construction procurement with perceptions of professional quantity surveyors in Nigeria. A review of the literature yields 15 different inhibitors to the deployment of CSCM practices in the procurement of construction projects. The results have revealed that inadequate investment in I.T, diverse objectives, ineffective communication, and passive subcontractors are the most significant factors constraining the deployment of SCM.

Regarding barriers in green SCM in construction industry, through literature review, the researchers (Balasubramanian, 2012; Ojo et al., 2014; Balaji et al., 2014) have given a number of green supply chain barriers as the lack of knowledge and experience, resistant of top level management towards implementation of green practices, lack of information sharing between construction firms and suppliers, lack of understanding among supply chain stakeholders, lack of training in SCM, and so on.

A summary of reference sources for barriers to the CSCM implementation is shown as Table 2.2. Although there are studies about CSCM however, most of the previous studies focused on other objectives rather than discovering the barriers. Therefore, they did not aim to identify barriers and only gave some barriers as an example. Some of the previous studies based on literature review and identified the common barriers. In summary, the found barriers from the previous studies were not enough. Moreover, there was a lack of analysis such as assessing barriers or uncovering the underlying relationship among them. This study attempts to deal with these gaps. As a result of the literature review, twenty two barriers to the CSCM implementation were identified.

Table 2.2 Summary of reference sources for barriers to the CSCM implementation

Barriers to the CSCM implementation	Vrijhoef (1998)	Akintoye et al. (2000)	Olsson (2000)	Harnan (2000)	Tan (2001)	Dainty et al. (2001)	Ahmed et al. (2002)	Jones & Saad (2003)
Lack of understanding supply chain concept		√		√			√	
Passive sub-contractors and suppliers	√					√		
Inappropriate tending methods			√	√				
Inappropriate organizational structure to support supply chain		√					√	
Lack of communication and information exchange	√			√	√	√		
Unwillingness to share risks and benefit, and emphasizing self-interest	√					√		
Lack of genuine collaboration and good working relations	√					√		
Lack of training in SCM				√				
Organizational resistance to SCM		√					√	
Lack of usage of IT system							√	
Lack of trust among the parties in supply chain	√			√	√	√	√	√
Lack of commitment to supply chain	√	√					√	
Lack of common goals among the parties in supply chain	√				√			
Lack of competence of parties in SCM			√				√	
Lack of effective leadership				√				
Ineffective problem solving mechanism								
Anticipated rewards unclear								
Power domination and frequent contractual non-commitments								
Complexity and harsh of supply chain process								
Temporary or short-term supply chain network			√					√
Lack of understanding customer requirements								
Fragmented characteristics of the construction industry			√					

Table 2.2 Summary of reference sources for barriers to the CSCM implementation (cont.)

Barriers to the CSCM implementation	Khalfan et al (2004)	Barratt (2004)	Wong et al. (2004 & 2005)	Albalousi & Skitmore (2008)	Benton & Henry (2010)	Jalbani (2010)	Hai (2012)
Lack of understanding supply chain concept			√		√		
Passive sub-contractors and suppliers			√				
Inappropriate tending methods			√	√			
Inappropriate organizational structure to support supply chain			√			√	
Lack of communication and information exchange			√	√	√	√	√
Unwillingness to share risks and benefit, and emphasizing self-interest			√	√	√		
Lack of genuine collaboration and good working relations		√		√	√		
Lack of training in SCM			√				
Organizational resistance to SCM							
Lack of usage of IT system			√				
Lack of trust among the parties in supply chain	√	√		√			
Lack of commitment to supply chain			√				
Lack of common goals among the parties in supply chain			√		√	√	
Lack of competence of parties in SCM							
Lack of effective leadership					√		
Ineffective problem solving mechanism							
Anticipated rewards unclear			√				
Power domination and frequent contractual non-commitments				√	√		
Complexity and harsh of supply chain process				√	√		√
Temporary or short-term supply chain network				√			√
Lack of understanding customer requirements		√	√		√	√	
Fragmented characteristics of the construction industry	√			√			√

Table 2.2 Summary of reference sources for barriers to the CSCM implementation (cont.)

Barriers to the CSCM implementation	Deshmukh et al. (2014)	Mulla et al. (2015)	Olaniyi et al (2015)	Sreejith (2012)	Ojo et al. (2014)	Balaji et al. (2014)
Lack of understanding supply chain concept	√	√	√	√		√
Passive sub-contractors and suppliers			√			
Inappropriate tending methods			√			
Inappropriate organizational structure to support supply chain			√			
Lack of communication and information exchange	√		√		√	
Unwillingness to share risks and benefit, and emphasizing self-interest	√		√			
Lack of genuine collaboration and good working relations						
Lack of training in SCM			√			√
Organizational resistance to SCM				√		
Lack of usage of IT system			√			
Lack of trust among the parties in supply chain						
Lack of commitment to supply chain			√		√	√
Lack of common goals among the parties in supply chain	√		√			
Lack of competence of parties in SCM	√	√	√			
Lack of effective leadership						
Ineffective problem solving mechanism			√			
Anticipated rewards unclear			√			
Power domination and frequent contractual non-commitments						
Complexity and harsh of supply chain process	√					
Temporary or short-term supply chain network		√				
Lack of understanding customer requirements	√			√		√
Fragmented characteristics of the construction industry		√				

2.4 Key factors affecting supply chain relationships in construction

Partnering in construction refers to a collaborative relationship in a construction supply chain. Supply chain collaboration is defined as a partnership process where multi-autonomous firms work together to plan and conduct supply chain operations to get mutual goals and common benefits (Cao and Zhang, 2010). Many researchers argued that partnering in construction can significantly improve the relationships among the parties in the project (Anderson and Polkinghorn, 2011; Ghaffari, 2015). So by examining the key aspects of partnering, the influencing factors on supply chain relationships can be identified (Cheng et al, 2000). The key aspects of partnering that are examined include the critical success factors of partnering, the key factors that result in traditional relationship and lead to unsuccessful partnering.

Regarding the critical success factors of partnering, for example, Black et al (2000) collected the opinions from different types of construction organizations, such as clients, contractors and consultants, in order to explore the success factors and the benefits of construction partnering. The key success factors that were identified in the study include mutual trust, effective communication, commitment from senior management, acting consistent with objectives, dedicated team, flexibility to change. Similar studies were reported by other researchers such as Cheng and Li (2002), Chan et al (2004), Lu and Yan (2007), and so on. The critical success factors of partnering were identified in Table 2.3.

Partnering is not always successful. Some problems inhibit the adoption of partnering approach. Other authors investigated the factors that result in unsuccessful partnering. For example, fifteen problematic issues identified from six contractors involved in the unsuccessful project partnering relationships (Ng et

al, 2002). Some problems occur with all stakeholders such as lack of continuous open and honest communication, lack of win-win attitude, lack of commitment to the partnering arrangement, lack of intimacy in the partnering relationship, ineffective problem solving, and unwillingness to compromise. Another research was conducted by Chan et al (2003) in Hong Kong. The survey findings of the research indicated that "facing commercial pressure", "lack of experience with the partnering approach", and "uneven levels of commitment" are the three most important problems that lead to the failure of construction partnering. Some researchers discovered the key factors that lead to the traditional adversarial relationships such as Gardiner and Simmons (1998), and Thomas and Thomas (2005). Table 2.4 summarizes the key factors that result in traditional relationship and lead to unsuccessful partnering. Table 2.3 and Table 2.4 are two sources of literature, which are established on the same principle. Based on these two sources, key influencing factors are summarized in Table 2.5, which may strengthen or hamper the supply chain relationships in construction. In Table 2.5, the key factors identified from two sources are ranked in a descending order in terms of the total cited number. And the top 12 key factors affecting supply chain relationships are extracted. The reasons for selecting these 12 influencing factors are: (1) they are identified most frequently by different authors, which means more important than other factors; (2) only these 12 influencing factors are identified on both positive side and negative side while other factors are only identified on either positive side or negative side; (3) some other factors can be covered by these 12 influencing factors, e.g., "effective coordination" can be covered by "communication", "low or uneven commitment" can be covered by "length of commitment" and "partnering agreement" can be covered by "goals and objectives".

Table 2.3 Critical success factors for construction partnering

Critical success factors for construction partnering	Crane et al (1999)	Black et al (2000)	Cheng et al (2000)	Kwan & Ofori (2001)	Cheng & Li (2002)	Naoum (2003)	Palaneeswaran et al (2003)	Peckham et al (2003)	Chan et al (2004)	Chen & Chen (2007)	Jones & Kaluarachchi (2007)	Lu & Yan (2007)
Mutual trust	√	√	√	√	√	√	√	√	√	√		√
Effective communication	√	√	√		√		√		√	√	√	√
Mutual objectives	√	√	√	√		√				√		√
Problem resolution	√		√		√	√			√			√
Risk allocation	√			√			√		√			
Teamwork	√	√			√	√		√		√		√
Win-win attitude						√	√	√				
Top management support		√	√	√	√				√	√	√	√
Sharing resources	√	√	√	√	√				√	√		
Continuous improvement	√	√			√	√				√		√
Long-term commitment		√	√		√		√		√		√	
Learning and innovation	√		√		√							
Good cultural fit		√								√		
Flexibility to change		√								√		
Financial security		√								√		
Effective coordination			√		√				√			
Partnering agreement					√							√
Partnering experience					√							√
Empowerment		√								√		

Table 2.4 Key factors leading to traditional adversarial relationship or unsuccessful partering

Traditional adversarial relationship or unsuccessful partnering	Larson (1997)	Boddy et al (1998)	Gardiner & Simmon (1998)	Thompson & Sanders (1998)	Akintoye et al (2000)	Bresnen & Marshall (2000)	Ng et al (2002)
Lack of trust	√			√		√	√
Poor communication			√	√	√		√
Self-objectives	√		√	√		√	
Ineffective problem solving	√	√	√				√
Unfair or unclear risk allocation	√	√		√		√	
Fragmentation and lack of teamwork	√						√
Win-lose attitude	√	√		√	√		√
Lack of top management support	√				√		√
Lack of sharing resources	√						
Lack of continuous improvement				√			
Short-term focus		√		√			
Lack of learning and innovation							
Low or uneven commitment					√		√
Commercial pressure							
Misunderstanding of partnering					√	√	
Over-dependency on partners		√	√				
Checking or monitoring	√						
Improper organization structure					√		
Not familiar with partnering							
Underestimating change scale		√					

Table 2.4 Key factors leading to traditional adversarial relationship or unsuccessful partnering (cont.)

Traditional adversarial relationship or unsuccessful partnering	Chan et al (2003)	Thomas & Thomas (2005)	Wood (2005)	Bennett & Peace (2006)	Eriksson & Nisson (2008)	Pryke (2009)	Le-Hoai et al (2010)
Lack of trust	√	√	√		√	√	√
Poor communication	√	√	√	√			√
Self-objectives	√	√	√		√	√	
Ineffective problem solving	√	√					√
Unfair or unclear risk allocation	√		√		√	√	√
Fragmentation and lack of teamwork		√		√	√	√	
Win-lose attitude	√		√		√		√
Lack of top management support							√
Lack of sharing resources	√	√		√			√
Lack of continuous improvement	√	√				√	
Short-term focus	√				√		
Lack of learning and innovation		√			√		
Low or uneven commitment	√				√		
Commercial pressure	√			√	√		√
Misunderstanding of partnering	√						
Over-dependency on partners	√						
Checking or monitoring				√			
Improper organization structure	√						
Not familiar with partnering	√						√
Underestimating change scale							

Table 2.5 Summary of key factors affecting supply chain relationships in construction

No	Factors	Source 1	Source 2	Total
1	Trust (mutual trust or suspicion/mistrust)	11	10	21
2	Communication (open and effective or ineffective)	9	9	18
3	Goals and objectives (common or self-objectives)	7	9	16
4	Problem resolution/conflict resolution	6	7	13
5	Risk allocation	4	9	13
6	Working relationship (teamwork or fragmentation)	7	6	13
7	Business attitude (win -win or win-lose)	3	9	12
8	Top management support	8	4	12
9	Sharing resources	7	5	12
10	Continuous improvement	6	4	10
11	Length of commitment (long-term or short-term)	6	4	10
12	Learning and innovation	3	2	5
13	Low or uneven commitment	0	4	4
14	Commercial pressure	0	4	4
15	Misunderstanding of partnering concept	0	3	3
16	Over-dependency on partners	0	3	3
17	Good cultural fit	2	0	2
18	Flexibility to change	2	0	2
19	Financial security	2	0	2
20	Effective coordination	2	0	2
21	Partnering agreement	2	0	2
22	Partnering experience	2	0	2
23	Empowerment	2	0	2
24	Checking and monitoring	0	2	2
25	Improper organization structure	0	2	2
26	Not familiar with partnering	0	2	2
27	Understanding change scale	0	1	1

2.5 Chapter summary

This chapter focuses on the literature review of benefits and barriers to the implementation of the CSCM, and key factors affecting CSC relationships. The benefits and barriers to the implementation of CSCM are reviewed first. Twenty benefits and twenty-two barriers to the implementation of CSCM are then identified through the previous studies as shown in Table 2.1 and Table 2.2. Based on the statistical analysis of the literature review on critical success factors for construction partnering and the literature review on factors leading to traditional adversarial relationship and unsuccessful partnering, top 12 influencing factors on supply chain relationships are identified. All these provide the basis for the development of the survey questionnaires in this study.

CHAPTER 3

BENEFITS OF CONSTRUCTION SUPPLY CHAIN MANAGEMENT

3.1 Introduction

SCM is extremely current due to its success in other industries and therefore considered to be the future of construction (JCT, 2012). However, it is accepted slowly because of lack interest from the parties involved in the project (Mulla et al., 2015). A lack of understanding about the benefits of the CSCM implementation may lead to lack of active participation of the parties to implement SCM. The objective of this chapter is to identify and discover the benefits of the CSCM implementation. It is hoped that the findings may help practitioners understand fully about the benefits of the CSCM implementation and create a strong motivation for them. This chapter reports profiles of the respondents of this study and focuses on the analysis results of the identified benefits. The benefits of the CSCM implementation are measured and compared. The core factors of benefits are identified and the level of their importance is also examined through factor score ranking. Furthermore, the chapter has analyzed perspectives of respondents' groups (the owner, the contractor, the designer, and the consultant) with the core factors extracted.

3.2 Research process

Figure 3.1 below shows the research process of this chapter.

```
┌─────────────────────────────┐        ┌──────────────────────────────┐
│  Identify benefits of the CSCM │◄───── │ Based on literature review and pilot test │
│  implementation and design       │        └──────────────────────────────┘
│  questionnaire                   │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐        ┌──────────────────────────────┐
│      Data collection            │◄───── │       Via electronic mail         │
└─────────────────────────────┘        └──────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐        ┌──────────────────────────────┐
│    Reliability assessment       │◄───── │   Internal consistency through     │
└─────────────────────────────┘        │   Cronbach's alpha coefficient     │
              │                          └──────────────────────────────┘
              ▼
┌─────────────────────────────┐        ┌──────────────────────────────┐
│       Ranking benefits          │◄───── │ - Kendall's coefficient of concordance │
└─────────────────────────────┘        │ - Spearman's rank correlation test │
              │                          └──────────────────────────────┘
              ▼
┌─────────────────────────────┐        ┌──────────────────────────────┐
│ Check consistency of opinion among │◄───── │          ANOVA test            │
│    the respondents' groups       │        └──────────────────────────────┘
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│   Exploratory Factor Analysis   │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│    Results and Conclusions      │
└─────────────────────────────┘
```

Figure 3.1 Research process of chapter 3

A survey questionnaire was designed to gather views from industrial practitioners. The development of the survey questionnaire used in this study was supported by the literature review. A preliminary set of benefits, barriers to the CSCM implementation, and key factors affecting supply chain relationships in construction was collected from the literature review and presented in the pretest questionnaires. A pilot study was then carried out to validate the questionnaire with five experts: two project managers who came from the contractors, one project manager who came from the owner, one project manager who came from the consultant, and one engineering manager who came from the designer. These experts had at least fifteen years of experience in construction. The experts were asked to comment on the readability, comprehensiveness, and accuracy of all

questions in the pretest questionnaires. Moreover, they were also asked to remove any benefits, barriers, and key factors perceived as being inappropriate and add other benefits, barriers, and key factors perceived as being necessary. However, the experts did not make significant additions. They believed that twenty benefits, twenty-two barriers, twelve key factors identified from the literature review can be enough to describe most of the gains, obstacles to the CSCM implementation, and the aspects affecting CSC relationships, respectively. Thus, it is not necessary to remove any benefits, barriers, and key factors in the pretest questionnaire. According to their comments, there were some minor adjustments in the structure of the questionnaire and revision of wording in the questions. The finalized questionnaire includes twenty benefits, twenty-two barriers of implementing CSCM, and twelve key factors affecting supply chain relationships. The questionnaire consists of five parts. The first part of the questionnaire introduces participants to the origin, the purpose of the survey and some basic knowledge about CSCM. In the second part, respondents were asked to assess their level of agreement on the benefits based on a five-point Likert scale (1 = strongly disagree and 5 = strongly agree). The third part intended to collect the level of the hindrance of the identified barriers according to a five –point Likert scale, where 1 = not hinder and 5 = extremely hinder with the statements. In the fourth part, respondents were asked to assess the degree of impact of the key factors on supply chain relationships in construction. The key factors were rated according to a five-point Likert scale ranging from 1 (not impact) and to 5 (extremely impact). This part also includes the questions regarding project performance. The project performance was evaluated using another five-point Likert scale: 1 = strongly disagree and 5 = strongly agree. The five-point scale has been widely used in the performance measurement (Mohamed, 2003; Doloi, 2009; Ozorhon et al., 2007, 2008a, 2008b, and 2011; Cho et al., 2009; Cao and Zang, 2010 and 2011; Doloi et al., 2011; Li et al., 2011; Debem et al., 2013). Lastly, the fifth part of the

questionnaire requests respondent's background information including types of organization, designations, and years of experience. The valid data set collected from the questionnaires was then analyzed using SPSS software and AMOS software.

This chapter focuses on reporting results relating to the benefits of the CSCM implementation. The reliability of the five-point scale used to measure benefits was determined first using Cronbach's coefficient alpha. The benefits of the CSCM implementation are analyzed using the "mean score" to establish the relative importance among them within various groups. These groups are divided based on the role of the parties involved in the Vietnam's construction industry (owners, contractors, designers, and consultants). Kendall's coefficient of concordance (W) analysis is performed to measure the agreement of respondents within a group on their rankings. If the Kendall's coefficient of concordance (W) is significant at the level of 0.05, an appropriate level of consensus is confirmed. The agreement between two groups of respondents on their rankings was measured by the Spearman rank correlation coefficient (r_s). When r_s is significant at the 0.05 level, an agreement between the two groups is indicated. Subsequently, an analysis of variance (ANOVA), which tests the null hypothesis that the mean of the dependent variable is equal in all the groups, was carried out to check consistency of opinion among the respondents' groups. Finally, factor analysis was conducted to derive the interrelationships among the benefits. After core factors of benefits were extracted, an analysis of the perspectives of respondents' groups against them was conducted. The level of importance of factors is also examined through factor score ranking.

3.3 Data collection

The supply chain is relevant to all members of the construction industry (owners, contractors, subcontractors, designers, suppliers, etc.). The research concentrated on four principal categories of respondent: owners, contractors, designers and consultants. The sampling method used in this study was convenience sampling preferred when it is difficult to get responses from sample elements selected at random (Uma, 2000). Due to the limitation of time, the respondents were only given one month to complete and return the questionnaires. A total of 400 questionnaires were distributed during the period of November to December 2015 via electronic mail to construction industry subjects. Out of 400 questionnaires distributed, 127 valid responses were received, representing the response rates of 31.75%. The response rate was acceptable compared with the norm of 20–30% with most questionnaire surveys in the construction industry (Akintoye, 2000).

3.4 Data analysis and discussion

3.4.1 Profiles of the respondents

Figure 3.2, Figure 3.3, and Figure 3.4 summarize the profiles of respondents from the questionnaire. The highest number of questionnaires received was from the contractors (41.73%), followed by the owners (23.62%), the consultants (22.83%), and the designers (11.81%). In terms of designation of respondents, directorate, construction manager/project manager, and specialists having a certain level of professional knowledge, ability and maturity account for nearly half (44.88%) of the respondents. Civil engineer/architect, site engineer/site supervisor, and other (quantity surveyor, project engineer) account for 14.96%, 30.71%, and 9.45%, respectively. In terms of years of experience, the number of respondents with experience from 5 to 10 years, 10 to 15 years is 49.61%, 23.62%,

respectively and more than 15 years as 14.96%. They account for a large rate of the respondents. Thus, the collected data are reliable and valuable. The respondents who have years of experience less than 5 only account for 11.81%.

Party	Frequency	Percent
Owner	30	23.62%
Contractor	53	41.73%
Designer	15	11.81%
Consultant	29	22.83%

Figure 3.2 Fields of work of respondents

Designation	Frequency	Percent
Directorate	22	17.32%
Civil engineer/Architect	19	14.96%
Specialist	16	12.60%
Site engineer/site supervisor	39	30.71%
Construction manager/Project manager	19	14.96%
Other	12	9.45%

Figure 3.3 Designation of respondents

Experience	Frequency	Percent
< 5 years	15	11.81%
5-10 years	63	49.61%
10-15 years	30	23.62%
> 15 years	19	14.96%

Figure 3.4 Years of experience of respondents

3.4.2 Internal consistency test

After the pilot test as mentioned in the research process, twenty benefits are identified as potential to bring incentives for implementing SCM in the construction industry (see Table 3.1). Table 3.1 also shows the statistical mean, standard deviation of the benefits. The standard deviation on a benefit represented a degree of consensus among respondents, while a mean response on the scale was an indicator of the degree of a benefit's importance in relation to other benefits (Singh and Singh, 2008). The standard deviation values of the benefits are less than one or around one, which reflects some consensus among the respondents (Ellif and Maarof, 2011).

The Cronbach's alpha value of 20 benefits was determined to be 0.844 (as shown in Table 3.2), and the five-point scale measurement was thus reliable (Hair et al. 2010).

Table 3.1 Benefits of the CSCM implementation (all respondents)

Code	Item (Benefits of the CSCM implementation)*	N	Min	Max	Mean	Standard Deviation
B1	Reduce project cost	127	2	5	4.20	0.80
B2	Repeat business with key clients	127	2	5	3.75	0.63
B3	Sharing problems and working together	127	2	5	3.83	0.71
B4	Increase speed of project construction	127	3	5	4.30	0.71
B5	Improved margin profit	127	2	5	4.13	0.78
B6	Improve project quality	127	2	5	4.01	0.74
B7	Remove waste from project process	127	1	5	3.87	0.78
B8	Reduce paperwork	127	1	5	3.61	0.97
B9	Development of mutual understanding	127	2	5	3.73	0.78
B10	Benefit allocation among the parties	127	2	5	3.69	0.82
B11	Development of no-blame culture	127	2	5	3.57	0.85
B12	Enhanced reputations and increased market competitiveness	127	2	5	3.80	0.69
B13	Increase customer satisfaction level	127	2	5	3.85	0.79
B14	Greater confidence in long-term planning	127	2	5	3.82	0.78
B15	Bureaucracy reduction in organization	127	1	5	2.94	0.95
B16	Risk sharing among the parties	127	1	5	3.40	0.93
B17	Better information, communication and coordination	127	3	5	4.39	0.71
B18	Shared resources, data and knowledge	127	2	5	3.69	0.80
B19	Efficiency in utilizing the resources and skills	127	2	5	4.09	0.76
B20	Improved worker motivation and team-working	127	1	5	3.26	0.80

* Items were rated on a five-point Likert scale with 1 = Strongly disagree and 5 = strongly agree

Table 3.2 Cronbach's alpha value of twenty benefits of the CSCM implementation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.844	.849	20

3.4.3 Ranking of benefits of the CSCM implementation

The benefits of the CSCM implementation were rated from different perspectives of four groups of respondents, i.e., the owner, the contractor, the designer, and the consultant. The results of the Kendall's coefficient of concordance (W) and the rankings of the benefits are presented in Table 3.3. The Kendall's coefficient of concordance (W) of the rankings of the benefits among the respondents in the owner group was 0.182; among the respondents in the contractor group, 0.194; among the respondents in the designer group, 0.285; and among the respondents in the consultant group, 0.191. All levels of significance of the Kendall's coefficient of concordance (W) were at 0.000. Thus, the respondents' ratings within a certain group are related to one another and this proved that there is a significant agreement among the respondents in each group on the rankings of the benefits of the CSCM implementation. All respondents also have a significant agreement together on the rankings with W value of 0.185.

