THREE STUDIES ON SUPPLY CHAIN INFORMATION SHARING AND COORDINATION

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THREE STUDIES ON SUPPLY CHAIN INFORMATION SHARING AND COORDINATION

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CERTIFICATE OF ORIGINALITY

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ABSTRACT

With the increasingly complex market environment and fierce market competition, many firms gain high market status through effective supply chain management (SCM). Supply chain information sharing and coordination are two important SCM practices. In this thesis, I focus on these two concepts and mainly consider customer information sharing and coordination as the core concepts for the overall framework. Extant literature still knows little about the antecedents and consequences of these two variables. Therefore, in this dissertation, I conducted three empirical studies to explore what factors drive customer information sharing and coordination and how they affect various types of firm performance.

Study 1 constructs the theoretical model from a combined perspective of both the socio-technical system view and the extended resource-based view. This study proposes that information system connectivity, as a technical resource, and relationship commitment, as a social resource, jointly lead to supply chain (SC) structured and unstructured information sharing (IS). It also considers various impacts of these two IS activities on supply chain performance (SCP). We use the structural equation modeling (SEM) method and data collected from Chinese manufacturing firms to test the conceptual model. Results show that (1) customer information system connectivity is positively related to structured and

unstructured IS, (2) customer relationship commitment is only positively related to unstructured IS, but is not significantly related to structured IS, and (3) both structured and unstructured IS are positively related to SCP. Study 2 focuses on relationships between customer information sharing, customer coordination, demand uncertainty, and SCP. Based on the framework of information processing theory, study 2 considers customer structured and unstructured IS as the antecedents of customer operational and strategic coordination and SCP as the consequence. Demand uncertainty is assumed to moderate relations between customer IS and coordination. Using data collected from 622 manufacturers in mainland China and Taiwan, the theoretical model is tested using the structural equation modeling method. We find that both customer structured IS and unstructured IS are positively associated with customer strategic coordination. Customer structured IS increases customer operational coordination, but customer unstructured IS does not. Demand uncertainty positively moderates the relations between customer unstructured IS and strategic coordination, and between customer structured IS and operational coordination. Also, demand uncertainty negatively moderates the relationship between customer structured IS and strategic coordination. Customer strategic coordination is positively related to SCP and to operational coordination. Customer operational coordination has no significant impact on SCP. The findings extend the empirical application of IPT. In addition, this study's findings direct SC managers to apply varied customer IS practices to enhance specific kinds of customer coordination activities, thereby enabling improved SCP.

Study 3 attempts to explore the antecedents of customer coordination from the organizational capability perspectives. Cross-functional team, process, and system coordination practices are deemed as antecedents of customer operational and strategic coordination, and operational performance is considered to be the consequence. The theoretical model is checked via data collected from 410 Chinese manufacturers. We found that cross-functional team coordination was positively associated with customer strategic coordination. Cross-functional process coordination increases customer operational and strategic coordination. Cross-functional system coordination directly enhances customer operational coordination. Both customer operational and strategic coordination boosts operational performance. This study deepens our understandings of supply chain coordination (SCC) concept, supplements the empirical application of organizational capability theory, and enriches extant knowledge about SCC-performance relationships. Besides, it provides practical guidance to firms on how to implement SCC to achieve better operational performance.

In general, this study contributes to the following theories, the extended resource-based view, the socio-technical system view, the information

processing theory, and the organizational capability theory. The conclusions of this thesis enable firms to better understand how to manage their supply chain information sharing and coordination issues.

Keywords: Customer structured information sharing; Customer unstructured information sharing; Customer operational coordination; Customer strategic coordination; Supply chain performance; Cross-functional system coordination; Cross-functional process coordination; Cross-functional team coordination; Operational performance; Customer information system connectivity; Customer relationship commitment; Customer demand uncertainty;

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Working papers:

Effects of customer information system connectivity and relationship commitment on customer information sharing and supply chain performance: A socio-technical systems view

The impact of cross-functional team, process and system coordination on customer operational and strategic coordination and operational performance

Table of contents

List of tables ... 14

List of figures ... 15

Chapter 1 Introduction ... 16

1.1 Research background ... 16

1.2 Research framework of this thesis ... 18

Chapter 2 Effects of customer information system connectivity and relationship commitment on customer information sharing and supply chain performance: A socio-technical systems view ... 22

2.1 Introduction ... 22

2.2 Theoretical background and research hypotheses ... 28

2.2.1 STS theory and extended RBV ... 29

2.2.2 Customer structured and unstructured IS ... 31

2.2.3 Relationships between customer IS and customer information system connectivity ... 34

2.2.4 Relationships between customer IS and customer relationship commitment ... 36

2.2.5 Relationships between customer structured and unstructured IS and SC performance ... 38

2.2.6 Interactive effects ... 40

2.3. Research methodology ... 41

2.3.1 Sampling and data collection ... 41

2.3.2 Reliability and validity ... 45

2.4. Analyses and results ... 49

2.5. Discussion ... 52

2.5.1 The role of structured and unstructured IS in improving SC performance ... 52

2.5.2 The influence of customer information system connectivity and relationship commitment on customer structured and unstructured IS ... 55

2.6. Conclusions and future research directions ... 58

Chapter 3: Information sharing, coordination and supply chain performance: The moderating effect of demand uncertainty ... 61

3.1 Introduction ... 61

3.2. Literature Review 69
3.2.1 Information processing theory 69
3.2.2 Customer operational coordination and strategic coordination 72
3.3. Research hypotheses 74
3.3.1 Relationships between customer IS and customer coordination 74
3.3.2 Relationships between customer coordination and SCP 77
3.3.3 The moderating effects of demand uncertainty 81
3.4. Methodology 83
3.4.1 Measures 83
3.4.2 Bias 85
3.4.3 Measurement model 86
3.5. Results 89
3.6. Discussion and implications 96
3.7. Conclusion and future research directions 105
Chapter 4: The impact of cross-functional team, process and system coordination on customer operational and strategic coordination and operational performance 107
4.1 Introduction 107
4.2 Theoretical background 112
4.2.1 Cross-functional coordination 112
4.2.2 Organizational capability theory 115
4.3 Theoretical hypothesis 116
4.3.1 Relationships between cross-functional coordination and customer coordination 117
4.3.2 Relationships between customer coordination and operational performance 121
4.4 Research methodology 124
4.4.1 Questionnaire development 124
4.4.2 Sampling and data collection 126
4.4.3 Reliability and validity 128
4.5 Results 131
4.6 Discussion 133
4.7 Conclusions and future research directions 140

Chapter 5 Summary of this dissertation 142

Appendix 147

References 152

LIST OF TABLES

Table 1. Summary of studies on technology and relationship antecedents of SCIS................25
Table 2. Comparisons of structured and unstructured information sharing 33
Table 3. Respondent profile 43
Table 4. EFA of supply chain performance, structured and unstructured information sharing, relationship commitment, and information system connectivity 45
Table 5. Reliability analysis 46
Table 6. Descriptive statistics...46
Table 7. Results of hypothesis testing 50
Table 8. Hierarchical regression analysis 52
Table 9. Studies on SCP antecedents...62
Table 10. Reliability analysis 87
Table 11. EFA of SCP, CSIS, and CUIS 87
Table 12. EFA of customer CSC, CDU, and COC 87
Table 13. Fit induces for the measurement model...88
Table 14. Correlational matrix 89
Table 15. Hierarchical regression test on customer strategic coordination.............................91
Table 16. Hierarchical regression test on customer operational coordination 93
Table 17. Hierarchical regression test on supply chain performance.....................................95
Table 18. Measure and reliability of major variables...125
Table 19. Company profiles...127
Table 20. Industry profile..127
Table 21. EFA results of delivery and flexibility performance...129
Table 22. EFA results of cross-functional coordination, customer coordination, and operational performance...129
Table 23. Correlational matrix 130
Table 24. Summary of results...132
Table 25. Hierarchical regression test 133

LIST OF FIGURES

Figure 1.The research framework 19
Figure 2. Conceptual model of study 1 29
Figure 3 SEM model with significant paths of study 1 50
Figure 4. Conceptual Model of study 2 83
Figure 5. Result model of study 2 90
Figure 6. The effect of SIS on StraC, as moderated by DU 92
Figure 7. The effect of UIS on StraC, as moderated by DU 93
Figure 8. The effect of SIS on OperC, as moderated by DU 94
Figure 9. Result model in production firm sample (n = 280) 100
Figure 10. Result model in consumer goods firm sample (n = 338) 100
Figure 11. Conceptual model of study 3 116
Figure 12. Estimated structural equation model of study 3 132

CHAPTER 1 INTRODUCTION

1.1 Research background

Supply chain management (SCM) refers to "the management of material and information flows both in and between facilities, such as vendors, manufacturing and assembly plants and distribution centers (Thomas and Griffin, 1996, p. 1)." As a drastic global business boosts market competition, SCM is increasingly recognized as an essential strategy (Huo et al., 2014b) for firms to survive under highly competitive environments. Firms endeavor to collaborate with their SC partners to achieve win-win situations along the entire SC (Xu et al., 2014). World-class companies, such as Hewlett-Packard, Dell, IBM, and P&G, occupy competitive positions in the market via effective SCM (Cao and Zhang, 2011). Besides, SCM has also drawn increasing attention from academicians (Grimm et al., 2015; Lee, 2015; Rebs et al., 2018; Schoenherr, 2015; Singh et al., 2018). Many aspects of SCM were explored, such as its definitions and issues (Lambert and Cooper, 2000; Mentzer et al., 2001), green and sustainable SCM (Carter and Rogers, 2008; Hervani et al., 2005; Seuring and Müller, 2008), and so on. All in all, SCM is important both academically and practically.

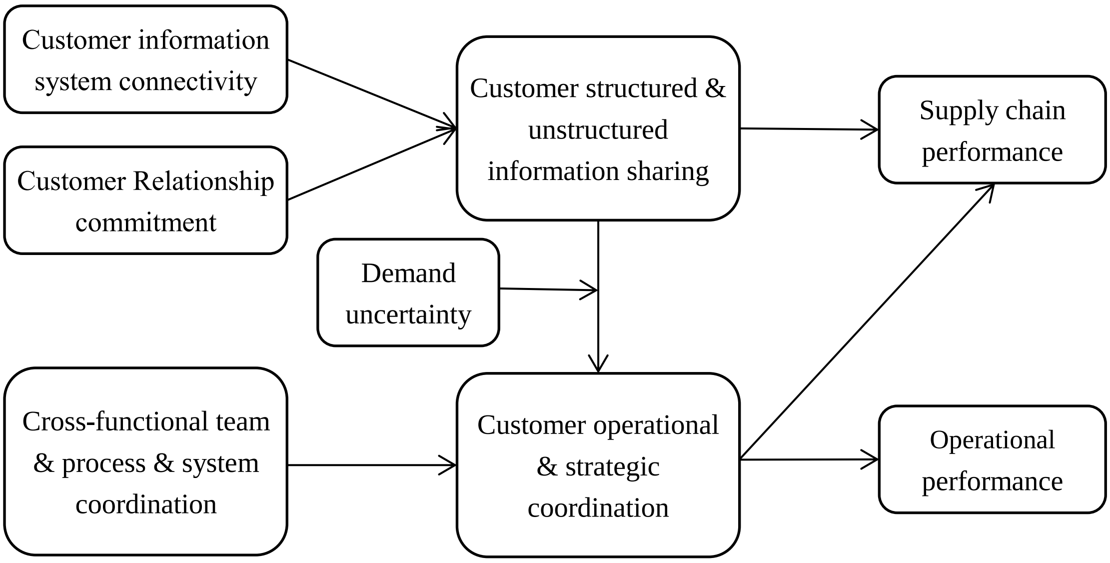
Supply chain information sharing (SCIS) is a crucial aspect of implementing SC management successfully (Ye and Wang, 2013). SCIS enables more information to be obtained across all SC members. This will lead to the enhancement of the entire system performance (Yu et al., 2001). SCIS is an effective way to cope with information asymmetry between SC upstream and downstream. The prediction of customer demands of SC members will be less accurate due to the partial information they acquired. Therefore, they tend to retain more inventory than what they actually need, leading to the famous bullwhip effect (Wu et al., 2014). SCIS enables SC members to obtain complete information on customer demands and reduces the bullwhip effect (Lee et al., 1997). Besides, it is considered to improve SC performance (Huo et al., 2014b) and promote SC practices (Zhou and Benton, 2007). SCIS is widely adopted by large companies such as Wal-Mart and Dell. Wal-Mart's widely implementation of SCIS practices allows its suppliers to share its inventory pressure. Dell shares its sale information efficiently across its SC, decreasing its stock levels (Fawcett et al., 2007). In general, SCIS serves a critical role in SCM processes. Considering the big value it created for firms, more attention should be paid to it in the academic field. This thesis sheds light on the critical concept of SCIS.

Supply chain coordination (SCC) is one of the most discussed topics in SCM literature (Ataseven and Nair, 2017) and an essential aspect of SCM (Huang et al., 2014). It refers to capacities for firms to integrate practices associated with transactions with SC members (Huo et al., 2015c). The necessity of SCC largely depends on the reality that SCs are complex and they usually include various activities which are organized by several firms. Therefore, the coordination mechanism is required which might contain "an explicit definition of processes, responsibilities and structures aligned with overall objective of whole SC to bring together multiple functions and organizations" (Arshinder et al., 2008, p. 317). Besides, the goal of the whole SC might contradict with the individual goals of different SC members to some extent (Zimmer, 2002). SCC is necessary for building a unified system of a SC (Arshinder et al., 2008). With SCC, firms can leverage internal and external SC resources and capabilities to pursue long-term benefits (Huo et al., 2014a). It also enables firms to reduce inventory costs while also ensuring customer service quality (Boyaci and Gallego, 2004). Therefore, this thesis also concentrates on SCC.

1.2 Research framework of this thesis

Based on the research background, this dissertation mainly focuses on two core concepts, SCIS and SCC. A minimum unit of a SC is composed of the supplier, manufacturer, and customer from upstream to downstream (Li et al., 2018). This thesis mainly considers the SCIS and SCC from the manufacturer and the customer perspectives. For most firms and SCs, their ultimate goals are to earn high profits by better serving their customers. Downstream SCM enables firms to establish more connections with customers, which allow firms to obtain more accurate demand information, and to achieve their final goals. Therefore, the core of our research framework sheds light on the customer side of the SCIS, including customer structured and unstructured information sharing, and SCC, including customer operational and strategic coordination. The detailed framework is depicted in Figure 1. I conducted three firm-level empirical studies to access various sections of this framework.

Figure 1.The research framework



Study 1: Effects of customer information system connectivity and relationship commitment on customer information sharing and supply chain performance: A socio-technical systems view

How do different types of SCIS practices influence supply chain performance (SCP)? How do inter-firm social and technical antecedents affect various SCIS activities? Study 1 mainly sheds light on the identification of two kinds of customer information sharing practices, customer structured and unstructured information sharing. It pinpoints their social antecedent, the customer relationship commitment, and technical antecedent, the customer information system connectivity from a combined perspective of both socio-technical system view and extended resource-based view. It hypotheses that these two resources jointly enable supply chain (SC) structured and unstructured information sharing (IS), which lead to SCP. It also considers the interactive effect of structured and unstructured information sharing and the interactive effect of relationship commitment and information system connectivity on SCP.

Study 2: Information sharing, coordination and supply chain performance: The moderating effect of demand uncertainty

Study one concentrates on the direct relationships between customer structured and unstructured information sharing and SCP. Extant literature indicates that there are mediation factors between SCIS and SCP (Chang et al., 2013; Prajogo and Olhager, 2012; Wu et al., 2014). Therefore, we further think about whether there are mediation variables between two customer information sharing practices and SCP and propose study 2. Study 2 intends to solve below research questions. How does customer structured IS and unstructured IS influence customer operational and strategic coordination? How does customer operational and strategic coordination affect SCP? This study explores the effects that customer structured and unstructured information sharing (IS) can have on customer operational and strategic coordination and on supply chain performance (SCP). In addition, the study examines how customer IS influences customer coordination under various levels of demand uncertainty. The conceptual model for this study is designed on the basis of information processing theory (IPT).

Study 3: The impact of cross-functional team, process and system coordination on customer operational and strategic coordination and operational performance

Based on two coordination activities proposed in study two, study 3 attempts to consider their antecedents from the organizational capability perspectives. Study 3 mainly solves below research questions. How do various cross-functional coordination influence customer strategic and operational coordination? How do customer strategic and operational coordination impact manufacturer’s operational performance? This study intends to investigate the relationship between cross-functional coordination, customer coordination, and operational performance. Cross-functional coordination is categorized into the cross-functional team, process, and system coordination, and customer coordination into customer operational and strategic coordination. This study builds the theoretical model via organizational capability theory.

CHAPTER 2 EFFECTS OF CUSTOMER INFORMATION SYSTEM CONNECTIVITY AND RELATIONSHIP COMMITMENT ON CUSTOMER INFORMATION SHARING AND SUPPLY CHAIN PERFORMANCE: A SOCIO-TECHNICAL SYSTEMS VIEW

2.1 Introduction

Previous studies on SCIS could be divided into the analytical, simulation, and empirical studies via research methodologies used. Analytical and simulation studies primarily concern outcomes of SCIS, such as bullwhip effect mitigation (Lee et al., 1997), SC cost decrease (Cachon and Fisher, 2000; Zhao and Xie, 2002), and inventory reduction (Lee et al., 2000). These studies mostly deem SC as a combination of series systems including production, inventory, and other physical systems using the mathematical modeling method. Human behavioral issues are less considered. However, SCIS is achieved not only through inter-firm information sharing (IS) system interfaces but also through social interactions of firms' employees. To better address human behavioral issues in SCIS, we use empirical methods and conduct a large-scale survey to investigate SCIS problems.

Some extant empirical studies regard SCIS as a holistic concept (Fu et al., 2017; Song et al., 2016; Wu et al., 2014; Zelbst et al., 2010). Some divide SCIS according to IS targets, including suppliers, customers, and internal functions (Carr and Hale, 2007; Huo et al., 2014b; Sezen, 2008). Zhou and Benton (2007) regard three facets of SCIS, SCIS technology, content, and quality. Li et al. (2014) split SCIS into SCIS content and quality. Fawcett et al. (2007) categorize IS capability into IS connectivity and willingness. Since customers are firms' primary profit sources, SCs should put customer service as a foremost goal. Essentially, SC management is towards customers (Huo et al., 2014b). In this study, we mainly focus on IS between the manufacturer and its major customer and divide it into structured and unstructured IS based on their different characteristics. Structured IS, which is conducted through information systems, is more formal, accurate, and timely. Unstructured IS which is conducted through interpersonal interactions is more informal and flexible. Compared with structured IS, unstructured IS stresses the influence of human behaviors during SCIS processes. Differentiating these two concepts enables us to understand the procedures of inter-firm information transmission better.

Regarding SCIS antecedents, two main streams exist in existing studies. The first research stream sheds light on the impact of relational factors on SCIS, such as trust (Fu et al., 2017; Li et al., 2014; Liao et al., 2011; Wu et al., 2014), commitment (Fu et al., 2017; Wu et al., 2014), relational ties (Song et al., 2016) and dependence (Fu et al., 2017). The second stream focuses on technical factors, such as RFID (Zelbst et al., 2010) and EDI use (Vijayasarathy and Robey, 1997). Only a few studies consider the joint impact of relational and technical factors on SCIS (Baihaqi and Sohal, 2013). Thus, little is known about how relational and technical factors concurrently affect SCIS (Table 1). Socio-technical systems (STS) theory contends that organizations are composed of two interdependent systems, technical and social systems (Manz and Stewart, 1997). The technical system depends on technical resources, while the social system is subject to social resources. Technical and social systems jointly work to achieve organizational goals, and firms should well coordinate these two systems to reach their joint optimization (Appelbaum, 1997). By applying STS theory to inter-organizational contexts (Kull et al., 2013), we endeavor to explore social and technical antecedents of SCIS and investigate how social and technical resources jointly influence SCIS and SC performance.