All respondents believed and ranked the "better information, communication and coordination" and "increase speed of project construction" to be the top two benefits. "Better information, communication and coordination" is ranked first. This could be explained that SCM creates an opportunity to provide a better working environment, enhances mutual understanding as well as the relationship among all parties. And this results in an efficiency of communication and coordination among them. All groups care much about project performance in term of time. Chan and Kumaraswamy (2002) showed that a project is considered as successful if it is handed over on schedule, in budget and meeting quality standard specified by the owner. All groups pay more attention to the time performance. This implies that the parties hope to apply SCM to ensure a better time performance for economic reasons. For example, contractors can reduce financial risks and get more profit when the project is handed over to owners

sooner. Owners can withdraw capitals quickly and get attractive returns anticipated from the finished projects.

It is rather surprising that the designers considered item B6 "improve project quality" as the second important benefit, whereas both the owners and the contractors ranked it sixth and the consultants ranked it fifth. This revealed that the awareness of a successful project regarding quality is not similar among the different groups. The designers might be conscious about project quality performance. Chan and Kumaraswamy (2002) confirmed that the achievement of the quality standards level nominated by the owners to be one of the criteria of a successful project. The designers could believe that SCM could improve their design quality. A similar result that showed a big difference between the designers and the others were also found in item B13 "increase customer satisfaction level". It was ranked sixteenth by the designers, but in the top 10 benefits by the owners, the contractors, and the consultants. The difference may be assigned to their various fields of works involved in a project. The owners, the consultants, and the contractors usually worked more closely in during the construction phase. This phase is the most complicated phase of a project and many problems faced by the parties involved. Therefore, customer satisfaction level may be stressed by the owners, the consultants, and the contractors and they perceived that SCM could increase customer satisfaction level.

The groups had different perspectives on the ranking of benefits. The disagreement may be attributed to the different expectations and interpretation of SCM among them. Moreover, Chan and Kumaraswamy (1995) showed out that the different perspectives among groups in the ranking may also be because of some "group bias" in their awareness, even though there is a significantly high and same experience degree of the survey respondents.

As shown in Table 3.3, it is easy to realize that the significant benefits are "increase speed of project construction", "reduce project cost", "improve project

quality", and "remove waste from project process". They were ranked in top 7 benefits. The least important benefits are development of no-blame culture, improved worker motivation and team-working, and bureaucracy reduction in the organization. The table shows that the significant benefits expected from parties are project-based benefits rather than better relationships and win-win outcomes (repeat business with key clients, greater confidence in long-term planning, sharing problems and working together, benefits allocation among the parties, and risk sharing among the parties, etc.). It can be inferred that a successful project is a win-win attitude among the parties and produces the better relationships among them.

Table 3.3 Ranking and Kendall's Coefficient of Concordance for the benefits of the CSCM implementation

Code	Item (Benefits of the CSCM implementation)	All respondents		Owner		Contractor		Designer		Consultant	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
B17	Better information, communication and coordination	4.39	1	4.37	1	4.47	1	4.60	1	4.17	2
B4	Increase speed of project construction	4.30	2	4.27	2	4.26	2	4.27	3	4.41	1
B1	Reduce project cost	4.20	3	4.30	3	4.21	3	4.27	3	4.07	3
B5	Improved margin profit	4.13	4	4.13	4	4.13	4	4.27	3	4.07	3
B19	Efficiency in utilizing the resources and skills	4.09	5	4.13	4	4.11	5	4.20	6	3.93	6
B6	Improve project quality	4.01	6	4.00	6	3.94	6	4.33	2	3.97	5
B7	Remove waste from project process	3.87	7	3.97	7	3.91	7	3.93	9	3.69	10
B13	Increase customer satisfaction level	3.85	8	3.97	7	3.85	9	3.47	16	3.93	6
B3	Sharing problems and working together	3.83	9	3.80	11	3.81	11	4.00	7	3.83	8
B14	Greater confidence in long-term planning	3.82	10	3.87	9	3.87	8	4.00	7	3.59	15
B12	Enhanced reputations and increased market competitiveness	3.80	11	3.83	10	3.85	9	3.87	10	3.62	13
B2	Repeat business with key clients	3.75	12	3.77	12	3.74	13	3.87	10	3.69	10
B9	Development of mutual understanding	3.73	13	3.70	15	3.74	13	3.60	14	3.83	8
B18	Shared resources, data and knowledge	3.69	14	3.73	14	3.66	16	3.80	12	3.66	12
B10	Benefit allocation among the parties	3.69	15	3.77	12	3.75	12	3.53	15	3.59	15
B8	Reduce paperwork	3.61	16	3.63	16	3.57	17	3.73	13	3.59	15
B11	Development of no-blame culture	3.57	17	3.50	17	3.68	15	3.47	16	3.52	18
B16	Risk sharing among the parties	3.40	18	3.47	18	3.28	18	3.27	19	3.62	13
B20	Improved worker motivation and team-working	3.26	19	3.27	19	3.26	19	3.33	18	3.21	19
B15	Bureaucracy reduction in organization	2.94	20	3.07	20	2.91	20	3.07	20	2.79	20
Number (N)		127		30		53		15		29	
Kendall's Coefficient of Concordance (W)		0.185		0.182		0.194		0.285		0.191	
Level of significance		0.000		0.000		0.000		0.000		0.000	

Note: Where H_0 = respondents' ratings are unrelated to each other within each group.

The next stage of the analysis was to test whether there is any similar substantial agreement among the respondents in the four groups which is determined by the Spearman rank correlation coefficient (r_s). The correlation coefficients of the ranking on benefits were 0.985, 0.888, 0.868, 0.892, 0.842 and 0.790 for owner and contractor, owner and designer, owner and consultant, contractor and designer, contractor and consultant, and designer and consultant, respectively (Table 3.4). The null hypothesis that there is a significant disagreement between the owner-the contractor, the owner-the designer, the owner-the consultant, the contractor-the designer, the contractor-the consultant, and the designer–the consultant on the ranking of the benefits of the CSCM implementation have to be rejected (Table 3.4 and Table 3.5). Hence, it was concluded that there was a significant agreement on the ranking of benefits among groups with 99% confidence.

Table 3.4 Spearman rank correlation test among groups of respondents for benefits of the CSCM implementation

	Owner	Contractor	Designer	Consultant
Owner	1.000	0.985[**]	0.888[**]	0.868[**]
Contractor	0.985[**]	1.000	0.892[**]	0.842[**]
Designer	0.888[**]	0.892[**]	1.000	0.790[**]
Consultant	0.868[**]	0.842[**]	0.790[**]	1.000

Note: [**]. Correlation is significant at the 0.01 level (2-tailed)

One more remarkable point is that the profiles for each of the 20 identified benefits of the CSCM implementation generally reveal a close scatter pattern (Figure 3.5). The nearly scattered pattern may indicate that most practitioners in Vietnam manifested a positive attitude towards CSCM that may bring some benefits to their projects.

Table 3.5 Comparison of Spearman rank correlation coefficient and its level of significance for benefits of the CSCM implementation

Comparison	r_s	Significant	Conclusion
Owner ranking vs Contractor ranking	0.985	0.01	Reject H_0
Owner ranking vs Designer ranking	0.888	0.01	Reject H_0
Owner ranking vs Consultant ranking	0.868	0.01	Reject H_0
Contractor ranking vs Designer ranking	0.892	0.01	Reject H_0
Contractor ranking vs Consultant ranking	0.842	0.01	Reject H_0
Designer ranking vs Consultant ranking	0.790	0.01	Reject H_0

Where H_0 = No significant agreement on the ranking

H_a = Significant agreement on the ranking

Figure 3.5 Cross-comparison of benefits among groups

3.4.4 Check consistency of opinion among the respondents' groups

The analysis of variance (ANOVA) was conducted to check whether the opinions of the owner, the contractor, the designer, and the consultant were the same for each of the 20 benefits of the CSCM implementation. A p value of below 0.05 indicates that there is a high level of difference of opinion among the groups (Landau and Everitt, 2004). ANOVA test results were shown in Table 3.6. The results showed that the p values were greater than 0.05, indicating that there was a consensus of opinion among the groups. Therefore, the collected data can be treated as a whole for further analysis.

Table 3.6 Results of ANOVA test on benefits of the CSCM implementation

Code	Item (Benefits of the CSCM implementation)	F	Sig.
B1	Reduce project cost	0.444	0.722
B2	Repeat business with key clients	0.271	0.846
B3	Sharing problems and working together	0.310	0.818
B4	Increase speed of project construction	0.326	0.807
B5	Improved margin profit	0.208	0.891
B6	Improve project quality	1.138	0.337
B7	Remove waste from project process	0.741	0.530
B8	Reduce paperwork	0.126	0.945
B9	Development of mutual understanding	0.300	0.826
B10	Benefit allocation among the parties	0.526	0.665
B11	Development of no-blame culture	0.463	0.708
B12	Enhanced reputations and increased market competitiveness	0.797	0.498
B13	Increase customer satisfaction level	1.525	0.211
B14	Greater confidence in long-term planning	1.241	0.298
B15	Bureaucracy reduction in organization	0.515	0.672
B16	Risk sharing among the parties	0.982	0.404
B17	Better information, communication and coordination	1.591	0.195
B18	Shared resources, data and knowledge	0.162	0.922
B19	Efficiency in utilizing the resources and skills	0.576	0.632
B20	Improved worker motivation and team-working	0.084	0.969

3.4.5 Exploratory Factor Analysis

In this chapter, factor analysis was used to determine whether the 20 benefits of the CSCM implementation can be grouped under different factors as well as to categorize them into a manageable number of factors, and to explore the underlying constructs of the identified benefits. The extracted factors can help the parties to easily recognize the core benefits of the CSCM implementation.

As a first step of performing the factor analysis, scanning correlation matrix and testing appropriateness of factor analysis on data were conducted. The correlation matrix aims to determine the strength of the relationship among the variables. According to Field (2009), in order to do a factor analysis, it was necessary to have variables that correlate fairly well, but not perfectly. In visually scanning the correlation matrix if any variables have lots of correlations below 0.3 or correlate with no others then consider excluding them. The results of the correlation coefficients show that each benefit has lots of correlations above 0.3 with respect to the others, which means that the benefits correlate fairly well one another and implies that it is not necessary to reject any benefits from the analysis (see Table 3.7). Then, the Kaiser-MeyerOlkin (KMO) test and the Bartlett's test of sphericity were performed to check the sufficiency of the survey data. The KMO value of 0.806 indicates that there is a compact correlation pattern among variables. The results of the Bartlett's test (sphericity of 974.914 and p-value at 0.000) show that the correlation matrix of the variables is not an identity matrix. Therefore, the factor analysis is an appropriate method (refer to Table 3.8).

Table 3.7 Correlation matrix of benefits of the CSCM implementation

Code	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
B1	1																			
B2	0.12	1																		
B3	0.06	0.51	1																	
B4	0.48	0.06	0.15	1																
B5	0.31	0.17	0.05	0.19	1															
B6	0.40	0.04	0.20	0.41	0.08	1														
B7	0.54	0.18	0.16	0.53	0.20	0.49	1													
B8	0.35	0.11	0.20	0.29	0.06	0.45	0.51	1												
B9	-0.01	0.20	0.26	0.09	0.06	0.09	0.10	0.31	1											
B10	0.04	0.20	0.25	0.13	0.29	0.10	0.13	0.27	0.42	1										
B11	-0.01	0.27	0.17	0.09	0.45	0.02	0.11	0.01	0.17	0.31	1									
B12	0.13	0.30	0.25	0.13	0.51	-0.06	0.10	0.07	0.13	0.33	0.58	1								
B13	0.10	0.26	0.41	0.21	0.27	0.07	0.02	0.12	0.37	0.53	0.25	0.42	1							
B14	0.05	0.58	0.53	0.10	0.18	0.06	0.13	0.15	0.17	0.26	0.25	0.31	0.27	1						
B15	0.08	0.24	0.26	0.05	0.28	0.00	0.09	0.09	0.05	0.05	0.19	0.40	0.10	0.23	1					
B16	-0.03	-0.02	0.15	0.14	0.11	0.12	0.02	0.15	0.47	0.40	0.15	0.21	0.43	0.05	0.03	1				
B17	0.05	0.52	0.32	0.05	0.19	0.01	0.00	0.05	0.09	0.21	0.25	0.23	0.09	0.57	0.26	-0.01	1			
B18	0.02	0.49	0.34	-0.05	0.12	0.04	0.06	0.13	0.15	0.17	0.18	0.11	0.10	0.37	0.20	0.03	0.49	1		
B19	0.10	0.30	0.31	0.16	0.38	0.11	0.29	0.22	0.19	0.36	0.44	0.59	0.32	0.36	0.30	0.19	0.29	0.31	1	
B20	-0.03	0.35	0.38	0.07	0.38	-0.04	0.07	0.09	0.21	0.49	0.58	0.57	0.33	0.37	0.40	0.22	0.35	0.35	0.57	1

Table 3.8 KMO and Bartlett's Test on benefits of the CSCM implementation

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.806
Bartlett's Test of Sphericity	Approx. Chi-Square	974.914
	df	190
	Sig.	.000

Next, communalities of each benefit were also examined to check the reliability of the factor model. A benefit is reflected well via the extracted factors when its communality is high. This means the extracted factors will account for a big proportion of the benefit's variance. According to Hair et al. (2010), in order to have sufficient explanatory value, each benefit's communality should be equal or more than value of 0.5. In this test, item B15 "bureaucracy reduction in organization" is discarded because its communality is less than 0.5 as shown in Table 3.9.

Table 3.9 Communalities of benefits of the CSCM implementation

Code	Item (Benefits of the CSCM implementation)	Initial	Extraction
B1	Reduce project cost	1.000	0.626
B2	Repeat business with key clients	1.000	0.660
B3	Sharing problems and working together	1.000	0.562
B4	Increase speed of project construction	1.000	0.536
B5	Improved margin profit	1.000	0.594
B6	Improve project quality	1.000	0.559
B7	Remove waste from project process	1.000	0.711
B8	Reduce paperwork	1.000	0.537
B9	Development of mutual understanding	1.000	0.590
B10	Benefit allocation among the parties	1.000	0.592
B11	Development of no-blame culture	1.000	0.567
B12	Enhanced reputations and increased market competitiveness	1.000	0.736
B13	Increase customer satisfaction level	1.000	0.567
B14	Greater confidence in long-term planning	1.000	0.628
B15	Bureaucracy reduction in organization	1.000	0.328
B16	Risk sharing among the parties	1.000	0.614
B17	Better information, communication and coordination	1.000	0.597
B18	Shared resources, data and knowledge	1.000	0.514
B19	Efficiency in utilizing the resources and skills	1.000	0.557
B20	Improved worker motivation and team-working	1.000	0.673

The KMO test and the Bartlett's test will be checked again. This time, the factor analysis result from SPSS software shows that KMO = 0.808 > 0.5, Sig. < 0.05 and communalities of all remaining benefits are found to be higher than 0.517 that indicates that the factor model is reliable. Regarding case to variable ratio, the number of observations per variable is approximately 7:1 (ratio of 127:19), which satisfies a desired ratio of 5 observations per variable (Hair et al., 2010).

After preliminary analysis, the 19 remaining benefits were subjected to the factor analysis, with principal component analysis and varimax rotation. The results of the principal component analysis are presented in Table 3.10. According to Kaiser's criteria, there are four factors retained because of eigenvalues greater

than 1.0 (Field, 2009). These four factors explained 60.599% of the total variance in the data.

Table 3.10 Principal components analysis results of benefits of the CSCM implementation

Principle component	Eigenvalue	Percentage of variance explained	Cumulative variance percentage
1	5.271	27.740	27.740
2	2.634	13.865	41.605
3	1.945	10.235	51.840
4	1.657	8.719	60.559
5	0.939	4.940	65.499
6	0.791	4.163	69.662
7	0.672	3.539	73.201
8	0.636	3.349	76.550
9	0.612	3.223	79.773
10	0.581	3.058	82.831
11	0.556	2.926	85.757
12	0.436	2.294	88.051
13	0.421	2.216	90.267
14	0.409	2.152	92.419
15	0.371	1.952	94.371
16	0.314	1.652	96.024
17	0.287	1.509	97.532
18	0.250	1.316	98.849
19	0.219	1.151	100.000

Table 3.11 shows the results of the factor analysis on the benefits of the CSCM implementation. All factor loadings of benefits are shown to be greater than 0.5, which means that the benefits have a significant contribution to the interpretation of four factors (Hair et al., 2010).

For the purpose of further discussion, each of the factors should be allocated a new name. Based on an examination of inherent relationships among the benefits under each of the factors, the four extracted factors can be reasonably interpreted

as follows: factor 1 represents systematic business system; factor 2 presents organization management and business strategy; factor 3 presents improved project performance, and factor 4 presents win-win outcomes among the parties.

Table 3.11 Four core benefit factors

Factor of the benefits	Variance explained (%)	Code	Benefits	Factor loading
Factor 1: Systematic business system	16.316	B2	Repeat business with key clients	0.793
		B14	Greater confidence in long-term planning	0.762
		B17	Better information, communication and coordination	0.748
		B18	Shared resources, data and knowledge	0.714
		B3	Sharing problems and working together	0.652
Factor 2: Organization management and business strategy	16.172	B12	Enhanced reputations and increased market competitiveness	0.818
		B11	Development of no-blame culture	0.750
		B5	Improved margin profit	0.749
		B20	Improved worker motivation and team-working	0.663
		B19	Efficiency in utilizing the resources and skills	0.633
Factor 3: Improved project performance	15.049	B7	Remove waste from project process	0.831
		B1	Reduce project cost	0.763
		B6	Improve project quality	0.729
		B4	Increase speed of project construction	0.709
		B8	Reduce paperwork	0.649
Factor 4: Win-win outcomes among the parties	13.022	B16	Risk sharing among the parties	0.776
		B9	Development of mutual understanding	0.756
		B13	Increase customer satisfaction level	0.662
		B10	Benefit allocation among the parties	0.654

One-way ANOVA was conducted to check whether there are significant differences among groups' perspectives (the owner, the contractor, the designer, and the consultant) on the four factors of benefits. It is considered significant

when the p value is less than 0.05. Table 3.12 shows the results of the ANOVA test according to the groups' perspectives on the four factors. All p values for four factors are greater 0.05, therefore it is concluded that no differences among groups' viewpoints regarding the four factors of benefits.

Table 3.12 Analyzing groups' perspectives on the four factors of benefits

Code	Factor	F	Sig.
F1	Systematic business system	0.964	0.412
F2	Organization management and business strategy	0.468	0.705
F3	Improved project performance	0.333	0.802
F4	Win-win outcomes among the parties	1.115	0.346

The level of importance of the four factors was then examined by ranking them. This was achieved by calculating the factor score of the four factors through the following equation:

$$F_i = \frac{\sum_j^n A_{ij}}{n}$$

Where F_i is the factor score, A_{ij} is the average score of the j_{th} benefit of factor i.

The factor score of each factor is the average score of the benefits grouped respectively in that factor. For example, factor score of Factor 1 (systematic business system) is calculated as below:

Factor 1 = [3.75 (Repeat business with key clients) + 3.82 (Greater confidence in long-term planning) + 4.39 (Better information communication and coordination) + 3.69 (Shared resources, data and knowledge) + 3.83 (Sharing problems and working together] / 5 = 3.90.

The results of ranking the factors are presented in Table 3.13.

Table 3.13 Factor score ranking of the benefits of the CSCM implementation

Code	Factor	Factor score	Rank
F3	Improved project performance	4.00	1
F1	Systematic business system	3.90	2
F2	Organization management and business strategy	3.77	3
F4	Win-win outcomes among the parties	3.67	4

The explanations of the relationship among the benefits under their factors are supplied in the following sections.

1) Systematic business system

This factor comprises the five benefits, namely, "repeat business with key clients", "greater confidence in long-term planning", "better information and coordination", "shared resources, data and knowledge", and "sharing problems and working together". The factor accounts for the greatest variance (16.316%) among all the factors. It was ranked second, which implies that one of the most significant gains of the implementation of SCM in the construction projects is to create a systematic business system among the parties. CSCM is as a coordination of inter-organization's decision making in CSC and the integration of key members involved CSC (Albaloushi and Skitmore, 2008). These characteristics of SCM have created good conditions for better information and coordination as well as enhancement of sharing problems and working together among the parties. As a corollary, the trust among the parties will be gradually formed which leads to a greater confidence in long-term planning among them. Therefore, one of the parties may be willing to continue to cooperate with the other parties in the next projects because they may believe that their projects will be run more smoothly with familiar working relationship before. Moreover, they are also willing to share their resources, data and knowledge together to ensure a successful project.

2) Organization management and business strategy

This factor explains 16.172% of the total variance in the data. The five benefits in the factor relating to organization management and business strategy are "enhanced reputations and increased market competitiveness", "development of no-blame culture", "improved margin profit", "improved worker motivation and team-working", and "efficiency in utilizing the resources and skills". The factor was ranked third among all the factors. The parties can get a lot of benefits as mentioned when they deploy SCM in their organizations. The benefit that can easily recognize is efficiency in utilizing the resources and skills by an overall management process of SCM. SCM is essential to monitor and control all logistic activities of resources like equipment, labor, material and other services (Ahmed et al., 2002). Besides, CSCM is said to be a practice of a group of companies and individuals working collaboratively in a network of interrelated processes (Albaloushi and Skitmore, 2008), so it can bring an improvement about the capability of team-working and motivation of workers. In a market that is becoming increasingly competitive, organizations alongside the support and working with their suppliers can enhance their own capacity to meet the owner's specifications, quality, flexibility and cost requirements (Black et al., 2000). This will not only help them survive in a competitive environment, but also enhance their reputation. Moreover, a joint strategy will enable organizations to improve margin profits while also reducing their risks (Black et al., 2000). It can also reduce the blame culture that is inevitable among the parties in construction projects.

3) Improved project performance

This factor consists of five benefits, namely, "remove waste from the project process", "reduce project cost", "improve project quality", "increase speed of project construction" and "reduce paperwork". The factor explains 15.049% of the total variance in the data. It ranked first, which shows that the improved project

performance is the most significant gain of the implementation of CSCM. This is in line with the conclusions of Ahmed et al. (2002) which found that SCM is a great opportunity to mainly improve profitability for the construction industry by reducing cost and time. The CSC includes the flow of information, flow of materials, services, products, and flow funds between owners, designer, consultant, contractor, subcontractors, suppliers, etc., thus an efficient management of such resources obviously brings benefits such as removing waste, cost savings, improving quality, speeding schedule, and reducing paperwork. SCM facilitates subcontractors and suppliers to early involve in a project as contractors. This would facilitate downstream members to suggest their expertise that could lead to potential cost savings (Proverbs and Holt, 2000). Moreover, the collaboration between main contractor and subcontractors through supply network can significantly improve quality (Humphreys et al., 2003). Furthermore, the collaborative working and the formation of integrated teams within the supply chain can remove waste and deliver a project successfully (JCT student essay competition, 2012). The waste may originate from the delays, errors, and litigation due to lack of collaboration and integrated team.

4) Win-win outcomes among the parties

This factor explains 13.022% of the total variance in the data. The four benefits, namely, "risk sharing among the parties", "development of mutual understanding", "increased customer satisfaction level" and "benefits allocation among the parties" included in the factor are related to win-win outcomes among the parties. This factor was placed on the last position. This reflects that the win-win outcomes have not been emphasized by the parties. This problem could be easy to understand because individual interests are always present and difficult to remove in the supply chain. The parties are unwilling to share risks and benefits, which may cause loss to them. However, a reasonable risk sharing among the

parties is the key line for the effective operation of a supply chain (Chundong et al., 2012). The appropriate or inappropriate allocation of benefit will influence the stability and long-term cooperation of the supply chain (Sheng and Ping, 2010). Moreover, a shared risk and reward may yield strategic competitive advantage. The principle of sharing risk and reward is the foundation for the entire process of cooperation for mutual benefit (Constructing excellence, 2004). In general, it is very unlikely that a single party could resist high intensity damages without the help of its partner companies in the supply chain. Hence, CSCM can be seen as an essential method to conciliate risk sharing with economic efficiency. CSCM creates an environment with joint working, collaboration, commitment, open communication and information, and trust. These help the parties to reach mutual understanding that brings the customer satisfaction and mutually beneficial outcomes. Handfield and Nichols (2002) showed that the mutual understanding among the parties will be developed and then the mutual benefits agreements among them can be formed when information is shared and made available to all parties in the supply chain.