Accompanying with advancements in information technologies (ITs), IT becomes essential for effective SC management, especially for SCIS (Gunasekaran and Ngai, 2004). For example, the adoption of RFID is found to increase SCIS (Zelbst et al., 2010). Inter-firm information system connectivity enables faster, more accurate, and timely IS. Besides, information system integration can improve SC flexibility (Swafford et al., 2008) because "seamless IS among SC partners needs IT infrastructure support" (p.370) (Ye and Wang, 2013, p. 370). Practically, firms adopt inter-organizational IT systems, such as Rosetta Net-based systems, electronic data interchange (EDI), and customer relationship management information systems, to better coordinate their SCs (Huo et al., 2015c). Although IT plays a pivotal role in SCIS practices, existing studies on relationships between information system connectivity and SCIS are insufficient (Table 1). Impacts of customer information system connectivity on customer structured and unstructured IS are still unclear. Thus, we identify customer information system connectivity as the technical antecedent for customer IS.

Table 1. Summary of studies on technology and relationship antecedents of SCIS

Perspective	Studies	Dimensions of SCIS	Antecedents
Relationship	Fu et al. (2017)	IS between farmers and agri-food companies	Farmers' dependence, trust, and relationship commitment in agri-food companies.
	Song et al. (2016)	SCIS	Strong ties and bridging ties
	Wu et al. (2014)	SCIS	Trust, commitment, reciprocity, and power
	Wang et al. (2014)	The extent of IS & quality of IS	Managerial ties and trust
	Vázquez-Casielles et al. (2013)	Internal and external strategic IS	Governance in manufacturer-distributor relationships
	Liao et al. (2011)	IS between manufacturer and supplier	Mutual trust
	Li et al. (2014)	IS quality and content	Social interaction, trust, shared vision
	Cheng et al. (2013)	IS with partners	Relational benefits and risk
	Cheng (2011)	IS with partners	Connectedness and dysfunctional conflict
Technology	Zelbst et al. (2010)	SCIS	RFID
	Vijayasarathy and Robey (1997)	Channel information intensity, formalization, and quality	EDI use
Combined	Baihaqi and Sohal	IS intensity	Integrated information

(2013)		technologies & cost and benefits sharing

Social-technical system theory indicates that both inter-firm technical and relational resources are essential to boost customer IS. SCIS is established not only via inter-firm technology linkages but also through inter-firm relational ties. Manufacturers' and customers' mutual trust and commitment to relationships between them would set customer IS on a more certain foundation. Relationship commitment reflects firms' willingness to invest maximum efforts to maintain the relationship (Morgan and Hunt, 1994). Many studies found positive relations between relationship commitment and SCIS. For example, Fu et al. (2017) found that farmers' relationship commitment to agri-food companies increased farmers' IS with agri-food companies. Wu et al. (2014) found that commitment improved SCIS. Although existing studies have reached a consensus that relationship commitment improves SCIS (Fu et al., 2017; Wu et al., 2014), various effects of customer relationship commitment on customer structured and unstructured IS are unexplored. Therefore, customer relationship commitment is recognized as a relational antecedent for customer IS in this study.

The resource-based view (RBV), which is internally focused, attributes firms' sustainable competitive advantages to their proprietary resources that are rare, valuable, unique, and non-substitutable (Barney, 1991).

However, in a SC setting, resources are not necessarily embedded within firms' boundaries but are also obtained from their external SC partners via boundary-spanning activities. RBV cannot appropriately describe and explain the effects of resources and capabilities outside of firms' boundaries on firms' competitive advantages and performance. To rectify this shortcoming of RBV, extended RBV is introduced and claims that external resources could be nourished by internal resources, finally leading to the enhancement of competitive advantages and the achievement of superior firm performance (Lai et al., 2012). Incorporating STS theory with extended RBV, this study aims to explore a more holistic and balanced view of the benefits of customer IS and its enablers.

Specifically, this study mainly addresses three research questions. First, how does customer information system connectivity influence customer structured and unstructured IS? Second, how does customer relationship commitment influence customer structured and unstructured IS? Third, how do customer structured and unstructured IS affect SC performance? This study contributes to SCIS literature by differentiating customer structured and unstructured IS and providing empirical evidence of how social and technical resources jointly influence various customer IS activities, which in turn improve SC performance. This study also enriches empirical studies on both STS theory and extended RBV.

The remainder of this chapter is organized as follows. We first review the related literature on this topic, describe the theoretical background and propose research hypotheses. Next, we illustrate our research methodology and data analysis procedures, present data analysis results and draw conclusions. Finally, we make discussions about our contributions and implications in theoretical and managerial aspects, present research limitations, and indicate future research directions.

2.2 Theoretical background and research hypotheses

Based on the combined perspective of STS theory and extended RBV, we construct a conceptual model to examine relationships among customer information system connectivity, customer relationship commitment, customer structured and unstructured IS and SC performance. We control the firm size variable because big firms may have richer resources to generate better SC performance (Huo et al., 2015c). We also control the industry variable since the SCP levels may vary across different industries. The research model is shown in Figure 2.

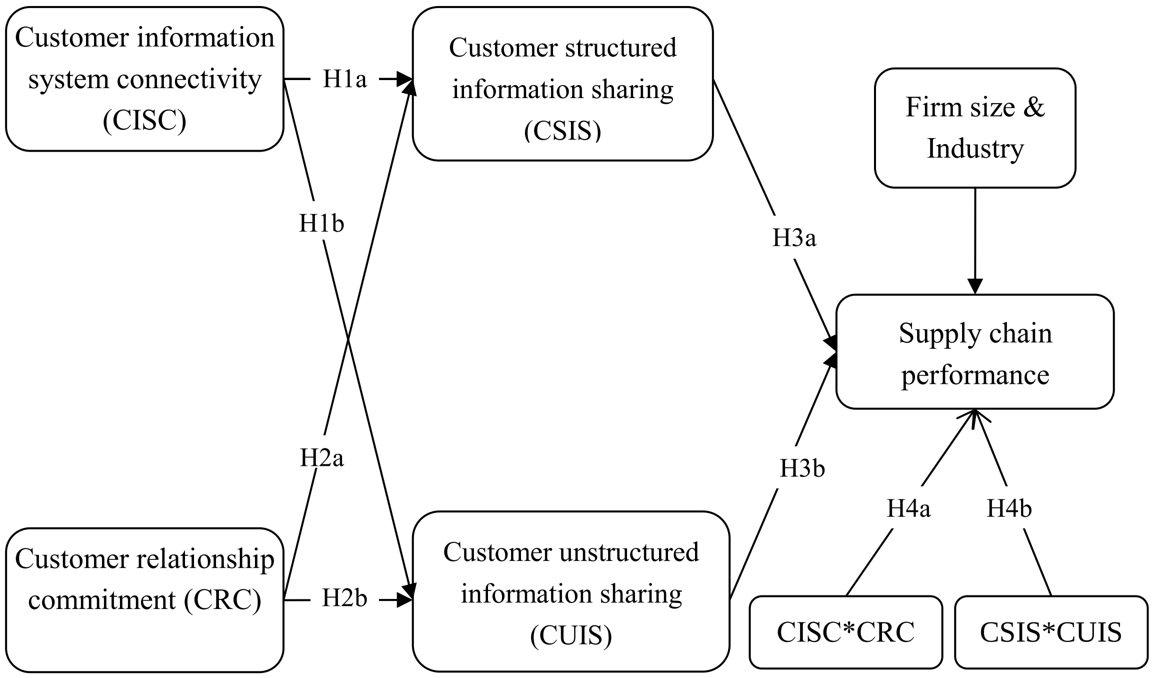


Figure 2. Conceptual model of study 1

2.2.1 STS theory and extended RBV

STS theory, articulated by Trist and Bamforth (1951) primitively, proposes that each organization consists of two independent but linked systems, social and technical systems (Frohlich and Dixon, 1999; Manz and Stewart, 1997). The technical system which transfers inputs into outputs contains “materials, machines, territory, and processes” (Fox, 1995, p. 93). The social system is made up of people and relationships (Ketchum and Trist, 1992). The basic tenet of STS theory is that the joint optimization of social and technical systems could best achieve organizational goals (Liu et al., 2006). Either optimization of these two systems is less desirable (Manz and Stewart, 1997). In addition to intra-organizational context, STS can also be applied in inter-organizational conditions (Huo et al., 2015c). An SC is a type of complex organizational system (Chandra and Grabis, 2007) consisting of both social and technical linkages. Following the basic lens of STS theory, this study, conducted under the SC setting, considers customer relationship commitment as an SC social linkage, and customer information system connectivity as an SC technical linkage, simultaneously, in our conceptual model.

RBV asserts that heterogeneous and imperfectly mobile resources that firms own bring them competitive advantages (Barney, 1991). However, this assumption ignores another potential source for firms' competitive advantages, resources and capabilities from firms' external partners (Park et al., 2017). Incorporating social network theory, relational view with RBV, Lavie (2006) developed extended RBV and applied it in the context of alliance networks. Instead of stressing resources and capabilities that firms own, extended RBV focuses on resource accessibility which is "the right to employ resources or enjoy their associated benefits" and proposes that it generates competitive advantages (p.165) (Cao and Zhang, 2011, p. 165). Inter-organizational relationships are emphasized as channels to obtain external resources and capabilities (Squire et al., 2009). In this study, inter-firm relationships between manufacturers and customers include customer information system connectivity and relationship commitment. Based on extended RBV, we regard customer information system connectivity and relationship commitment as two kinds of boundary spanning resources which facilitate customer structured and unstructured IS and SC performance. Customer structured and unstructured IS are considered as basic capabilities to coordinate information flow between manufacturers and customers (Fawcett et al., 2007; Shore and Venkatachalam, 2003), bringing firms with superior SC performance.

2.2.2 Customer structured and unstructured IS

SCIS is about the extent of communicating crucial and proprietary information with SC partners (Monczka et al., 1998). IS among SC partners has been a major focus of many studies (Huo et al., 2014b; Zhou and Benton, 2007). The practice of IS is widely viewed as one of the five main foundations for establishing stable relationships among SC partners (Lalonde, 1998). It could be divided into internal, supplier, and customer IS (Huo et al., 2014b). This study only pays attention to customer IS. Customer IS reflects the degree to which vital and proprietary information is communicated between manufacturers and their customers (Hsu et al., 2008). With improved customer IS, customer demand information can be better transferred and understood by the other SC firms, thus accelerating their response to changes in market demand (Huo et al., 2014b; Li and Lin, 2006). More accurate customer demand information enables SC firms to reduce their inventory costs (Sezen, 2008).

Various researchers have investigated SCIS via subdividing it into different types of activities. For instance, Du et al. (2012) identified two types of IS among SC partners, namely template-based IS (which operates according to a predefined contract) and proactive IS (which is voluntary and can be beneficial to others beyond the contracted parties). Fawcett et al. (2007) considered SCIS in terms of connectivity and willingness. To the best of our knowledge, however, previous studies have failed to differentiate among types of SCIS according to the different types of information shared. Besides, technical characteristics of SCIS are more emphasized in the extant literature (Fawcett et al., 2007). SCIS is not only a process conducted through technical systems but also via social interactions. In this study, we consider both the technical and social facets of SCIS and compare their different characteristics.

We classify customer IS into structured and unstructured IS. These two kinds of customer IS practices differ mainly in terms of the media and the content involved (Table 2). Regarding the IS content, customer structured IS is mainly used to convey information that is easy to codify and structure, such as inventory information. Customer-related unstructured IS usually involves highly variable messages such as customer feedback information, which is more complicated and challenging to codify. In addition, the content shared is inevitably related to the media through which it is shared. Structured information can be easily codified and transferred via computer-based information management systems. Customer structured IS generally requires a formal enterprise information management system to serve as the IS medium. Unstructured information, however, is complex and vague. It is most suitable for being conveyed by direct communication between people. Therefore, unstructured IS is mainly conducted through inter-firm social interactions, such as face-to-face communications between managers. The activities of customer structured IS can typically be handled by establishing ERP (enterprise resource planning) systems between firms and their customers, which allow them to share practical information on orders, inventory, production plans, or other kinds of standardized information. One of the most typical kinds of unstructured IS activity involves giving customers follow-up calls regarding purchased products and services.

Table 2. Comparisons of structured and unstructured information sharing

	Structured information sharing	Unstructured information sharing
Information sharing media	Mostly through enterprise information management systems, such as ERP and EDI.	Through inter-firm social interactions
Characteristics of shared information	Easy to be codified, highly structured and formal	Difficult to be codified, unstructured and informal

Both types of inter-firm IS activities have pros and cons and are widely used in practices. Structured IS is more accurate and timely but less flexible. In contrast, unstructured IS is more flexible but less accurate and timely. The former is appropriate to be applied in routine activities, while the latter is suitable to support complex issues. These two IS activities could supplement each others' roles in alleviating information asymmetry between manufacturers and customers.

2.2.3 Relationships between customer IS and customer information system connectivity

Customer information system connectivity is the construction of inter-firm computer-to-computer linkages, such as EDI, EPR, RFID, between manufacturers and customers. It is a type of information system utilization in the SC. Via applying information systems in SCs, firms could coordinate analogous functions and diminish redundant practices, promoting their abilities to fulfill customers' demands (Narasimhan and Kim, 2001). Customer information system connectivity could benefit SCIS in many ways. First, it enables more accurate and timely SCIS (Carr and Hale, 2007). Second, the utilization of various information transmission technologies enlarges information pools about firms' business activities (Bhatt, 2000).

Results of many empirical studies could support positive relationships between customer information system connectivity and SCIS. For instance, Huo et al. (2016b) found that IS systems increased information content. Ye and Wang (2013) found that IT alignment was positively related to IS. Vijayasarathy and Robey (1997) found that EDI use facilitated channel information intensity. Zelbst et al. (2010) found that

RFID increased SCIS.

Based on the extended RBV and STS theory, customer information system connectivity is a kind of technical resource embedded in customer-manufacturer relationships. Establishing inter-firm IT systems requires vast efforts devoted by both manufacturers and customers. Therefore, it could not be easily imitated by competitors. Once established, it will benefit both parties a lot. Thus it satisfies requirements for strategic resources which could generate competitive advantages (Barney, 1991). Firms' IT resources could bring them IT capabilities (Bharadwaj, 2000). Since inter-firm IT system integration constructs a platform to barter information of great value among business partners (Huo et al., 2013), information system connectivity with customers is the pre-condition to nurture IS capabilities with customers. Therefore, well-established information system linkages between manufacturer and customer are beneficial for structural IS, which usually processes information captured and stored in enterprise information systems. On the other hand, although unstructured IS does not necessarily rely on enterprise information system linkages, connected information systems still provide a reservoir for this type of IS. Additionally, the adoption of inter-firm IT enables easier inter-firm communication (Carr and Smeltzer, 2002). Therefore, we propose that:

H1a. Customer information system connectivity is positively related to *customer structured IS.*

H1b. Customer information system connectivity is positively related to customer unstructured IS.

2.2.4 Relationships between customer IS and customer relationship commitment

Based on the STS theory, SCIS should not only rely on technical resources represented by customer information system connectivity, but also depend on social resources, such as customer relationship commitment. Customer relationship commitment embodies the inclination of firms to retain relationships with customers via investing resources in financial, physical, or relational facets (Morgan and Hunt, 1994; Zhao et al., 2008; Zhao et al., 2011). Whether a firm will maintain a good relation with its SC partner depends not only on whether they can, but also on whether they want. Relationship commitment enhances SC members' confidence regarding future SC relationships, facilitating their motivation to maintain good relationships with each other (Zhao et al., 2011). Relationship commitment enables the achievement of the greatest value of inter-firm cooperation (Wu and Cavusgil, 2006). Because of it, SC partners could be connected more intrinsically to overall SC objectives and voluntarily share information with each other (Chen and Paulraj, 2004a; Zhao et al., 2011). Based on the extended RBV, it is a kind of strategic inter-firm relational resource which could facilitate SCIS.

Many empirical studies could support this viewpoint. For example, Fu et al. (2017) found that farmers' relationship commitment to agri-food companies was positively associated with IS between them. Wu et al. (2014) found that commitment of SC partners increased SCIS. Arnold et al. (2010) found that commitment increased IS.

Based on Morgan and Hunt (1994), relationship commitment could facilitate inter-firm cooperation between trading partners. Huo et al. (2015c) also found that customer relationship commitment was positively related to customer coordination. Thus, with higher levels of inter-firm relationship commitment, firms have higher possibilities to build cooperative relationships with each other, generating more inter-firm social interactions. Unstructured IS is conducted through inter-firm social interactions. Therefore, more frequent social interactions between manufacturers and customers establish foundations for the greater extent of customer unstructured IS. Structured IS requires investment in building specialized inter-firm IS systems. With higher levels of customer relationship commitment, both manufacturers and customers are willing to devote more to maintain their relationships and behave less opportunistically (Wu and Cavusgil, 2006). Thus, barriers to establishing inter-firm IT systems will be removed, and structured IS will be naturally increased. Therefore, we propose that:

H2a. Customer relationship commitment is positively related to customer *structured IS.*

H2b. Customer relationship commitment is positively related to customer unstructured IS.

2.2.5 Relationships between customer structured and unstructured IS and SC performance

"SC performance refers to operational performance of the whole SC, including the focal company and its major SC partners." (Huo et al., 2014b, p. 556). Regarding SCP measures, various studies have different viewpoints. For example, Beamon (1999) considers resource, output, and flexibility as three types necessary SCP measures. Seo et al. (2014) and Panayides and Lun (2009) prefer to measure the overall conditions of supply chain operations. Chang et al. (2013) takes into account of the tangible and intangible aspects of SCP. In this study, we shed light on the operational facet of the SCP which is in accordance with Huo et al. (2014b).

Based on the extended RBV, SCIS is firms' capacity to manage SC information flow. It enables SCs to resist uncertainties and risks, helps to understand demands for SC members and thus leads to better SC performance (Huo et al., 2014b). Both analytical (Cachon and Fisher, 2000; Chen, 1998; Lee et al., 2000) and simulation studies (Zhao and Xie, 2002) found important roles that SCIS played in facilitating SC performance. Many empirical studies also found that SCIS improved SC performance, such as Wu et al. (2014), Zelbst et al. (2010) and Huo et al. (2014b).

Customer structured and unstructured IS represents the technical and social aspects of SCIS, respectively. Customer structured IS, mostly conducted via inter-firm IT systems, enables standardized, routine, and mostly operational information exchange between manufacturers and customers. With it, customer demand information could be transferred to manufacturers on a real-time basis, improving delivery performance (Bourland et al., 1996). Customer unstructured IS, relying on inter-firm social interactions, could be flexibly employed in more complex conditions to transfer information which is difficult to be codified by traditional IT systems. It required less initial investments. Thus, it is efficient in conveying information of lower volume. Paulraj et al. (2008) deemed inter-organizational communication as a relational competitive advantage which could arise inter-firm learning, cultivate awareness of the success of the whole SC and nurture confidence in maintaining SC relationships, which led to both buyer and supplier performance. These two kinds of IS activities could complement each other in facilitating SC information transmission processes and in increasing SC information transparency. Therefore, we propose that:

H3a. Customer structured IS is positively related to SC performance.

H3b. Customer unstructured IS is positively related to SC performance.

2.2.6 Interactive effects

Based on STS theory, to better attain organizational goals, firms should strive to achieve the joint optimization of organizational social and technical systems (Liu et al., 2006). In this study, we selected customer relationship commitment and information system connectivity to represent social and technical aspects of inter-firm relationship management, respectively. Customer relationship commitment enables more stable relationships between manufacturers and customers and reduces uncertainties (Fynes et al., 2005). With it, both the manufacturer and the customer are more willing to cooperate to achieve better SC performance. Customer information system connectivity builds IT linkages between manufacturers and customers. It sets the foundation for SCIS, which could further improve SC performance (Huo et al., 2014b). Based on the STS theory, the joint optimization of these two concepts could lead to superior SC performance. With relationship commitment, opportunism behaviors among SCIS procedures will be largely hindered. Thus, the value of customer information system on SC performance could be better achieved. With customer information system, a larger amount of information will be fully exchanged between manufacturers and customers, which can leverage specific investments of relationship commitment to enhance SC performance. Therefore, these two constructs could function interactively to improve SC performance. Structured and unstructured IS represents technical and social facets of customer IS, respectively. Structured IS could remedy defects of unstructured IS via more timely and accurate inter-firm IS in enhancing SC performance. Unstructured IS can flexibly supplement structured IS in improving SC performance. Based on STS theory, the joint optimization of them will lead to better SC performance. Therefore, we propose that:

H4a. The interaction of customer relationship commitment and customer information system connectivity is positively related to SC performance

H4b. The interaction of customer structured and unstructured IS is positively related to SC performance.