3.5 Chapter summary

This chapter aims to identify the benefits of the CSCM implementation and uncover the underlying relationships among them. Twenty benefits were identified and then ranked according to the different viewpoints of four groups of respondents, including the owner, the contractor, the designer, and the consultant. These groups generally had a convergence of perceptions on the twenty benefits identified. They agreed that "increase speed of project construction", "reduce project cost", "improved margin profit", "efficiency in utilizing the resources and skills", and "improve project quality" were the most significant benefits. Through the factor analysis technique, the benefits were investigated and were categorized into the four factors: (1) systematic business system, (2) organization management

and business strategy, (3) improved project performance, and (4) win-win outcomes among the parties. A model of the benefits of the CSCM implementation is described as Figure 3.6. The findings showed that the implementation of SCM in the construction projects will bring the most significant gains relating to the improved project performance followed by systematic business system, and organization management and business strategy, whereas the win-win outcomes among the parties have not been emphasized by the parties. The findings of this chapter could help practitioners understand fully about the benefits of the CSCM implementation and create a strong motivation for them to apply SCM in their projects.

Figure 3.6 Benefits of the CSCM implementation

CHAPTER 4

BARRIERS TO CONSTRUCTION SUPPLY CHAIN MANAGEMENT

4.1 Introduction

SCM brings benefits to all parties. As found in chapter 3, the core factors of the benefits are: improved project performance, systematic business system, organization management and business strategy, and win-win outcomes among the parties. Despite such the benefits to CSCM, there are barriers militating against the implementation. These hamper the willingness of the industry to practice SCM in construction projects. Moreover, the potential benefits offered by the CSCM in projects may be not achieved if barriers against its implementation are not rejected. This chapter aims to identify and examine the barriers to SCM in the construction industry. The barriers to the CSCM implementation are measured and compared according to perceptions of the parties. The chapter also uncovers the underlying relationships among barriers refined into core factors of barriers. Besides, the consensus among the parties regarding barriers as well as the factors of barriers is checked as well. The findings of the chapter are expected to help the parties to give appropriate strategies for their organizations in SCM.

4.2 Research process

The research process of the chapter is described as Figure 4.1.

Figure 4.1 Research process of chapter 4

The process of identifying barriers to the CSCM implementation and collecting data had been mentioned in the previous chapter. This chapter focuses on analyzing and reporting results regarding barriers to the CSCM implementation. First, the five-point Likert scale (1 = not hinder and 5 = extremely hinder) was tested to measure internal consistency among barriers. The "mean score" method was then applied to rank barriers according to the role of the parties (owners, contractors, designers, and consultants). In rating barriers, Kendall's coefficient of concordance (W) and the Spearman rank correlation coefficient (r_s) were applied to examine the perceptions of respondents in each individual group and among groups to each other on ranking barriers.

In the next step of analysis, the ANOVA was performed which test whether the mean values on each barrier were equal among the groups of owners, contractors, designers, and consultants. In this test, the null hypothesis is that all groups have the same mean and a p value below 0.05 suggests a high degree of difference of opinion among groups on the barriers. Lastly, factor analysis was employed to uncover the underlying relationships among barriers to the CSCM implementation. In order to strengthen factors of barriers extracted from factor analysis, the ANOVA test on factors continue to be checked. And factor score ranking is also examined to facilitate discussion of results.

4.3 Data analysis and discussion

4.3.1 Internal consistency test

After the pilot test as presented in the previous chapter, twenty-two barriers are identified as potential to hinder the implementation of SCM in the construction industry (see Table 4.1). Table 4.1 gives the mean scale ratings of the hindrance of the twenty-two barriers. The mean scores of the 22 barriers range from 3.2 (Fragmented characteristics of the construction industry) to 4.3 (Lack of effective leadership). It can be seen that their mean scores are higher than the midpoint score of 2.5 in a five-point scale. This can be indicated that, as a whole, the respondents agreed that the above 22 barriers hinder the implementation of SCM in the construction projects. There are 16 barriers, rated as "very hinder" ($3.5 \leq$ mean < 4.5), and the others are rated as "averagely hinder" ($2.5 \leq$ mean < 3.5) (Majid and Mccaffer, 1997). Besides, the standard deviation values of the barriers are less than one, which reflects some consensus among the respondents (Ellif and Maarof, 2011).

As shown in Table 4.2, the Cronbach's alpha value of 22 barriers was determined to be 0.898, therefore the five-point scale measurement (1 = not hinder

and 5 = extremely hinder) was reliable at the 5% significance level (Hair et al. 2010).

Table 4.1 Barriers to the CSCM implementation (all respondents)

Code	Item (Barriers to the CSCM implementation)*	N	Min	Max	Mean	Standard Deviation
H1	Lack of understanding supply chain concept	127	2	5	4.17	0.78
H2	Passive sub-contractors and suppliers	127	2	5	4.13	0.75
H3	Inappropriate tending methods	127	1	5	3.87	0.88
H4	Inappropriate organizational structure to support supply chain	127	2	5	3.57	0.96
H5	Lack of communication and information exchange	127	2	5	3.95	0.72
H6	Unwillingness to share risks and benefit, and emphasizing self-interest	127	2	5	3.63	0.86
H7	Lack of genuine collaboration and good working relations	127	2	5	3.92	0.82
H8	Lack of training in SCM	127	2	5	3.54	0.78
H9	Organizational resistance to SCM	127	2	5	4.07	0.76
H10	Lack of usage of IT system	127	2	5	3.49	0.85
H11	Lack of trust among the parties in supply chain	127	1	5	3.76	0.95
H12	Lack of commitment to supply chain	127	1	5	3.65	0.87
H13	Lack of common goals among the parties in supply chain	127	2	5	3.73	0.85
H14	Lack of competence of parties in SCM	127	2	5	4.20	0.72
H15	Lack of effective leadership	127	2	5	4.30	0.75
H16	Ineffective problem solving mechanism	127	1	5	3.42	0.95
H17	Anticipated rewards unclear	127	1	5	3.38	0.90
H18	Power domination and frequent contractual non-commitments	127	2	5	3.83	0.89
H19	Complexity and harshness of supply chain process	127	1	5	3.28	0.93
H20	Temporary or short-term supply chain network	127	2	5	3.31	0.86
H21	Lack of understanding customer requirements	127	1	5	3.68	0.86
H22	Fragmented characteristics of the construction industry	127	1	5	3.20	0.98

* Items were rated on a five-point Likert scale with 1 = Not hinder and 5 = Extremely hinder

Table 4.2 Cronbach's alpha value of twenty-two barriers to the CSCM implementation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.898	.896	22

4.3.2 Ranking the barriers to the CSCM implementation

The results of the computation of the Kendall's coefficient of concordance (W) and the rankings of barriers are presented in Table 4.3. The Kendall's coefficients of concordance (Ws) for the owner group, the contractor group, the designer group, and the consultant group were in turn 0.190, 0.184, 0.119, and 0.195, respectively. The Kendall's coefficient of concordance (W) for all respondents was 0.163. All the Kendall's coefficients of concordance (Ws) are different from zero. This indicated that the null hypothesis that the respondents' ratings are unrelated to each other within each group was rejected at a 0.0001 significant level. It also meant that there is significant agreement among the respondents in each group and all groups on the rankings of the barriers to the CSCM implementation.

When taking all responses into account, the barriers, such as lack of effective leadership (H15, mean value 4.30), lack of competence of the parties in SCM (H14, mean value 4.20), lack of understanding supply chain concept (H1, mean value 4.17), passive sub-contractors and suppliers (H2, mean value 4.13), and organizational resistance to SCM (H9, mean value 4.07) were the most significant hindrances. On the other hand, the barriers of temporary or short-term supply chain network, complexity and harshness of supply chain process, and fragmented characteristics of the construction industry were considered to be least hindrances by the respondents.

Lack of effective leadership was ranked top by all respondents, implying that leadership is of paramount importance for SCM. Lack of effective leadership was also found as one of the major challenges in the Value chain management

(Harman, 2000). When the leadership role is taken, parties' internal business processes can integrate into the supply chain business processes and each member of the band is playing the same tune. A strong leadership will drive the direction of the chain and lack leadership can affect the level of commitment of other members in the supply chain (Lambert and Cooper, 2000). For this barrier, contractors, designers and consultants ranked it as the first position while owners ranked it fourth. The owners do not seem to emphasize this barrier as the others. This is probably because a part of their work is supported by the consultants. The consultants can be considered as the representative of the owners in most of the issues relating to the contract. They have to be responsible for the quality of design works and construction supervision on site. Therefore the consultants can usually work more closely with the contractors and the designers on issues regarding projects, which explain that the parties ranked lack of effective leadership as the first barrier except the owners.

Lack of competence of the parties in SCM and lack of understanding supply chain concept were ranked second and third, respectively. According to Jha and Iyer (2007), competence is considered as the key factor for achieving the project performance in terms of schedule, cost, and quality. Lack of competence can make the parties deal with more risk and uncertain circumstances when they take part in the complex and harsh supply chain network. Moreover, if one of the parties has no ability to join within their role, SCM can therefore be unlikely to achieve the desired results. For example, the incompetent owners may carry out their project before receiving its full data. They may postpone schedule without planning and also may not be able to recruit a competent representative to look after their interest. All these lead to an unsuccessful result as far as the schedule is concerned (Jha, 2013). Akintoye et al. (2000) pointed out that lack of understanding of SCM concepts is recognized as the most critical barriers to CSC relationships. Lack of understanding supply chain concept can result in the parties' disregard to

implement SCM. The parties do not understand what are about SCM and its benefits. Hence, they always prefer traditional methods in their projects.

Next, passive sub-contractors and suppliers was ranked fourth. A cognitive deficiency about SCM is that it only has involvement of owners, contractors, consultants, and designers. Involvement of subcontractors and suppliers should be included with the others in the SCM. Their opinion and advice can be ignored if they are not involved in the SCM so the users' requirements can be very difficult to obtain the best results. SCM provides a business environment required the effective integration of subcontractors and suppliers, however, most of the construction companies have not been interested in doing this (Deshmukh et al., 2014). Organizational resistance to SCM occupies the fifth position. Resistance of organizations to a new approach is always present. Therefore, it is hard to change habits and present working culture in any organization. They often want to follow a routine and from the same process, and so the application of the new approach and change their ways of working may be not better than the former approach from their thought. Many organizations are reluctant to change into the integrating culture as SCM. And the resistance from the parties can be element inhibiting the wider use of CSCM.

Some differences were found among the rankings of four groups (Table 4.3). The main disparity is observed in item H6, "Unwillingness to share risks and benefits, and emphasizing self-interest" (ranked eighteenth by the owners, ninth by the contractors, eleventh by the designers, and fifteenth by the consultants). The owners seem not to be concerned with the unfairness of sharing the risks and benefits and do not perceive it as the main barrier of CSCM. It is likely a common practice in Vietnam for the owners to transfer most of the risk to the contractor as much as possible. Hence, it is not surprising to see such a various view on the unwillingness to share risks and benefit as a barrier to the implementation of CSCM.

While the owners maintained that "Power domination and frequent contractual non-commitments" was one of the significant barriers (ranked sixth), both the designers and the consultants ranked it ninth, and the contractors ranked it twelfth. The situation is perhaps related to the decisive role of the owners in the project. The owners have the right to make decision with most issues relating to their projects. Their decision can impact all systems in the CSC, therefore they may believe that the power domination and frequent contractual non-commitments from one of the parties will hinder the implementation of SCM. Moreover, the others may think that it is the inevitable problems in relationships and they may withstand it to ensure something like maintaining relationships.

A similar result was found on the barrier of "Lack of understanding customer requirements", which was ranked eighth by the owners, ranked fifth, thirteenth, and tenth by the contractors, the designers, and the consultants, respectively. This is easy to understand when the owners stress understanding customer requirements more than the others. The projects were made to cater for themselves or their representatives, so they always ask the other parties to have to understand what are their requirements in order to ensure the best results. Another disparity in ranking was observed: the contractors ranked "lack of trust among the parties in supply chain" as the eighth, whereas both the designers and the consultants ranked it tenth, and the owners ranked it fourteenth. This indicates that the contractors have a significant interest in the trust among the parties in the supply chain. This interest is probably because the contractors play an intermediary role as a tier in the CSC to link between upstream members and downstream members, so they may believe that a successful implementation of SCM requires the trust among the parties in the supply chain.

Table 4.3 Ranking and Kendall's Coefficient of Concordance for the barriers to the CSCM implementation

Code	Item (Barriers to the CSCM implementation)	All respondents		Owner		Contractor		Designer		Consultant	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
H15	Lack of effective leadership	4.30	1	4.20	4	4.32	1	4.13	1	4.45	1
H14	Lack of competence of parties in SCM	4.20	2	4.37	1	4.21	2	4.07	3	4.10	3
H1	Lack of understanding supply chain concept	4.17	3	4.37	1	4.09	4	4.13	1	4.10	3
H2	Passive sub-contractors and suppliers	4.13	4	4.27	3	4.04	5	4.07	3	4.17	2
H9	Organizational resistance to SCM	4.07	5	4.10	5	4.17	3	3.93	5	3.93	6
H5	Lack of communication and information exchange	3.95	6	3.93	7	4.02	6	3.93	5	3.86	7
H7	Lack of genuine collaboration and good working relations	3.92	7	3.83	10	4.02	6	4.07	7	3.76	8
H3	Inappropriate tending methods	3.87	8	3.87	8	3.77	10	4.07	7	3.97	5
H18	Power domination and frequent contractual non-commitments	3.83	9	4.03	6	3.74	12	4.00	9	3.69	9
H11	Lack of trust among the parties in supply chain	3.76	10	3.70	14	3.85	8	3.87	10	3.62	10
H13	Lack of common goals among the parties in supply chain	3.73	11	3.83	10	3.77	10	3.60	16	3.62	10
H21	Lack of understanding customer requirements	3.68	12	3.87	8	3.58	15	3.73	13	3.62	10
H12	Lack of commitment to supply chain	3.65	13	3.77	13	3.64	13	3.67	14	3.52	13
H6	Unwillingness to share risks and benefit, and emphasizing self-interest	3.63	14	3.43	18	3.81	9	3.80	11	3.41	15
H4	Inappropriate organizational structure to support supply chain	3.57	15	3.83	10	3.53	16	3.47	19	3.45	14
H8	Lack of training in SCM	3.54	16	3.60	15	3.60	14	3.67	14	3.28	19
H10	Lack of usage of IT system	3.49	17	3.57	16	3.53	16	3.33	21	3.41	15
H16	Ineffective problem solving mechanism	3.42	18	3.20	21	3.43	18	3.80	11	3.41	15
H17	Anticipated rewards unclear	3.38	19	3.33	20	3.36	19	3.60	16	3.34	18
H20	Temporary or short-term supply chain	3.31	20	3.40	19	3.26	20	3.47	19	3.21	21

Code	Item (Barriers to the CSCM implementation)	All respondents		Owner		Contractor		Designer		Consultant	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
	network										
H19	Complexity and harshness of supply chain process	3.28	21	3.50	17	3.21	21	3.60	16	3.03	22
H22	Fragmented characteristics of the construction industry	3.20	22	3.17	22	3.13	22	3.33	21	3.28	19
Number (N)		127		30		53		15		29	
Kendall's Coefficient of Concordance (W)		0.163		0.190		0.184		0.119		0.195	
Level of significance		0.000		0.000		0.000		0.000		0.000	

Note: Where H_0 = respondents' ratings are unrelated to each other within each group.

Next, the Spearman rank correlation coefficient (r_s) was calculated to check whether there is any similar consensus among groups on the ranking barriers. The correlation results are presented in Table 4.4 and Table 4.5. The calculated r_s between the owner and the contractor, the owner and the designer, the owner and the consultant, the contractor and the designer, the contractor and the consultant, and the designer and the consultant were in turn 0.829, 0.767, 0.908, 0.848, 0.894, and 0.864 respectively. They all had significance level at 0.01. Hence, the alternative hypothesis is accepted that there is a significant agreement exists among groups on the ranking of barriers to the CSCM implementation. A general agreement can be concluded among the groups on the ranking as shown in Table 4.5.

Table 4.4 Spearman rank correlation test among groups of respondents for barriers to the CSCM implementation

	Owner	Contractor	Designer	Consultant
Owner	1.000	0.829**	0.767**	0.908**
Contractor	0.829**	1.000	0.848**	0.894**
Designer	0.767**	0.848**	1.000	0.864**
Consultant	0.908**	0.894**	0.864**	1.000

Note: **. Correlation is significant at the 0.01 level (2-tailed)

Table 4.5 Comparison of spearman rank correlation coefficient and its level of significance for barriers to the CSCM implementation

Comparison	r_s	Significant	Conclusion
Owner ranking vs Contractor ranking	0.829	0.01	Reject H_0
Owner ranking vs Designer ranking	0.767	0.01	Reject H_0
Owner ranking vs Consultant ranking	0.908	0.01	Reject H_0
Contractor ranking vs Designer ranking	0.848	0.01	Reject H_0
Contractor ranking vs Consultant ranking	0.894	0.01	Reject H_0
Designer ranking vs Consultant ranking	0.864	0.01	Reject H_0

Where H_0 = No significant agreement on the ranking

H_a = Significant agreement on the ranking

The profiles for each of the 22 listed barriers to the CSCM indicate in general, a close scatter pattern as shown in Figure 4.2. The close scatter pattern indicates that most respondents exhibit a negative attitude towards barriers in the implementation of SCM.

Figure 4.2 Cross-comparison of barriers among groups

4.3.3 Check consistency of opinion among the respondents' groups

Regarding consistency of opinion among the respondents' groups, the ANOVA test was conducted to test the null hypothesis that the groups did not disagree in their opinion on the 22 barriers to the CSCM implementation. The results of the ANOVA test showed that the p values were greater than 0.05, indicating that there was a consensus of opinion among the groups. Therefore, the collected data can be treated as a whole in further analysis. ANOVA test results were presented in Table 4.6.

Table 4.6 Results of ANOVA test on barriers to the CSCM implementation

Code	Item (Barriers to the CSCM implementation)	F	Sig.
H1	Lack of understanding supply chain concept	0.869	0.459
H2	Passive sub-contractors and suppliers	0.668	0.573
H3	Inappropriate tending methods	0.567	0.638
H4	Inappropriate organizational structure to support supply chain	0.990	0.400
H5	Lack of communication and information exchange	0.306	0.821
H6	Unwillingness to share risks and benefit, and emphasizing self-interest	2.164	0.096
H7	Lack of genuine collaboration and good working relations	0.895	0.446
H8	Lack of training in SCM	1.413	0.242
H9	Organizational resistance to SCM	0.806	0.493
H10	Lack of usage of IT system	0.356	0.785
H11	Lack of trust among the parties in supply chain	0.455	0.715
H12	Lack of commitment to supply chain	0.403	0.751
H13	Lack of common goals among the parties in supply chain	0.465	0.707
H14	Lack of competence of parties in SCM	0.888	0.450
H15	Lack of effective leadership	0.815	0.488
H16	Ineffective problem solving mechanism	1.337	0.265
H17	Anticipated rewards unclear	0.346	0.792
H18	Power domination and frequent contractual non-commitments	1.141	0.335
H19	Complexity and harsh of supply chain process	1.961	0.123
H20	Temporary or short-term supply chain network	0.459	0.711
H21	Lack of understanding customer requirements	0.743	0.529
H22	Fragmented characteristics of the construction industry	0.240	0.868

4.3.4 Exploratory Factor Analysis

Another task of this chapter is that relationships among barriers should be discovered to derive a reduced set of barriers which can be readily used in practice. Consequently, factor analysis was employed to catch the multivariate interrelationships existing among the barriers. It is very important to abide by the basic requirements of factor analysis, which include scanning correlation matrix, testing the appropriateness of using factor analysis on data, checking communalities, checking case to variable ratio.

The matrix of the correlation coefficients as shown in Table 4.7 indicates that each barrier has lots of correlations above 0.3 with respect to the others, which means that the barriers correlate fairly well one another and implies that it is not necessary to remove any barriers for the next analyses. The adequacy of the survey data was examined by checking the Kaiser-MeyerOlkin (KMO) test and the Bartlett's test of sphericity. In these tests, the Bartlett's test of sphericity is significant (p = 0.000), and the value of the KMO index is 0.841 (higher than 0.5). The results confirmed that the data are appropriate for factor analysis (Refer to Table 4.8). Regarding the communalities of each barrier as presented in Table 4.9, the two barriers, namely, "Inappropriate organizational structure to support supply chain" (H4) and "Lack of usage of IT system" (H10) are eliminated because their communalities are less than 0.5, which does have enough explanatory value (Hair, 2010). This step retains 20 barriers for final factor analysis. The Kaiser-MeyerOlkin (KMO) test and the Bartlett's test of sphericity will be checked again. This trial shows that KMO = 0.834 > 0.5, Sig. < 0.05 and communalities of all the remaining barriers are found to be much greater than 0.505 that signifies that the factor model is reliable. In term of the case to variable ratio, as the current study sample includes 127 respondents, it supplies a ratio of variables to sample size as 1:6, which indicates that factor analysis is appropriate.

Table 4.7 Correlation matrix of barriers to the CSCM implementation

Code	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22
H1	1																					
H2	0.14	1																				
H3	0.23	0.36	1																			
H4	0.29	0.20	0.39	1																		
H5	0.13	0.48	0.28	0.24	1																	
H6	0.11	0.25	0.36	0.27	0.21	1																
H7	0.07	0.26	0.34	0.16	0.15	0.54	1															
H8	0.32	0.06	0.24	0.31	0.12	0.30	0.21	1														
H9	0.14	0.48	0.27	0.11	0.44	0.30	0.14	0.22	1													
H10	0.22	0.18	0.34	0.34	0.24	0.32	0.19	0.31	0.20	1												
H11	0.09	0.15	0.35	0.13	0.11	0.60	0.54	0.16	0.07	0.18	1											
H12	0.20	0.51	0.38	0.40	0.45	0.43	0.17	0.28	0.53	0.44	0.20	1										
H13	0.16	0.56	0.29	0.27	0.35	0.43	0.29	0.26	0.51	0.27	0.20	0.53	1									
H14	0.38	0.06	0.12	0.15	0.02	0.12	0.16	0.52	0.09	0.26	0.18	0.19	0.12	1								
H15	0.50	0.07	0.24	0.17	0.14	0.09	0.08	0.45	0.10	0.19	0.16	0.19	0.08	0.54	1							
H16	0.15	0.16	0.55	0.32	0.05	0.31	0.18	0.35	0.17	0.31	0.24	0.39	0.28	0.19	0.19	1						
H17	0.35	0.33	0.66	0.43	0.19	0.40	0.37	0.40	0.32	0.39	0.34	0.50	0.40	0.21	0.24	0.55	1					
H18	0.14	0.21	0.41	0.24	0.02	0.58	0.54	0.30	0.16	0.34	0.54	0.30	0.36	0.16	0.10	0.23	0.41	1				
H19	0.10	0.24	0.37	0.34	0.17	0.33	0.16	0.21	0.25	0.32	0.28	0.34	0.27	0.04	0.03	0.28	0.34	0.32	1			
H20	0.22	0.13	0.28	0.38	0.11	0.28	0.12	0.28	0.36	0.32	0.15	0.38	0.34	0.10	0.14	0.29	0.41	0.30	0.57	1		
H21	0.31	0.26	0.43	0.43	0.23	0.37	0.25	0.32	0.28	0.38	0.43	0.42	0.25	0.34	0.35	0.34	0.48	0.36	0.57	0.60	1	
H22	0.09	0.17	0.36	0.31	0.04	0.32	0.21	0.28	0.27	0.38	0.25	0.32	0.23	0.13	0.10	0.35	0.45	0.33	0.57	0.34	0.41	1

Table 4.8 KMO and Bartlett's Test on barriers to the CSCM implementation

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.841
Bartlett's Test of Sphericity	Approx. Chi-Square	1222.663
	df	231
	Sig.	.000

Table 4.9 Communalities of barriers to the CSCM implementation

Code	Item (Barriers to the CSCM implementation)	Initial	Extraction
H1	Lack of understanding supply chain concept	1.000	0.505
H2	Passive sub-contractors and suppliers	1.000	0.663
H3	Inappropriate tending methods	1.000	0.719
H4	Inappropriate organizational structure to support supply chain	1.000	0.430
H5	Lack of communication and information exchange	1.000	0.579
H6	Unwillingness to share risks and benefit, and emphasizing self-interest	1.000	0.683
H7	Lack of genuine collaboration and good working relations	1.000	0.689
H8	Lack of training in SCM	1.000	0.542