2.3. Research methodology

2.3.1 Sampling and data collection

Our sample pool was the set of all manufacturers in China. The Chinese cities where these firms are located are distributed among diverse regions, which display differing levels of economic development (Zhao et al., 2006). We selected four representative cities in mainland China, namely Tianjin, Chongqing, Shanghai, and Guangzhou, as the sites to collect our data, as these four cities represent the range of diversity among mainland Chinese cities. Chongqing, a transportation hub in southwest China, represents Chinese cities at an early stage of economic development. Tianjin, near the coast of the Bohai Sea, has a middle-ranking economy among mainland cities. Guangzhou and Shanghai, China's critical first-tier cities, have highly developed economies and markets. Taiwan, located in Southeast Asia, supplements the sample with its specific economic and geographical traits.

We randomly choosed firms from the Yellow Pages of China Telecom in the above-mentioned four Chinese mainland cities, and from the directory of the Manufacturers Association in Taiwan. For each chosen firm, a key informant who was knowledgeable about that firms' SC management was identified. We phoned each of the key informants to check whether they agreed to participate in our investigation, and obtained their exact addresses. Two indicators were applied to ensure that these informants had sufficient knowledge of their firms' SCM issues and would be suitable for answering our questionnaire. First, these key informants had to occupy positions that were related to SCM, such as being a logistics manager, factory manager, chairman, or a purchasing manager. Second, these informants needed to have at least three years of relevant work experience. We accepted a few informants with less experience, but 84.7% of our key informants met this requirement. These informants' rich work experience and SCM-related job positions enabled them to answer our questions on behalf of their companies.

Next, we mailed questionnaires to the informants, with return-postage-paid envelopes and cover letters explaining the aims and the importance of our study. We asked the informants to complete the questionnaires and mail them back to us. We also made follow-up calls in an effort to reduce missing values and enhance the response rate (Frohlich, 2002). A total of 2,878 questionnaires were distributed in the mainland cities, and 410 of them were returned. Around 2,000 questionnaires were sent out in Taiwan, and 212 of them were mailed back. The response rate was 14.2% in mainland China, and 10.6% in Taiwan. The profiles of our respondents are displayed in Table 3. Our respondents were distributed in a wide range of industries, and represented firms of various sizes. Thus, they were a diverse sample, representing the various types of Chinese manufacturers.

Table 3. Respondent profile

Industry	**Total (N = 622)**	**Employees**	**Total (N = 622)**
Art and crafts	4 (0.6%)	< 50	235 (37.8%)
Building materials	33 (5.3)	50 to 99	111 (17.8)
Chemicals and petrochemicals	53 (8.5)	100 to 199	101 (16.2)
Electronics and electrical	125 (20.1)	200 to 499	79 (12.7)
Food, beverages, alcohol, and cigars	20 (3.2)	500 to 999	36 (5.8)
Jewelry	1 (0.2)	1,000 to 4,999	33 (5.3)
Metals, mechanical, and engineering	193 (31.0)	5,000 or more	27 (4.3)
Pharmaceutical and medical	15 (2.4)	**Sales (RMB)**	**Total (N = 622)**
Publishing and printing	24 (3.9)	< 5 m	202 (32.5%)
Rubber and plastics	54 (8.7)	5 m to < 10 m	89 (14.3)
Textiles and apparel	40 (6.4)	10 m to < 20 m	67 (10.8)
Toys	4 (0.6)	20 m to < 50 m	74 (11.9)
Wood and furniture	21 (3.4)	50 m to < 100 m	59 (9.5)
Other	35 (5.6)	100 m or more	131 (21.1)

The early and late responses of some major constructs (including customer information system connectivity, customer relationship commitment, and unstructured IS) were compared using t-tests to check for late response bias (Armstrong and Overton, 1977). The t-statistic results were not significant at the 0.05 level, indicating that the late response bias was not a big concern.

Since all questions in one questionnaire were answered by a single informant, we tested the potential common method bias. Harman's single factor test (Podsakoff et al., 2003; Podsakoff and Organ, 1986) revealed five distinct factors with eigenvalues above or near to 1.0, explaining 70.4% of the total variance. The first factor explained 33.0%, which was not the majority of the total explained variance. We also used confirmatory factor analysis (CFA) to assess Harman's single-factor model (Sanchez and Brock, 1996). The fit indices of the one-factor model were χ^2 (152) = 3293.84, CFI = 0.61, RMSEA = 0.22, NNFI = 0.56, and SRMR = 0.15, implying that the single-factor model was not acceptable (Hu and Bentler, 1999). Besides, we also compared below two models, the first one contains only major variables in this study, and the second one comprises the major variables and a method factor (Paulraj, Lado, & Chen, 2008; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In comparison with the first model, the second one's fit indices were improved slightly (CFI by 0.02, NNFI by 0.01, RMSEA by -0.014, SRMR by -0.024). This result suggests that this method factor only explains a small variance (Paulraj et al., 2008). Therefore, common method bias was not a trouble in this study.

2.3.2 Reliability and validity

2.3.2.1 Unidimensionality and reliability

A two-step method was followed to assess the reliability of our constructs (Narasimhan and Jayaram, 1998). First, we performed exploratory factor analysis (EFA) to confirm the unidimensionality of our constructs. Second, Cronbach's alpha for every construct was computed to certify construct reliability. We used the principal components extraction method and the Varimax with Kaiser Normalization to perform EFA (Table 4). Results showed that all items had higher loadings on constructs they measured and lower loadings on constructs they were not supposed to measure, revealing unidimensionality of constructs. Cronbach's alpha values for all constructs (Table 5) were above the recommended threshold of 0.70 (Hair et al., 1998). The corrected item-total correlation (CITC) of each construct was greater than 0.30, the minimum acceptable criterion. Therefore, our constructs were reliable. Correlations, means and standard deviation of constructs were presented in Table 6.

Table 4. EFA of supply chain performance, structured and unstructured information sharing, relationship commitment, and information system connectivity

	Factor Loadings				
	Supply chain performance	Structured information sharing	Relationship commitment	Unstructured information sharing	Information system connectivity
SCP3	**.832**	.090	.056	-.025	.024

SCP4	**.826**	.097	.056	-.137	.113
SCP6	**.768**	.078	.071	.221	-.059
SCP5	**.753**	.047	.085	.149	.084
SCP2	**.656**	.192	.192	.015	.032
SCP1	**.645**	.066	.074	.150	.109
CSIS3	.105	**.846**	.002	.068	.237
CSIS4	.191	**.841**	.079	.026	.142
CSIS2	.130	**.798**	.066	.283	.114
CSIS1	.083	**.723**	-.023	.354	.184
CRC2	.112	.060	**.861**	.174	.084
CRC1	.097	.037	**.861**	.168	.036
CRC3	.194	-.003	**.819**	.136	.040
CUIS2	.076	.230	.166	**.778**	.274
CUIS3	.079	.229	.308	**.733**	.060
CUIS1	.134	.150	.205	**.679**	.385
CIS2	.063	.233	.035	.159	**.875**
CIS1	.043	.205	.075	.204	**.850**
CIS3	.244	.311	.078	.385	**.534**
Eigenvalue	3.604	2.973	2.402	2.219	2.172
Total variance explained			70.370%		

Table 5. Reliability analysis

Construct	Item number	Cronbach's alpha	CITC
Customer relationship commitment	3	0.849	0.679-0.742
Customer information system connectivity	3	0.815	0.546-0.762
Customer structured information sharing	4	0.874	0.685-0.757
Customer unstructured information sharing	3	0.807	0.623-0.714
Supply chain performance	6	0.857	0.548-0.728

Table 6. Descriptive statistics

	CRC	ISC	SIS	UIS	SCP
Customer relationship commitment (CRC)	0.81^{a}				
Customer information system connectivity (ISC)	0.21**	0.79^{a}			
Customer structured information sharing (SIS)	0.15**	0.53**	0.80^{a}		
Customer unstructured information sharing (UIS)	0.45**	0.58**	0.48**	0.77^{a}	
Supply chain performance (SCP)	0.29**	0.25**	0.30**	0.26**	0.71^{a}

Mean	6.21	4.66	4.11	5.30	5.25
Standard deviation	0.729	1.360	1.298	1.124	0.847

$p^{**}<0.01$; Square root of AVE[a]

2.3.2.2 Construct validity

Construct validity describes the extent that measures can accurately reflect the theoretical concept, containing content, discriminant,and convergent validity (Carmines and Zeller, 1979). To certify content validity, we comprehensively reviewed related literature and adapted extant measures for customer structured (Wang et al., 2014; Zhou and Benton, 2007), and unstructured IS (Narasimhan and Kim, 2002). Structured IS measured the extent of sharing easy to be codified and highly structured information, such as inventory availability, production plan, and POS information. Unstructured IS stresses inter-firm social interactions and communication. Customer information system connectivity (Narasimhan and Kim, 2002), customer relationship commitment (Morgan and Hunt, 1994), and SC performance (Huo et al., 2015c) were also adapted from extant measures. The questionnaire was first generated in English and then translated into Chinese by an operations management researcher. Then, it was back-translated into English by another operations management researcher to check for consistency against the first version. We did the pilot test and revised our questionnaire based on feedback from some experienced managers to ensure the understandability of our scales. Thus, the content validity of our scale could be further confirmed. We used the 7-point Likert scale to measure our constructs, where higher values represented the greater extent of information system connectivity, relationship commitment, IS, and better SC performance. Firm size was reflected by the number of firms' employees. As for the industry, we formulated three dummies to seize the industry effect, the metals, mechanical, and engineering industry, the electronics and electrocal industry, and the rubber and plastics industry. Other industries in our sample were categorized into the baseline group. Detailed scales are presented in Appendix.

CFA was performed to examine discriminant and convergent validity (O'Leary-Kelly and Vokurka, 1998). For convergent validity, we connected every measure to its corresponding construct and freely estimated the covariance among various constructs. Fit indices of the CFA model were $\chi^2(142) = 645.33$, RMSEA = 0.076, CFI = 0.96, NNFI = 0.95, and SRMR = 0.062, which were acceptable based on the recommended criterion of (Hu and Bentler, 1999). Factor loadings of all items were above 0.50, all *t*-values were higher than 2.0, suggesting convergent validity of constructs (Chau, 1997). As for discriminant validity, we calculated the square roots of the average variance extracted (AVE) of each construct and compared them with the values of the inter-construct correlation. Results in Table 6 confirmed the discriminant validity of our scales.

2.4. Analyses and results

We adopted the structural equation modeling (SEM) method to check our hypotheses using LISREL 8.80 software. Results with significant path coefficients were presented in Figure 3. Fit indices of the SEM model were χ^2 (209) = 792.10, CFI = 0.95, RMSEA = 0.069, NNFI = 0.94, and SRMR = 0.062. These indices exceeded threshold values suggested by (Hu and Bentler, 1999), denoting that our model was acceptable. Our SEM results show that customer information system connectivity is positively related to customer structured and unstructured IS. Customer relationship commitment is positively related to customer unstructured IS and has no significant impact on customer structured IS. Both customer structured and unstructured IS are positively associated with SC performance. Besides, the impact of electronics and electrical industry on the supply chain performance is significantly negative (Table 7).

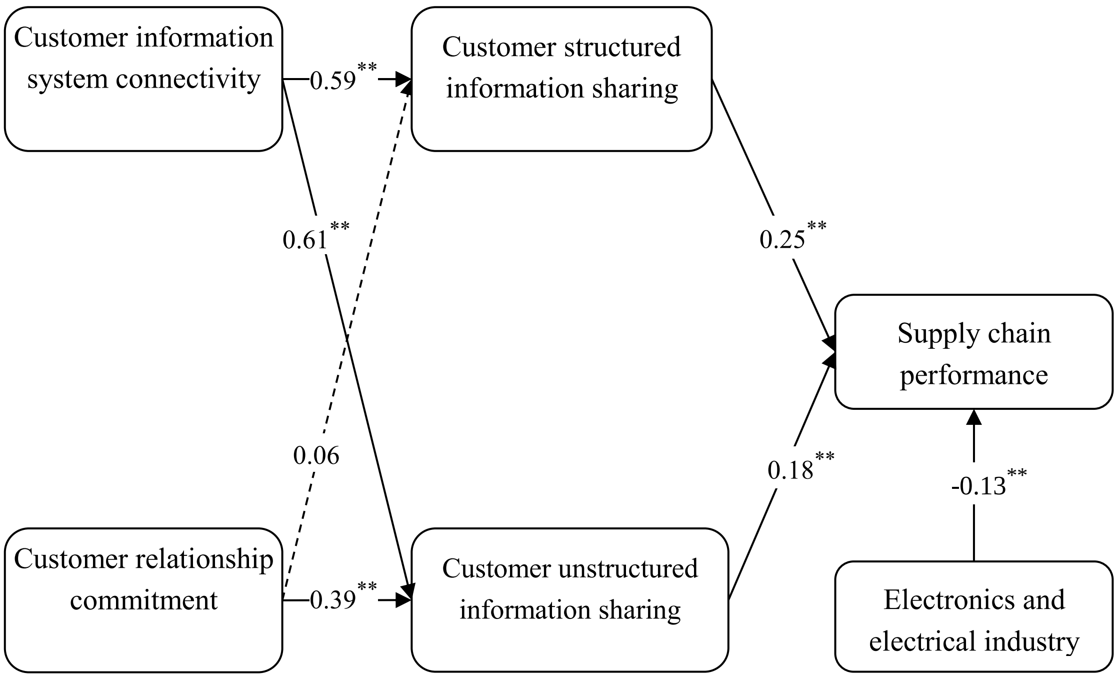


Figure 3 SEM model with significant paths of study 1
$^{**}p<0.01$, the insignificant relationship is indicated by the dashed line.

Table 7. Results of hypothesis testing

Hypothesis	Path coefficient (t-value)	Outcome
Information system connectivity → structured information sharing	0.59^{**} (12.18)	Supported
Information system connectivity →unstructured information sharing	0.61^{**} (13.35)	Supported
CRC→ structured information sharing	0.06 (1.47)	Rejected
CRC→unstructured information sharing	0.39^{**} (9.61)	Supported
Structured information sharing → SCP	0.25^{**} (4.80)	Supported
Unstructured information sharing → SCP	0.18^{**} (3.35)	Supported

$^{**}p<0.01$

Furthermore, we tested whether structured and unstructured IS mediated relationships between information system connectivity, relationship commitment, and SC performance. First, we confirmed that three preconditions of mediation effects were satisfied (Baron and Kenny, 1986). (1) Independent variables (IVs) (relationship commitment and information system connectivity) influenced the dependent variable (DV) (SC performance; t= 7.40, 6.51, respectively), (2) IVs (relationship commitment and information system connectivity) influenced mediating variables (MVs) (structured and unstructured IS; t=3.67, 15.51, 12.39, 17.80, respectively), (3) MVs (structured and unstructured IS) influenced the DV (SC performance; t=7.78, 6.66, respectively). Then, the Sobel test was adopted to check whether MVs carried the impact of IVs to the DV (Huo et al., 2015c). Three mediation effects were proved to be significant at the 0.01 level, including the mediation effect of unstructured IS between relationship commitment and SC performance (Sobel z=3.70, p<0.01), the mediation effect of structured IS between information system connectivity and SC performance (Sobel z=4.87, p<0.01), and the mediation effect of unstructured IS between information system connectivity and SC performance (Sobel z=3.46, p<0.01).

Finally, we conducted hierarchical linear regression analysis to test whether interactions of structured and unstructured IS and of relationship commitment and information system connectivity affect SC performance. Results were presented in Table 8, showing that the interactive effect of information system connectivity and relationship commitment on SC performance was negatively significant. Thus, H4a is rejected. However, the interactive effect of structured and unstructured IS was positively significant, supporting H4b.

Table 8. Hierarchical regression analysis

Independent variable	Dependent variable: supply chain performance		
	Model 1	Model 2	Model 3
Constant	**5.20**(0.074)	**5.32**(0.069)	**5.31**(0.070)
Firm size	0.03(0.020)	-0.01(0.019)	-0.01(0.019)
Metal, mechanical, and engineering industry	0.03(0.081)	0.00(0.075)	0.01(0.074)
Electronics and electrical industry	-0.12(0.094)	**-0.23**(0.088)	**-0.23**(0.087)
Rubber and plastics industry	-0.05(0.128)	-0.11(0.118)	-0.13(0.118)
Customer structured information sharing (SIS)		**0.15**(0.030)	**0.14** (0.030)
Customer unstructured information sharing (UIS)		-0.00(0.039)	0.01(0.040)
Customer relationship commitment (CRC)		**0.28**(0.049)	**0.23** (0.051)
Customer information system connectivity (ISC)		**0.06**(0.030)	**0.08** (0.031)
SIS*UIS			**0.04** (0.020)
ISC*CRC			**-0.09**(0.037)
R^2	0.006	0.166	0.176
Change in R^2	0.006	0.160	0.010
F	0.954	15.263	13.085
Change in F	0.954	29.398	3.813
p-value	0.433	0.000	0.000

The standard error for each unstandardized parameter estimate are listed in parentheses
Significant parameter estimates at the 0.05 level are in bold

2.5. Discussion

2.5.1 The role of structured and unstructured IS in improving SC performance

Our findings indicate that both customer structured and unstructured IS activities are positively related to SC performance. These conclusions are in accordance with previous findings that SCIS enhanced SC performance (Huo et al., 2014b; Wu et al., 2014; Zelbst et al., 2010). Specifically, we pay attention to IS activities in downstream SCs, the customer side IS. With customer IS, manufacturers could get rich knowledge of customer demands, allowing better customer-oriented SC management (Huo et al., 2014b). To advance and deepen extant understandings of SCIS, we identify two types of IS practices based on their different attributes, structured and unstructured IS. Customer structured IS heavily relies on inter-firm information system linkages and processes to share highly structured explicit information. It is a technology-based IS activity, which is more underlined by extant studies (Fawcett et al., 2007). For example, previous studies on SCIS (Li et al., 2014; Wang et al., 2014; Wu et al., 2014; Zhou and Benton, 2007) mainly focused on sharing transaction-based operational information, such as POS, demand forecast, inventory status, and production plan information. This type of information is usually highly organized, easy to be codified and explicit, indicating that it is suitable to be stored and transferred via enterprise information management systems, such as ERP and EDI. Customer structured IS enables timely and accurate information exchange between manufacturers and customers. With it, manufacturers can obtain real-time customer demand information, leading to superior SC performance. However, the implementation of customer structured IS requires huge initial investments in building inter-firm IT platforms. Thus, it is more appropriate to transfer information of large volume to offset high costs.

In addition to structured IS, another type of IS activity is also common in practice but is less considered by academicians, unstructured IS. It mainly shares information which is difficult to be codified, implicit, unstructured, and informal, indicating that it is inappropriate to be shared automatically by inter-firm information systems. It is conducted via interpersonal social interactions, such as face-to-face communication and periodic meetings, thus is regarded as the social side of customer IS. Compared with structured IS, unstructured IS is more flexible and could be applied in complex circumstances. It could be carried out in many boundary spanning activities, such as inter-firm meetings, co-design of new products and raw material procurements. With unstructured IS, lower volume information could be flexibly exchanged, supply and demand could be better matched, SC visibility will be improved, finally resulting in better SCP. The positive relationship between unstructured IS and SCP is consistent with the findings of Paulraj et al. (2008). The interaction of structured and unstructured IS was found positively influence SCP, which is in accordance with our anticipation. These two kinds of IS activities could complement each other, and ultimately lead to the effective enhancement of SCP. Therefore, firms need to flexibly adopt both these two types of IS practices.

These findings make several contributions to theories. Based on the extended RBV, both structured and unstructured IS are firms' capabilities to manage inter-firm information flow. Combining STS theory with extended RBV, they represent technical and social aspects of customer IS, respectively, and are both critical in improving SC performance. Our findings enrich empirical applications in the SC management field for both extended RBV and STS theory. Dividing customer IS into structured and unstructured IS could fulfill the research gap that extant studies emphasize more on technical perspectives of inter-firm IS activities, but ignore human behavior issues of IS. The division of SCIS deepens our insights into this critical concept.

Managerially, our findings could inspire managers that both IS through IT systems and social interactions with customers areessential for SC performance. These two kinds of IS activities foster different types of information processing capabilities. The better alignment between firms' information processing capabilities and environmental information processing requirements generates better firm performance (Egelhoff, 1991). Thus, structured and unstructured IS should be employed in various circumstances based on their characteristics. Structured IS is more suitable for sharing large volume information, which is explicit, easy to be codified, highly organized, and formal. Unstructured IS is more effective in transferring low volume information,which is implicit, difficult to be codified, unstructured, and informal.

2.5.2 The influence of customer information system connectivity and relationship commitment on customer structured and unstructured IS

We found that customer information system connectivity could improve both customer structured and unstructured IS. These findings are in accordance with those of many empirical studies (Huo et al., 2016b; Vijayasarathy and Robey, 1997; Ye and Wang, 2013; Zelbst et al., 2010). According to the combined perspective of STS theory and extended RBV, customer information system connectivity is a technical resource embedded in inter-firm relationships and could bring firms with both social and technical inter-firm IS. Customer relationship commitment, the inter-firm social resource, was only found to positively affect unstructured IS and had no significant impact on structured IS. Most extant studies found that relationship commitment improved SCIS (Arnold et al., 2010; Fu et al., 2017; Wu et al., 2014). Our findings could supplement this finding by indicating that relationship commitment only improves social-based IS, but has no impact on technology-based IS. The information shared through structured IS is usually operational information required for basic SC operations. No matter whether two connected parties are committed to their relationships, this information must be shared to support normal operations of SCs. Having better relationships with business partners will not necessarily add value for structured IS. Unstructured IS needs more trust, which can be cultivated and enhanced by relationship commitment with customers.

We also found that the impact of information system connectivity on SC performance was mediated by both structured and unstructured IS. The impact of relationship commitment on SC performance was only mediated by unstructured IS. These findings indicate that customer information system connectivity could indirectly improve SC performance via two mechanisms, the enhancement of social-based and technical-based IS. Customer relationship commitment can indirectly boost SC performance only via improving social-based IS. Our multiple regression analyses showed that the interaction of customer information system connectivity and relationship commitment had a significant negative relationship with SC performance. Thus, these two constructs function substitutionally in facilitating SC performance, which is against our expectations from STS theory. One possible explanation for this is that these two activities influence SC performance via increasing SCIS. Thus, they could replace each other' roles in enhancing SC performance.

Using the empirical method, we found that both social and technical factors can simultaneously improve SCIS. It fulfills the research gap that few studies concurrently consider social and technical antecedents for SCIS and enriches the application of extended RBV and STS theory. STS theory proposes that both social and technical subsystems are important(Frohlich and Dixon, 1999). Our findings complement this view and reveal that the inter-firm technical resource, customer information system connectivity, is more important than the social resource, customer relationship commitment, in improving SCIS. However, this does not mean that relationship commitment could be less stressed. From the perspective of extended RBV, both information system connectivity and relationship commitment are critical inter-firm resources. A firm's information system connectivity is relatively easier for its competitors to imitate than relationship commitment because the latter is more socially complex and requires considerable time to establish inter-firm ties. In this sense, relationship commitment deserves further attention in the SC context.

Managerially, we suggest firms establish inter-firm information systems, such as ERP, EDI, and RFID, to improve both technical- and social-based IS. Firms should also attempt to interact frequently with their customers to ensure that they are all committed to their relationships. This will enable more smooth social-based IS between manufacturers and customers, such as face-to-face communication and inter-firm meetings.

2.6. Conclusions and future research directions

Incorporating STS theory with extended RBV, this study proposes a "resource-capability-performance" framework and considers both social and technical aspects of customer IS and their social and technical antecedents. Based on data collected from 622 manufacturers, we found that customer information system connectivity positively influenced both structured and unstructured IS. Customer relationship commitment only affected unstructured IS and had no significant influence on structured IS.

Both structured and unstructured IS improved SC performance. It is the first attempt, to our best knowledge, to apply STS theory in SCIS issues, accumulating empirical evidence to apply STS theory in inter-organizational conditions (Kull et al., 2013). As organizational boundaries become vague, we expect an increasing trend of applying originally inward-looking organization theories in SCM studies. In addition, this study distinguishes itself from other IS studies by examining different types of SCIS. Our findings also provide guidance for practitioners to develop boundary-spanning technical and social resources to foster social and technical information processing capacities and thus improve the performance of the whole SC.

Although this study significantly contributes to both theories and practices, it also has some limitations that provide future research directions. First, we only collected data from manufacturers in Greater China. In the future, we can collect data in more countries and more industries (e.g., service industry) to generalize our findings. Second, cross-sectional data we collected can only validate the static view of our research model. Future studies can collect longitudinal data to test our conceptual model from a dynamic perspective. Third, we did not consider the influence of the business environment, which would definitely influence relationships among technical and social resources, IS, and SC performance. Future studies may consider different characteristics of business environments, such as environmental uncertainties, dynamism, and complexity.

CHAPTER 3: INFORMATION SHARING, COORDINATION AND SUPPLY CHAIN PERFORMANCE: THE MODERATING EFFECT OF DEMAND UNCERTAINTY

3.1 Introduction

In the current market environment, competition occurs more between supply chains (SCs) than between firms (Sangari et al., 2015; Wu et al., 2014). Firms are uniting in the form of SCs so they can better respond to market changes (Cigolini et al., 2004; Wu et al., 2014). In recent years, researchers have paid increasing attention to the challenge of enhancing supply chain performance (SCP) (Chen et al., 2013; Kahn et al., 2006; Lin et al., 2010; Seo et al., 2014). SCP reflects the operational performance of the entire SC (Huo et al., 2014b). However, the reasons why some SCs perform better than others are still not adequately understood (Sangari et al., 2015). In this study, we seek to shed new light on SCP and its antecedents. We summarize the studies on this topic in Table 9. As the table shows, SC information sharing (SCIS) (Wu et al., 2014; Zhao et al., 2002) and SC coordination (SCC) (Abdallah et al., 2014; Alam et al., 2014; Chen et al., 2013; Seo et al., 2014; Wu et al., 2014) are commonly considered to be antecedents of SCP. However, studies have failed to answer an important set of questions. How do various types of SCIS and SCC practices function differently? What are the relationships between these practices and SCP?

Table 9. Studies on SCP antecedents

Author (Year)	Antecedents	Major conclusions
Zhao et al. (2002)	Information sharing; Order coordination	Information sharing and order coordination significantly influence SCP.
Lin et al. (2010)	Market orientation; Resource orientation; Value-cocreation; Embedding operant resource; Resource integration; Value constellations	Market orientation, value-cocreation, and value constellations enhance SCP.
Wu et al. (2014)	Information sharing; Collaboration	Both information sharing and collaboration facilitate SCP.
Seo et al. (2014)	Supply chain integration (SCI); Innovativeness;	Innovativeness directly improves SCP. This effect disappears when considering SCI as the mediator.
Sangari et al. (2015)	Knowledge management processes	Knowledge management processes enhance SCP. This effect "is positively moderated by IT/IS support and supply chain integration" (p. 603).
Qrunfleh and Tarafdar (2014)	Lean supply chain strategy; Agile supply chain strategy	Lean and agile SC strategies are both positively associated with SCP. These two effects are separately moderated by IS for efficiency and for flexibility strategy.
Chen et al. (2013)	Hospital-supplier integration	Hospital-supplier integration increases SCP.
Alam et al. (2014)	Logistics integration	Logistics integration improves SCP.
Abdallah et al. (2014)	Supplier integration; Internal integration; Customer integration; Information sharing; Postponement	Internal integration, postponement, and customer integration facilitate SC effectiveness performance.

To answer these questions and enhance our understanding of SCP antecedents, this study considers SCIS and SCC simultaneously in one theoretical model. Obviously, if firms are to manage their SCs better, they need to coordinate flows of both information and physical products (Frohlich and Westbrook, 2001). SCIS stresses information flow, and SCC is mainly focused on physical flow. To achieve better performance, the information flow must be efficiently transferred to the physical flow (Prajogo and Olhager, 2012). Therefore, this study deems SCIS as the antecedent of SCC and treats SCP as a consequence. Many studies have supported this logic (Chang et al., 2013; Prajogo and Olhager, 2012; Wu et al., 2014).

As information is one of the most critical resources for firms, effectively obtaining and processing relevant information is essential for maintaining a competitive position. Therefore, SCIS is a hot topic in the operational management literature (Huo et al., 2014b; Zhou and Benton, 2007). Determining how to effectively exchange information with customers is a challenge for most firms, and the ways they address this challenge affect their competitiveness.

In this study, we focus on IS between manufacturers and customers. Most studies have treated SCIS as a complex concept involving many varied components. For instance, some studies have considered different kinds of IS targets (Carr and Hale, 2007; Huo et al., 2014b; Sezen, 2008). Other studies have emphasized the analysis of IS content and quality (Li et al., 2014; Zhou and Benton, 2007). Lee et al. (2018) focused on bi-directional SCIS. Current classifications of SCIS are mostly based on distinctions between IS technology (Carr and Hale, 2007; Zhou and Benton, 2007), IS objects (Carr and Hale, 2007; Huo et al., 2014b; Sezen, 2008), and IS quality (Moberg et al., 2002; Monczka et al., 1998). However, the literature offers little empirical evidence to indicate how different outcomes can be achieved by sharing various types of information. To the best of our knowledge, only one study has empirically tested the effects that sharing demand forecasts and inventory data with first-tier suppliers has on supplier volumes and delivery flexibility (Dwaikat et al., 2018). Some studies have used the simulation method, and found that using various information-sharing structures (Datta and Christopher, 2011), or sharing different types of information (Yu et al., 2010), may cause diverse SC outcomes. This line of enquiry needs to be pursued more rigorously by using empirical methods.

The transfer of information via SCIS can happen in many ways, and such transfers can be categorized into different types, according to the types of information involved. Clearly, various types of information are suitable to be transferred via different channels. For example, some kinds of information, such as inventory and order information, are easy to codify and structure. Such highly structured information is fit to be shared via enterprise information systems. Other kinds of information, such as customer feedback or tacit knowledge, is difficult to codify or structure. Such unstructured information is suitable for sharing via face-to-face communication. SCIS activities for sharing these two types of information exist simultaneously in business practices, and each type of information-sharing affects other activities, and the firm’s overall performance, in different ways. Therefore, distinguishing and comparing these kinds of SCIS activities is important.

To the best of our knowledge, studies have not made this distinction. They have not analyzed different kinds of SCIS, according to the differing characteristics of the shared information, not to mention to study how they affect firms differently. This study aims to fill in this research gap by investigating two types of IS activities, namely customer structured IS and unstructured IS. These two kinds of IS activities are compared in terms of two dimensions: IS media and IS content. This classification enables us to examine how different kinds of information can be shared most effectively and efficiently among SC partners, as they seek to increase SCP.

SCC requires joint work between the SC members, such as the suppliers, customers, and manufacturers (Huo et al., 2015c). This study, however, focuses mainly on customer coordination. Most studies on customer coordination have not analyzed any subcategories of this subject (Huo et al., 2015c; Jayaram et al., 2011; Koufteros et al., 2005; Wong et al., 2011). Clearly, however, firms may conduct a variety of practices to implement customer coordination. For example, Wal-Mart cooperates with P&G in its logistics operations, thereby enabling it to place more focus on sales activities[1]. Many firms collaborate with their customers to better forecast customer demand or to design production plans. Different SC firms may cooperate in ways that are both strategic and operational. Considering customer coordination as a holistic concept prevents us from exploring the particular effects that various types of coordination practices can have on firm's SCs.

This study distinguishes two types of customer coordination, namely customer operational coordination and strategic coordination. Customer operational coordination involves an assumption that the manufacturer and the customer both play important roles in each other's procedures, and they need to jointly generate solutions to cope with potential conflicts (Liu et al., 2015). This kind of interaction reflects the operational facet of customer coordination. Customer strategic coordination is focused mainly on how both parties are involved in planning-related activities. These kinds of activities represent the strategic side of customer coordination. We also explore how these two types of customer IS each influence two kinds of customer coordination practices, and how the interaction of these various coordination efforts can lead to improved SCP.

This study draws on information processing theory (IPT), which stresses the alignment between firms' information-processing capabilities and

[1] This case is based on the information from the following URL: https://baike.baidu.com/item/%E5%AE%9D%E6%B4%81%E2%80%94%E6%B2%83%E5%B0%94%E7%8E%9B%E6%A8%A1%E5%BC%8F/12742435

their information-processing requirements (Bensaou and Venkatraman, 1996). On the basis of IPT, we identify customer structured IS and customer unstructured IS as two kinds of practices that can enhance firms' information-processing capabilities. With better customer IS, more information can be provided to implement customer coordination, which ultimately improves SCP.

The IPT framework also indicates that the information-processing requirements of the business environment should be taken into account, as the SC partners seek to deal with various kinds of uncertainty. Partnership uncertainty is one of the most common causes of increased demand for information processing in the inter-organizational context (Bensaou and Venkatraman, 1996). In general, there are three main sources of uncertainty that influence the SC: the supplier, the manufacturer, and the customer (Yu et al., 2001). Customer demand uncertainty may cause the bullwhip effect, which is a serious issue for many manufacturers (Yu et al., 2001). We consider customer demand uncertainty as a moderator of coordination efforts. This kind of uncertainty reflects the level of demand for information processing that arises in the relationship between a firm and its customers. The relations between customer IS and customer coordination may vary with different levels of customer uncertainty.

This study therefore attempts to address the following research questions.

First, how do customer structured IS and unstructured IS influence customer operational and strategic coordination? Second, how do customer operational coordination and strategic coordination affect SCP? Third, how does customer demand uncertainty moderate the relationship between customer IS and customer coordination?

Through answering these questions, this study can make several contributions to the field. First, the study can enrich our understandings of SCP antecedents via considering various types of SCIS and SCC practices simultaneously in one theoretical model. The findings from this exercise can offer specific kinds of guidance for firms seeking to enhance their SCP. Second, our study differentiates and compares two types of IS activities, namely structured and unstructured IS, which allows us to deepen our understanding of SCIS. This distinction among IS activities enables us to perceive how various coordination outcomes can be attained via sharing different types of information. This effect of different IS activities is also discussed in relation to circumstances involving high and low customer demand uncertainty. Third, our study considers two kinds of coordination practices, namely operational and strategic coordination. Making this distinction enables us to test how these kinds of coordination operate differently, and have different effects on SCP. Fourth, this study clarifies the empirical implications of IPT in SC contexts by applying this theory in constructing our conceptual model.

The remainder of this section is organized as follows. First, we review the literature on IPT and our major constructs, and develop our hypotheses. Second, we explain the research methodology and perform the statistical analyses. Third, we draw conclusions and compare our findings with those of previous studies. Fourth, we discuss the theoretical and practical implications of our conclusions, identify the study's limitations, and indicate directions for future research.

3.2. Literature Review

3.2.1 Information processing theory

IPT treats a firm as an open information-processing system (Bensaou and Venkatraman, 1996) that must cope with various types of uncertainty (Tushman and Nadler, 1978). Firms have a fundamental need to establish a suitable structure that incorporates various processes and information technologies. Their managers need to design systems that enable various essential information-processing procedures, such as the gathering, exchange, and allocation of information (Bensaou and Venkatraman, 1996; Galbraith, 1973). IPT suggests that the suitability of a firm's design is determined by the degree of fit between its capability to process information and its information-processing requirements (Narayanan et al., 2011). To enhance their information-processing capabilities, firms need to set up information systems and build lateral relationships

(Galbraith, 1974). Information systems, such as the accounting system, enable firms to formalize the modes of communication they use when making decisions, thus minimizing information-processing costs and increasing the level of information transfer (Galbraith, 1974). The generation of lateral relationships, such as direct contacts between different firms' managers, facilitates processes of joint decision making (Galbraith, 1974).

A firms' information-processing needs are determined by the levels of uncertainty that it confronts (Bensaou and Venkatraman, 1996). The most common sources of uncertainty include environmental, partnership, and task-related factors, and uncertainty in these areas can generate increased demand for information-processing (Bensaou and Venkatraman, 1996). Partnership uncertainty is "the uncertainty a dyad member experiences about its relationship with another member" (Bensaou and Venkatraman, 1996, p. 10). In the SC environment, partnership uncertainty is a significant issue for each of the firms involved. According to IPT, improved alignment between the partners' information-processing capacities and needs is a key to enabling better outcomes.

We have two main reasons for considering IPT as the right theory for this study. First, the logic of our conceptual model accords with the basic lens of IPT. We aim to test how the alignment between information-processing capabilities (represented by SCIS activities) and information-processing demands (represented by customer demand uncertainty) can influence outcomes in terms of SCC practices. Second, IPT has been broadly applied in other studies related to the SC context. For instance, Narayanan et al. (2011) applied IPT in a study of the relationship between business process outsourcing (BPO) integration and firm performance. Their study found that both the internal and external aspects of process integration positively affected the performance of firms engaged in BPO. Wong et al. (2011) investigated the relations between SCIS and operational performance. Their study considered environmental uncertainty as a moderator, and used IPT to analyze various relationships among firms. Wong et al. (2015) applied IPT in a study showing that information integration between firms tended to improve IT-enabled collaborative decision making, thereby enhancing customer service performance with a great degree of IT infrastructure development. As indicated by the above-described studies, IPT has been widely applied in studies related to supply chain management (SCM). Our study is embedded in the SC context, and it focuses on SCM-related problems. All in all, we consider it appropriate to use IPT in constructing our research model, which tests the relationships among two types of customer IS, two aspects of customer coordination, the moderating factor of customer demand uncertainty, and SCP.

The definitions of customer structured and unstructured IS could refer to section 2.2.2. IPT explains both the construction of information systems and the establishment of social connections to enhance a firm's information-processing capacities (Galbraith, 1974). Our categories for types of customer IS are in accordance with IPT. Specifically, the categories of customer structured and unstructured IS concern the information systems and the social relationships, respectively.

3.2.2 Customer operational coordination and strategic coordination

SCC is one of the crucial SCI components and reflects human facets of SCI (Huo et al., 2015c). Customer coordination is a sub-dimension of SCC, which refers to "the degree to which a firm and its critical customers structure inter-organizational practices and processes into a collaborative, synchronized process" (Huo et al., 2015c, p. 729). Customer coordination has many benefits for firms. For instance, Koufteros et al. (2005) showed that customer coordination could help to guarantee that firms seriously considered their customers' concerns when developing products. Moreover, these researchers found that customer coordination improved quality performance and product innovation. Huo et al. (2015c) found that customer coordination enhanced SCP. Wong et al. (2011) found that customer coordination facilitated operational performance in areas such as delivery, product cost, quality, and flexibility. Flynn et al. (2010) found that customer coordination improved operational performance. Braunscheidel et al. (2010) found that external coordination, including supplier and customer coordination, enhanced delivery performance. Koufteros et al. (2010) found that customer coordination facilitated market success. Chiang et al. (2015) found that customer coordination boosted customer response speed. Therefore, customer coordination is pivotal for firms to advance performance.

In this study, we divide the subject of customer coordination into the two categories of customer operational coordination and strategic coordination. Based on SCOR model, planning activities attempt to match supply and demand to make most suitable decisions (Li et al., 2011). These kinds of coordination can set firm foundations for other activities pursued by SCs (Zhou et al., 2011).

Customer strategic coordination is the collaboration between manufacturers and their customers, and it involves inter-firm planning-related practices such as joint forecasting and making production plans (Cai et al., 2010). The primary goals of customer strategic coordination are to form concepts and goals for enhancing inter-firm cooperation and reducing uncertainties (Hoegl et al., 2004). This type of coordination is a strategic practice that facilitates successful inter-firm collaboration (Gupta and Wilemon, 1990).

Customer operational coordination requires that both the manufacturer and its customers participate in inter-firm processes of collaboration (Liu et al., 2015) in areas such as new product development. This kind of coordination aims to transform inter-firm plans into reality (Hoegl et al., 2004). The manufacturer and its customers need to solve numerous complex problems as they execute their plans jointly.

The strategic-operational dichotomy is employed in many studies (Leonard and McAdam, 2002; McAdam et al., 2011; Mukhopadhyay and Kekre, 2002; Sabri and Beamon, 2000). However, to the best of our knowledge, this dichotomy has not been applied to the customer coordination construct. Our study therefore seeks to apply this dichotomy to reveal the varied effects that different coordination practices can have on SCP.