Code	Item (Barriers to the CSCM implementation)	Initial	Extraction
H9	Organizational resistance to SCM	1.000	0.625
H10	Lack of usage of IT system	1.000	0.365
H11	Lack of trust among the parties in supply chain	1.000	0.694
H12	Lack of commitment to supply chain	1.000	0.656
H13	Lack of common goals among the parties in supply chain	1.000	0.591
H14	Lack of competence of parties in SCM	1.000	0.679
H15	Lack of effective leadership	1.000	0.692
H16	Ineffective problem solving mechanism	1.000	0.686
H17	Anticipated rewards unclear	1.000	0.728
H18	Power domination and frequent contractual non-commitments	1.000	0.665
H19	Complexity and harshness of supply chain process	1.000	0.736
H20	Temporary or short-term supply chain network	1.000	0.685
H21	Lack of understanding customer requirements	1.000	0.663
H22	Fragmented characteristics of the construction industry	1.000	0.531

After preliminary analysis, the 20 remaining barriers were depended on the factor analysis with principal component analysis and varimax rotation. As shown in Table 4.10, five factors were extracted with eigenvalues greater than 1. They explained 65.714% of the variance, which is greater than the 60% as recommended by Hair (2010). The results of the factor analysis on barriers to the CSCM implementation are shown in Table 4.11. A factor loading value that is greater than 0.50 will be considered for inclusion of barriers within a factor. Factor loadings of all barriers are greater than 0.5 (Table 4.11). Based on an examination of inherent relationships among the barriers under each of the factors, the five factors have been given the following new names:

Factor 1: Lack of support and active participation from the parties

Factor 2: Confronting culture and adversarial behavior

Factor 3: Inherent difficulties in the supply chain

Factor 4: Lack of knowledge and competence

Factor 5: Deficiencies in the contract system

Table 4.10 Principal components analysis results of barriers to the CSCM implementation

Principle component	Eigenvalue	Percentage of variance explained	Cumulative variance percentage
1	6.557	32.784	32.784
2	2.072	10.361	43.145
3	1.887	9.434	52.579
4	1.533	7.665	60.245
5	1.094	5.469	65.714
6	0.922	4.611	70.325
7	0.749	3.745	74.070
8	0.673	3.366	77.436
9	0.576	2.879	80.315
10	0.553	2.763	83.077
11	0.495	2.477	85.554
12	0.452	2.262	87.816
13	0.429	2.146	89.962
14	0.380	1.901	91.863
15	0.343	1.717	93.579
16	0.323	1.616	95.196
17	0.290	1.448	96.644
18	0.269	1.347	97.991
19	0.216	1.079	99.070
20	0.186	0.930	100.000

Table 4.11 Five factor of barriers to the CSCM implementation

Factor of the barriers	Variance explained (%)	Code	Barriers	Factor loading
Factor 1: Lack of support and active participation from the parties	14.991	H2	Passive sub-contractors and suppliers	0.782
		H5	Lack of communication and information exchange	0.761
		H9	Organizational resistance to SCM	0.738
		H13	Lack of common goals among the parties in supply chain	0.686
		H12	Lack of commitment to supply chain	0.665
Factor 2: Confronting culture and adversarial behavior	14.168	H7	Lack of genuine collaboration and good working relations	0.807
		H11	Lack of trust among the parties in supply chain	0.805
		H18	Power domination and frequent contractual non-commitments	0.751
		H6	Unwillingness to share risks and	0.737

Factor of the barriers	Variance explained (%)	Code	Barriers	Factor loading
			benefit, and emphasizing self-interest	
Factor 3: Inherent difficulties in the supply chain	13.027	H19	Complexity and harshness of supply chain process	0.825
		H20	Temporary or short-term supply chain network	0.796
		H21	Lack of understanding customer requirements	0.653
		H22	Fragmented characteristics of the construction industry	0.614
Factor 4: Lack of knowledge and competence	12.752	H15	Lack of effective leadership	0.829
		H14	Lack of competence of the parties in SCM	0.806
		H1	Lack of understanding supply chain concept	0.682
		H8	Lack of training in SCM	0.652
Factor 5: Deficiencies in the contract system	10.775	H16	Ineffective problem solving mechanism	0.820
		H3	Inappropriate tending methods	0.740
		H17	Anticipated rewards unclear	0.693

ANOVA test was also conducted on the five factors of barriers to check the consensus of opinion among groups (the owner, the contractor, the designer, and the consultant). Table 4.12 reveals that all p-values are above 0.05. Therefore, it is concluded that there are no significant differences among groups regarding the five factors.

Table 4.12 Analyzing groups' perspectives on the five factors of barriers

Code	Factor	F	Sig.
F1	Lack of support and active participation from the parties	0.484	0.694
F2	Confronting culture and adversarial behavior	0.808	0.492
F3	Inherent difficulties in the supply chain	1.104	0.350
F4	Lack of knowledge and competence	0.404	0.750
F5	Deficiencies in the contract system	1.654	0.180

The factor analysis enables barriers to be grouped into the five core factors. Each factor contains different barriers with a various degree of hindrance. To assist management in identifying the major factors of barriers, a rank of the level of the harmful impact of these five factors was performed. These factors can be

prioritized by using the factor score. The level of the harmful impact of these factors will help the parties to identify which factors should be concerned earlier than others in order to promote the development of the CSCM implementation. The following formula is applied to compute the factor score of each factor:

$$F_i = \frac{\sum_j^n A_{ij}}{n}$$

Where F_i is the Factor score, A_{ij} is the mean score of the j_{th} barrier of factor i. The factor score of each factor is the mean score of the barriers grouped accordingly to the factor analysis. Factor scores and rankings of five factors are presented in Table 4.13. The top three most hindrance factors impeding the implementation of CSCM are Factor 4, lack of knowledge and competence; Factor 1, lack of support and active participation from the parties; and Factor 2; confronting culture and adversarial behavior. These three factors represent 13 barriers out of 20 barriers to the CSCM implementation.

Table 4.13 Factor score ranking of barriers to the CSCM implementation

Code	Factor	Factor score	Rank
F4	Lack of knowledge and competence	4.05	1
F1	Lack of support and active participation from the parties	3.91	2
F2	Confronting culture and adversarial behavior	3.79	3
F5	Deficiencies in the contract system	3.56	4
F3	Inherent difficulties in the supply chain	3.37	5

The explanations of the relationship among the barriers under their factors are supplied in the following sections.

1) Lack of support and active participation from parties

This factor comprises five barriers, namely, passive sub-contractor and suppliers, lack of communication and information exchange, organizational

resistance to SCM, lack of common goals among the parties in the supply chain, and lack of commitment to supply chain. The factor accounts for the greatest variance (14.991%) among all the factors and is ranked second. All barriers in the factor are related to lack of support and active participation from parties. A positive attitude from parties is necessary for implementing CSCM. However, the sub-contractors and suppliers are often passive and lack of involvement in the supply chain. Because of this lack of involvement, communication between owners and subcontractors is indirect, which may be reason that results in poor quality (Lin and Gibson, 2011). Moreover, subcontractors often do not have any formal contractual relationship with the owner, however, they have done most of the work on the construction site (Tam et al., 2011). In current CSC practices, subcontractors have little interest and active motivation to supply the excellent results for the owners. In most of the cases, subcontractors always do not have a full awareness and interest about the owners' requirements because of inefficient communication between them, and this problem could result in defective or abortive work (Chiang, 2009). Lewis (1995) showed that when suppliers fail to participate in the design phase of a project, a lot of potential value may be lost. Therefore, involvement of subcontractors and suppliers in the specification stage is really necessary to integrate design and construction planning (Akintoye et al., 2000) and the project schedule can shorten through concurrent engineering (Brown et al., 2001; Cheung et al., 2001). Proverbs and Holt (2000) advocated that early involvement of subcontractors and suppliers as the involvement of main contractor in a project would provide an opportunity to downstream members to suggest their expertise that may lead to potential cost savings. Moreover, through the involvement of subcontractors and suppliers early in the design stage, the risk of harmful rigid division of work tasks decreases, whilst integration of work and knowledge exchange increases (Eriksson et al., 2008).

Lack of support and active participation can lead to lack of communication and information exchange among the parties. Information is important to the performance of a supply chain because it provides the basis for supply chain managers to make decisions. And the sharing information is valuable for the whole CSC (Tiwari et al., 2014). Benton et al. (2010) also showed that lack of communication and information exchange results in negative influences such as poor quality, cost and time overruns, change orders, reworks and so on. Sharing information such as previous experience, historical background, new advance technology, market condition, and so on is necessary for the CSCM but most of the parties do not want to share such information because of fearing loss of management (Deshmukh et al., 2014). Barson et al. (2000) gave a similar conclusion that some of organizations fear of losing company stability and market position when they share technical information with other chain members. Lack of communication and information exchange may also result from organizational resistance to SCM. Besides, the organizational resistance to SCM may be considered as one of the reasons causing lack of support and active participation from the parties. The supply chain managers do not realize the real benefits of information sharing and do not have confidence in information sharing system. The beginning of information sharing requires fundamental changes in process and behavior of the parties in the supply chain (Khurana et al., 2011). However, the organizations are not always willing to reach a new approach. This is because they mostly have a conservative and defensive culture that inhibits change and encourages maintenance of the status quo. Integrating into SCM requires some changes in the organizational structure to fit with the other members in the supply chain. Commonly, the parties in supply chain resist the changes because they have structural conflicts and different management practices (Khurana et al., 2011). Behara et al. (2015) found that construction organizations tend to conservative

referring to the need to change, because of the risks associated with the procurement of projects.

Lack of support and active participation from the parties can result in lack of commitment to supply chain and lack of common goals among the parties in the supply chain. Lack of the parties' commitment to supply chain is described as lack of long-term relationships and partnering, reduced consideration of downstream impacts on upstream decision, non-responsiveness to the needs of other supply chain members, and lack of incentive and funds for innovations and product development. As mentioned by Chan et al. (2003), lack of commitment is common in practice because of differing goals and objective among the parties. The formation of common objectives and mutual values are important goals to bring about cooperation and reduced conflict in construction projects (O'Brien et al., 2009). Although each stakeholder and supply chain member has specific goals, the entire organization should share common supply chain objectives with regard to end customers and users. Failure to share common supply chain objectives may lead to ineffective decision-making, inappropriate strategies, inadequate measurement of performance and enhanced risk exposure among the parties (Zsidisin and Ritchie, 2008). Constructing Excellence (2004) showed that all parties have to be committed to working for the long term on the basis of continuous improvement and innovation. If any one of the parties tends to quit when the process is in trouble, the supply chain will fail.

2) Confronting culture and adversarial behavior

This factor explains 14.168% of the total variance in the data. The four barriers included in this factor are lack of genuine collaboration and good working relations, lack of trust among the parties in the supply chain, power domination and frequent contractual non-commitments, and unwillingness to share risks and benefit, and emphasizing self-interest. All of them are describing the confronting

culture and adversarial behavior among the parties. The factor is ranked third. This indicates that the confronting culture and adversarial behavior are one of the main barriers to the implementation of the CSCM, because it promotes win-lose attitudes among the parties. The parties are used to working in opposition to each other, lack of genuine collaboration, achieving individual objectives, rather than working together towards a joint objective. The uncooperative behavior and adversarial relationship among the parties is the cause of many various kinds of waste (Yan, 2012). Traditionally, the contracts among the parties are too strict and do not stress cooperation and sharing of responsibilities and risks. Instead, they focus on their individual responsibilities that create the distance among them. During the construction processes, the parties only consider their own interests when they collaborate with other parties (Eriksson et al., 2008).

The lack of trust is seen as a major obstacle in SCM. This makes the parties unwilling to work together and share information because they fear that the other party will take their advantages or use the information unethically (Wisner et al., 2012). Normally, project organizations are restructured for each project. This means that CSCs are characterized by different procedure and discrete relationships, and so CSC parties generally have short term relationships instead of long term risk sharing partnerships. A consequence of this is the lack of trust among the parties. Confronting culture and adversarial behavior also represent the aspect of power domination and frequent contractual non-commitments. The failure to comply with contract and power domination among the parties may bring a negative attitude in working together. For example, between subcontractors and main contractors there is a difference in the power position, main contractors who have arrogant attitudes, short-term focus and narrowly win-lose attitudes bully and treat with little respect to their subcontractor (Packham et al., 2003; Xue et al., 2007). Thus, subcontractors are not necessary to have significant motivation for solving problems from the view of main contractors or

the owners. Wong et al. (2005) pointed that unfair allocation of risks and benefits being common existence in current contracting systems hinder the effective application of CSCM. The parties usually focus on personal interests and this is common in the construction industry. However, the principle of sharing risk and reward is the foundation for the entire process of cooperation for mutual benefit. This will encourage the parties to continue to provide the optimum value for their client (Constructing Excellence, 2004).

3) Inherent difficulties in the supply chain

This factor explains 13.027% of the total variance in the data. The four barriers in this factor relating to inherent difficulties in the supply chain are complexity and harshness of supply chain process, temporary or short-term supply chain network, lack of understanding customer requirements, and fragmented characteristics of the construction industry. The factor is ranked the last position. During the implementation of SCM always exists the inherent difficulties that are inevitable such as complexity, harshness, temporary, fragmentation in supply chain, and disregard of customers' requirements. The construction industry is one of the most complex and harsh industries. CSC includes a network of multiple members and relationships, so according to Xue et al. (2007), the problems of CSC are rooted from their interfaces involved in the CSC. Because of various trades and roles, the parties often work on their own way for their own operations, and a good cooperative environment among them has not been built (Sun and Zhang, 2006). As a result, this makes the parties extremely difficult to collaborate and integrate their works readily, and thus there is a tendency to result in the challenges in managing the CSC. Thus, CSC is common to suffer the high proportion of failures such as poor quality, cost overruns, schedule delays, and clients' dissatisfaction. The nature of the supply chain has always been competitive. Traditionally, CSC favors a high degree of well-competitive bidding

in the contractor firms (Briscoe et al., 2001). In competitive bidding, contractors have to bid high enough to make a profit, but low enough to get a job. As a result, the parties lack commitment and willingness to support others throughout the whole supply chain process and therefore the formation of supply chain integration is extremely rare in construction.

Besides, supply chain networks also exists the temporary nature and short-term focus, which hinder the implementation of SCM. The average time frame of construction project lasts only in a few years in different geographic locations. In this temporary supply-chain network, it is hard to have the desire of the close interaction of parties and activities in a CSC (Sun and Zhang, 2006). Vrijhoef and Koskela (2000) agreed that organizations need to be reconfigured for each new project although the processes can be the same for construction projects of a kind. This can make the parties very difficult to develop long-term relationships in temporary and little repetition supply chain, which ultimately makes the management of supply chain harder.

Understanding customer requirements are the important element to achieve the work quality as expected. However, due to the complexity and fragmentation of the construction industry, the lack of understanding customer is inevitable. This results in many problems that inhibit the implementation of the SCM. The problems may occur, such as lack of the mutual goals among the parties, the poor quality, conflicts and disputes. Moreover, the lack of understanding customer may also cause the capture of false information between tie-point in the supply chain. Benton et al. (2010) stressed that a high level of awareness between each participating firms and their partners will create inter-firm collaboration management in the supply chain. Another common problem that belongs to the inherent difficulties in supply chain is the fragmented industry structure. Separation of the design from the rest of the project process can easily recognize

in fragmented characteristics. Due to the interruption of operation, it hampers the integration and early involvement of the parties in CSC (Xue et al., 2007). The fragmentation is not only in terms of the number and size of construction firms, but also the diversity of professions and trades. Many main contractors no longer undertake work directly. This leads the main contractors to subcontract the work to specialist subcontractors, hire plant, use labor-only subcontractors and use many suppliers. The use of subcontractors that may further subcontract their work and the use of labor only subcontractors with little or no training could easily exacerbate the problem (Hatmoko, 2008).

4) Lack of knowledge and competence

Lack of effective leadership, lack of competence of the parties in SCM, lack of understanding supply chain concept, and lack of training in SCM are grouped in this factor. These barriers are related to lack of knowledge and competence. This factor explains 12.757 % of the total variance in the data and is ranked first among all of the factors. This indicates that lack of knowledge and competence is the most hindrance factor impeding the implementation of SCM. Leadership is one of the important antecedents of the implementation of SCM (Lambert et al., 1998). Ou et al. (2010) showed that a successful SCM strategic vision is established on the basis of effective management leadership, which creates and communicates the corporate strategic vision of SCM. A firm is able to mobilize its resources through management leadership to satisfy various customer needs when the customer focus is identified. Management leadership is the main driving force behind initiating a change towards concentrating a firm's efforts on mobilizing human resources and improving operating processes (Ou et al., 2010).

The effect leadership requires competence, understanding, and training about SCM. Lack of competence is an organizational barrier. Ng et al. (2002) reported

that relationships become strained if the parties have low confidence in the owner's ability to manage the project. All parties need to develop new competencies to participate in SCM. For example, contractors and subcontractors need to develop new competencies in order to be able to contribute their expertise in the design stage (Eriksson et al., 2007). High relevant competence and exchange of competence among the parties are seen as positive for building cooperative relationships because these characteristics contribute to improving trust (Lazar, 2000). Lack of understanding the supply chain concept may result in the parties' disregard to the implementation of SCM. The parties do not understand the role of their own and others in the CSC. The parties may fail to understand how the SCM implementation could provide benefits which inspire and motivate them. Hence, a full understanding of SCM concept is essential to create a successful SCM implementation. Most subcontractors and suppliers are small-sized companies and they do not have enough knowledge and resources. Therefore, they could have little training on knowledge relating to SCM. Deficiency of training SCM in organizations is the underlying cause of failure of its implementation. And the parties cannot fully understand the concept of SCM and thus they are not able to implement SCM successfully. As above discussion, the training about SCM is necessary to enhance knowledge, competence of the parties.

5) Deficiencies in the contract system

This factor explains 10.775 % of the total variance in the data and is ranked fourth. Ineffective problem solving mechanism, inappropriate tending methods, and anticipated rewards unclear are extracted for this factor. These barriers are related to the deficiencies in the contract system. The adversarial nature of the construction industry contributes to the germination of construction problems. Problems are inevitable during a project. Therefore, the effective problem solving

mechanism should be effective to ensure the smooth operation of SCM throughout the project. The ineffective problem solving mechanism may increase conflicts and disputes among the parties. This seriously affects their relationships that are the foundation for SCM. In order to ensure effective problem solving, the contract system should be fully prepared possible provisions related to dispute and conflict resolution when the problems occurred. Moreover, the clear reward system should be included in the contract in order to encourage the involvement of the parties in the SCM implementation. Wong et al. (2005) considered lack of reward system as one of the barriers impeding the SCM implementation. They showed that the parties have lack of incentives to encourage them to perform well in the CSC. The current contracting system emphasizes only one how to recover the loss of the owners caused by the main contractor. This increases the win-lose attitude among the parties.

Inappropriate tending methods are another barrier in deficiencies in the contract system. The firms may get contracts on lowest price against fixed specifications. Main contractors have a tendency to accept the lowest bidder in selecting subcontractors and suppliers. This problem also occurs in a similar way between owners and main contractors. Hence, main contractors/suppliers/subcontractors often try to deliver their product or service as cheaply as possible to their customers. This limits profit that forces them to sacrifice quality in order to ensure their own profits (Lin and Gibson, 2011). Furthermore, this may reduce commitment and mutual objectives among the parties. The parties will have no motivation to work in the owners' interest. Traditional procurement methods are therefore inappropriate, mainly because of their focus on price and competition, rather than trust and cooperation (Eriksson et al., 2008). Thus, tending methods should require more other parameters such as

quality, previous experience, competence, collaborative ability, and so on in order to ensure a successful SCM implementation.

4.4 Chapter summary

This chapter aims to identify the barriers to the CSCM implementation and discover the underlying relationships among them. Twenty-two barriers were identified and then ranked according to the viewpoints of the owner group, the contractor group, the designer group, and the consultant group.

In general, all groups had a convergence of perceptions on the 22 barriers to the CSCM implementation. They agreed that "lack of effective leadership", "lack of competence of the parties in SCM", "lack of understanding the supply chain concept", "passive sub-contractors and suppliers", and organizational resistance to SCM" were the five most important barriers found in CSCM. Through the factor analysis technique, the barriers have been grouped into the five factors. They are (1) lack of support and active participation from parties, (2) confronting culture and adversarial behavior, (3) inherent difficulties in the supply chain, (4) lack of knowledge and competence, and (5) deficiencies in the contract system. Among of them, factor 4, factor 1, and factor 2 are the most significant factors that should pay instant attention to promote the development of the CSCM implementation.

CHAPTER 5

A STRUCTURAL MODEL FOR THE IMPACT OF THE SUPPLY CHAIN RELATIONSHIP TRAITS ON PROJECT PERFORMANCE

5.1 Introduction

The previous chapters have presented clearly the benefits and barriers of the CSCM implementation. These results can help practitioners to glimpse CSCM. However, in order to have success in CSCM, the relationships among the parties should be interested. Managing business relationships between customers and suppliers at different tires is the essential element of SCM. SCM is as the management of supply relationships (Harland, 1996). Hence, it is necessary to discover factors affecting relationships among the parties in CSC. This will help practitioners to have insight about CSCM and obtain success in managing CSC. Moreover, relationship management affects all areas of the supply chain and has a dramatic impact on performance (Handfield, 2003). Few researchers have identified the influence of supply chain relationships on the project performance in construction. This chapter aims to identify key factors affecting supply chain relationships in construction and to develop a structural model to test the impact of the supply chain relationship traits on project performance (cost, quality, and time). The results of this chapter lay the foundation for the development of a CSC relationship assessment framework later on in this study.

5.2 Research process

The research process of this chapter is described as Figure 5.1.

Identify key factors affecting CSC relationships and design questionnaire	←	Based on literature review and pilot test
Data collection	←	Via electronic mail
Reliability assessment	←	Internal consistency through Cronbach's alpha coefficient
Check consistency of opinion among the respondents' groups	←	ANOVA test
Exploratory Factor Analysis		
Confirmatory factor analysis (Check Construct validity: reliability, convergent, and discriminant validity assessments)		
Structural model analysis (SEM model)		
Results and Conclusions		

Figure 5.1 Research process of chapter 5

The process of identifying key factors affecting supply chain relationships in construction and collecting data had been mentioned in the previous chapter. This chapter focuses on analyzing and reporting results regarding the key factors affecting CSC relationships and impact of supply chain relationships on the

project performance. Firstly, the five-point Likert scale (1 = not impact and 5 = extremely impact) was tested to measure internal consistency among the key factors. Regarding measurement of the project performance, it was evaluated using five-point Likert scale: 1 = strongly disagree and 5 = strongly agree. This five-point scale has been widely used in the performance measurement (Mohamed, 2003; Doloi, 2009; Ozorhon et al., 2007, 2008a, 2008b, and 2011; Cho et al., 2009; Cao and Zang, 2010 and 2011; Doloi et al., 2011; Li et al., 2012; I. Ikediashi et al., 2013). Next, ANOVA was performed which test whether the mean values on each factor for the groups were equal for owners, contractors, designers, and consultants. In this test, the null hypothesis is that all groups have the same mean and a probability value (significance level) below 0.05 suggests a high degree of difference of opinion among groups on the key factors. An exploratory factor analysis (EFA) was then performed to determine the initial constructs of key factors affecting supply chain relationships in construction. Afterward, confirmatory factor analysis (CFA) was conducted as the first step in SEM to establish confidence in the measurement model. The measurement model will determine the appropriate relationships of the key factors to the constructs (Syed and Kumar, 2012). The validity of the constructs included in the measurement model is also guaranteed by examining the convergent validity and discriminant validity. Finally, SEM was performed to confirm the hypothesized relationships among constructs of the structural model. SEM technique requires a large enough sample size (Mainul Islam and Faniran, 2005). Hox and Bechger (1998) recommended that the sample size should be larger than 200 to avoid the risk of sample non-normality. The sample size of this study is 127 samples. However, it is accepted and sufficient for SEM analyses as compared with previously published SEM studies that used a sample size less than 200, for example; Mainul Islam and Faniran (2005) used 52 samples, Eybpoosh et al. (2011) used 166 samples, Chen et al. (2012) used 124 samples, Doloi et al. (2011) used 97 samples

and Xiong et al. (2014) used 125 samples, whereas Bagozzi and Yi (2012) recommended a exceeding the minimum of 100 samples.

5.3 Data analysis and discussion

5.3.1 Internal consistency and ANOVA test

After the pilot test as described in the previous chapter, twelve key factors affecting CSC relationships were identified as shown in Table 5.1. The mean scores of the 12 key factors range from 3.54 (continuous improvements) to 4.21 (working relationship), which mean that these factors are rated as "very impact" to CSC relationships. Besides, the standard deviation values of these factors are less than one, which reflects some consensus among the respondents. The five factors, namely, communication (R4), business attitude (R5), trust (R2), top management support (R10), and working relationship (R9) are very highly ranked by all the respondents.

Table 5.2 shows the Cronbach's alpha value of 12 key factors. It is determined to be 0.893, which is above the acceptable limit of 0.7 for a satisfactory level of reliability in the given dataset.