3.3. Research hypotheses

3.3.1 Relationships between customer IS and customer coordination

IPT stresses the importance of information-processing capability for successful firm operations (Tushman and Nadler, 1978), and various studies have shown how firms can build this capacity by various mechanisms, both independently and collectively (Bensaou and Venkatraman, 1996). Naturally, information collection and distribution are both critical aspects of organizational information processing (Narayanan et al., 2011). In general, firms need quality information if they are to confront uncertainties and learn to make better decisions (Premkumar et al., 2005). Customer IS enables various types of information to be transferred between manufacturers and customers (Wu et al., 2014). Such IS advances the acquisition and distribution aspects of a firm's information-processing capabilities. Customer coordination, plays a different role, of facilitating inter-firm decision-making abilities via reducing task uncertainty (Narayanan et al., 2011). This kind of coordination also helps to transform information into physical outputs (Prajogo and Olhager, 2012), and helps to addresses whatever problems are identified via IS. To conduct such customer coordination, firms need procedures for analyzing and interpreting information. Of course gaining information is a precondition for the analysis of that information (Huber, 1991). In addition, SCIS can promote the establishment and strengthening of social connections among SC members (Lotfi et al., 2013). Therefore, customer IS tends to increase customer coordination. Many empirical studies have supported this set of assumptions (Chang et al., 2013; Prajogo and Olhager, 2012; Wu et al., 2014).

Establishing inter-firm information systems (such as ERP systems) is a common method of improving information-processing capacity (Bensaou and Venkatraman, 1996). Structured IS is mainly conducted via inter-firm information systems, which reduce information-processing costs via formalizing IS languages (Galbraith, 1974). With structured IS, information that is easy to codify can be efficiently transferred between manufacturers and customers. This kind of IS enables manufacturers to better coordinate with their customers. Sharing some types of structured information helps firms to make better inter-firm planning decisions, thereby enhancing their strategic coordination. For example, sharing point-of-sale (POS) information facilitates better demand forecasting (Prajogo and Olhager, 2012). With more accurate demand forecasts, manufacturers can make better production plans for appropriately serving their customers. Sharing inventory position information enables manufacturers to plan their replenishment and delivery schedules (Bitran and Hax, 1977). Obtaining inventory information from customers enables manufacturers to plan their procurement and production activities (Dwaikat et al., 2018). Structured IS is also a necessary pre-step for operational coordination. Sharing information about production and delivery enhances "coordination of allocated resource, activities, and roles across the supply chain" (Wu et al., 2014, p. 124). Therefore, we put forward the below hypotheses (see Figure 4):

H1a. Customer structured IS is positively related to customer operational coordination.

H1b. Customer structured IS is positively related to customer strategic coordination.

Building lateral relationships, such as direct contacts between SC managers, is another method for enhancing information-processing capability (Galbraith, 1974). Unstructured IS is generally conducted via inter-firm social interactions, such as face-to-face communications. Frequent communication between firms enables them to better maintain their value-adding relationships (Paulraj et al., 2008). Mohr and Spekman (1994) found that communication quality predicts successful partnership. Unstructured IS can nurture confidence and trust (Fischer, 2013), facilitate cooperation between manufacturers and customers (Paulraj et al., 2008), and ultimately enable successful customer coordination. Frequent social interactions and communication via unstructured IS enable SC partners to coordinate more effectively in both strategic and operational decisions. With more inter-firm communication, inter-firm plans can be made more accurately, and the barriers to inter-firm operational coordination can be reduced. Therefore, we propose the following additional hypotheses:

H2a. Customer unstructured IS is positively related to customer operational coordination.

H2b. Customer unstructured IS is positively related to customer strategic coordination.

3.3.2 Relationships between customer coordination and SCP

SC environments are highly uncertain, because SC systems are loosely coupled by nature. The firms involved in an SC need to balance their interests with those of their SC partners when making decisions (Wang et al., 2015). Customer coordination enables firms to better cope with the uncertainties of SC operations by building closer relationships and facilitating inter-firm dialogue. Over time, these efforts lead to better inter-firm decision-making. In addition, customer coordination enables manufacturers to acquire more customer demand information, thereby reducing SC inventory costs and improving customer responsiveness (Sezen, 2008). These developments all tend to enhance SCP. Numerous studies have elaborated the relationship between customer coordination and SCP. Sezen (2008) and Seo et al. (2014) found that SCI improves SCP. Wu et al. (2014) found that SC collaboration is positively related to SCP. Alam et al. (2014) found that logistics integration increases SCP. Abdallah et al. (2014) detected a positive relationship between customer integration and SC effectiveness.

Although studies have not considered the effects that different types of customer coordination have on SCP, we believe that these studies' various findings can be generalized to help explain the effects that both customer operational and strategic coordination have on SCP. Customer strategic coordination enables both manufacturers and their customers to engage in inter-firm planning-related practices such as jointly making production schedules. Such joint planning helps to identify possible future emergencies or obligations for the SC members (Cai et al., 2010). In that case, SC activities can be further streamlined and integrated, thereby improving SCP. Also, SCP is evaluated primarily by the quality of service to customers (Gunasekaran et al., 2004). Therefore the customers' involvement in planning-related activities helps the manufacturers to become more customer-oriented from the start. Customer operational coordination lets customers and manufacturers collaborate in various processes such as new product development or service design. With the aid of the customers, more accurate customer demand information can be obtained, decreasing the time needed for designing products, and avoiding inventory obsolescence (Flynn et al., 2010). Monitoring business processes with the customers helps to ensure that the manufacturers' products can meet the customers' requirements, thereby reducing the risk of returned purchases. All of these kinds of information exchange can enable SCP improvement. Therefore, we propose another set of hypotheses:

H3a. Customer operational coordination is positively related to SCP.

H3b. Customer strategic coordination is positively related to SCP.

The SCOR model proposes four elementary SC procedures: plan, source, make, and deliver (Stewart, 1997). Planning practices enable the operation of the other three activities (Zhou et al., 2011). Interactive planning helps to match the total demand and the supply, which enables firms to make the most suitable decisions for their other activities, such as sourcing or delivery (Li et al., 2011). Zhou et al. (2011) found that planning positively influences the processes of sourcing, making, and delivering. Customer strategic coordination, which is an SC planning practice, enables manufacturers and customers to anticipate possible future emergencies, and to assess the mutual obligations among business partners and customers (Cai et al., 2010). This kind of coordination lays a solid basis for further operational collaboration between manufacturers and customers. In addition, ongoing coordination drafts strategic directions for inter-firm operational cooperation to emerge. Therefore, we propose another hypothesis:

H3c. Customer strategic coordination is positively related to customer operational coordination.

These two types of customer coordination practices could help each other to better improve SCP. With the help of customer strategic coordination, the inter-firm cooperation plans will be more explicit. Thus, the activities of customer operational coordination could be arranged in a clearer way. The effect of customer operational coordination on SCP will be enhanced. With better customer operational coordination, there will be more understanding between manufacturers and customers. Therefore, the inter-firm plans could be better designed, better improving SCP. We propose below hypothesis:

H3d: The interaction of customer strategic and operational coordination is positively associated with SCP.

3.3.3 The moderating effects of demand uncertainty

SC operations involve uncertainties that are both internal and external (Datta and Christopher, 2011). Demand uncertainty is one of the most critical kinds of external uncertainty for SCs (Davis, 1993). This kind of uncertainty can arise from hidden or unforeseeable developments that affect the scale and the timing of demands on the SC (Fynes et al., 2004; Yigitbasioglu and Management, 2010). With demand uncertainty, the SC environment becomes more volatile, further causing exaggerated or deficient firm capabilities in specific areas (Huo et al., 2015b). IPT posits that uncertainty increases the demands for information processing (Bensaou and Venkatraman, 1996). To cope with such demands, firms use various mechanisms to enhance their information-processing capabilities (Bensaou and Venkatraman, 1996). An alignment between information-processing demands and capabilities produces better outcomes (Premkumar et al., 2005). Therefore, when the demand uncertainty is high, firms need to improve their information-processing capabilities, and this can be done through customer IS. A fit between demand uncertainty and customer IS ultimately helps manufacturers to better implement customer coordination.

However, higher demand uncertainty also makes it more challenging to fulfill the customers' requirements (Dedrick et al., 2008), and this difficulty increases the barriers to successful customer coordination.

When the risk of failing to satisfy customers increases, customer IS becomes more valuable, because it helps manufacturers to better understand their customers' needs (Huo et al., 2014b). That kind of understanding helps SC members to counteract the harmful effects of uncertainty (Lotfi et al., 2013). In other words, customer demand uncertainty pushes manufacturers to rely on IS with their customers to achieve better operational and strategic coordination. Therefore, we propose another series of hypotheses:

H4a: The positive relationship between customer structured IS and customer operational coordination is stronger in situations of high demand uncertainty rather than in low.

H4b: The positive relationship between customer structured IS and customer strategic coordination is stronger in situations of high demand uncertainty rather than in low.

H4c: The positive relationship between customer unstructured IS and customer operational coordination is stronger in situations of high demand uncertainty rather than in low.

H4d: The positive relationship between customer unstructured IS and customer strategic coordination is stronger in situations of high demand uncertainty rather than in low.

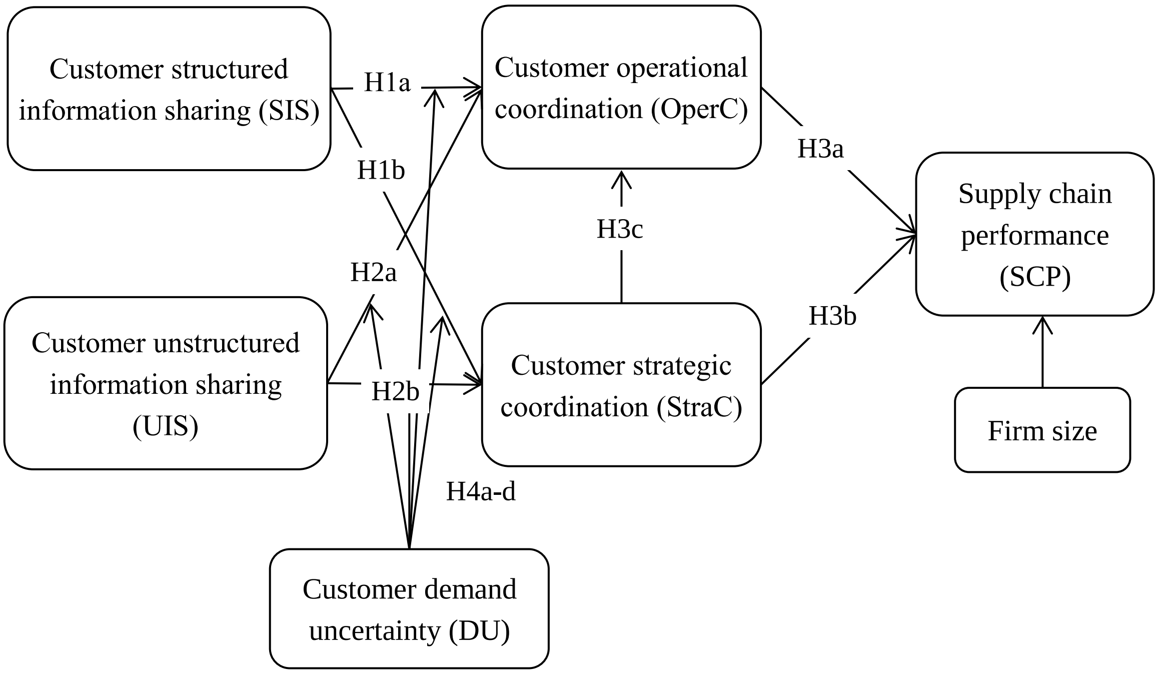


Figure 4. Conceptual Model of study 2

3.4. Methodology

3.4.1 Measures

To ensure content validity, the measures adopted in this study were mostly adapted from other studies, following a thorough literature review. If no appropriate scales were found available, we established new measures according to our perceptions of the related constructs and our understanding of firm practices (Huo et al., 2014b). The measurement of customer structured IS involves assessing practices for sharing kinds of information that are easy to codify and structure (such as information of POS, production plans, inventory availability, or demand forecasts). Measures of customer unstructured IS, however, assess the extent of social interactions (such as inter-firm communications) between firms and their major customers. Our measures of structured IS were adapted from Wang et al. (2014) and Zhou and Benton (2007). Our scales of unstructured IS were adapted from Narasimhan and Kim (2002).

The measurement of customer operational coordination involves assessing the degree of active cooperation between manufacturers and their major customers. However, measuring customer strategic coordination requires evaluating the planning-related activities shared by a manufacturer and its major customer. We adopted the current measures for customer operational coordination (Chiang et al., 2015; Narasimhan and Kim, 2002) and for strategic coordination (Narasimhan and Kim, 2002). To measure SCP, we assessed the operational performance of the entire SC (Huo et al., 2014b), and to do this we adapted the scale from Huo et al. (2015c). The scale for customer demand uncertainty was adapted from Chen and Paulraj (2004b).

The English questionnaire was developed first, and it was then translated into Chinese by an operational management (OM) scholar. Next, the Chinese questionnaire was back-translated by another OM professor, and was checked against the initial English questionnaire to ensure the exactness and consistency of the translation. Our major variables were measured via a 7-point Likert scale (with “1” representing the lowest degree of practice or performance, and “7” indicating the greatest extent). The control variable, firm size, was indicated by the number of employees in each firm. The detailed measures are presented in Appendix A. The sampling and data collection procedures could refer to section 2.3.1.

3.4.2 Bias

To check for non-response bias, we conducted a *t*-statistics analysis to compare the means of the early and the late responses regarding data on the number of employees, the type of industry, the nature of the business, and the firm's fixed assets (Armstrong and Overton, 1977). The insignificant results of the *t*-statistics analysis ($p < 0.05$) demonstrated that there were no obvious differences between the early and late responses, which suggested no presence of serious non-response bias.

As the answers on each questionnaire were collected from one key informant in each selected firm, we assessed the potential for issues arising from common method bias. First, we carried out Harman's single factor test (Podsakoff et al., 2003; Podsakoff and Organ, 1986) with an EFA (exploratory factor analysis). The results revealed four separate factors with eigenvalues above 1.0. The first factor explained 33.7% of the variance, which was less than a majority of the total explained variance (62.4%). Second, we conducted a confirmatory factor analysis (CFA) to examine the Harman's single-factor model (Sanchez and Brock, 1996). The fit indices of this model were χ^2 (209) = 2950.71, CFI = 0.76, NNFI = 0.74, RMSEA = 0.17, and SRMR = 0.13. These results indicated that a single-factor model was unacceptable. Third, the model containing only the traits and the model containing the traits and a method factor were compared (Podsakoff et al., 2003;Paulraj et al., 2008). The fit indices of the latter is enhanced only to a small degree compared to that of the former (NNFI by 0.01, CFI by 0.01, SRMR by -0.012, RMSEA by -0.013). Therefore, the variance explained by the method factor is small (Paulraj et al., 2008). In summary, the danger of common method bias was found to be acceptably low in our study.

3.4.3 Measurement model

In addition to checking our questionnaire through a comprehensive literature review, we ensured content validity via a pilot test with 11 firms. The questionnaires were revised based on feedback from the managers, as collected via interviews regarding the questionnaire. To assure the construct reliability, we adopted a two-step approach developed by Narasimhan and Jayaram (1998). First, the widely accepted indicator, Cronbach's alpha, was applied to check the scale reliability. The Cronbach's alpha values (shown in Table 10) for all of the constructs were greater than 0.70, which showed that the measures of the constructs were reliable (Hair et al., 1998). Also, all of the CITC (corrected item total correlation) values were higher than 0.30, which is the minimum acceptable standard. Second, an EFA (with principal components and varimax with Kaiser normalization rotation methods) was selected to test the unidimensionality of the scales. All of the items loaded more onto the constructs that they were designed to reflect, and loaded less on the constructs that they were not designed to measure. These results demonstrated construct unidimensionality (see Tables 11 and 12).

Table 10. Reliability analysis

Construct	Number of items	Cronbach's alpha	CITC range
Customer structured information sharing	4	0.874	0.685–0.757
Customer unstructured information sharing	3	0.807	0.623–0.714
Customer operational coordination	3	0.768	0.578–0.645
Customer strategic coordination	3	0.853	0.687–0.767
Customer demand uncertainty	3	0.773	0.549–0.662
Supply chain performance	6	0.857	0.548–0.728

Table 11. EFA of SCP, CSIS, and CUIS

	Factor Loadings		
	Supply chain performance(SCP)	Customer structured information sharing(CSIS)	Customer unstructured information sharing(CUIS)
SCP3	**.834**	.093	-.017
SCP4	**.831**	.116	-.088
SCP6	**.767**	.069	.169
SCP5	**.754**	.066	.161
SCP2	**.676**	.169	.098
SCP1	**.648**	.088	.179
CSIS3	.103	**.871**	.124
CSIS4	.197	**.844**	.085
CSIS2	.130	**.799**	.293
CSIS1	.074	**.744**	.340
CUIS2	.083	.245	**.838**
CUIS1	.146	.192	**.795**
CUIS3	.103	.191	**.791**
Eigenvalue	3.531	2.865	2.288
Total variance explained		66.804%	

Table 12. EFA of customer CSC, CDU, and COC

Factor Loadings

	Customer strategic coordination(CSC)	Customer demand uncertainty(CDU)	Customer operational coordination(COC)
CSC2	**.889**	.033	.203
CSC1	**.806**	.024	.338
CSC3	**.786**	.061	.307
CDU2	.056	**.865**	.019
CDU1	.005	**.829**	.129
CDU3	.054	**.785**	.013
COC1	.219	.059	**.881**
COC3	.389	.034	**.704**
COC2	.480	.130	**.613**
Eigenvalue	2.492	2.080	1.914
Total variance explained		72.065%	

The CFA approach was adopted to access the convergent and discriminant validity (O'Leary-Kelly and Vokurka, 1998). We linked each item to its matching theoretical construct, and freely estimated covariances among different constructs. The fit indices of the CFA models were χ^2 (194) = 632.14, CFI = 0.97, RMSEA = 0.062, NNFI = 0.97, and SRMR = 0.042. Therefore, the structural model was found acceptable (see Table 13). In addition, all of the *t*-values were higher than 2.0, and all of the factor loadings were greater than 0.50, which indicated acceptable convergent validity (Fornell and Larcker, 1981a). Then we examined the discriminate validity by comparing the squared root of the AVE values with inter-construct correlations (Fornell and Larcker, 1981b). The results revealed acceptable discriminate validity (see Table 14).

Table 13. Fit induces for the measurement model

Measurement	**Statistics**	**Desirable range**	**References**
Degrees of freedom	194		(Hu and Bentler, 1999; Hu et al.,
Minimum fit function chi-square	632.14		
Root mean square error of	0.062	≤ 0.08	

approximation (RMSEA)			1992)
Non-normed fit index (NNFI)	0.97	≥ 0.90	
Comparative fit index (CFI)	0.97	≥ 0.90	
Standardized root mean squared residual (SRMR)	0.042		

Table 14. Correlational matrix

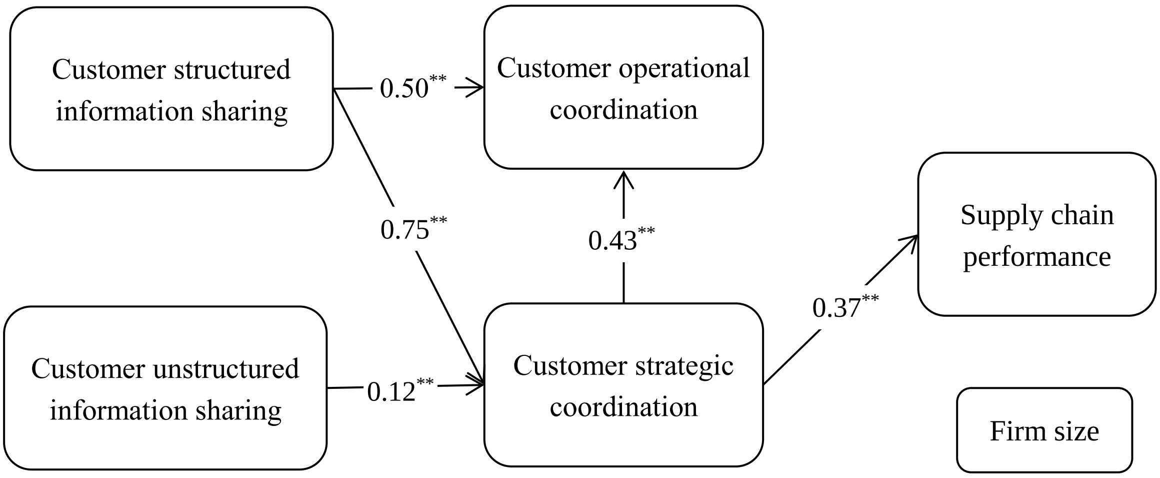
Construct	Mean	S.D.	SIS	UIS	SCP	OperC	StraC	DU
Customer structured information sharing (SIS)	4.11	1.298	0.80[a]					
Customer unstructured information sharing (UIS)	5.30	1.124	0.48**	0.77[a]				
Supply chain performance (SCP)	5.25	0.847	0.30**	0.26**	0.71[a]			
Customer operational coordination (OperC)	4.13	1.330	0.70**	0.41**	0.31**	0.72[a]		
Customer strategic coordination (StraC)	4.41	1.347	0.70**	0.45**	0.36**	0.69**	0.82[a]	
Customer demand uncertainty (DU)	4.01	1.241	0.12**	-0.06	0.15**	0.16**	0.11**	0.74[a]

**Correlation is significant at the 0.01 level; [a] Square root of AVE values

3.5. Results

For our analytic method, we selected co-variance-based structure equation modeling (CB-SEM) instead of PLS-SEM, for the following reasons. First, CB-SEM is more appropriate for application in studies designed for theory testing and confirmation, and PLS-SEM is more suitable for studies designed to predict and develop theory (Hair et al., 2011). This study aimed to test IPT and confirm our proposed conceptual model. Second, the PLS-SEM method is unable to generate "adequate global measure of goodness of model fit" (Hair et al., 2011, p. 143). Third, many relevant studies (Huo et al., 2014b; Zhao et al., 2008) have used CB-SEM methods. All in all, CB-SEM appeared to be a more appropriate method for our study than PLS-SEM.

We tested our conceptual model by using LISREL 8.80 software, and used the structural equation modeling method with maximum likelihood estimation to test our conceptual model. The fit indices of the resulting model were χ^2 (160) = 571.38, CFI = 0.97, RMSEA = 0.066, NNFI = 0.97, and SRMR = 0.045, all of which were acceptable according to Hu and Bentler (1999).



$^{**}p < 0.01$

Figure 5. Result model of study 2

We found that customer structured IS positively influenced customer operational and strategic coordination. Customer unstructured IS positively related to customer strategic coordination, but it had no direct impact on customer operational coordination. Customer strategic coordination increased customer operational coordination. Customer strategic coordination directly enhanced SCP, but customer operational coordination did not. Therefore, H2a and H3a were rejected, and H1a–b, H2b, and H3b–c were supported (Figure 5).

We then conducted an hierarchical linear regression analysis to examine the moderating effects of customer demand uncertainty. First, we performed the regression with customer strategic coordination as the dependent variable (see Table 15). The results indicated that the interaction between customer structured IS and customer demand uncertainty was negatively significant (β = -0.08; $p < 0.05$), which is in contract with the prediction of H4b. The interaction of customer unstructured IS and customer demand uncertainty was found to be positive and significant (β = 0.13; $p < 0.05$), which supported H4d.

Table 15. Hierarchical regression test on customer strategic coordination

Independent variable	Dependent variable: Customer strategic coordination	
	Model 1	Model 2
Constant	**4.41** (0.038)	**4.44** (0.038)
Customer structured information sharing (SIS)	**0.64** (0.034)	**0.63** (0.034)
Customer unstructured information sharing (UIS)	**0.19** (0.039)	**0.19** (0.039)
Customer demand uncertainty (DU)	0.05 (0.031)	0.04 (0.031)
SIS*DU		**-0.08** (0.026)
UIS*DU		**0.13** (0.033)
R^2	0.503	0.515
Change in R^2	0.503	0.012
F	208.253	130.796
Change in F	208.253	7.768
P-value	0.000	0.000

The standard errors for each unstandardized parameter estimate are shown in parentheses.
Significant parameter estimates are set in bold.

Following the method proposed by Aiken et al. (1991), we plotted these two interaction effects and conducted a simple slope analysis. The effects of both customer structured IS and unstructured IS on customer strategic coordination were estimated for both high and low levels of customer demand uncertainty (as set to one standard deviation above and below the mean). Figure 6 shows that when the demand uncertainty (DU) was low, the effect of SIS on StraC was positive and significant (b = 0.73, p < 0.001). When the DU was high, the impact of SIS on StraC was positive and significant (b = 0.53, p < 0.001). Figure 7 shows that when DU was low, the effect of UIS on StraC was positive but non-significant (b = 0.04, *n.s.*). When DU was high, the influence of UIS on StraC was positive and significant (b = 0.35, p < 0.001).

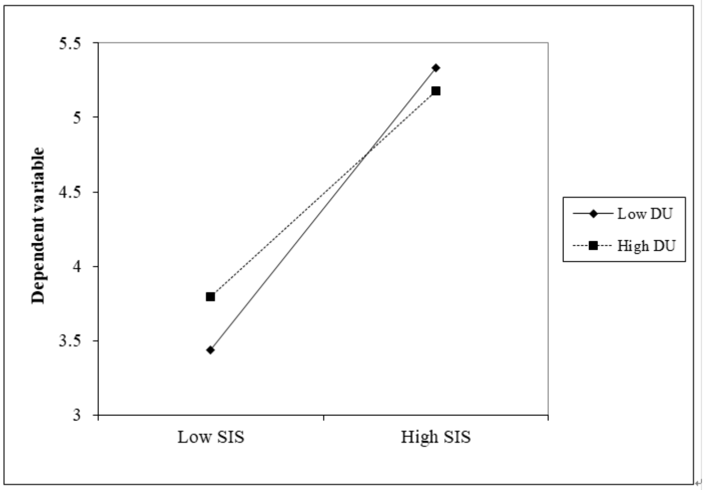


Figure 6. The effect of SIS on StraC, as moderated by DU

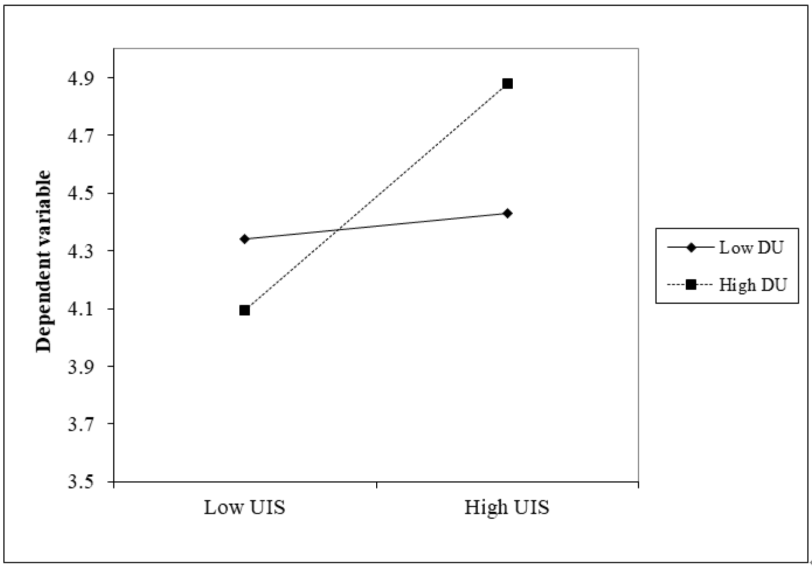


Figure 7. The effect of UIS on StraC, as moderated by DU

Second, we generated the regression analysis regarding customer operational coordination as the dependent variable (Table 16). The results showed that the interaction of customer structured IS and customer DU was positively significant ($\beta = 0.05$; $p < 0.05$), which supported H4a. However, the interaction of customer unstructured IS and customer DU was not significant, which contradicted H4c.

Table 16. Hierarchical regression test on customer operational coordination

Independent variable	Dependent variable: Customer operational coordination	
	Model 1	Model 2
Constant	**4.13** (0.035)	**4.12** (0.035)
Customer structured information sharing (SIS)	**0.41** (0.039)	**0.40** (0.039)
Customer unstructured information sharing (UIS)	0.06 (0.036)	0.05 (0.036)
Customer demand uncertainty (DU)	**0.08** (0.029)	**0.08** (0.029)
Customer strategic coordination (StraC)	**0.38** (0.037)	**0.38** (0.037)

SIS*DU		**0.05** (0.024)
UIS*DU		-0.01 (0.031)
R^2	0.575	0.579
Change in R^2	0.575	0.004
F	208.267	140.732
Change in F	208.267	2.984
P-value	0.000	0.000

The standard errors for each unstandardized parameter estimate are shown in parentheses.
Significant parameter estimates are set in bold.

In addition, we plotted the effect of SIS on OperC, as moderated by DU, and then conducted a simple slope analysis (Figure 8). The results demonstrated that when the DU was low, the effect of SIS on operational coordination (OperC) was positive and significant ($b = 0.34$, $p < 0.001$). When the DU was high, the effect of SIS on OperC was also positive and significant ($b = 0.47$, $p < 0.001$).

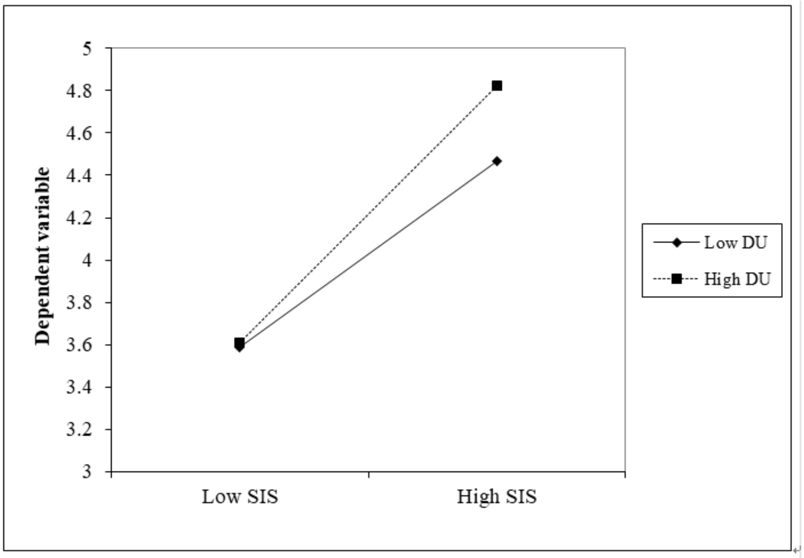


Figure 8. The effect of SIS on OperC, as moderated by DU

We carried on a multiple linear regression analysis to test the interaction effect between customer strategic and operational coordination on SCP. The results are summarized in the below table 17. We found that the interaction between customer strategic and operational coordination is positively associated with SCP. Our finding is in accordance with our assumption.

Table 17. Hierarchical regression test on supply chain performance

Independent variable	Dependent variable: SCP		
	Model 1	Model 2	Model 3
Constant	**5.19**(0.061)	**5.27**(0.058)	**5.22**(0.060)
Firm Size	0.02(0.019)	-0.01(0.018)	-0.01(0.018)
Customer strategic coordination (StraC)		**0.18**(0.033)	**0.20**(0.033)
Customer operational coordination (OperC)		**0.07**(0.033)	**0.07**(0.033)
StraC*OperC			**0.04** (0.014)
R^2	0.002	0.136	0.148
Change in R^2	0.002	0.133	0.012
F	1.331	32.305	26.739
Change in F	1.331	47.692	8.814
P-value	0.249	0.000	0.000

The standard errors for each unstandardized parameter estimate are shown in parentheses.
Significant parameter estimates are set in bold.

A chi-square difference analysis was conducted to compare the effects that customer structured and unstructured IS had on StraC. The chi-square difference (44.15) revealed that SIS (H1b, $\beta = 0.75$) generated a significantly greater impact on StraC than UIS (H2b, $\beta = 0.12$). Furthermore, SIS also showed a greater effect on OperC than UIS. We also tested the indirect effects of customer structured and unstructured IS on SCP via customer StraC by using the Sobel test. The results indicated that StraC mediated the relationship between SIS and SCP

(Indirect effect = 0.28; Sobel z = 5.46, $p < 0.001$). StraC was also found to mediate the relationship between UIS and SCP (Indirect effect = 0.04; Sobel z = 6.37, $p < 0.001$).

3.6. Discussion and implications

As the results showed, SIS had a positive influence on both OperC and StraC. UIS increased StraC. These results are in accordance with those of many other studies which have found that IS tends to enhance coordination (Prajogo and Olhager, 2012; Wu et al., 2014). However, UIS showed no relationship with OperC. OperC (which is an operational level practice) requires a great deal of information concerning a firms' current operating status. Information sharing via social interactions is less efficient in transferring large volumes of information than IS via information systems. Also, information interchanged by social interactions may be inaccurate, and can cause negative effects on OperC. Therefore, UIS tends to have no direct influence on OperC. We found that SIS had a stronger impact on OperC and StraC than UIS. This finding indicates that sharing information via formal enterprise information systems is more effective for facilitating customer coordination (in both its operational and strategic aspects) than sharing information via inter-firm social interactions. These findings provide deeper insights into the relations between customer IS and customer coordination.

We also considered this relationship under conditions that were characterized by high DU. The results showed that when the DU was high, the effect of UIS on StraC became significant. Therefore, we expect that sharing information via social interactions becomes more effective for enhancing StraC when the customer demand is highly unpredictable, and it becomes less effective when customer demand is stable. Results indicate that DU negatively moderates the relationship between SIS and StraC. When the DU becomes higher, SIS becomes less effective for enhancing StraC. According to media richness theory, enterprise information systems are more fit for "communicating about routine activities," and face-to-face communication is more appropriate for dealing with complex issues (Suh, 1999, p. 296). As SIS is mainly conducted via inter-firm information systems, it is more suitable to be applied in routine activities. When the DU is high, inter-firm planning-related issues become more complicated and uncertain. Therefore, SIS grows less capable of enhancing StraC under circumstances of high DU.

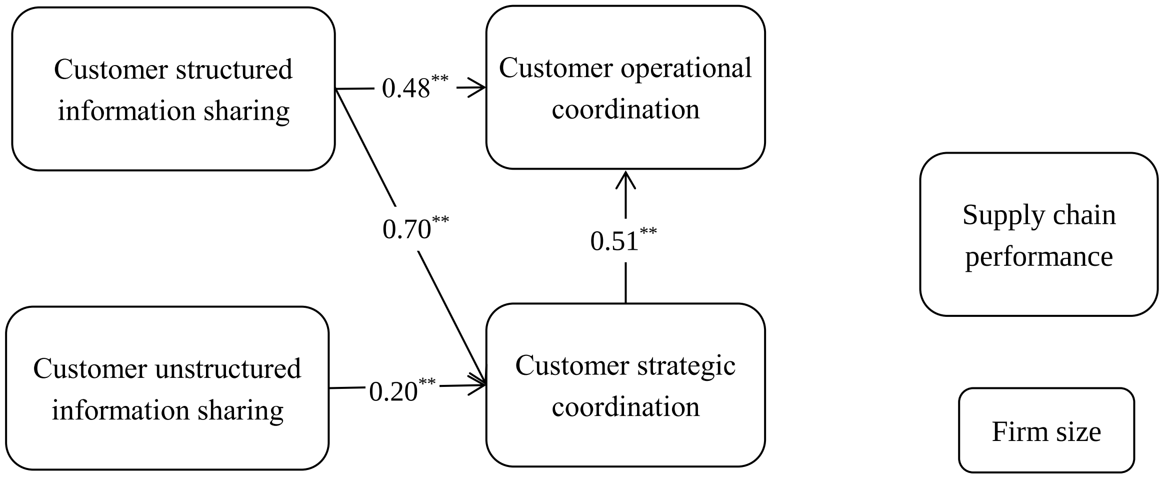
In contrast, UIS (which is implemented via social interactions such as face-to-face communications) is more appropriate for handling complex issues. When the DU is high, UIS can effectively exchange information between manufacturers and customers, which enables the creation of inter-firm plans and improves StraC. Our conclusions are in accordance with the primary premise of IPT, namely that to gain better outcomes, firms should achieve a fit between their information-processing capabilities and the demands they need to meet (Galbraith, 1974; Premkumar et al., 2005).

DU was found to positively moderate the relationship between SIS and OperC. This finding is in accordance with our prediction. As we mentioned previously, OperC tends to focus on operational-level current issues. When the customer demand is more uncertain, firms need more information to implement effective inter-firm OperC. SIS is efficient in transmitting information that involves large volumes of data. Thus, the exchange of such structured information has a greater impact in situations of high DU. In contrast, UIS mainly transfers information via face-to-face communication. It is not suitable for conveying large amounts of data. Our results also show that the relationship between UIS and OperC is not moderated by DU.

We found that StraC positively influences SCP, but OperC has no significant effect on SCP. This set of findings differs from that of other studies, which have found that all types of coordination tend to improve SCP (Abdallah et al., 2014; Alam et al., 2014; Chen et al., 2013; Seo et al., 2014; Sezen, 2008; Wu et al., 2014). We conclude that StraC is more important for improving SCP than OperC. One possible explanation for the insignificant relationship between OperC and SCP might be that

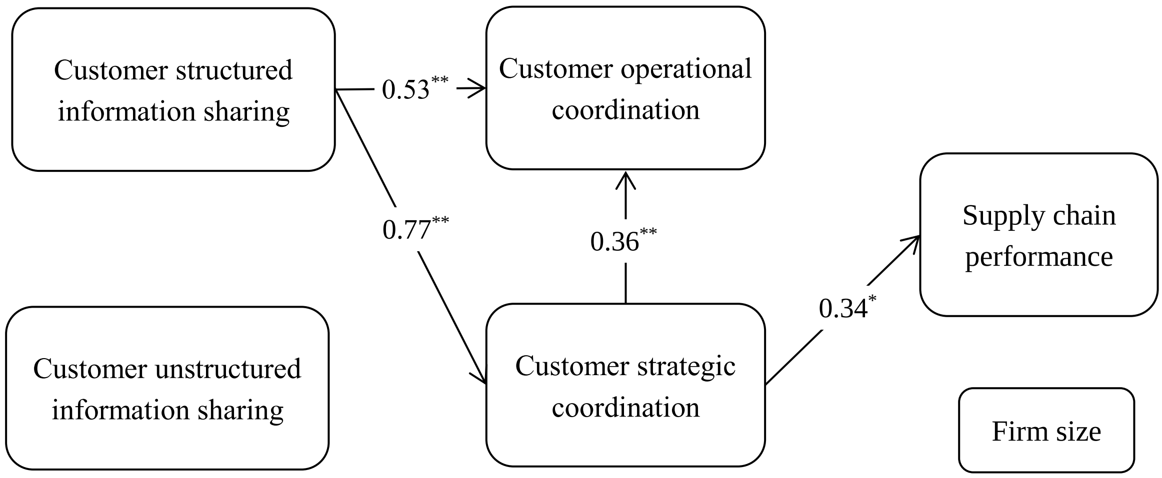
OperC requires vast investments, such as human resource and managerial inputs (Liu et al., 2015). The costs of such investments may offset the benefits that OperC contributes to SCP. In addition, both SIS and UIS could significantly affect SCP via StraC. The positive relationship between StraC and OperC was supported by Zhou et al. (2011).

In dealing with their various types of customers, firms may implement different IS and coordination practices as appropriate. The firms in our sample mainly had two types of principle customers: the production firms and the consumer goods firms in their SCs. In our questionnaire, each firm was asked to designate the types of their major customers, and four options were provided: manufacturers, distributors/wholesalers, retailers, and others. Firms that selected the manufacturers as their answer were deemed to have production firms as their major customers, and firms that chose any of the other three options were regarded as having consumer goods firms as their major customers. The four firms that did not answer this question were excluded from this analysis. Our conceptual model was tested separately for the production firm sample (n = 280) and the consumer goods firm sample (n = 338). The results are presented in Figures 9 and 10.



$^{**}p < 0.01$

Figure 9. Result model in production firm sample (n = 280)



$^{**}p < 0.01$, $^{*}p < 0.05$

Figure 10. Result model in consumer goods firm sample (n = 338)

For the production firm sample, most of the results were consistent with those found for the full sample. However, StraC was found ineffective in promoting SCP for the production firm sample. As the major customers of firms in the production firm sample were manufacturers, their demands were largely determined by their customers. StraC is mainly useful for shedding light on joint demand forecasting and plan-making with customers. When the customers themselves are unable to estimate their demands accurately, then StraC cannot play its positive role for enhancing SCP. For the customer goods firm sample, most of the results were in accordance with those of the full sample model. However, UIS did not enhance StraC. As the major customers of firms in the consumer good sample were distributors, wholesalers, retailers, or others, StraC with these firms may have required large volumes of information. As UIS is generally unsuitable for conveying large volumes of data, this mode of IS was unable to improve StraC for this sample.