Table 5.1 Key factors affecting CSC relationships (all respondents)

Code	Item (Key factors affecting CSC relationships)*	N	Min	Max	Mean	Standard Deviation
R1	Problem solving/conflict resolution	127	2	5	3.85	0.82
R2	Trust (mutual trust or suspicion/mistrust)	127	2	5	4.17	0.82
R3	Goals and objectives (common or self-objectives)	127	2	5	3.92	0.75
R4	Communication (open and effective or ineffective)	127	2	5	4.09	0.89
R5	Business attitude (win-win or win-lose)	127	2	5	4.15	0.89
R6	Length of commitment (long-term or short-term)	127	2	5	3.69	0.84
R7	Risk allocation/sharing risks	127	2	5	3.72	0.92
R8	Continuous improvement	127	2	5	3.54	0.93

R9	Working relationship (teamwork or fragmentation)	127	2	5	4.21	0.86
R10	Top management support	127	2	5	4.19	0.90
R11	Learning and innovation	127	1	5	3.45	0.93
R12	Sharing resources	127	1	5	3.77	0.94

[*] Items were rated on a five-point Likert scale with 1 = Not impact and 5 = Extremely impact

Table 5.2 Cronbach's alpha value of twelve key factors affecting CSC relationships

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.893	.894	12

Table 5.3 shows the results of the ANOVA test, which was performed to clarify whether or not the opinions of the groups (the owner, the contractor, the designer, and the consultant) were the same for rating the 12 key factors. The results showed that the p values were much higher than 0.05, suggesting that there was a consensus of opinion among the groups and so the collected data can be treated as a whole for further analysis.

Table 5.3 Results of ANOVA test on key factors affecting CSC relationships

Code	Item (Key factors affecting CSC relationships)*	F	Sig.
R1	Problem solving/conflict resolution	0.295	0.829
R2	Trust (mutual trust or suspicion/mistrust)	0.118	0.949
R3	Goals and objectives (common or self-objectives)	0.865	0.461
R4	Communication (open and effective or ineffective)	0.198	0.898
R5	Business attitude (win-win or win-lose)	0.362	0.780
R6	Length of commitment (long-term or short-term)	0.579	0.630
R7	Risk allocation/sharing risks	1.574	0.199
R8	Continuous improvement	0.329	0.804
R9	Working relationship (teamwork or fragmentation)	0.391	0.760
R10	Top management support	0.677	0.568
R11	Learning and innovation	1.257	0.292
R12	Sharing resources	0.626	0.599

5.3.2 Exploratory Factor Analysis

The EFA was used to identify constructs of the key factors affecting CSC relationships. According to this technique, the preliminary analysis on scanning correlation matrix, testing the appropriateness of using factor analysis on data, checking communalities, checking case to variable ratio should be conducted first. The matrix of the correlation coefficients shows that the factors correlate fairly well one another and implies that there is no need to delete any factors from the analysis (Refer to Table 5.4). The Bartlett's test of sphericity is significant ($p = 0.000$), and the value of the KMO index is 0.857 (Refer Table 5.5). Besides, as the current research sample comprises 127 respondents, it gives a ratio of variables to sample size as 1:11. These results confirmed that the data are appropriate for factor analysis. Moreover, the communalities of all the factors were determined to be greater than 0.611, confirming that the factor model is reliable.

Table 5.4 Correlation matrix of key factors affecting
CSC relationships

Code	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
R1	1											
R2	0.62	1										
R3	0.57	0.56	1									
R4	0.63	0.65	0.58	1								
R5	0.30	0.33	0.38	0.39	1							
R6	0.24	0.24	0.24	0.30	0.32	1						
R7	0.28	0.28	0.32	0.31	0.73	0.34	1					
R8	0.32	0.33	0.33	0.32	0.32	0.66	0.28	1				
R9	0.66	0.67	0.66	0.62	0.39	0.28	0.33	0.35	1			
R10	0.22	0.28	0.20	0.42	0.29	0.65	0.25	0.64	0.20	1		
R11	0.30	0.30	0.41	0.35	0.28	0.64	0.35	0.60	0.39	0.60	1	
R12	0.61	0.46	0.58	0.49	0.36	0.28	0.30	0.29	0.71	0.21	0.42	1

Table 5.5 KMO and Bartlett's Test on key factors affecting CSC relationships

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.857
	Approx. Chi-Square	864.370
Bartlett's Test of Sphericity	df	66
	Sig.	.000

Table 5.6 Communalities of key factors affecting CSC relationships

Code	Item (Key factors affecting CSC relationships)	Initial	Extraction
R1	Problem solving/conflict resolution	1.000	0.705
R2	Trust (mutual trust or suspicion/mistrust)	1.000	0.649
R3	Goals and objectives (common or self-objectives)	1.000	0.655
R4	Communication (open and effective or ineffective)	1.000	0.645
R5	Business attitude (win-win or win-lose)	1.000	0.857
R6	Length of commitment (long-term or short-term)	1.000	0.763
R7	Risk allocation/sharing risks	1.000	0.868
R8	Continuous improvement	1.000	0.718
R9	Working relationship (teamwork or fragmentation)	1.000	0.783
R10	Top management support	1.000	0.745
R11	Learning and innovation	1.000	0.690
R12	Sharing resources	1.000	0.611

The preliminary analysis is satisfied, the 12 key factors are then subjected to the factor analysis with principal component analysis and varimax rotation. Table 5.7 shows that three constructs were produced with eigenvalues greater than 1, explaining 72.413% of the variance, which is higher than the 60% recommended by Hair (2010). Table 5.8 shows the results of the factor analysis on key factor affecting CSC relationships. All the factors have factor loadings more than 0.5. This indicates that all the factors are considered significant in contributing to the interpretation of the constructs. By examining the inherent relationships among the factors against each of the constructs, the three extracted constructs can be reasonably interpreted as follows: construct 1 represents collaboration management in the supply chain, construct 2 represents support and commitment

to the supply chain, and construct 3 represents sharing the benefits and risks. The explanations of these constructs are provided in the next sections.

Table 5.7 Principal components analysis results of key factors affecting CSC relationships

Principle component	Eigenvalue	Percentage of variance explained	Cumulative variance percentage
1	5.588	46.568	46.568
2	1.908	15.898	62.465
3	1.194	9.948	72.413
4	0.702	5.850	78.263
5	0.458	3.816	82.079
6	0.445	3.708	85.787
7	0.382	3.181	88.968
8	0.355	2.959	91.927
9	0.307	2.555	94.483
10	0.253	2.105	96.588
11	0.218	1.817	98.405
12	0.191	1.595	100.000

Table 5.8 Three constructs of key factors

Construct of key factors affecting CSC relationships	Variance explained (%)	Code	Key factors affecting CSC relationships	Factor loading
Construct 1: Collaboration management in the supply chain (COL)	33.377	R9	Working relationship (teamwork or fragmentation)	0.855
		R1	Problem solving/conflict resolution	0.826
		R2	Trust (mutual trust or suspicion/mistrust)	0.783
		R3	Goals and objectives (common or self-objectives)	0.773
		R4	Communication (open and effective or ineffective)	0.749
		R12	Sharing resources	0.746
Construct 2: Support and commitment to the supply chain (COM)	24.431	R10	Top management support	0.850
		R6	Length of commitment (long-term or short-term)	0.847
		R8	Continuous improvement	0.809
		R11	Learning and innovation	0.770
Construct 3: Sharing the benefits and risks (SHA)	14.605	R7	Risk allocation/sharing risks	0.893
		R5	Business attitude (win-win or win-lose)	0.869

1) Collaboration management in the supply chain (COL)

This construct comprises six factors, namely, working relationship, problem solving/conflict resolution, trust, goals and objectives, communication, and sharing resources. The construct accounts for the greatest variance (33.377%) among all the constructs. All factors in the construct are related to the collaboration management in the supply chain. Collaboration among supply chain members is to ensure efficiency and responsiveness of the supply chain. Collaboration would lay the foundation for good relationships among the parties. The CSC relationships will be improved gradually better when it starts with the integrated team culture that is characterized by collaborative working rather than conflict, confrontation and fragmentation. In order to work together closely, joint decision making is a necessary process. The purpose of joint decision making is to adopt a more productive strategy and to find a mutually agreed solution (Chan et al, 2004).

The parties always have different objectives and expectations, hence conflicting problems among them are inevitable in a project. Conflicts can bring tension among the parties and lead to bad relationships among them. In order to avoid serious consequences, problems and conflicts should be identified and solved as early as possible. An effective problem resolution process requires the parties to work together for searching for possible solutions. Moreover, common goals and objectives among the parties should be established to share responsibility both for dealing with problems and maintaining their relationships. Collaboration in supply chain creates an opportunity for the parties to reach common goals and objectives. Hudnurka et al. (2014) showed that through collaborative supply chain relationships, business objective can be easily obtained, while it seems to be difficult to get by individual organizations. The common goal is essential for successful teamwork. Without alignment of objectives, the parties

will be pulling in different directions and have the ability to cancel out the efforts of others because they just focus on their own objectives.

To manage the CSC relationships effectively, the mutual trust among the parties needs to be established (Pinto et al., 2009). Lack of trust is considered as a main obstacle to the collaborative relationship (Akintoye and Main, 2007). Mutual trust can help the parties to increase information exchange and joint problem resolution that brings better outcomes. Mutual trust is important to build relationships among the parties. Through building up trust, the parties can begin to develop confidence one another. Confidence will gradually influence the parties to merge their boundaries, allowing active inter-organizational exchange (Crowley and Karim 1995). Trust helps the parties to remove adversarial relationships that facilitate to increase the degree of sharing resources and knowledge among them (Ghffari, 2015). Moreover, trust also brings positive attitudes to the parties in communication; they become to be willing cooperation and have a good communication one another (Ghffari, 2015). The supply chain is related to inter-organizational communications. Communication is very important in project management because information sharing among stakeholders can result in minimum of errors and reworks, reduction of schedule delays (Hu and Xinhua, 2008). However, under traditional contracts, the parties tend to keep their information that can affect the formation of long-term relationships among them. The open and effective communication facilitates the parties to exchange easily ideas and visions, which can lead to fewer misunderstanding and encourage mutual trust to achieve a win-win outcome (Cheng et al., 2000; Hu and Xinhua, 2008).

Sharing resources is known as a process of leveraging competences and properties and investing competences and properties with supply chain partners (Cao and Zang, 2011). Main resources that an organization can share with others include knowledge, technology, information, specific skills, and capital (Chan et

al., 2004). Sharing resources can improve relationships among the parties because according to Cheng et al., (2000) this may be used to strengthen the competitiveness and the construction competence of the partnering relationship. However, Chan et al (2004) pointed out that in reality it is difficult for a party to share its resources with others because of scarcity and competition of resources.

2) Support and commitment to the supply chain (COM)

This construct explains 24.431% of the total variance in the data. The four factors included in this construct are top management support, length of commitment, continuous improvement, and learning and innovation. All of them are describing the support and commitment to supply chain. Akintoye et al. (2000) discovered that top management support is one of the most important factors for effective CSC relationships, and lack of top management support is the greatest hindrance to implementing successful supply chain collaboration. Top management plays a key role in building up the strategy and business direction of an organization, so their decisions greatly affect the activities of their organization. This proves that the top management has a strong impact on the relationship management culture and a lack of active support from them can bring a failure in managing relationship (Cheung and Rowlinson, 2007). Top management also decides the length of commitment to supply chain and continuous improvement of an organization. Commitment among the parties can be either long-term or short-term. Traditional relationship is typically one-off and short-term focused. According to Thompson and Sanders (1998), the parties involved in traditional projects concentrate on maximizing their benefits and they have little or no mutual goals with others. Similarly, this was described by Li et al (2000) as that all parties in traditional projects look for short-term benefits and pursue their own concern at the expense of other parties. In this situation, project parties perceive others as adversaries (Drexler and Larson, 2000) that often result in conflict and claim in

the project (Thompson and Sanders, 1998). Thus the traditional relationship is full of either arms-length or adversarialism (Crowley and Karim, 1995). A long-term relationship facilitates to form the cooperative relationship that helps the parties to achieve the mutual benefits in SCM. Long-term commitment is depicted as the willingness of the stakeholders to integrate continuously to overcome unforeseen difficulties (Ghaffari, 2015).

The support and commitment to supply chain is reflected in part by the continuous improvement. The continuous improvement is promised to deliver greater value and increase mutual competitive advantages. By continuous improvement, the parties can identify areas to improve and remove the works that do not add value (Thomas and Thomas, 2005). The parties can repeat the inefficient way of working that leads to poor performance if they do not have continuous improvement in their organizations. Learning and innovation should also be of interest to improve the performance of the parties and the relationships among them. Learning is the acquisition and development of skills, knowledge, experience and values to improve the current conditions and avoid a repeat occurrence of the same problem. Without effective learning, people and firms continue with the same thinking, methods and procedures, experiencing the same old problems (Maloney, 2000). The lessons learnt from problem resolutions help the parties to understand the root causes of problems. This forms the basis for continuous improvement. Jones and Saad (2003) defined innovation as a new idea which can lead to enhanced performance. Learning is increasingly being recognized as a key to innovation and change. A main reason for this increasing interest in learning is the growing pressure on organizations to respond to the challenges of the rapid pace of change and competition. The pressure and opportunity for change demand innovation, the success of which depends on learning (Jones and Saad, 2003). Thomas and Thomas (2005) stressed that innovation is a key to continuous improvement. Integrated project team members

who innovate to add value for their customers will succeed while those who do not will fail. In summary, both learning and innovation come from the need for change and the demand for better value. Learning contributes to innovation. Innovation, in turn, promotes continuous improvement.

3) Sharing the benefits and risks (SHA)

Risk allocation/sharing risks and business attitude (win-win or win-lose) are grouped in this construct. These factors are related to sharing the benefits and risks. This construct explains 14.605 % of the total variance in the data. Sharing the benefits and risks is a commitment among the parties in CSC to share profits achieved and to share losses damaged in the project. A benefit and risk sharing can be a motivation to achieve mutual goals among the parties. However, it may encounter obstacles in practice because of the adversarial behavior among the parties that exists in the traditional approach. Risk allocation is to assign responsibilities associated with possible future losses and gains among project parties (Lam et al, 2007). Wang and Chou (2003) believed that the root problem of much litigation under traditional contracts is the lack of related contract clauses, unclear provisions about the justice of risk allocation. Therefore, it is critical to clarify responsibilities in the contracts and assign risks equally. Business attitudes may be either win-win or win-lose. Win-lose is a result when one party's gain is the other party's loss. Win-lose results in an adversarial relationship among the parties (Black et al., 2000). On the contrary, win-win is a positive-sum game in which both sides have gains. However, Cox et al (2006) pointed out that it is almost impossible to achieve win-win in practice. Win-partial win and partial win-partial win may be more feasible. Win-partial win means that one party achieves more than the other. One party achieves almost all objectives while the other only achieves some of the objectives. In order to achieve gains like win-partial win and

partial win-partial win, the parties are required to compromise and ensure mutual objectives one another.

5.3.3 Structural equation modeling (SEM)

A structural model is set up to test the impact of the supply chain relationship traits on the project performance. Project performance can be measured and evaluated using a large number of performance indicators that could be related to various dimensions (groups) such as time, cost, quality, client satisfaction, client changes, business performance, health and safety. Time, cost and quality are, however, the 3 predominant performance evaluation dimensions (Enshassi et al., 2009). Both Chan and Chan (2004) and Masrom and Skitmore (2009) also mentioned that the evaluation of the project performance is gauged mainly on the basis of three main dimensions, namely cost, time and quality. Therefore, this study measures the project performance according to three criteria in terms of time, cost and quality.

The development of the SEM model is built according to a two-step method as followed by Xiong et al. (2014); Qureshi and Kang (2015). This approach reveals an advantage that the fitness of the measurement model (CFA model) will provide a basis for evaluating the fitness of the SEM model (Hair et al. 2010). CFA is conducted as the first step and proves a satisfactory goodness of fit (GOF). Once the better-fitting measurement model is found or the GOF is satisfactory in the CFA phase, in the next step the correlations between the constructs will be replaced with hypothesized causal relationships in order to specify and test the structural model (Qureshi and Kang, 2015; Anvuur and Kumaraswamy, 2012).

5.3.3.1 Confirmatory factor analysis

The three-dimensional structure extracted through the exploratory factor analysis approach for the measurement of the supply chain relationship traits is

validated using CFA. The measurement model of the supply chain relationship traits is shown as Figure 5.2.

Chi-square= 80.020; df= 51; Chi-square/df = 1.569;TLI= .955; CFI= .965; RMSEA= .067

Figure 5.2 Measurement model of supply chain relationship traits

The appropriateness of measurement model and structural model is assessed by the GOF indexes. Four common indexes used in this study to assess the model's overall goodness of fit included: the ratio of X2 to degree of freedom (df), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). All the model fit indexes refer to their common acceptance levels suggested by previous research (Doloi et al., 2012 and Chen et al., 2012). The details of fit indexes for measurement model are described as Table 5.9. These fit indexes are in turn: X2/df = 1.569; TLI = 0.955; CFI = 0.965; and RMSEA = 0.067 with a 90% confidence interval of (0.037, 0.094).

They provide proof that the measurement model displayed a good fitness with the data collected.

Table 5.9 Fit indexes for the measurement model of supply chain relationship traits

Good of fit (GOF) measure	Recommended level of GOF measure	Overall model
X^2/df	Recommended level from 1 to 2	1.569
TLI	0 (no fit) to 1 (perfect fit)	0.955
CFI	0 (no fit) to 1 (perfect fit)	0.965
RMSEA	< 0.05, very good; 0.05-0.08, fairly good fit; 0.08-0.1, acceptable fit; >0.1, unacceptable fit	0.067

The standardized regression weights and squared multiple correlations (SMCs) of factors in the measurement model are presented in Table 5.10. The standardized regression weights are equivalent to the factor loadings in factor analysis. They measure the association of each factor to its corresponding construct; with a higher value showing a stronger association. In the COL construct, working relationship shows the most impact. Length of commitment shows the most influence on the construct of support and commitment to the supply chain (COM) followed by continuous improvement, top management support and learning and innovation. Business attitude shows higher influence than risk allocation/sharing risks on the construct of sharing the benefits and risks (SHA).

Table 5.10 Standardized regression weights and squared multiple correlations (SMCs) of measurement model of supply chain relationship traits

Item	Standardized regression weights			SMC
	COL	COM	SHA	
R12	0.743[a]			0.553
R4	0.758			0.575
R3	0.762			0.580
R2	0.760			0.577
R1	0.783			0.613
R9	0.868			0.753

Item	Standardized regression weights			SMC
	COL	COM	SHA	
R11		0.776[a]		0.602
R8		0.799		0.639
R6		0.822		0.675
R10		0.780		0.608
R5			0.895[a]	0.801
R7			0.811	0.658

All factors without superscript 'a' are significant at p < 0.001; factors
with superscript 'a' are fixed to 1.00 before estimation

In order to validate the measurement model, construct validity is then checked by validities of convergent and discriminant. In this model, convergent validity measures the level of positive correlation of one factor and other factors within their same construct. It can be assessed through examining the standardized regression weights (SRW), the average variance extracted (AVE), and composite reliability of constructs (CR) (Hair et al., 2010). Generally, SRW and AVE estimates of 0.5 or higher, and CR estimates of 0.7 or higher will indicate a good convergent validity (Hair et al., 2010). In the measurement model, all SRW are higher than a value of 0.5 and range from 0.553 to 0.801, which indicates that the factors converge on their common constructs. CR values of constructs range from 0.843 to 0.903, which suggest an adequate reliability. All the AVE values exceed the 0.5 threshold, thus the measurement model meets a satisfactory convergent validity (Table 5.11).

Table 5.11 Construct reliabilities, Construct correlations, and Average variance extracted (AVE)

Construct	CR	COL	COM	SHA
1. COL	0.903	**0.609**		
2. COM	0.872	0.476	**0.631**	
3. SHA	0.843	0.504	0.442	**0.729**

Note: CR = Construct reliability; Entries below the diagonal are correlations among constructs;
Diagonal entries are average variance extracted (AVE)

Discriminant validity aims to test whether a construct is truly distinct from other constructs. It is established if the AVE estimate of one construct is greater than its highest squared correlation with other constructs (Xiong et al. 2015). As shown in Table 5.11, each AVE estimate showed along the diagonal of a matrix of inter-construct correlations is greater than the square of the correlations among the constructs in the column or row in which it is found, thus the measurement model satisfies discriminant validity.

Measurement model results of the project performance are also provided in Table 5.12 and Figure 5.3.

Table 5.12 Measurement model results of project performance

Construct	Standardized regression weights		AVE	CR
Performance	Quality	0.809	0.667	0.857
	Cost	0.834		
	Schedule	0.806		

Figure 5.3 Measurement model of project performance

5.3.3.2 Structural model and hypothesis

After the confidence in the measurement model was established, a structural equation model was built and tested to examine the hypothesized relationship between supply chain relationship traits and project performance. The hypothesized model is shown in Figure 5.4. In the proposed model, the supply chain relationship traits are formed from a three-dimensional structure composed of COL construct, COM construct, and SHA construct. They are the second-order construct that can maximize the interpretability of both the measurement and the

structural models according to recommendation of Hair et al. (2010). The dark arrow in Figure 5.4 describes the direction of the influence between the relationship traits and performance, while the light arrows define their dimensions. Based on the proposed model, the hypothesis that the supply chain relationship traits have a significant positive influence on the performance is tested as follows:

The null hypothesis (H_o): Path coefficient between supply chain relationship traits and project performance is not significantly different from zero.

The alternative hypothesis (H_a): Supply chain relationship traits have significant positive influence on project performance.

Figure 5.4 Structural model of linkage between supply chain relationship traits and project performance

Table 5.13 supplies a comparison of all fit indices with their corresponding recommended values that proved a good model fit of structural model (X2/df = 1.844, p = .000; TLI = 0.914; CFI = 0.924; and RMSEA = 0.062).

Table 5.13 Fit indexes for the structural model

Good of fit (GOF) measure	Recommended level of GOF measure	Overall model
X²/df	Recommended level from 1 to 2	1.488
TLI	0 (no fit) to 1 (perfect fit)	0.952
CFI	0 (no fit) to 1 (perfect fit)	0.961
RMSEA	< 0.05, very good; 0.05-0.08, fairly good fit; 0.08-0.1, acceptable fit; >0.1, unacceptable fit	0.062

The SEM results of the final model are shown in Figure 5.5. The relationships between the constructs as well as the relationships among the constructs and their observed variables are reflected by the path coefficients. The relationship between the supply chain relationship traits and the project performance can be interpreted similarly to a regression coefficient that describes the linear relationship between constructs. Regarding the coefficients pointing from supply chain relationship traits to their observed variables, the larger the coefficient value, the more important the variable can be considered as an indicator of supply chain relationship traits. As shown in Figure 5.5, all of the standardized path coefficients are positive and statistically significant (p <0.001). The path coefficients for collaboration management in the supply chain (COL), support and commitment to the supply chain (COM), sharing the benefits and risks (SHA) are 0.84, 0.57, and 0.62. These path coefficients can be seen as a manifestation of the relative importance of each construct. Comparing the path coefficients of these three constructs, collaboration management in the supply chain (COL) scored the highest, which shows that collaboration management in the supply chain (COL) emerges to be the most important supply chain relationship trait. The value (0.77) of the path coefficient between construct of the supply chain relationship traits and construct of the project performance supports the hypothesis H_a that supply chain relationship traits have a significant positive impact on the project performance.

Figure 5.5 Structural model results of linkage between supply chain relationship traits and project performance

As results shown, it can be stated that collaboration management in the supply chain is very important to the project performance followed sharing the benefits and risks. The project performance with a deeper view relating collaboration in supply chain depends on the factors like working relationship (factor loading 0.88), problem solving (factor loading 0.78), communication (factor loading 0.77), trust (factor loading 0.76), goals and objectives (factor loading (0.76), and sharing resources (factor loading 0.74). In consideration of the construct of sharing benefits and risks, the project performance depends on the factors like business attitude (factor loading 0.86), risk allocation (factor loading 0.84). Support and commitment to supply chain is the least important to supply chain relationship

traits, nevertheless it cannot be ignored and should be interested to improve the project performance. Regarding this construct, performance of a project in a detail view depends on the factors as length of commitment (factor loading 0.82), continuous improvement (factor loading 0.8), top management support (factor loading 0.78), and learning and innovation (factor loading 0.78).

5.4 Chapter summary

The key factors affecting supply chain relationships and the influence of supply chain relationship traits on the project performance have been discovered in this chapter. Three constructs including twelve factors affecting the supply chain relationships were extracted by EFA. A two-step SEM model is then established to test the hypothesized relationship about the impact of supply chain relationship traits on the project performance. In this SEM model, the relationship traits were measured by a three-dimensional structure that includes collaboration management in the supply chain, support and commitment to the supply chain, sharing the benefits and risks. The findings indicated that the supply chain relationship traits have a significant impact on the project performance as described by the path coefficient value of 0.77 with $p < 0.001$.

The constructs identified in this SEM model may help parties to identify the factors that may result in the effective performance of a project. It can be shown that collaboration in supply chain, support and commitment to supply chain, and sharing benefits and risks play a main role to ensure the successful project performance, as reflected by the direct link between collaboration in supply chain, support and commitment to supply chain, and sharing benefits and risks – related supply chain relationship traits to project performance. Among of them, collaboration management in the supply chain plays a decisive role to ensure the successful project performance because it has the biggest path coefficient value

(0.84). Hence, it can be recognized that working relationship, problem solving, communication, trust, goals and objectives, and sharing resources, will positively influence the project performance.

CHAPTER 6

A FRAMEWORK FOR EVALUATING THE SUPPLY CHAIN RELATIONSHIPS IN CONSTRUCTION

6.1 Introduction

As discussed in the previous studies, the managing supply chain relationship is the essential element of CSCM. Therefore, the relationships should be continuously evaluated to improve the efficiency of SCM. In order to assess CSC relationships in a systematic manner, an evaluation framework is built in this chapter. The evaluation framework hopes to be a useful tool for evaluating the degree of the relationship among the parties in the supply chain. It could help organizations in construction to assess their current relationship with others in the supply chain and then to determine key areas that need to be improved better for a long-term cooperation planning in the future.

6.2 Research process

The research process of this chapter is described as Figure 6.1.

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┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
│  ┌─────────────────────────────┐ │      ┌─────────────────────────────┐
│  │ Identify key factors affecting CSC │ │      │ Identify hierarchy structure for │
│  │ relationships and design questionnaire │ │      │ assessment criteria │
│  └─────────────────────────────┘ │      └─────────────────────────────┘
│              ↓                   │                    ↓
│  ┌─────────────────────────────┐ │      ┌─────────────────────────────┐
│  │      Data collection        │ │      │      Design questionnaire    │
│  └─────────────────────────────┘ │      └─────────────────────────────┘
│              ↓                   │                    ↓
│  ┌─────────────────────────────┐ │      ┌─────────────────────────────┐
│  │    Reliability assessment   │ │      │       Data collection        │
│  └─────────────────────────────┘ │      └─────────────────────────────┘
│              ↓                   │                    ↓
│  ┌─────────────────────────────┐ │      ┌─────────────────────────────┐
│  │ Check consistency of opinion among the │ │      │  Identify weights of criteria by │
│  │    respondents' groups      │ │      │         AHP method           │
│  └─────────────────────────────┘ │      └─────────────────────────────┘
│              ↓                   │                    ↓
│  ┌─────────────────────────────┐ │      ┌─────────────────────────────┐
│  │  Exploratory Factor Analysis │ │      │  Framework for evaluating CSC │
│  └─────────────────────────────┘ │      │       relationships          │
│              ↓                   │      └─────────────────────────────┘
│  ┌─────────────────────────────┐ │                    ↓
│  │  Confirmatory factor analysis │ │      ┌─────────────────────────────┐
│  │ (Check Construct validity: reliability, │ │      │       Conclusions            │
│  │ convergent, and discriminant validity │ │      └─────────────────────────────┘
│  │      assessments)           │ │
│  └─────────────────────────────┘ │
│              ↓                   │
│  ┌─────────────────────────────┐ │
│  │ Structural model analysis (SEM model) │ │
│  └─────────────────────────────┘ │
│              ↓                   │
│  ┌─────────────────────────────┐ │
│  │    Results and Conclusions  │ │
│  └─────────────────────────────┘ │
│      Research process of chapter 5 │
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
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Figure 6.1 Research process of chapter 6

This chapter attempts to build a framework for evaluating the CSC relationships. Based on results of factor analysis in the previous chapter, a hierarchy structure for assessment criteria is formed as shown in Figure 6.2. The hierarchy structure includes two-level criteria with three main criteria and twelve sub-criteria. The main criteria are not evaluated directly. In lieu of this, each main criterion is subdivided into the sub-criteria. The evaluation of each main criterion

is based on the evaluation results of its sub-criteria. A questionnaire including questions of pair-wise comparison among the criteria was then designed based on the AHP method to collect the opinions of experts. AHP exceeds the comparative judgment approach by relaxing the normality assumption of parameters (Saaty, 2010). This questionnaire used the widely accepted nine-point scale which is the original scale suggested by Saaty (2000). The meaning of each of the values of the scale is shown in Table 6.1. The feedback questionnaires from experts were estimated by the consistency ratio (CR) to ensure their reliability and validity (Lee et al., 2011; Haery et al., 2014).

Table 6.1 Pair-wise comparison scale of impact level

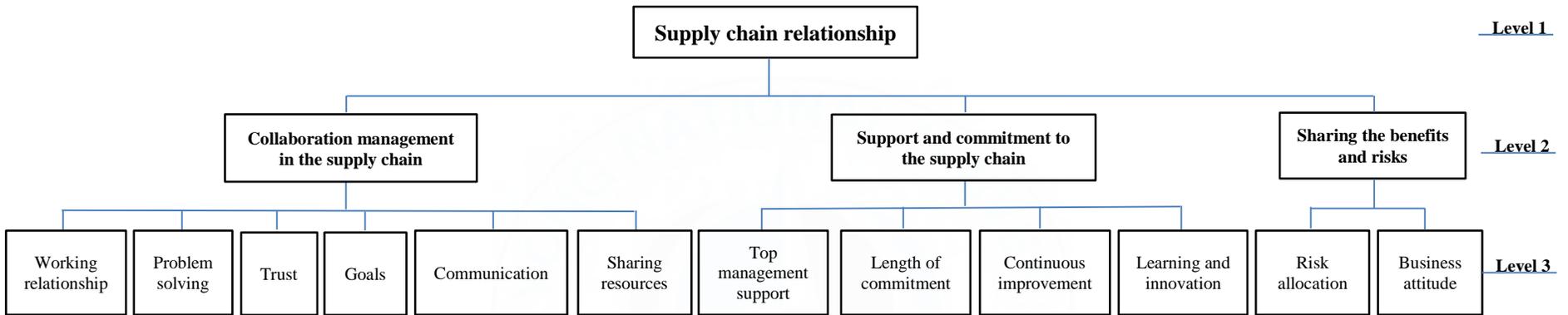| Numerical rating	Judgments of impact level
1	A impacts equally to B
2	A impacts equally to moderately over B
3	A impacts moderately over B
4	A impacts moderately to strongly over B
5	A impacts strongly over B
6	A impacts strongly to very strongly over B
7	A impacts very strongly over B
8	A impacts very strongly to extremely over B
9	A impacts extremely over B

Figure 6.2 A hierarchical structure for assessment criteria

To determine the weights of the criteria, this chapter took the following steps: (1) examination of the consistency of the experts' judgments; (2) combination of experts' judgments; (3) calculation of the weights. These steps are described as the following. In term of checking the consistency, the responses with values passing the consistency test will ensure their reliability and validity. The maximum acceptable limit of consistency ratio (CR) is 0.1 (Saaty, 2000). If the CR value of the response is more than 0.1, it will highlight that the pairwise comparison is inconsistent. In that case, Saaty (2005) recommended that firstly, it is necessary to identify which judgments are inconsistent and determine judgment values of experts that need to be improved in order to increase consistency. Subsequently, the experts who have inconsistent judgments will be contacted again to review their comparisons (Saaty, 2005). If the resulted CR is still greater than 0.1, the judgment will be rejected (Saaty and Kearns, 1985). In term of combination of experts' judgments, the geometric mean method is applied to combine all experts' judgments as a general judgment (Saaty, 2008). This general judgment is a representation of the opinion of the whole group of experts. The reciprocal property plays an important role in combining the judgments of several individuals to obtain a single judgment for the group (Saaty, 2008). Judgments must be combined so that the reciprocal of the synthesized judgments is equal to the syntheses of the reciprocals of these judgments (Saaty, 2008). It has been proved that the geometric mean, not the frequently used arithmetic mean, is the only way to do that (Saaty, 2008). In term of calculation of the weights, the priority weights are automatically calculated with the support of the Expert Choice software that performs the computation required by the AHP.

After weights of main criteria and sub-criteria are determined, a framework for evaluating CSC relationships is formed based on the hierarchy structure of assessment criteria.

6.3 Data analysis and discussion

6.3.1 Profiles of the experts

The AHP questionnaire was sent to 27 experts via electric email however, only 18 experts replied their questionnaires. This number of responses is considered to be enough to make meaningful conclusions in this study. Doloi (2008) found that a small sample size is not a problem with the AHP methodology because AHP exceeds the comparative judgment approach by relaxing the normality assumption of parameters as mentioned in the previous section. For example, Doloi (2008) used 19 targeted experts for his study on improvement of productivity on site. Salman et al. (2007) used only 12 cases in validating a BOT viability model for large-scale infrastructure projects. In the research of Dias and Ioannou (1996), only 8 experts had accepted to participate and finish the questionnaires.

Profiles of experts are presented in Table 6.2. Profiles imply that the collected data are reliable and valuable for the analysis.

Table 6.2 Profiles of experts

Variable	Category	Frequency	Percentage
Fields of work	Owner	4	22.22%
	Contractor	7	38.89%
	Designer	3	16.67%
	Consultant	4	22.22%
	Total	18	100.0%
Designation of respondents	General manager	2	11.11%
	Engineering manager	3	16.67%
	Project manager	6	33.33%
	Specialist	3	16.67%
	Construction manager	4	22.22%
	Total	18	100.0%
Years of experience	From 10 to 15	9	50.00%
	From 15 to 20	7	38.89%
	Above 20	2	11.11%
	Total	18	100.0%

6.3.2 Criteria weights

1) Weights of main criteria

The computed local weights for each main criterion are shown in Table 6.3. After computing, it is found that all 18 responses to the pairwise comparisons reached a CR of less than 0.1 (Table 6.3). Therefore, the experts' pairwise comparison matrices were acceptable or the responses were reliable and valid. 100% of the responses indicate that the collaboration management in the supply chain criterion is the most important superior criterion in the evaluating CSC relationship. The second important criterion was the sharing the benefits and risks criterion, while the support and commitment to the supply chain criterion had the least importance. The average weights for the three main criteria as well reveal that collaboration management in the supply chain criterion represents 64.1% of the total CSC relationship score, support and commitment to the supply chain – 15.1%, and sharing the benefits and risks – 20.8%. Thus, the collaboration management in the supply chain is about fourfold as important as the support and commitment to the supply chain criterion, and about three times as important as the sharing the benefits and risks. Based on these results, decision makers have to assign the collaboration management in the supply chain the highest priority when assessing the CSC relationships.

Table 6.3 Local priority weights of main criteria

Expert (E)	Local priority weights of main criteria			Consitency ratio (CR)
	Collaboration in the supply chain	Support and commitment to the supply chain	Sharing the benefits and risks	
E1	0.669	0.088	0.243	0.01
E2	0.717	0.088	0.195	0.09
E3	0.600	0.200	0.200	0.00
E4	0.550	0.210	0.240	0.02
E5	0.571	0.143	0.286	0.00
E6	0.637	0.105	0.258	0.04
E7	0.648	0.122	0.230	0.00
E8	0.696	0.075	0.229	0.07
E9	0.691	0.218	0.091	0.05
E10	0.625	0.238	0.136	0.02
E11	0.778	0.111	0.111	0.00
E12	0.655	0.095	0.250	0.02
E13	0.600	0.300	0.100	0.00
E14	0.637	0.105	0.258	0.04
E15	0.625	0.238	0.136	0.02
E16	0.667	0.111	0.222	0.00
E17	0.540	0.163	0.297	0.01
E18	0.637	0.105	0.258	0.04

The general weight of all experts' judgments (group weight) for each criterion is necessary to be calculated in order to determine the weight of its contribution to the CSC relationship score. The general weights of criteria are almost the same as the average of local weight. As shown in Table 6.4, the CR for combined judgments of the 18 responses was less than 0.1, which indicates that the experts' judgments are consistency in comparing the main criteria. The collaboration management in the supply chain has the highest weight of 0.656 followed by sharing the benefits and risks 0.202, and the support and commitment to the supply chain 0.142.

Table 6.4 Group pairwise comparison of main criteria and group priority weights

Group weights	Relative importance (Geo-M)
Comparison among main criteria	
Collaboration management in the supply chain versus support and commitment to the supply chain	4.39
Collaboration management in the supply chain versus sharing the benefits and risks	3.43
Support and commitment to the supply chain versus sharing the benefits and risks	0.67
Group weights	
Collaboration management in the supply chain	0.656
Support and commitment to the supply chain	0.142
Sharing the benefits and risks	0.202
Consistency ratio (CR)	0.00

2) Weights of sub – criteria

The 12 sub-criteria were classified according to their relation to the six sub-criteria under the collaboration in supply chain criterion, the four sub-criteria under the support and commitment to supply chain criterion, and the two sub-criteria under the sharing the benefits and risks criterion. The relative local sub-criteria weights allocated by the experts are shown in Table 6.5. The local weights of sub-criteria under their main criteria reveals that "working relationship" included the collaboration in supply chain criterion, "top management support" included the support and commitment to supply chain criterion, and "risk allocation" included the sharing the benefits and risks criterion are the most significant sub-criteria that have the greatest impact on their main criteria relationships.

The general weights for the sub-criteria were computed in a similar way as in the main-criteria general weights. The results presented in Table 6.6 reveal that

"working relationship" in the collaboration management in the supply chain criterion, "top management support" in the support and commitment to the supply chain criterion, and "risk allocation" in the sharing the benefits and risks criterion get the biggest weights of 0.320, 0.524, and 0.620 within their main criteria, respectively.

Table 6.5 Local priority weights of sub-criteria

Expert (E)	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18
Collaboration in the supply chain																		
Working relationship	0.215	0.331	0.250	0.333	0.290	0.380	0.438	0.330	0.469	0.168	0.404	0.289	0.295	0.354	0.255	0.456	0.238	0.213
Problem solving	0.089	0.076	0.250	0.107	0.110	0.060	0.061	0.075	0.045	0.075	0.048	0.162	0.097	0.068	0.079	0.046	0.065	0.167
Trust	0.406	0.256	0.250	0.195	0.290	0.240	0.243	0.246	0.249	0.393	0.297	0.302	0.178	0.302	0.447	0.258	0.305	0.389
Goals and objectives	0.046	0.109	0.064	0.107	0.075	0.104	0.096	0.095	0.064	0.053	0.086	0.080	0.053	0.078	0.044	0.076	0.118	0.048
Communication	0.210	0.184	0.140	0.195	0.194	0.182	0.132	0.207	0.129	0.271	0.139	0.115	0.347	0.166	0.140	0.137	0.232	0.150
Sharing resources	0.033	0.044	0.045	0.064	0.042	0.034	0.030	0.047	0.043	0.040	0.028	0.052	0.030	0.032	0.034	0.027	0.041	0.032
Consistency ratio (CR)	0.02	0.04	0.01	0.01	0.03	0.05	0.07	0.02	0.04	0.02	0.06	0.03	0.05	0.06	0.05	0.07	0.04	0.02
Support and commitment to the supply chain																		
Top management support	0.522	0.560	0.492	0.538	0.492	0.500	0.650	0.628	0.321	0.390	0.665	0.603	0.538	0.556	0.362	0.607	0.459	0.423
Length of commitment	0.200	0.249	0.306	0.220	0.306	0.304	0.202	0.192	0.543	0.390	0.195	0.234	0.220	0.281	0.513	0.254	0.305	0.423
Continuous improvement	0.200	0.095	0.125	0.121	0.125	0.142	0.089	0.111	0.090	0.152	0.086	0.111	0.121	0.109	0.073	0.099	0.143	0.104
Learning and innovation	0.078	0.095	0.078	0.121	0.078	0.054	0.600	0.069	0.046	0.068	0.053	0.051	0.121	0.054	0.052	0.040	0.093	0.051
Consistency ratio (CR)	0.02	0.02	0.02	0.01	0.02	0.04	0.06	0.02	0.04	0.02	0.04	0.06	0.01	0.06	0.05	0.09	0.03	0.03
Sharing the benefits and risks																		
Risk allocation	0.333	0.333	0.250	0.500	0.333	0.200	0.667	0.167	0.250	0.500	0.250	0.667	0.333	0.500	0.667	0.333	0.500	0.250
Business attitude	0.667	0.667	0.750	0.500	0.667	0.800	0.333	0.833	0.750	0.500	0.750	0.333	0.667	0.500	0.333	0.667	0.500	0.750
Consistency ratio (CR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6.6 Group priority weights of sub-criteria

Sub-criteria	Group weights
Collaboration management in the supply chain	
Working relationship	0.320
Problem solving/conflict resolution	0.086
Trust	0.297
Goals and objectives	0.078
Communication	0.179
Sharing resources	0.040
Consistency ratio (CR)	0.02
Support and commitment to the supply chain	
Top management support	0.524
Length of commitment	0.290
Continuous improvement	0.117
Learning and innovation	0.069
Consistency ratio (CR)	0.02
Sharing the benefits and risks	
Risk allocation	0.620
Business attitude	0.380
Consistency ratio (CR)	0.00

6.3.3 A framework for evaluating the CSC relationships

Based weights of criteria identified, a framework for evaluating the CSC relationships is formed for practice. The whole CSC may be divided into several tiers from the perspective of the owner. Main contractors are owners' supplier considered as the first tier. They are responsible for the link between the upstream (owners) and downstream (sub-contractors, suppliers). Subcontractors are the second tier. And the third tier is labor, material and equipment suppliers. The framework proposed can be used to assess both the upstream and downstream relationships, for example, between the owners and the main contractors; between the main contractors and their sub-contractors/suppliers. When the owners have the direct relationships with their sub-contractors/suppliers, the framework can be used to evaluate as well.

Five levels of CSC relationship assessment have been proposed. They are (i) bad (0-20), (ii) poor (21-40), (iii) fair (41-60), (iv) good (61-80), and (v) excellent (81-100). The decision makers will give their assessment scores according to the actual conditions about the relationship among their organizations and their partners. After getting the final scores, the decision makers as senior/top management in the parties can evaluate their current relationship with their partners in the supply chain and then to determine key areas that need to be improved better for a long-term cooperation planning. The Table 6.7 shows the framework for evaluating CSC relationships, which include the detailed weights of main criteria and sub-criteria and nature of measurement.

6.4 Chapter summary

The evaluation framework of the CSC relationships is built in this chapter. This framework aims to measure and improve CSC relationships among the parties in the supply chain. In order to build the framework, the AHP method has been adopted. The proposed framework consists of main criteria, sub-criteria, and levels of assessment. There are three main criteria in the framework, namely, collaboration in supply chain, support and commitment to supply chain, and sharing benefits and risks. However, the main criteria are not evaluated directly. In lieu of this, they are subdivided into sub-criteria. An evaluation is made directly against sub-criteria. The evaluating the individual relationships of each party in the supply chain facilitates to have an overview about the entire supply chain relationships. The proposed framework can be applied to evaluate both the upstream relationship and the downstream relationship of the supply chain. The framework can help the parties to determine the specific areas that their relationship with their partners needs to be improved better.

Table 6.7 The framework for evaluating CSC relationships

	Criteria	Weight (W)	Assessment of decision makers (Scores: 0-100)	Score of sub-criteria (3 x 4)	Score of main criteria	Proposed evaluation criteria	Qualitative or quantitative
	1. Collaboration management in the supply chain	**0.656**		$A = \sum_{i=1}^{6} WixAi$	**A' = 0.656 x A**		
1	Working relationship	0.320	A1	0.320 x A1		Fragmentation (0-20%) – teamwork (81-100%)	Qualitative
2	Problem solving/conflict resolution	0.086	A2	0.086 x A2		Conflict (0-20%) – mutual solving (81-100%)	Qualitative
3	Trust	0.297	A3	0.297 x A3		Mistrust (0-20%) – mutual trust (81-100%)	Qualitative
4	Goals and objectives	0.078	A4	0.078 x A4		Self-goals (0-20%) – mutual goals (81-100%)	Qualitative
5	Communication	0.179	A5	0.179 x A5		Ineffective (0-20%) – open and effective (81-100%)	Qualitative
6	Sharing resources	0.040	A6	0.040 x A6		Very few (0-20%) - very much (81-100%)	Qualitative
	2. Support and commitment to the supply chain	**0.142**		$B = \sum_{j=1}^{4} WjxBj$	**B' = 0.142 x B**		
1	Top management support	0.524	B1	0.524 x B1		Very few (0-20%) - very much (81-100%)	Qualitative
2	Length of commitment	0.290	B2	0.290 x B2		Short term (0-20%) - long term (81-100%)	Qualitative
3	Continuous improvement	0.117	B3	0.117 x B3		Very few (0-20%) - very much (81-100%)	Qualitative
4	Learning and innovation	0.069	B4	0.069 x B4		Very few (0-20%) - very much (81-100%)	Qualitative
	3. Sharing the benefits and risks	**0.202**		$C = \sum_{k=1}^{2} WkxCk$	**C' = 0.202 x C**		
1	Risk allocation	0.620	C1	0.620 x C1		Very few (0-20%) - very much (81-100%)	Qualitative
2	Business attitude	0.380	C2	0.380 x C2		Win-lose (0-20%) - win-win (81-100%)	Qualitative
	RESULT				**A' + B' + C'**	**Comments on result:**	

Bad 20 Fair 60 Excellent 100
Poor 40 Good 80
0

Reviewed by:
Name:
Designation:
Organization name:
Data:
Comments:

CHAPTER 7

CONCLUSIONS

7.1 Conclusions

This chapter presents an overall summary of this study. It covers conclusion of all objectives of the study, and its contribution to both practice and academics. Through the analysis and discussion of the results in chapter 3, chapter 4, chapter 5, and chapter 6, all the objectives are met its requirement. Besides, some limitations of this study and suggestion for further studies are also presented in the final part of this chapter.

Generally, all objectives were achieved based on the analysis results of the survey questionnaires that provided by the respondents from industrial practitioners. The benefits of the CSCM implementation, barriers to the CSCM implementation, and the key factors affecting to supply chain relationships in construction were derived from the literature review. The conclusions of this study were summarized in the following sections:

7.1.1 The benefits of the SCM implementation in construction

Twenty benefits were identified through the literature review and ranked from the different perspectives of four groups of respondents, i.e., the owner, the contractor, the designer, and the consultant. These groups generally had a convergence of perceptions on the twenty benefits identified. They agreed that "increase speed of project construction", "reduce project cost", "improved margin profit", "efficiency in utilizing the resources and skills", and "improve project quality" were the most significant benefits. By using the factor analysis technique,

the benefits were investigated and were categorized into the four factors: (1) systematic business system, (2) organization management and business strategy, (3) improved project performance, and (4) win-win outcomes among the parties. The findings showed that the implementation of SCM in the construction projects will bring the most significant gains relating to the improved project performance followed by systematic business system, and organization management and business strategy, whereas the win-win outcomes have not been emphasized by the parties. This problem could be easy to understand because individual interests are always present and difficult to remove in the supply chain. The parties are unwilling to share benefits, which may cause loss to them. Moreover, they are also ready to share risks together because the shared risks may be a burden to them.

7.1.2 The barriers to the SCM implementation in construction

Twenty-two barriers to the CSCM implementation were identified through the literature review and ranked according to the different perspectives of four groups of respondents, including the owner, the contractor, the designer, and the consultant. In general, these groups had a convergence of perceptions on the 22 barriers. All of them agreed that "lack of effective leadership", "lack of competence of the parties in SCM", "lack of understanding the supply chain concept", "passive sub-contractors and suppliers", and organizational resistance to SCM" were the five most important barriers found in CSCM. By using the factor analysis technique, the five factors of the barriers have extracted in the study. They are (1) lack of support and active participation from parties, (2) confronting culture and adversarial behavior, (3) inherent difficulties in the supply chain, (4) lack of knowledge and competence, and (5) deficiencies in the contract system. Among of them, factor 4, factor 1, and factor 2 are the most significant factors that should pay instant attention to promote the development of the CSCM implementation.

7.1.3 The key factors affecting supply chain relationships in construction

Based on the literature review, top 12 key factors which have a significant influence on supply chain relationships were identified. And three constructs of the key factors, which in turn were named as "collaboration management in the supply chain", "support and commitment to the supply chain", and "sharing the benefits and risks", respectively, were found by the factor analysis. These constructs were discussed in detail. The key factors and constructs are the important elements to support the development of the structural model for testing the influence of supply chain relationship traits on project performance. They are also main criteria and sub criteria to establish the framework for evaluating the supply chain relationships in construction.