This study has several theoretical implications. First, this is one of the first studies to investigate the effects from two types of IS practices (which share different kinds of information). Dwaikat et al. (2018) investigated the effects of sharing demand forecasts and inventory data with suppliers, and they found that these different kinds of information had varied effects on the flexibility of both supplier volume and delivery performance. That study shed light on two important types of structured IS. Our study, however, compared the effects of sharing both structured and unstructured information. Two other simulation studies have also indicated the necessity of investigating the effects and practices of sharing different types of information (Datta and Christopher, 2011; Yu et al., 2010). According to IPT, structured and unstructured IS embody two conventional approaches for boosting a firm's information-processing capabilities, for establishing inter-firm information systems, and for building lateral relationships (Srinivasan and Swink, 2018). The differentiation of structured IS from unstructured IS yields a clear conceptual picture for researchers, and it helps us to understand the distinct roles played by IS activities that share different types of information.

On the one hand, our results revealed that the sharing of structured and unstructured kinds of information have some similarities, as both kinds of IS showed significant and positive effects for enabling StraC. On the other hand, we found some differences between these kinds of IS. For instance, SIS showed a more significant effect on StraC than UIS. SIS directly enhanced OperC, but UIS did not. When the DU was high, the effects of UIS on StraC, and the effects of SIS on OperC, were both amplified. However, the effect of SIS on StraC was reduced. These results indicate the necessity of separating these two concepts, and the need for conducting future studies with this distinction in mind.

In addition to making a distinction between types of customer IS, this study also distinguished between two kinds of customer coordination practices, namely OperC and StraC. This distinction differentiated our study from other studies of SCC (Huo et al., 2015c; Koufteros et al., 2005; Wong et al., 2011), and it enabled us to see the different effects that various coordination practices can have on SCP. Our results imply a more critical role for StraC in facilitating SCP, with OperC playing a more supplementary role. In addition, StraC was proved able to mediate the relations between customer IS and SCP. Our differentiation between OperC and StraC has provided a new direction for future research in this area. Considering different kinds of SCIS and SCC in our theoretical model has deepened our understanding regarding the antecedents of SCP. The literature has already proven that coordination significantly mediates the relation between SCIS and SCP (Wu et al., 2014). This study has complemented this conclusion by indicating that only StraC mediates relationships between customer structured and unstructured IS and SCP, and that OperC does not.

Last but not least, this study has applied IPT (Srinivasan and Swink, 2018) to inform its conceptual model. We considered two critical SCIS components (Huo et al., 2015c), namely customer IS and customer coordination, and we investigated their various effects on SCP in our conceptual model. Customer structured IS and unstructured IS were assumed to improve the respondent firms' information-processing capabilities. These kinds of IS could help firms and SCs to implement OperC and StraC, thereby assisting them to achieve SCP. Our results have therefore verified the significance of information-processing capabilities for firms in the SC context. On the basis of IPT, we also considered this effect under various levels of DU, and we found that DU has a moderating role between customer structured IS and coordination, and between customer unstructured IS and StraC. Our results confirmed the importance of an alignment between a firm's information-processing abilities and the demands it must deal with. All in all, this study has enriched the application of IPT in SC contexts, and it has provided improved theoretical explanations for the relations between SCIS and SCP.

Our research findings also yield practical implications for SC managers. These findings indicate that to implement differing coordination practices, firms should adopt appropriate means to share information. To coordinate with customers on strategic issues, firms should share information with customers through both IS systems and social relationships. Regarding cooperation with customers in operational issues, we found that SC managers should adopt IS systems to share information with their customers. However, when the demand from customers becomes highly uncertain, the sharing of information via IS systems is less effective, as IS via social relationships is more helpful for boosting cooperation on strategic issues between customers and manufacturers. Also, to enhance cooperation with customers on operational issues, sharing information via IS systems is more effective in circumstances where the customers' demands are uncertain. Therefore, appropriate IS channels should be carefully selected, with consideration for the particular purposes and business environments involved. In addition, we suggest that SC managers need to establish greater strategic cooperation with their customers. This is the approach that ultimately brings firms better SCP.

3.7. Conclusion and future research directions

On the basis of IPT, this study investigated the effects that both customer IS and customer coordination have on SCP under circumstances of varying customer DU. Our study made a distinction between structured IS and unstructured IS, according to the differing kinds of media and content involved. The study also differentiated between customer coordination that deals with operational matters, and coordination that deals with strategic issues. Surveys collected from 622 manufacturers in mainland China and Taiwan were used to test a series of hypotheses. The results suggested that both customer structured IS and unstructured IS are positively related to StraC. However, only SIS was found to promote OperC, as UIS failed to do so. In addition, the effects of SIS were found to be greater than the effects of UIS in various customer coordination practices. DU was found to significantly amplify the positive relationships between UIS and StraC, and between SIS and OperC, but greater uncertainty significantly reduced the positive relationship between SIS and StraC. StraC was found positively related to both OperC and SCP.

OperC, however, showed no direct impact on SCP.

Like all studies, this study has inevitable limitations, which can indicate approaches for future studies. First, the data for this study were collected in East Asia. In the future, comparable data from additional regions across the world should be collected to test the generalizability of the results. Second, this study used a cross-sectional data method, which may have limited its ability to confirm causality in the theoretical model. Therefore in the future, longitudinal data can be used to further validate the causality of the observed results. Third, we only considered IS and coordination practices in relation to customers. Future research should consider coordination practices in more kinds of business relationships.

CHAPTER 4: THE IMPACT OF CROSS-FUNCTIONAL TEAM, PROCESS AND SYSTEM COORDINATION ON CUSTOMER OPERATIONAL AND STRATEGIC COORDINATION AND OPERATIONAL PERFORMANCE

4.1 Introduction

The topic of relationships between various SCC dimensions and performance measures were frequently explored since the mid-1990s (Ataseven and Nair, 2017; Braunscheidel and Suresh, 2009; Flynn et al., 2010; Koufteros et al., 2010; Stank et al., 2001). Previous studies reached different conclusions regarding this question. For instance, some proposed positive SCC-performance relationships (Antonio, 2011; Braunscheidel and Suresh, 2009; Braunscheidel et al., 2010; Li et al., 2018; Liu et al., 2013), while some revealed non-significant ones (Han et al., 2013; Koufteros et al., 2010). The inconsistent conclusion issues caused concern in previous research (Ataseven and Nair, 2017; Flynn et al., 2010; Mackelprang et al., 2014), and these studies suggested various solutions. For example, Flynn et al. (2010) attributed this problem to incomplete SCC conceptualizations, thus introduce a complete concept to address it. Ataseven and Nair (2017) and Mackelprang et al. (2014) used a meta-analytical method to synthesize findings from existing studies. This study attempts to solve this problem from a new perspective, dividing coordination into various dimensions. This approach not only enables us to see individual effects of separate coordination dimensions on performance, but also allows us to provide more detailed practical guidance to managers. All in all, this study focuses on the vital problem of how SCC influences operational performance and aims to bring more profound thoughts and specific solutions to this question.

SCC comprises supply, customer, and cross-functional coordination (Flynn et al., 2010; Huo et al., 2015a; Li et al., 2018; Vickery et al., 2013). This study accentuates on the downstream SC to comprehend how manufacturers implement cross-functional and customer coordination practices to attain better operational performance, a performance measure reflecting the extent to which the manufacturer can serve customers regarding responsiveness, delivery, etc (Feng et al., 2014). Based on the organizational capability theory, we deem cross-functional coordination as firms' operational capabilities, customer coordination as dynamic capabilities. Dynamic capabilities act on operational capabilities to strengthen firm performance (Collis, 1994; Zott, 2003). Therefore, we consider the cross-functional coordination as the antecedent of customer coordination and operational performance as the outcome. Our logic is in accordance with that of previous studies (Chiang et al., 2015; Horn et al., 2014; Koufteros et al., 2005; Koufteros et al., 2010).

Cross-functional coordination was widely discussed in the previous literature, both as a sub-dimension of SCC (Flynn et al., 2010) and as an independent business practice (Anthony et al., 2014). Many studies prove that it brings firms benefits, such as the promotion of customer coordination (Huo, 2012; Koufteros et al., 2010; Vickery et al., 2013; Zhao et al., 2011) and the enhancement of firm performance (Eng, 2006). Existing studies hold different views on cross-functional coordination. On the one hand, most extant studies deem cross-functional coordination as a holistic concept (Alfalla-Luque et al., 2015; Braunscheidel and Suresh, 2009; Braunscheidel et al., 2010; Flynn et al., 2010; Foerstl et al., 2013; Tsai et al., 2012; Vickery et al., 2013), on the other hand, some studies shed light on specific types of cross-functional coordination. For instance, cross-functional team management is emphasized by some studies (Chen, 2007; Young-Hyman, 2017), especially for new product development (Jassawalla and Sashittal, 1999). It yields a formal structure for parallel communication and knowledge sharing (DeSanctis and Jackson, 1994). Some studies concentrate on cross-functional coordination based on information systems (DeSanctis and Jackson, 1994; Rai et al., 2006). With it, firms can achieve internal seamless information flow integration (Gosain et al., 2005). Eng (2005) proposes the coordination via internal connected processes as the critical components of cross-functional coordination and indicates that it determines SC capabilities. These three types of cross-functional coordination practices are consequential theoretically and are adopted by firms practically (Turkulainen et al., 2017). However, existing literature, to our best knowledge, failed to empirically test and compare these three cross-functional coordination practices simultaneously. This research gap makes us unable to understand how these three coordination activities operate differently in influencing customer coordination. Therefore, this study classifies cross-functional coordination into the cross-functional system, process, and team coordination, and tests various effects of these practices on customer coordination.

Customer coordination enables firms to access precise customer demand information, decreasing the time for designing products and planning production, and reducing excess inventory. It ultimately brings the improvement of operational performance (Flynn et al., 2010). The literature on partnership considered various types of partnership, such as strategic (Johnson, 1999; Mentzer et al., 2000; Varadarajan and Cunningham, 1995) and operational partnership (Mentzer et al., 2000). However, previous studies on customer coordination, a kind of partnership between manufacturers and customers, generally deem it as an un-splittable variable (Boon□itt and Wong, 2011; Chen et al., 2018; Flynn et al., 2010; Jayaram et al., 2011; Koufteros et al., 2005). Actually, firms employ varied activities to coordinate with their customers. For instance, Wal-Mart collaborates with P&G to perform logistics business, ensuring that it can concentrate on and yield its advantages of product sale[2]. Dell directly contacts its customers for more accurate demand anticipation[3]. Regarding various customer coordination practices as a whole hinders us from understanding how they affect operational performance differently. This research separates customer coordination into customer operational and strategic coordination. Customer strategic coordination underlines the inter-firm cooperation in SC planning-related issues, while operational coordination emphasizes the collective participation courses of both manufacturers and customers.

Specifically, this study intends to address two research questions: (1) How do the cross-functional team, process, and system coordination influence customer operational and strategic coordination? (2) How do customer operational and strategic coordination affect operational performance? This study makes contributions to the extant literature in the consequent manners. First, it identifies different cross-functional coordination and customer coordination practices, deepening our understandings of SCC concept and dimensions. Second, it reveals various impacts of three cross-functional coordination practices on two customer coordination activities, and two customer coordination activities on operational performance. Third, this study enriches the empirical application of organizational capability theory and provides more

[2] This case is based on the information from the following URL: https://baike.baidu.com/item/%E5%AE%9D%E6%B4%81%E2%80%94%E6%B2%83%E5%B0%94%E7%8E%9B%E6%A8%A1%E5%BC%8F/12742435

[3] This case is based on the information from the following URL: https://baike.baidu.com/item/戴尔公司/1559839?fr=aladdin

theoretical supports for SCC-performance relationships by applying organizational capability theory to explain relationships between SCC and performance.

This section expands as follows. First, we review previous studies on core concepts and organizational capability theory and build the conceptual model. Second, we demonstrate the research methodology and test our proposed model. Third, we discuss our results, theoretical and managerial implications. Fourth, we draw conclusions, discuss limitations, and future research directions.

4.2 Theoretical background

4.2.1 Cross-functional coordination

Cross-functional coordination refers to "the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfill customer requirements" (Zhao et al., 2011, p. 19). It sheds light on the collaboration among firms' internal functions (Tsai et al., 2012), such as operations, R&D, and marketing functions. With cross-functional coordination, barriers between internal functions will be largely eliminated (Flynn et al., 2010), organizational goals could be aligned among departments (Luca and Atuahene-Gima, 2007; Tsai et al., 2012). It also facilitates internal information sharing, supporting firms to introduce products which could meet customer demands (Tsai et al., 2012).

Cross-functional coordination enables firms to gain better access to resources and knowledge (Mohsen and Eng, 2016) distributed in diverse functions. For instance, cooperation between marketing and manufacturing functions allows firms to transfer complicated and implicit customer demand information into exact outcomes (Bendoly et al., 2012). Collaborating between marketing and R&D functions decreases uncertainties (Tsai et al., 2012). In this study, we consider three types of cross-functional coordination, cross-functional system, process, and team coordination.

Cross-functional system coordination refers to the extent to which firms employ integrated computer information systems to manage information flows across internal functions (Joshi, 1998). It mainly brings firms benefits from three aspects. First, with more integrated computer information systems, the visibility of SC procedures could be enhanced (Rai et al., 2006). Second, it takes the place of functionally oriented and disconnected software, reducing infrastructure support costs (Hendricks et al., 2007). Third, it improves the consistency of shared data (Rai et al., 2006) by connecting various information databases and setting unified data definitions. With it, firms can get access to accurate, real-time information reflecting the operation of various functions. Enterprise resource planning (ERP) and customer relationship management (CRM) systems are two conventional systems that the firm may utilize. The adoption of ERP systems enables firms to respond to customers quickly and enhance delivery speeds. CRM systems help firms to establish long-term oriented relationships with their customers (Hendricks et al., 2007).

Cross-functional process coordination stresses seamlessly connected internal procedures (Eng, 2005) and synergy among firms' functions (Huo et al., 2015c). Several practices are operated to perform cross-functional process coordination. For instance, firms carry out joint planning and strategic partnership to facilitate various functions' collectively operating towards the overall goal of the firm (Turkulainen et al., 2017). Firms may also implement standardized measurements among internal functions which ensure the unchanging measures of critical financial and operational issues, boosting goal alignment (Turkulainen et al., 2017). With improved synergy and aligned goals among internal functions, cross-functional process coordination effectively reduces duplicated work (Martin and Eisenhardt, 2010) and creates a more united internal atmosphere.

The cross-functional team gathers people who master various skills to cooperate to better attain firms' goals (Holland et al., 2000). With it, employees who are expert in various areas could interact with each other and generate knowledge (Chen, 2007). It also establishes foundations for a high level of cross-fertilization of ideas (Jassawalla and Sashittal, 1999).

Besides, many studies indicate that cross-functional team assists new product development (Sarin and McDermott, 2003; Valle and Avella, 2003). Cross-functional team coordination refers to the degree of employing cross-functional team practices to collaborate internal functions. Regarding differences between cross-functional team and process coordination, the former stresses gathering people from various functions to form teams, while the latter emphasizes building connected procedures among various functions. Cross-functional team coordination requires lower startup costs, accordingly is more flexible. The definitions of customer operational and strategic coordination refer to section 3.2.2.

4.2.2 Organizational capability theory

Organizational capability is a high-ranking procedure to convert flows and decisions into specific outcomes (Winter, 2003). Firms with higher organizational capabilities could perform better (Alegre and Chiva, 2008; Bharadwaj, 2000; Ravichandran et al., 2005). Organizational capability theory indicates that various firm capabilities could mainly be categorized into two sorts, operational and dynamic capabilities (Huo et al., 2016a; Karna et al., 2016). Operational capabilities sustain firms to execute fundamental practices, including factory arrangement, delivery, and sale, with higher efficiency compared with competitors (Collis, 1994). They safeguard that a firm could earn a living (Winter, 2003). Dynamic capabilities refer to processes that firms restructure and utilize their internal and external capabilities to cope with fast-changing markets (Teece et al., 1997). To obtain competitive advantages, firms should not only facilitate their operational capabilities which enable them to perform their existing business efficiently but also enhance dynamic capabilities that allow them to advance extant or develop new operational capabilities (Karna et al., 2016). Regarding relationships between these two capabilities, dynamic capabilities, which can directly enhance firm performance (Zott, 2003), operate upon operational capabilities (Collis, 1994).

4.3 Theoretical hypothesis

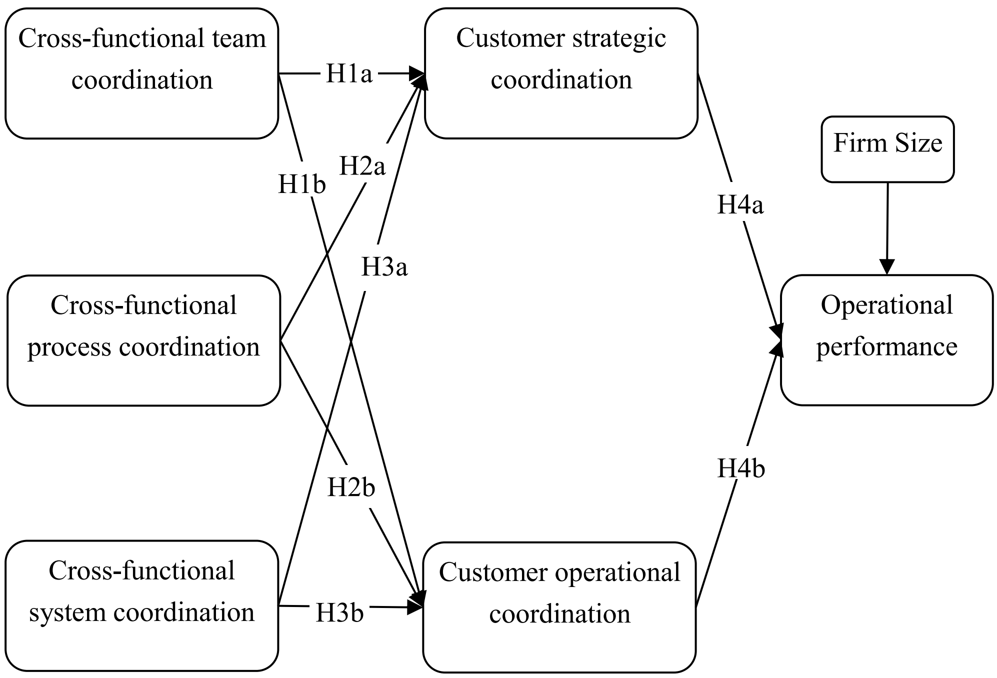


Figure 11. Conceptual model of study 3

4.3.1 Relationships between cross-functional coordination and customer coordination

Operational capability is mainly developed to cope with functional issues (Amit and Schoemaker, 1993) and to sustain the operation of fundamental activities (Collis, 1994). Cross-functional coordination integrates the capabilities of various departments to support basic activities and manage internal processes of firms (Huo, 2012). Therefore, cross-functional coordination stands for operational capabilities. Dynamic capabilities stress the utilization of firms' internal and external resources and competencies to answer the changing surroundings (Teece et al., 1997). Previous studies deem various abilities as dynamic capabilities, such as abilities to respond to technological changes (Benner, 2009), and abilities to adapt to a changing environment (Zhou and Li, 2010). Customer coordination enables firms to collaborate with their customers to better solve inter-firm dynamic issues. With it, firms can better cope with customer demand changes. Thus, it represents dynamic capabilities. Based on organizational capability theory, customer coordination acts upon cross-functional coordination. Cross-functional coordination sets the base to develop customer coordination (Huo, 2012). Besides, cross-functional coordination enhances firms' abilities to learn from their customers, facilitating customer coordination (Huo, 2012). All in all, we assume a positive relationship between cross-functional coordination and customer coordination (Chiang et al., 2015; Huo, 2012; Koufteros et al., 2010; Vickery et al., 2013).