7.1.4 The structural model to test the impact of supply chain relationship traits on project performance

The key factors affecting supply chain relationships and the influence of supply chain relationship traits on project performance have been investigated. Three constructs including twelve factors affecting the supply chain relationships were extracted by EFA. The findings indicated that the supply chain relationship traits have a significant impact on the project performance as described by the path coefficient value of 0.77 with p <0.001.

The constructs identified in this SEM model may help parties to identify the factors that may result in the effective performance of a project. It is concluded that collaboration management in the supply chain, support and commitment to the supply chain, and sharing benefits and risks play a main role to ensure the

successful project performance. Among of them, collaboration management in the supply chain plays a decisive role to ensure the successful project performance.

7.1.5 The framework for evaluating the supply chain relationships in construction

A systematic framework was developed in chapter 6 for the assessment of CSC relationships. The development of assessment framework is based on the AHP method. The proposed framework consists of main criteria, sub-criteria, and assessment matrix. The assessment criteria are organized in a hierarchy structure. Three main criteria are broken down into twelve sub-criteria. An assessment is made against sub-criteria. This makes main criteria manageable and provides convenience to present the final result. This evaluation framework supplies a useful tool for evaluating the degree of the relationship among the parties in the supply chain. The framework can help the parties to determine the specific areas that their relationship with their partners needs to be improved better.

7.2 Contributions of research

The findings of this study hope to benefit both practice and academics.

- Academic perspective:
  - ✓ SCM in construction is a new research field in Vietnam, so this thesis is the basis for future studies on the subject of SCM in Vietnam.

  - ✓ This study hopes to be as a valuable additional contribution to the body of knowledge relating to the SCM in the construction industry.

  - ✓ Although the study concentrates on Vietnam, the findings can be could be useful to similar studies in other countries for international comparison.

- Practical perspective:
  - ✓ It can be a document for construction practitioners to understand the key issues of good SCM and how they can manage supply chains better.

  - ✓ By using the evaluation framework of CSC relationships, construction organizations and project teams can evaluate their current relationship with others in SC and then to determine key areas that need to be improved better for a long-term cooperation planning in the future.

7.3 Limitations and suggestion for further studies

Despite completing all the objectives set out, this study has some limitations. Firstly, the non-probability sampling method is conducted to collect data because of difficulties of geographical distance and research schedule. Thus, there may be biases inherent in the sample. Second, the research uses only data from questionnaire surveys; there is a lack of case studies to be analyzed to get the practical view about SCM in the Vietnamese construction industry. Third, the study has not examined SCM related issues in terms of different project types. Lastly, this study was conducted in the context of Vietnam, therefore the findings may not be generalized to other geographical locations.

Recommendations are also made herein for further researches:

- ✓ Assess the hindrance degree of barriers that uses multiple regression analysis on the extracted factors to explore the relative importance.

This would highlight the significance in the unit hindrances to SCM in the construction industry.

✓ Investigate various case studies to have practice view about CSCM in projects.

✓ Discover CSCM in terms of different project types.

✓ Studies can also be performed to compare the result of this study in Vietnam with that of other countries in the region as a way of strengthening the validity of the findings.

REFERENCES

1. Ahmed S, Azhar S., and Ahmad I. (2002). "Supply Chain Management in Construction: Scope, Benefits and Barriers." Delhi Business Review, Vol. 3, No. 1, pp. 5-10.

2. Akintoye, A. (2000). "Analysis of factors influencing project cost estimating practice." Construction Management and Economics, Vol. 18, No. 1, pp. 77–89.

3. Akintoye, A., McIntosh, G. and Fitzgerald, E. (2000). "A survey of supply chain collaboration and management in the UK construction industry." European Journal of Purchasing & Supply Management, Vol. 6, No. 3, pp.159-168.

4. Akintoye, A., Main, J. (2007). "Collaborative relationships in construction: the UK contractors' perception." Engineering, Construction and Architectural Management, Vol. 14, No. 6, 597–617.

5. Albaloushi, H. and Skitmore, M. (2008). "Supply chain management in the UAE construction industry." International Journal of Construction Management, Vol. 8, No. 1, pp.53-71.

6. Aloini, D., Dulmin, R., Mininno, V., and Ponticelli, S. (2012). "A conceptual model for construction supply chain management implementation." Proc. 28th Int. Smith, Annual ARCOM Conference, Edinburgh, UK, Association of Researchers in Construction Management, pp. 675-685.

7. Anderson Jr, L.L. and Polkinghorn, B.D. (2010). "Efficacy of partnering on the Woodrow Wilson Bridge project: Empirical evidence of collaborative

problem-solving benefits." Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, Vol. 3, No. 1, pp.17-27.

8. Anvuur, A.M. and Kumaraswamy, M.M. (2011). "Measurement and antecedents of cooperation in construction." Journal of Construction Engineering and Management, Vol. 138, No. 7, pp.797-810.

9. Bagozzi, R.P. and Yi, Y. (2012). "Specification, evaluation, and interpretation of structural equation models." Journal of the academy of marketing science, Vol. 40, No. 1, pp.8-34.

10. Balaji, M., Velmurugan, V., and Manikanda, P.K. (2014). "Barriers in green supply chain management: an Indian foundry perspective." International Journal of Research in Engineering and Technology, Vol. 3, Special Issue. 7, pp. 423-429.

11. Balasubramanian, S. (2012). "A hierarchical framework of barriers to green supply chain management in the construction sector." Journal of Sustainable Development, Vol. 5, No. 10, pp.15-27.

12. Bankvall, L., Bygballe, L.E., Dubois, A. and Jahre, M. (2010). "Interdependence in supply chains and projects in construction." Supply Chain Management: An International Journal, Vol. 15, No. 5, pp.385-393.

13. Barratt, M. (2004). "Understanding the meaning of collaboration in the supply chain." Supply Chain Management: An International Journal, Vol. 9, No. 1, pp. 30 – 42.

14. Barson, R.J., Foster, G., Struck, T., Ratchev, S., Pawar, K., Weber, F. and Wunram, M. (2000). "Inter-and intra-Organisational barriers to sharing knowledge in the extended supply-chain." In Proceedings of the eBusiness and eWork (pp. 18-20).

15. Behera, P., Mohanty, R.P. and Prakash, A. (2015). "Understanding Construction Supply Chain Management." Production Planning & Control, Vol. 26, No. 16, pp.1332-1350.

16. Bennett, J. and Peace, S. (2006). Partnering in the construction industry: A code of practice for strategic collaborative working. Routledge.

17. Benton, W.C., and McHenry, L.F. (2010). Construction purchasing & supply chain management. New York: McGraw-Hill.

18. Black, C., Akintoye, A. and Fitzgerald, E. (2000). "An analysis of success factors and benefits of partnering in construction." International Journal of Project Management, Vol. 18, No. 6, pp.423-434.

19. Boddy, D., Cahill, C., Charles, M., Fraser-Kraus, H. and Macbeth, D. (1998). "Success and failure in implementing supply chain partnering: an empirical study." European Journal of Purchasing & Supply Management, Vol. 4, No. 2, pp.143-151.

20. Bresnen, M. and Marshall, N. (2000). "Partnering in construction: a critical review of issues, problems and dilemmas." Construction Management & Economics, Vol. 18, No. 2, pp.229-237.

21. Briscoe, G., Dainty, A.R.J., and Millett, S. (2001). "Construction supply chain partnerships: skills, knowledge and attitudinal requirements." European Journal of Purchasing & Supply Management, Vol. 7, No.4, pp. 243-255.

22. Brown, D.C., Ashleigh, M.J., Riley, M.J. and Shaw, R.D. (2001). "New project procurement process." Journal of management in engineering, Vol. 17, No. 4, pp.192-201.

23. Cao, M. and Zhang, Q. (2010). "Supply chain collaborative advantage: a firm's perspective." International Journal of Production Economics, Vol. 128, No. 1, pp.358-367.

24. Cao, M. and Zhang, Q. (2011). "Supply chain collaboration: Impact on collaborative advantage and firm performance." Journal of Operations Management, Vol. 29, No. 3, pp.163-180.

25. Chan, D.W. and Kumaraswam, M.M. (1995). "Reasons for delay in civil engineering projects–the case of Hong Kong." HKIE Transactions, Vol. 2, No. 3, pp.1-8.

26. Chan, D.W., and Kumaraswamy, M.M. (2002). "Compressing construction durations: lessons learned from Hong Kong building projects." International Journal of Project Management, Vol. 20, No. 1, pp.23-35.

27. Chan, A.P., Chan, D.W. and Ho, K.S. (2003). "Partnering in construction: critical study of problems for implementation." Journal of Management in Engineering, Vol. 19, No. 3, pp.126-135.

28. Chan, A.P. and Chan, A.P. (2004). "Key performance indicators for measuring construction success." Benchmarking: an international journal, Vol. 11, No. 2, pp.203-221.

29. Chan, A.P., Chan, D.W., Chiang, Y.H., Tang, B.S., Chan, E.H. and Ho, K.S. (2004). "Exploring critical success factors for partnering in construction projects." Journal of Construction Engineering and Management, Vol. 130, No. 2, pp.188-198.

30. Chen, W.T. and Chen, T.T. (2007). "Critical success factors for construction partnering in Taiwan." International Journal of Project Management, Vol. 25, No. 5, pp.475-484.

31. Chen, Y.Q., Zhang, Y.B., Liu, J.Y. and Mo, P. (2012). "Interrelationships among critical success factors of construction projects based on the structural equation model." Journal of Management in Engineering, Vol. 28, No. 3, pp.243-251.

32. Cheng, E.W., Li, H. and Love, P.E.D. (2000). "Establishment of critical success factors for construction partnering." Journal of management in engineering, Vol. 16, No. 2, pp.84-92.

33. Cheng, E.W., Li, H., Love, P.E., and Irani, Z. (2001). "An e-business model to support supply chain activities in construction." Logistics information management, Vol.14, No.1/2, pp.68-78.

34. Cheng, E.W.L., Li, H. (2002). "Construction partnering process and associated critical success factors: quantitative investigation." Journal of Management in Engineering, Vol. 18, No. 4, pp. 194–202.

35. Cheung, S.O., Lam, T.I., Leung, M.Y. and Wan, Y.W. (2001). "An analytical hierarchy process based procurement selection method." Construction Management & Economics, Vol. 19, No. 4, pp.427-437.

36. Cheung, Y.K.F., and Rowlinson, S. (2007) "Supply chain engagement through relationship management?" In London, Kerry and Thayarapen, G. and Chen, Jessica, Eds. Proceedings Symposium: Building Across Borders Built Environment Procurement CIB W092 Procurement Systems, pp. 119-126, Newcastle, New South Wales.

37. Chiang, Y.H. (2009). "Subcontracting and its ramifications: A survey of the building industry in Hong Kong." International Journal of Project Management, Vol. 27, No. 1, pp. 80-88.

38. Cho, K., Hong, T. and Hyun, C. (2009). "Effect of project characteristics on project performance in construction projects based on structural equation model." Expert Systems with Applications, Vol. 36, No. 7, pp.10461-10470.

39. Chundong, W., Lei, W., Juri, S. and Jie, X. (2012). "Risk sharing in two-level supply chain with risk aversion supplier." In Management of Technology (ISMOT), International Symposium on IEEE, pp. 197-200.

40. Constructing Excellence (2004). "Supply chain management." http://constructingexcellence.org.uk/wpcontent/uploads/2015/03/supplychain.pdf. [Accessed on September 2015].

41. Cox, A.W., Ireland, P. and Townsend, M. (2006). Managing in Construction Supply Chains and Markets: Reactive and Proactive Options for Improving Performance and Relationship Management. Thomas Telford.

42. Crane, T.G., Felder, J.P., Thompson, P.J., Thompson, M.G. and Sanders, S.R. (1999). "Partnering measures." Journal of Management in Engineering, Vol. 15, No. 2, pp.37-42.

43. Crowley, L.G. and Karim, M.A. (1995). "Conceptual model of partnering." Journal of management in engineering, Vol. 11, No. 5, pp.33-39.

44. Dainty, A. R. J., Briscoe, G. H., and Millett, S. (2001). "New perspectives on construction supply chain integration." Supply Chain Management: An International Journal, Vol. 6, No. 4, pp. 163 – 173.

45. Deshmukh, P.S., More, A.B., and Chavan, S.A. (2014). "Supply Chain Management in Residential Construction Sector." International Journal of Engineering and Advanced Technology. Vol.4, No.2, pp.87-90.

46. Dewilarasati. (2010). "Preliminary study on the Indonesian Construction Industry Supply Chain System." https://dewilarasatizr.wordpress.com/2010/02/23/preliminary-study-on-the-indonesian-construction-industry-supply-chain-system/. [Accessed on September 2015].

47. Dias Jr, A. and Ioannou, P.G. (1996). "Company and project evaluation model for privately promoted infrastructure projects." Journal of Construction Engineering and Management, Vol. 122, No. 1, pp.71-82.

48. Doloi, H. (2008). "Application of AHP in improving construction productivity from a management perspective." Construction Management and Economics, Vol. 26, No. 8, pp.841-854.

49. Doloi, H. (2009). "Relational partnerships: the importance of communication, trust and confidence and joint risk management in achieving project success." Construction Management and Economics, Vol. 27, No. 11, pp.1099-1109.

50. Doloi, H., Iyer, K.C. and Sawhney, A. (2011). "Structural equation model for assessing impacts of contractor's performance on project success." International Journal of Project Management, Vol. 29, No. 6, pp.687-695.

51. Doloi, H., Sawhney, A. and Iyer, K.C. (2012). "Structural equation model for investigating factors affecting delay in Indian construction projects." Construction Management and Economics, Vol. 30, No. 10, pp.869-884.

52. Drexler Jr, J.A. and Larson, E.W. (2000). "Partnering: Why project owner contractor relationships change." Journal of Construction Engineering and management, Vol. 126, No. 4, pp.293-297.

53. Elmuti, D. (2002). "The perceived impact of supply chain management on organizational effectiveness." Journal of Supply Chain Management, Vol. 38, No. 2, pp.49-57.

54. Ellif, Z.H.A. and Maarof, N. (2011). Oral Communicative Activities in the Saudi Third Year Secondary EFL Textbooks. Advances in Language and Literary Studies, Vol. 2, No. 1, pp.9-17.

55. Enshassi, A., Mohamed, S. and Abushaban, S. (2009). "Factors affecting the performance of construction projects in the Gaza Strip." Journal of Civil engineering and Management, Vol. 15, No. 3, pp.269-280.

56. Eriksson, P.E. (2006), "Procurement and governance management – development of a conceptual procurement model based on different types of control." Management Revue, Vol. 17 No. 1, pp. 30-49.

57. Eriksson, P.E., and Laan, A. (2007). "Procurement effects on trust and control in client-contractor relationships." Engineering, Construction and Architectural Management, Vol. 14, No. 4, pp. 387-399.

58. Eriksson, P.E., Dickinson, M. and Khalfan, M. (2007). "The influence of partnering and procurement on subcontractor involvement and innovation." Facilities, Vol. 25 Nos 5/6, pp. 203-14.

59. Eriksson, P.E, Nilsson, T. and Atkin, B. (2008). "Client perceptions of barriers to partnering." Engineering, Construction and Architectural Management, Vol. 15, No. 6, pp.527-539.

60. Eybpoosh, M., Dikmen, I. and Talat Birgonul, M. (2011). "Identification of risk paths in international construction projects using structural equation modeling." Journal of Construction Engineering and Management, Vol. 137, No. 12, pp.1164-1175.

61. Field, A. (2009) Discovering statistics using SPSS, Sage Publications, Thousand Oaks, CA.

62. Gardiner, P.D. and Simmons, J.E.L. (1998). "Conflict in small-and medium-sized projects: Case of partnering to the rescue." Journal of Management in Engineering, Vol. 14, No. 1, pp.35-40.

63. Ghaffari, A. (2015). "Strategic Concept of Partnering In Construction Projects." Bulletin of the Georgian National Academy of Sciences, Vol. 9, No. 1, pp. 138-155.

64. Haery, F.A., Ghorbani, H. and Farahmand, A.A. (2014). An AHP Approach for Ranking Critical Success Factors of Customers Experience in Iranian Banks from Managers' Viewpoint. International Journal of Marketing Studies, 6(1): 168-176.

65. Hai, T.K., Aminah, M.Y., Syuhaida, I. and Wei, L.F. (2012). "Reviewing the Construction Supply Chain Challenges and Construction Supply Chain Management Strategic Management." International Journal of Civil Engineering and Structures, Vol.1, No.1, pp.8-18.

66. Hair, J.F., Black, W.C., Babin, B.J., and Anderson, R.E. (2010). Multivariate data analysis, 7th Ed., Pearson Education, Upper Saddle River, NJ.

67. Hall, M. (2001). "Root Cause Analysis-a tool for closer supply chain integration in construction." Proc., 17th Int. Annual ARCOM conference, Salford: Association of Researchers in Construction Management, University of Salford, Vol. 1, pp. 929-938.

68. Handfield, R.B., and Nichols, E.L. (2002). Supply chain redesign: Transforming supply chains into integrated value systems. FT Press.

69. Handfield, R.B. (2003). "Managing relationships in the supply chain." https://scm.ncsu.edu/scm-articles/article/managing-relationships-in-the-supply chain. [Accessed on September 2015].

70. Harland, C.M. (1996). "Supply chain management: relationships, chains and networks." British Journal of management, Vol. 7, No. s1, pp.S63-S80.

71. Harnan, P. (2000). Management: Missing links. Industry Week, March 15.

72. Harsha, N., Punith, M.Y.R., and Nagendra, G.C.K. (2013). "Importance of Information Sharing in Construction Supply Chain Management: A Review." Proc., 10th Int. AIMS International Conference on Management, Bangalore, India, pp. 6-9.

73. Hatmoko, J.U.D. (2008). The impact of supply chain management practice on construction project performance.

74. Hox, J.J. and Bechger, T.M. (1998). "An introduction to structural equation modeling." Family Science Rewiew, 11, 354-373.

75. Hu, W. (2008). "Improving construction collaboration performance through supply chain control and management." Proc., Int. Information Management, Innovation Management and Industrial Engineering, ICIII'08. International Conference on IEEE, Vol. 1, pp. 58-61.

76. Hu, W. and Xinhua, H. (2008). "Communication improvement for integrated construction supply chain management systems." In Proceedings of 2008 International Conference on Logistics Engineering and Supply Chain, pp. 20-22.

77. Humphreys, P., Matthews, J., and Kumaraswamy, M. (2003). "Pre-construction project partnering: from adversarial to collaborative

relationships." Supply Chain Management: An International Journal, Vol. 8, No. 2, pp.166-178.

78. Hudnurkar, M., Jakhar, S., and Rathod, U. (2014). "Factors affecting collaboration in supply chain: a literature review." Procedia-Social and Behavioral Sciences, 133, pp.189-202.

79. I. Ikediashi, D., O. Ogunlana, S. and Udo, G. (2013). "Structural equation model for analysing critical risks associated with facilities management outsourcing and its impact on firm performance." Journal of Facilities Management, Vol. 11, No. 4, pp.323-338.

80. Jalbani, A.A. (2010). Supply chain management in UAE construction industry. MSc diss., Heriot Watt University, UK School of Built Environment Dubai Campus.

81. JCT student Essay Competition (2012). "A vision for the future of construction: supply chain management and integration." Overall Winner: Richard Hope, Nottingham Trend University. https://www.jctltd.co.uk/docs/JCTEssayCompetition2012OverallWinnerRichardHope.pdf. [Accessed on September 2015].

82. Jha, K.N. and Iyer, K.C. (2007). "Commitment, coordination, competence and the iron triangle." International Journal of Project Management, Vol. 25, No. 5, pp.527-540.

83. Jha, K.N. (2013). Determinants of Construction Project Success in India. Springer.

84. Jian-hua, C., and Wan, T. (2010). "Time-cost trade-off problem in construction supply chain: A bi-level programming decision model." Proc., Int. Management Science and Engineering (ICMSE), IEEE, pp. 212-217.

85. Jones,M. and Saad, M. (2003) Managing innovation in construction, Thomas Telford, London.

86. Jones, K., Kaluarachchi, Y. (2007). "Operational factors affecting strategic partnering in UK social housing." Engineering, Construction and Architectural Management, Vol. 14, No. 4, pp. 334–345.

87. Karatas, A. (2009). Survey of Supply Chain Management as Perceived by the US Construction Industry. MSc diss., University of Florida.

88. Khalfan, M., McDermott, P., and Cooper, R. (2004). "Integrating the supply chain within construction industry." Pro., 20th Int. ARCOM Conference, pp. 897-904.

89. Khalfan, M.M.A., and McDermott, P. (2006). "Innovating for supply chain integration within construction." Construction Innovation, Vol. 6, No. 3, pp.143-157.

90. Khurana, M.K., Mishra, P.K. and Singh, A.R. (2011). "Barriers to information sharing in supply chain of manufacturing industries." International Journal of Manufacturing Systems, Vol. 1, No. 1, pp.9-29.

91. Kumar, V., and Viswanadham, N. (2007). "A CBR-based decision support system framework for construction supply chain risk management." Proc., Int. Automation Science and Engineering, CASE, IEEE, pp. 980-985.

92. Kwan, A.Y. and Ofori, G. (2001). "Chinese culture and successful implementation of partnering in Singapore's construction industry." Construction Management & Economics, Vol. 19, No. 6, pp.619-632.

93. Landau, S., and Everitt, B. (2004). A handbook of statistical analyses using SPSS (Vol. 1). Boca Raton, FL: Chapman & Hall/CRC.

94. Lam, K.C., Wang, D., Lee, P.T. and Tsang, Y.T. (2007). "Modelling risk allocation decision in construction contracts." International Journal of Project Management, Vol. 25, No. 5, pp.485-493.

95. Lambert, D.M., Stock, J.R. and Ellram, L.M. (1998). Fundamentals of logistics management. McGraw-Hill/Irwin.

96. Lambert, D.M. and Cooper, M.C. (2000). "Issues in supply chain management." Industrial marketing management, Vol 29, No 1, pp.65-83.

97. Larson, E. (1997). "Partnering on construction projects: a study of the relationship between partnering activities and project success." Engineering Management, IEEE Transactions on, Vol. 44, No. 2, pp.188-195.

98. Latham, S.M. (1994). Constructing the team. London: HM Stationery Office.

99. Lazar, F. (2000). "Project partnering: improving the likelihood of win/win outcomes." Journal of Management in Engineering, ASCE, Vol. 16 No. 2, pp. 71-83.

100. Lee, C.P., Lou, S.J., Shih, R.C. and Tseng, K.H. (2011). An AHP-based weighted analysis of network knowledge management platforms for elementary school students. The Turkish Online Journal of Educational Technology, Vol. 10, No. 4, pp.52-59.

101. Le-Hoai, L., Dai Lee, Y. and Son, J.J. (2010). "Partnering in construction: Investigation of problematic issues for implementation in Vietnam." KSCE Journal of Civil Engineering, Vol. 14, No. 5, pp.731-741.

102. Lewis, JD. (1995). "The connected corporation." New York: Free Press. pp. 1-13.

103. Li, H., Cheng, E.W. and Love, P.E. (2000). "Partnering research in construction." Engineering, Construction and Architectural Management, Vol. 7, No. 1, pp.76-92.

104. Li, H., Arditi, D. and Wang, Z. (2012). "Transaction-related issues and construction project performance." Construction Management and Economics, Vol. 30, No. 2, pp.151-164.

105. Lin, L. and Gibson, P. (2011). "Implementing Supply Chain Quality Management in Subcontracting System for Construction Quality." Journal of System and Management Sciences, Vol. 1, No. 1, pp.46-58.

106. London, K., Kenley, R., and Agapiou, A. (1998). "Theoretical supply chain network modelling in the building industry." Association of Researchers in Construction Management (ARCOM), Reading, UK, ARCOM.

107. Lu, S., Yan, H. (2007). "An empirical study of incentives of strategic partnering in China: views from construction companies." International Journal of Project Management, Vol. 25, No. 3, pp.241–249.

108. Maloney, W.F. (2000). "Learning Organizations: A Special Issue." Journal of Management in Engineering, Vol.16, No.4, pp.3-3.

109. Mainul Islam, M., and Faniran, O.O. (2005). "Structural equation model of project planning effectiveness." Construction Management and Economics, Vol. 23, No. 2, pp.215–23.

110. Majid, M. and McCaffer, R. (1997). Assessment of Work Performance of Maintenance Contractors in Saudi Arabia. Journal of Management in Engineering, Vol. 13, No. 5, pp.91–91.

111. Masrom, M.A. and Skitmore, M. (2009). "Conceptual models of satisfaction level in construction." In The Second Infrastructure Theme Postgraduate Conference: Conference Proceedings, pp. 117-127. Queensland University of Technology.

112. Matipa, W.M., and Siamuzwe, V.M.M. (2005). "Information and communication technology [ICT] supported supply chain management - benefits for construction business in landlocked developing nations." Proc. 21st Int. Annual ARCOM Conference, SOAS, University of London. Association of Researchers in Construction Management, Vol. 1, pp.489-98.

113. McDermott, P., and Khalfan, M.M.A. (2006). "Achieving supply chain integration within construction industry." Australasian Journal of Construction Economics and Building, Vol. 6, No. 2, pp.44-54.

114. Meng, X., Sun, M., and Jones, M. (2011). "Maturity model for supply chain relationships in construction." Journal of Management in Engineering, Vol.27, No. 2, pp.97-105.

115. Mohamed, S. (2003). "Performance in international construction joint ventures: Modeling perspective." Journal of Construction Engineering and Management, Vol. 129, No. 6, pp.619-626.

116. Mulla, A.I., Gupta, A.K., and Desai, D.B. (2015). "Supply chain management: effective tool in construction industry." International Journal of Novel Research in Engineering and Science, Vol. 2, No. 1, pp.35-40.

117. Naoum, S. (2003). "An overview into the concept of partnering." International Journal of Project Management, Vol. 21, No. 1, pp. 71–77.

118. Ng, T., Rose, T., Mak, M., and Chen, S.E. (2002). "Problematic issues associated with project partnering - the contractor perspective." International Journal of Project Management, Vol. 20 No. 6, pp. 437-49.

119. O'brien, W.J. (1999). "Construction supply-chain management: a vision for advanced coordination, costing, and control." In NSF Berkeley-Stanford Construction Research Workshop, Stanford, California.

120. O'Brien, W.J., London, K.., and Vrijhoef, R. (2004). "Construction supply chain modeling: a research review and interdisciplinary research agenda." ICFAI journal of operations management, Vol. 3, No. 3, pp.64-84.

121. O'Brien, W.J., London, K., and Vrijhoef, R. (2009). Construction supply chain management handbook, CRC Press, Boca Raton, London, New York.

122. Office of Government Commerce (OGC) (2005). Supply Chain Management in Public Sector Procurement: a Guide. http://webarchive.nationalarchives.gov.uk/20110822131357/http:/www.ogc gov.uk/documents/SupplyChainManagementGuide.pdf. [Accessed on September 2015].

123. Ojo, E., Mbowa, C., and Akinlabi, T.E. (2014). "Barriers in Implementing Green Supply Chain Management in Construction industry." Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management Bali, Indonesia, January 7 – 9, pp.1974-1981.

124. Olaniyi, A., Bosede, A., and Olusola, O. (2015). "Supply Chain Management Practices in Construction Procurement: Perceptions of Professional Quantity

Surveyors in Ondo State, Nigeria." PM world Journal, Vol IV, No. VI, pp. 1-12.

125. Olsson F. (2000). Supply chain management in the construction industry-opportunity or utopia? Thesis for the degree Licentiate in Engineering, Department of Design Sciences, Logistics, Lund University, Sweden.

126. Ou, C.S., Fang C. Liu, C.F. Yu C. Hung David C. Yen. (2010). "A structural model of supply chain management on firm performance." International Journal of Operations & Production Management, Vol. 30, No. 5, pp.526 - 545.

127. Ozorhon, B., Arditi, D., Dikmen, I. and Birgonul, M.T. (2007). "Effect of host country and project conditions in international construction joint ventures." International Journal of Project Management, Vol. 25, No. 8, pp.799-806.

128. Ozorhon, B., Arditi, D., Dikmen, I. and Birgonul, M.T. (2008a). "Effect of partner fit in international construction joint ventures." Journal of Management in Engineering, Vol. 24, No. 1, pp.12-20.

129. Ozorhon, B., Arditi, D., Dikmen, I. and Birgonul, M.T. (2008b). "Implications of culture in the performance of international construction joint ventures." Journal of Construction Engineering and Management, Vol. 134, No. 5, pp.361-370.

130. Ozorhon, B., Arditi, D., Dikmen, I. and Birgonul, M.T. (2011). "Toward a multidimensional performance measure for international joint ventures in construction." Journal of construction engineering and management, Vol. 137, No. 6, pp.403-411.

131. Packham, G., Thomas, B. and Miller, C. (2003). "Partnering in the house building sector: a subcontractor's view." International Journal of Project Management, Vol. 21, No. 5, pp.327-332.

132. Palaneeswaran, E., Kumaraswamy, M., Rahman, M. and Ng, T. (2003). "Curing congenital construction industry disorders through relationally integrated supply chains." Building and Environment, Vol. 38, No. 4, pp.571-582.

133. Pinto, J.K., Slevin, D.P., English, B. (2009). "Trust in projects: an empirical assessment of owner/contractor relationships." International Journal of Project Management, Vol. 27, No. 6, pp.638–648.

134. Proverbs, D.G., and Holt, G.D. (2000). "Reducing construction costs: European best practice supply chain implications." European Journal of Purchasing & Supply Management, Vol. 6, No. 3, pp.149-158.

135. Preweb (2014). http://www.prweb.com/releases/construction-in-vietnam/opportunities-to-2018/prweb12095349.htm. [Accessed on September 2015].

136. Pryke, S. (2009). Construction Supply Chain Management: Concepts and Case Studies. Wiley-Blackwell, London.

137. Qureshi, S.M. and Kang, C. (2015). "Analysing the organizational factors of project complexity using structural equation modelling." International Journal of Project Management, Vol. 33, No. 1, pp.165-176.

138. Saaty, T.L., Kearns, K.P. (1985). Analytical Planning–The Organizations of Systems. Pergamon Press, Oxford, UK.

139. Saaty, T.L. and Vargas, L.G. (2000). Models, Methods, Concepts and Applications of the Analytic Hierarchy Process. Boston: Kluwer Academic Publisher.

140. Saaty, T.L., (2005). Theory and Applications of the Analytical Network Process:Decision-Making with Benefits, Opportunities, Costs, and Risk. RWS Publications, Pittsburgh, PA, USA.

141. Saaty, T.L., (2008). "Decision making with the analytic hierarchy process." International Journal of Services Sciences, Vol. 1, No. 1, pp. 83–98.

142. Saaty, T.L. (2010). Mathematical Principles of Decision Making. USA: RWS Publications.

143. Salman, A.F., Skibniewski, M.J. and Basha, I. (2007). "BOT viability model for large-scale infrastructure projects." Journal of Construction Engineering and Management, 133(1), pp.50-63.

144. Santander-trade (2015). https://en.santandertrade.com/analyse markets/vietnam/economic-outline.[Accessed on September 2015].

145. Sekaran Uma (2000). Research methods for business: a skill building approach. 3rd ed. New York: John Wiley.

146. Sheng, Y.G., and Ping, L.R. (2010). "The benefit distribution of construction supply chain based on TOPSIS coordination method." Proc., 2nd Int. Information Science and Engineering (ICISE), IEEE, pp. 3219-3223.

147. Singh, M. and Singh, D.P. (2008). Violence: Impact and Intervention. India: ATLANTIC Publishers & Distributors (P) LTD.

148. Souza, D.V.S. and Koskela, L. (2012). "On improvement in construction supply chain management." Proc. 20th Int. Annual Conference of the International Group for Lean Construction.

149. Spillane, J.P., Oyedele, L.O., Von Meding, J., Konanahalli, A., Jaiyeoba, B.E., and Tijani, I.K. (2011). "Challenges of UK/Irish contractors regarding material management and logistics in confined site construction." International Journal of Construction Supply Chain Management, Vol. 1, No. 1, pp.25-42.

150. Stanford, K., Hobbs J.E., Gilbert M., Jones, S.D.M., Price, M.A., Klein, K.K., and Kerr, W. A. (1999) Lamb-Buying Preferences of Canadian Abattoirs and Producer Marketing Groups: Implications for the Canadian Supply Chain, Industrial Engineering, Vol. 4, No. 2, pp.86-94.

151. Sun, S.S., and Zhang, M. (2006). "Construction supply chain system based on the general contractor." In: Proceedings of the 7th International Conference on Innovation & Management, Paris, France, pp.1649-1652.

152. Syed, Z.S.T., and Kumar, N.J. (2012). "Success Traits for a Construction Project." Journal of Construction Engineering and Management, ASCE, Vol. 138, No. 10, pp.1131–1138.

153. Tam, V.W., Shen, L.Y. and Kong, J.S. (2011). "Impacts of multi-layer chain subcontracting on project management performance." International Journal of Project Management, Vol. 29, No. 1, pp.108-116.

154. Tan, K. C. (2001). "A framework of supply chain management literature." European Journal of Purchasing and Supply Management, Vol. 7, pp. 39 – 48.

155. Thompson, P.J. and Sanders, S.R. (1998). "Partnering continuum." Journal of Management in Engineering, Vol. 14, No. 5, pp.73-78.

156. Thomas, G. and Thomas, M. (2005) Construction Partnering & Integrated Teamworking, Blackwell, London.

157. Tiwari, R., Shepherd, H., and Pandey, R.K. (2014). "Supply chain management in construction: a literature survey." International Journal of Management Research and Business Strategy, Vol.3, No.1, pp.7-28.

158. Tran, V., and Tookey, J.E. (2012). "Directions for future construction supply chain management research in New Zealand: A real options perspective." International Journal of Construction Supply Chain Management, Vol. 2, No. 1, pp.34-45.

159. Uma, S. (2000). Research methods for business: a skill building approach. 3rd ed. New York: John Wiley.

160. Vrijhoef, R. (1998). Co-markership in construction towards construction supply chain management. MSc diss., Delft University of Technology.

161. Vrijhoef, R., and Koskela, L. (2000). "The four roles of supply chain management in construction." European Journal of Purchasing & Supply Management, Vol. 6, No.3, pp.169-178.

162. Vrijhoef, R., and Voordijk, H. (2003). "Improving supply chain management in construction: what can be learned from the food and grocery sector." Proc. CIB Joint International Symposium on Knowledge Construction, pp. 22-24.

163. Walker, T. William and Alber, Karen L. (1999). "Understanding Supply Chain Management." APICS online Edition, Vol. 99, No 1, pp 38-43.

164. Wang, M.T., and Chou, H.Y. (2003). "Risk allocation and risk handling of highway projects in Taiwan." Journal of management in Engineering, Vol. 19, No. 2, pp.60-68.

165. Wisner, J., Tan, K.C., and Leong, G. (2012). Principles of supply chain management: a balanced approach. Cengage Learning.

166. Wong, P.S.P., Tsoi, J.N.Y., and Cheung, S.O. (2004). "Identifying obstacles against implementation of supply chain management in construction." Hong Kong Surveyor, Vol. 15, No. 2, pp.12-22.

167. Wong, P., Cheung, S., and Tsoi, J. (2005). "Construction supply chain management in Hong Kong", 3rd International Structural Engineering and Construction Conference (ISEC-03): Collaboration and Harmonization in Creative Systems, pp. 527-535, London, Taylor and Francis.

168. Xiong, B., Skitmore, M., Xia, B., Masrom, M.A., Ye, K. and Bridge, A. (2014). "Examining the influence of participant performance factors on contractor satisfaction: A structural equation model." International Journal of Project Management, Vol. 32, No. 3, pp.482-491.

169. Xiong, B., Skitmore, M. and Xia, B. (2015). "A critical review of structural equation modeling applications in construction research." Automation in Construction, Vol. 49, pp.59-70.

170. Xue, X., Wang, Y., Shen, Q., and Yu, X. (2007). "Coordination mechanisms for construction supply chain management in the Internet environment." International Journal of Project Management, Vol. 25, No. 2, pp.150-157.

171. Yan, C. (2012). "Study on the Application of Lean Construction Supply Chain Management in EPC Project." Applied Mechanics and Materials, Vol. 201, pp.1207-1212.

172. Zsidisin, G.A., and Ritchie, B. (2008). "Supply chain risk: a handbook of assessment, management, and performance." Springer Science & Business Media.

APPENDIX

APPENDIX 1

QUESTIONNNAIRE No.1

Supply Chain Management in the Vietnamese Construction Industry

Dear Sir/Madam,

My name is Nguyen Thanh Viet; I am a post graduate student of Construction Engineering and Management in Ho Chi Minh city University of Technology. Currently, I am conducting the research with content **"Supply Chain Management in the Vietnamese Construction Industry".**

The main purpose of this survey is to gather opinions and experience of you in rating benefits, barriers of construction supply chain management, and the key factors affecting supply chain relationships in construction. The information provided from you will contribute greatly to the success of this research. Therefore, I look forward to receiving your interest and help. This questionnaire will be processed in the strictest confidence and for academic purposes only.

For this purpose, I would like to give a brief summary about supply chain and supply chain management in construction as follows:

Construction supply chain (CSC) consists of all the construction business processes, from the demands by the client, conceptual, design and construction to maintenance, replacement and eventual decommission of building, and organizations, which are involved in the construction process, such as client/owner, designer, general contractor, subcontractor, supplier, consultant, etc. CSC is not a chain of construction businesses with business-to-business relationships but a network of multiple organizations and relationships, which includes the flow of information the flow of materials, services or products, and the flow funds among client, designer, contractor and supplier.

Construction supply chain management (CSCM) is the integration of key construction business processes, from the demands of client, design to construction, and key members of construction supply chain, including client/owner, designer, contractor, subcontractor and supplier. CSCM focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage. Managing business relationships between customers and suppliers at different tires is the essential element of SCM.

A. BENEFITS OF SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION

Please rate your degree of agreement to benefits of construction supply chain management by marking √ in corresponding box according to the conventional scale of 1 to 5, as follows:

"1" = "Strongly disagree", "2" = "Disagree", "3" = "Neutral", "4" = "Agree", "5" = "Strongly agree"

No.	Benefits of supply chain management in construction	Degree of agreement				
		1	2	3	4	5
1	Reduce project cost	☐	☐	☐	☐	☐
2	Repeat business with key clients	☐	☐	☐	☐	☐
3	Sharing problems and working together	☐	☐	☐	☐	☐
4	Increase speed of project construction	☐	☐	☐	☐	☐
5	Improved margin profit	☐	☐	☐	☐	☐
6	Improve project quality	☐	☐	☐	☐	☐
7	Remove waste from project process	☐	☐	☐	☐	☐
8	Reduce paperwork	☐	☐	☐	☐	☐
9	Development of mutual understanding	☐	☐	☐	☐	☐
10	Benefit allocation among the parties	☐	☐	☐	☐	☐
11	Development of no-blame culture	☐	☐	☐	☐	☐
12	Enhanced reputations and increased market competitiveness	☐	☐	☐	☐	☐
13	Increase customer satisfaction level	☐	☐	☐	☐	☐
14	Greater confidence in long-term planning	☐	☐	☐	☐	☐
15	Bureaucracy reduction in organization	☐	☐	☐	☐	☐
16	Risk sharing among the parties	☐	☐	☐	☐	☐

No.		1	2	3	4	5
17	Better information, communication, and coordination	☐	☐	☐	☐	☐
18	Shared resources, data and knowledge	☐	☐	☐	☐	☐
19	Efficiency in utilizing the resources and skills	☐	☐	☐	☐	☐
20	Improved worker motivation and team-working	☐	☐	☐	☐	☐

B. BARRIERS TO SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION

Please rate hindrance degree of the following barriers to the implementation of construction supply chain management. The hindrance degree is defined as follows:

"1" = "Not hinder", "2" = "Less hinder", "3" = "Averagely hinder", "4" = "Strongly hinder", "5" = "Extremely hinder"

No.	Barriers to supply chain management in construction	Hindrance degree				
		1	2	3	4	5
1	Lack of understanding supply chain concept	☐	☐	☐	☐	☐
2	Passive sub-contractors and suppliers	☐	☐	☐	☐	☐
3	Inappropriate tending methods	☐	☐	☐	☐	☐
4	Inappropriate organizational structure to support supply chain	☐	☐	☐	☐	☐
5	Lack of communication and information exchange	☐	☐	☐	☐	☐
6	Unwillingness to share risks and benefit, and emphasizing self-interest	☐	☐	☐	☐	☐
7	Lack of genuine collaboration and good working relations	☐	☐	☐	☐	☐
8	Lack of training in SCM	☐	☐	☐	☐	☐
9	Organizational resistance to SCM	☐	☐	☐	☐	☐
10	Lack of usage of IT system	☐	☐	☐	☐	☐
11	Lack of trust among the parties in supply chain	☐	☐	☐	☐	☐
12	Lack of commitment to supply chain	☐	☐	☐	☐	☐
13	Lack of common goals among the parties in supply chain	☐	☐	☐	☐	☐

14	Lack of competence of parties in SCM	☐	☐	☐	☐	☐
15	Lack of effective leadership	☐	☐	☐	☐	☐
16	Ineffective problem solving mechanism	☐	☐	☐	☐	☐
17	Anticipated rewards unclear	☐	☐	☐	☐	☐
18	Power domination and frequent contractual non-commitments	☐	☐	☐	☐	☐
19	Complexity and harsh of supply chain process	☐	☐	☐	☐	☐
20	Temporary or short-term supply chain network	☐	☐	☐	☐	☐
21	Lack of understanding customer requirements	☐	☐	☐	☐	☐
22	Fragmented characteristics of the construction industry	☐	☐	☐	☐	☐

C. KEY FACTORS AFFECTING CONSTRUCTION SUPPLY CHAIN RELATIONSHIPS

Based on the experience of projects that you had been involved in before, please rate the level of influence of the following factors to the relationship in the supply chain. The level of influence is defined as follows:

"1" = "Not impact", "2" = "Less impact", "3" = "Averagely impact", "4" = "Strongly impact", "5" = "Extremely impact"

No.	Key factors affecting construction supply chain relationships	Degree of impact				
		1	2	3	4	5
1	Problem solving/conflict resolution	☐	☐	☐	☐	☐
2	Trust (mutual trust or suspicion/mistrust)	☐	☐	☐	☐	☐
3	Goals and objectives (common or self-objectives)	☐	☐	☐	☐	☐
4	Communication (open and effective or ineffective)	☐	☐	☐	☐	☐
5	Business attitude (win-win or win-lose)	☐	☐	☐	☐	☐
6	Length of commitment (long-term or short-term)	☐	☐	☐	☐	☐
7	Risk allocation/sharing risks	☐	☐	☐	☐	☐
8	Continuous improvement	☐	☐	☐	☐	☐
9	Working relationship (teamwork or fragmentation)	☐	☐	☐	☐	☐
10	Top management support	☐	☐	☐	☐	☐
11	Learning and innovation	☐	☐	☐	☐	☐

12	Sharing resources	☐ ☐ ☐ ☐ ☐

Along with answering the above, please evaluate the result of the performance of the majority of the projects that you had been involved previously (project performance is measured based on three basic criteria including Schedule, Cost, Quality). The level of rating is defined as follows:

"1" = "Strongly disagree", "2" = "Disagree", "3" = "Neutral", "4" = "Agree", "5" = "Strongly agree"

No.	Project performance	Degree of agreement				
		1	2	3	4	5
1	The project was handed over on schedule	☐	☐	☐	☐	☐
2	The project was completed within budget	☐	☐	☐	☐	☐
3	The project quality achieved as desired	☐	☐	☐	☐	☐

D. PROFILES OF RESPONDENT

1. Please state the type of organization involved:

   ☐ Owner
   ☐ Contractor
   ☐ Designer
   ☐ Consultant
   ☐ Other, please state………………………

2. Please state your designation:

   ☐ Directorate
   ☐ Civil engineer/Architect
   ☐ Specialist
   ☐ Site engineer
   ☐ Construction manager
   ☐ Other, please state……………………

3. Please state your working experience in the construction industry:

   ☐ Under 5 years

☐ From 5 to 10 years
☐ From 10 to 15 years
☐ Above 10 years

Any inquiry/comment/suggestion, please reply to the author via email address: thanhviet61105@gmail.com

THANKS SO MUCH FOR YOUR PARTICIPATION

APPENDIX 2

QUESTIONNAIRE No.2

Assessing the Impact of Criteria to Relationships among the Parties in Construction Supply Chain

Dear Sir/Madam!

• My name is Nguyen Thanh Viet; I am a PhD. Candidate, Interdisciplinary Program in Construction Engineering and Management, Pukyong National University, Busan, South Korea. Currently, I am conducting the survey with content **"Assessing the impact of criteria to relationships among the parties in construction supply chain".**

• The research uses three main criteria and 12 sub-criteria to evaluate the relationships among the parties in the construction supply chain as described below. Based on the results of pair-wise comparison of each criterion in the questionnaire, then the research identifies the weights of each criterion to a framework for evaluating relationships among the parties in the supply chain.

Main criteria	Sub-criteria
Collaboration in the supply chain	Working relationship (teamwork or fragmentation)
	Problem solving/conflict resolution
	Trust (mutual trust or suspicion/mistrust)
	Goals and objectives (common or self-objectives)
	Communication (open and effective or ineffective)
	Sharing resources
Support and commitment to the supply chain	Top management support
	Length of commitment (long-term or short-term)
	Continuous improvement
	Learning and innovation
Sharing the benefits and risks	Risk allocation/sharing risks
	Business attitude (win-win or win-lose)

• The information provided from you will contribute greatly to the success of this research. Therefore, I look forward to receiving your interest and help. This

questionnaire will be processed in the strictest confidence and for academic purposes only.

Questions

Please assess the degree of impact of the criteria in the left over the criteria in the right when considering the degree of impact of the criteria to the relationships among the parties in the supply chain. The degree of impact is explained as follows:

Numerical rating	Definition	Explanation
1	Impact equally	A impacts equally to B
2	Impact equally to moderately	A impacts equally to moderately over B
3	Impact moderately	A impacts moderately over B
4	Impact moderately to strongly	A impacts moderately to strongly over B
5	Impact strongly	A impacts strongly over B
6	Impact strongly to very strongly	A impacts strongly to very strongly over B
7	Impact very strongly	A impacts very strongly over B
8	Impact very strongly to extremely	A impacts very strongly to extremely over B
9	Impact extremely	A impacts extremely over B

For example: If you find that *working relationship* and *trust* is **impact equally** to the relationships among the parties in the supply chain, you choose as follows:

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		
Working relationship									x										**Trust**

Or you find that *working relationship* is **impact moderately** over *trust,* you choose as follows:

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		
Working relationship											x								**Trust**

Please ensure **<u>consistency</u>** in answering the questions. Example: The solution A is more effective than the solution B, the solution B is more effective than the solution C, then the solution A must be more effective than the solution C.

Please complete the following questionnaire:

Pair-wise comparison among sub-criteria in main criterion **"Collaboration management in the supply chain"**

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Working relationship (teamwork or fragmentation)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Problem solving/conflict resolution
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Trust (mutual trust or suspicion/mistrust)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Goals and objectives (common or self-objectives)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Communication (open and effective or ineffective)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing resources
Problem solving/conflict resolution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Trust (mutual trust or suspicion/mistrust)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Goals and objectives (common or self-objectives)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Communication (open and effective or ineffective)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing resources

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Trust (mutual trust or suspicion/mistrust)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Goals and objectives (common or self-objectives)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Communication (open and effective or ineffective)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing resources
Goals and objectives (common or self-objectives)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Communication (open and effective or ineffective)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing resources
Communication (open and effective or ineffective)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing resources

Pair-wise comparison among sub-criteria in main criterion **"Support and commitment to the supply chain"**

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Top management support	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Length of commitment (long-term or short-term)
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Continuous improvement
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Learning and innovation
Length of commitment (long-term or short-term)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Continuous improvement
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Learning and innovation
Continuous improvement	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Learning and innovation

Pair-wise comparison among sub-criteria in main criterion **"Sharing the benefits and risks"**

Sub-criteria	Degree of impact																		Sub-criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		
Business attitude (win-win or win-lose)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		Risk allocation/sharing risks

Pair-wise comparison among main criteria

Main criteria	Degree of impact																	Main criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Collaboration management in the supply chain	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Support and commitment to the supply chain
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing the benefits and risks
Support and commitment to the supply chain	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sharing the benefits and risks

<u>Profiles of respondent</u>

1. Please state the type of organization involved:

   ☐ Owner
   ☐ Contractor
   ☐ Designer
   ☐ Consultant
   ☐ Other, please state ▢

2. Please state your designation:

   ☐ General manager
   ☐ Engineering manager
   ☐ Project manager
   ☐ Specialist
   ☐ Construction manager
   ☐ Other, please state ▢

3. Please state your working experience in the construction industry:

   Please state ▢

THANKS SO MUCH FOR YOUR PARTICIPATION