Cross-functional teams gather people with different skills together to achieve specific organizational goals (Holland et al., 2000). People from different functions could communicate with each other from various aspects to acquire mutual understandings (Jassawalla and Sashittal, 1999) within cross-functional teams. Team members obtain knowledge of different domains and analyze firms' problems based on "a shared frame of reference" (Jassawalla and Sashittal, 1999, p. 54). A more affluent knowledge base and a more comprehensive analytical perspective allow firms to satisfy customer demands better. Frequent communication among team members is found to be directly related to successful product development (Dougherty, 1990). Regarding customer strategic coordination, cross-functional team coordination enables people to discuss inter-firm plans from standpoints of various functions. Consequently, more feasible joint plans with customers could be made, heightening customer strategic coordination. Customer operational coordination requires the cooperation of employees from different firms, generating potential complex and dynamic issues for firms to handle. Cross-functional team structures foster synergistic interactions, leading to the weighing of multiple facets to make decisions, more openness to risk-taking issues, and the greater forbearance of failure (Jassawalla and

Sashittal, 1999). Accordingly, firms' capabilities to solve dynamic problems are advanced, boosting customer operational coordination. Consequently, we put forward that (Table 11):

H1a: Cross-functional team coordination is positively related to customer strategic coordination.

H1b:Cross-functional team coordination is positively related to customer operational coordination.

Cross-functional process coordination enables various internal functions to collectively work towards organizational goals (Turkulainen et al., 2017). Therefore, resources and capabilities from different functions could be integrated to fulfill customer demands better, boosting customer coordination. With cross-functional process coordination, there will be less duplicated work among various functions (Turkulainen et al., 2017). Firms could more accurately estimate their capabilities, allowing them to make more precise plans with customers. Cross-functional process coordination also prevents various functions from chasing their sub-goals and silo-thinking via enhanced internal goal alignment (Turkulainen et al., 2017). As a result, the organizational goal of customer operational coordination could be better executed. Therefore, we propose:

H2a: Cross-functional process coordination is positively related to customer strategic coordination.

H2b: Cross-functional process coordination is positively related to *customer operational coordination.*

Cross-functional system coordination stresses employing enterprise information systems to manage internal functions. With it, internal information sharing language could be formalized and standardized (Galbraith, 1974), ensuring that firms could provide their customers more information of the greater extent of accuracy (Galbraith, 1974; Mostaghel et al., 2012) when executing customer coordination. Enterprise information systems, such as the ERP system (Hendricks et al., 2007), allow firms to collect real-time information from various functions. This information enables firms to make joint plans with customers based on firms' current operating circumstances (Hendricks et al., 2007), enhancing customer strategic coordination. Customer operational coordination requires both manufacturers and customers to participate in inter-firm procedures. Many complex decisions should be made during this process. Without enterprise information systems, supply chain managers have to make decisions based on hand-operated, hard-copy reports, setting barriers for them to grasp the whole picture of the business (Mostaghel et al., 2012). Therefore, cross-functional system coordination facilitates customer operational coordination. We propose:

H3a: Cross-functional system coordination is positively related to customer strategic coordination.

H3b: Cross-functional system coordination is positively related to *customer operational coordination.*

4.3.2 Relationships between customer coordination and operational performance

"Operational performance refers to the measurable aspects of the outcomes of an organization's processes, such as reliability, production cycle time, and inventory turns" (Voss et al., 1997, p. 1048). Operational performance is a complex concept which is reflected by many sub-dimensions, such as delivery, production cost, production quality, and flexibility (Khanchanapong et al., 2014; Wong et al., 2011; Yu et al., 2014). Many studies only concentrate on two or three dimensions of operational performance, such as innovation, cost performance, and disturbances (Corsten et al., 2011), cost and service performance (Huo et al., 2008; Wang et al., 2010), quality and inventory management performance (Baird et al., 2011). The delivery performance should be emphasized since on-time delivery has been a common demand both in the industry and from customers (Vachon and Klassen, 2002). Delivery performance assesses firms' capabilities to shorten delivery lead-time and to provide reliable and on-time delivery services (Milgate, 2001). With the shortened lead time, firms can also decrease their safety stock (Yang and Pan, 2004). Flexibility performance measures "a system's ability to accommodate volume and schedule fluctuations" from customers (Beamon, 1999, p. 284). It is crucial in a challenging and changing market nowadays (Jayaram et al., 2011). Therefore, we consider delivery and flexibility performance to represent operational performance in this study. Since firms' with larger firm sizes might possess more resources (Huo et al., 2015c) to achieve better operational performance, we select the firm size as the control variable.

As we mentioned before, customer coordination represents firms' dynamic capabilities. Organizational capability theory indicates that dynamic capabilities enhance firm performance (Zott, 2003). Developing dynamic capabilities determines firms' success (Teece, 2007). Customer coordination enables firms to acquire accurate demand information and react quickly to customers' requirements (Flynn et al., 2010). Therefore, firms' flexibility performance could be enhanced. With more precise demand information and involvement of customers into inter-firm procedures, firms can deliver products to customers smoothly, improving delivery performance. Previous empirical studies found that customer coordination was positively related to operational performance (Flynn et al., 2010; Wong et al., 2011). Customer strategic coordination enables customers to participate in making delivery plans with manufacturers, setting solid foundations for on-time delivery between them. Besides, with customer strategic coordination, firms and their customers could jointly forecast future orders, enhancing firms' capabilities to respond to customer demand changes. Therefore, we believe that customer strategic coordination boosts operational performance. Besides, previous studies suggest that collaborative planning could generate positive outcomes (Kulp et al., 2004; Mohr and Spekman, 1994). With customer operational coordination, both manufacturers and customers can invest resources and capabilities in constructing inter-firm procedures, enhancing inter-firm interactions. Therefore, information sharing channels between manufacturers and customer could be established, more updated customer demand information could be transferred between manufacturers and customers. The delivery and flexibility will be both finally enhanced. Therefore, we propose:

H4a: Customer strategic coordination is positively related to operational performance.

H4b: Customer operational coordination is positively related to operational performance.

With customer strategic coordination, “future contingencies and the resulting duties and responsibilities” in cooperation between customers and manufacturers could be explicated (Cai et al., 2010, p. 260). Then, potential opportunistic behaviors of both manufacturers and customers during coordination processes will be largely hindered. Consequently, the impact of customer operational coordination on operational performance could be strengthened. Customer operational coordination allows manufacturers and customers to contact more and get familiar with each other. This ensures their better understanding of demand and supply in the supply chain, facilitating them to make more feasible inter-firm plans towards operational performance improvement. Therefore, we propose the following hypothesis:

H5: The interaction of customer strategic and operational coordination is positively associated with operational performance.

4.4 Research methodology

4.4.1 Questionnaire development

An extensive literature review could ensure the content validity of our measures. For most measures, mature items validated in previous research were adopted or adapted (listed in the Table 18). In addition, some new measures were originated based on our perception and watching during company visits and manager interviews when no existing measures were available. For operational performance, we regard flexibility and delivery performance as second-order constructs of operational performance. Constructs were all designed with seven-point Likert scales. Higher values implied higher levels of practices or better performance. We used the value of firms' employee numbers to assess firm size. The English questionnaire was initially formed and was then translated into Chinese by a Chinese professor who was knowledgeable of Operations Management (OM). Next, the Chinese questionnaire was back-translated into English by another OM professor and was checked against the initial English version for consistency and accuracy. The pilot test with eleven firms was carried out to guarantee content validity for our measures further. The questionnaire was amended according to feedback obtained via interviewing with some managers.

Table 18. Measure and reliability of major variables

Variable	Cronbach's alpha	CR	Scale
Cross-functional system coordination	0.864	0.87	Flynn et al. (2010); Huo et al. (2014a); Narasimhan and Kim (2002)
Cross-functional process coordination	0.885	0.90	Flynn et al. (2010); Narasimhan and Kim (2002)
Cross-functional team coordination	0.836	0.85	Flynn et al. (2010); Huo et al. (2014a)
Customer operational coordination	0.696	0.70	Narasimhan and Kim (2002)
Customer strategic coordination	0.773	0.79	Flynn et al. (2010); Gentry (1996); Liu et al. (2015)
Flexibility	0.806	0.88	Flynn et al. (2010)
Delivery	0.768	0.84	Devaraj et al. (2007); Flynn et al. (2010); Wong et al. (2011)
Operational performance	0.694	0.90	

We compared early and late responses of items containing total sales, employee numbers, industry types, ownership and whether or not listing firms via t-test to check whether there exist non-response bias issues (Armstrong and Overton, 1977). Results demonstrated that there were no significant differences between answers of these variables collected at early and late time points, demonstrating that non-response bias was not a major concern. Also, we considered the potential common method bias (CMB) issue because questions of each questionnaire were answered by a single informant from every firm. Using exploratory factor analysis (EFA), Harman's single-factor test indicated six distinct factors with eigenvalues above 1.0 (Podsakoff et al., 2003; Podsakoff and Organ, 1986), accounting for 65.6% of the total variance explained. The first factor explained 32.7% of the total variance (not the majority). Confirmatory factor analysis (CFA) was also performed to test Harman's one-factor model (Sanchez and Brock, 1996). The model fit indices were χ^2 (299) = 2570.87, NNFI = 0.75, CFI = 0.77, RMSEA = 0.16, and SRMR = 0.11, indicating that this model was not acceptable based on cutoff values recommended by Hu and Bentler (1999). Thus, CMB was not a big issue in this study.

4.4.2 Sampling and data collection

To obtain a sample containing various types of Chinese manufacturers, four representative cities with different economic and geographical traits were selected to distribute our questionnaires (Zhao et al., 2006). Chongqing, locating in the southwest of Chinese inland, could represent cities of early developing phases and low economic levels. Tianjin is a northern Chinese city and has average economic and development levels. Shanghai and Guangzhou are in the most affluent areas of China. These two cities have higher levels of economic developing stages.

Our respondent firms were selected from the Chinese Telecom Yellow Pages randomly. We phoned target firms to obtain their agreements to participate and identify the suitable key informant, who knew about firms' operating situations, for each firm. Most key informants (82.7%) have been in their positions for no less than three years. Typical positions for these key informants were executive, factory director, general manager, and so on. Each key informant was mailed the questionnaire, self-addressed and stamped envelopes and cover letters stating our aims and value. Then we contacted these key informants frequently to enhance response rates and to decrease missing value (Frohlich, 2002). We distributed 2878 questionnaires and 410 usable one returned. The response rate is 14.2%. The profile of respondents is in Table 19 and 20, revealing that the sample presents a vast collection of company size, legal status, and industries.

Table 19. Company profiles

Employee	**Total (N=410)**	**The legal status**	**Total**	**Sales** (RMB)	**Total**
<50	150 (36.6%)	State-owned	41 (10.0%)	<5m	168 (41.0%)
50-99	79 (19.3)	Collectively-owned	30 (7.3)	5m to <10m	71 (17.3)
100-199	84 (20.5)	Privately owned	270 (65.9)	10m to <20m	46 (11.2)
200-499	64 (15.6)	Partnership	41 (10.0)	20m to <50m	49 (12.0)
500-999	16 (3.9)	Foreign-funded	24 (5.9)	50m to <100m	29 (7.1)
1000-4999	12 (2.9)	Others	4 (1.0)	100m or more	47 (11.5)
5000 or more	5 (1.2)				

Table 20. Industry profile

Industry	**Total (N=410)**
Art and crafts	4 (1.0%)
Building materials	29 (7.1)
Chemicals and petrochemicals	38 (9.3)
Electronics and electrical	59 (14.4)
Food, beverages, alcohol, and cigars	19 (4.6)
Jewelry	1 (0.2)

Metals, mechanical, and engineering	146 (35.6)
Pharmaceutical and medical	4 (1.0)
Publishing and printing	22 (5.4)
Rubber and plastics	27 (6.6)
Textiles and apparel	34 (8.3)
Wood and furniture	18 (4.4)
Other	9 (2.2)

4.4.3 Reliability and validity

We conducted a rigorous procedure to perform reliability and validity analyses of measures. To test reliability, we followed a two-step method from Narasimhan and Jayaram (1998). First, we checked the unidimensionality of measures via exploratory factor analysis (EFA). Second, we examined Cronbach's alpha of each construct for reliability. The EFA test was performed separately for first-order and second-order variables via the maximum likelihood extraction method. Operational performance was regarded as a second-order variable containing flexibility and delivery performance as two first-order variables. The EFA analysis was performed among these two first order variables (Table 21). Then another EFA test was conducted on operational performance and other first-order variables (Table 22). Both results indicated that all items had higher loadings on constructs that they are supposed to measure and had lower loadings on constructs that they do not intend to reflect. Thus, we concluded that the unidimensionality of our constructs was acceptable. The Cronbach's alpha value of each construct was greater than 0.70, except for customer operational coordination (0.696) and operational performance (0.694). Besides, composite reliability (CR) was calculated and all values were higher than 0.70. Therefore, the reliability of our constructs could be ensured.

Table 21. EFA results of delivery and flexibility performance

	Factor Loadings	
	Delivery	Flexibility
Del2	**.856**	.108
Del1	**.785**	.217
Del3	**.744**	.258
Del4	**.660**	.330
Del5	**.454**	.167
Fle2	.203	**.842**
Fle1	.200	**.834**
Fle3	.318	**.761**
Eigenvalue	2.727	2.244
Total variance explained		62.143%

Table 22. EFA results of cross-functional coordination, customer coordination, and operational performance

	Factor Loadings					
	Cross-functi onal system coordinatio n	Cross-functi onal process coordination	Customer strategic coordinati on	Cross-functi onal team coordination	Customer operational coordinatio n	Operation al performan ce
SystemC3	**.789**	.019	.015	.059	.274	-.011
SystemC4	**.782**	.104	.125	.109	-.020	.118
SystemC1	**.767**	.141	.091	.139	.119	.126
SystemC5	**.751**	.167	.192	.199	.001	.082
SystemC2	**.735**	.288	.056	.162	.096	.083
ProcessC2	.090	**.817**	.154	.238	.066	.121
ProcessC3	.164	**.786**	.158	.242	.246	.037
ProcessC1	.213	**.763**	.077	.234	.040	.126
ProcessC4	.206	**.744**	.242	.128	.161	.202
CSC2	.105	.144	**.868**	.030	.125	.023
CSC1	.092	.222	**.717**	.154	.232	.092

CSC3	.156	.104	**.716**	.195	.180	.041
TeamC2	.256	.252	.228	**.791**	.154	.065
TeamC3	.167	.303	.150	**.764**	.085	.192
TeamC1	.312	.391	.072	**.629**	.075	.134
COC1	.100	.035	.108	.067	**.850**	.023
COC2	.085	.141	.254	.206	**.655**	.065
COC3	.221	.352	.304	-.049	**.617**	-.016
Flex	.156	.073	.032	.082	.098	**.901**
DEL	.136	.365	.113	.224	-.053	**.723**
Eigenvalue	3.394	3.235	2.221	2.062	1.876	1.527
Total variance explained				71.566%		

Next, we tested convergent and discriminant validity. In examining convergent validity, we connected each item to its matching theoretical construct and freely estimated covariance among all constructs. The fit index of the CFA model were χ^2 (283) = 873.62, RMSEA = 0.068, CFI = 0.96, NNFI = 0.95, and SRMR = 0.11, which was acceptable according to the recommended cutoff value of Hu and Bentler (1999). Factor loadings of all items were greater than 0.50, except for the factor loading of one delivery performance item (0.44), and all t-values were above 2.0 (Chau, 1997). Thus, convergent validity was acceptable (Appendix). We compared the square root value of average variance extracted (AVE) and correlations among paired constructs to test discriminant validity (Table 23). The results suggested acceptable discriminant validity.

Table 23. Correlational matrix

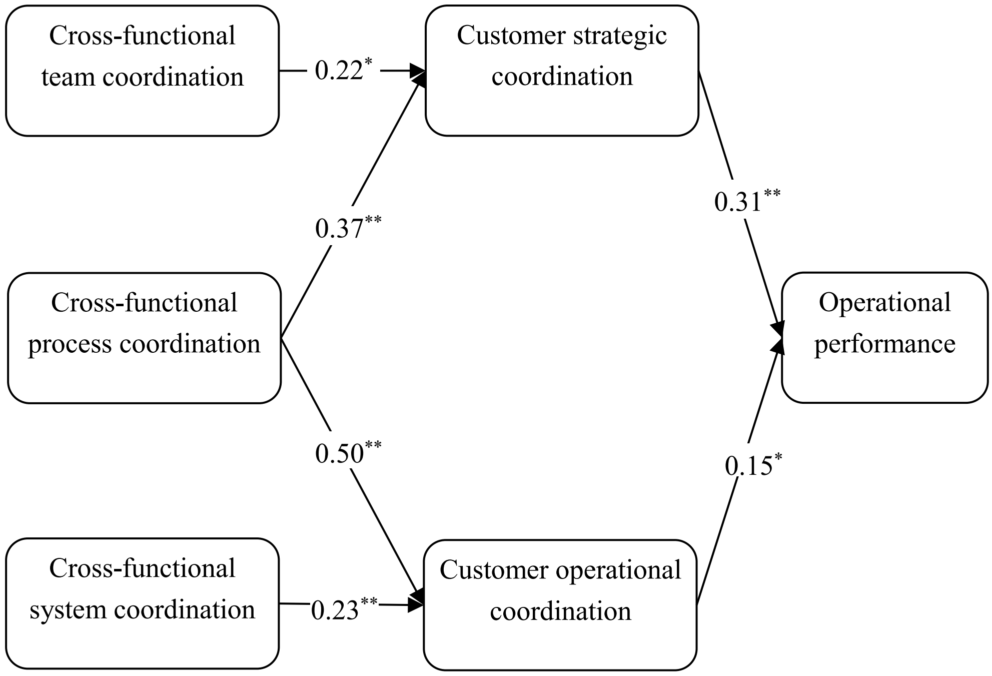
Constructs	1	2	3	4	5	6	7
1. Cross-functional system coordination	0.76^{a}						
2. Cross-functional process coordination	0.44^{**}	0.83^{a}					
3. Cross-functional team coordination	0.52^{**}	0.65^{**}	0.81^{a}				
4. Customer strategic coordination	0.33^{**}	0.45^{**}	0.43^{**}	0.74^{a}			
5. Customer operational coordination	0.36^{**}	0.44^{**}	0.37^{**}	0.52^{**}	0.66^{a}		
6. Flexibility	0.28^{**}	0.28^{**}	0.30^{**}	0.16^{**}	0.16^{**}	0.84^{a}	

7. Delivery	0.31**	0.50**	0.47**	0.25**	0.15**	0.54**	0.73[a]
Mean	4.57	4.48	4.49	4.41	4.16	5.48	5.49
S.D.	1.189	1.234	1.235	1.139	1.148	0.928	0.815

$^{**}p<0.01$, [a]Square root of AVE value

4.5 Results

With LISREL 8.8 software, we employed the structural equation modeling (SEM) method to test our theoretical model. The good fit induces were χ^2 (308) = 991.46, CFI = 0.95, NNFI = 0.94, RMSEA = 0.074, and SRMR = 0.087, indicating that the model was acceptable (Hu and Bentler, 1999). Figure 12 presented standardized coefficients of SEM results. These results indicated that both the cross-functional team and process coordination were positively related to customer strategic coordination, supporting H1a and H2a. Both the cross-functional process and system coordination were positively associated with customer operational coordination, supporting H2b and H3b. Relationships between cross-functional team coordination and customer operational coordination and between cross-functional system coordination and customer strategic coordination were not significant, rejecting H1b and H3a. Both customer strategic and operational coordination were related to operational performance. Thus, H4a and H4b were supported (Table 24).



*p<0.05, **p<0.01

Figure 12. Estimated structural equation model of study 3

Table 24. Summary of results

Hypotheses	Path coefficient (t-value)	Outcome
H1a: Cross-functional team coordination→Customer strategic coordination	0.22* (2.25)	Supported
H1b: Cross-functional team coordination→Customer operational coordination	0.01 (0.09)	Rejected
H2a: Cross-functional process coordination →Customer strategic coordination	0.37** (4.25)	Supported
H2b: Cross-functional process coordination →Customer operational coordination	0.50** (5.09)	Supported
H3a: Cross-functional system coordination →Customer strategic coordination	0.12(1.67)	Rejected
H3b: Cross-functional system coordination →Customer operational coordination	0.23** (3.13)	Supported
H4a: Customer strategic coordination→Operational performance	0.31** (3.55)	Supported
H4b: Customer operational coordination→ Operational performance	0.15* (1.97)	Supported

*p<0.05; **p<0.01

We further tested the interactive effect of customer strategic and operational coordination on operational performance using the hierarchical linear regression method (Table 25). The interactive effect or customer strategic and operational coordination was significantly related to operational performance. Therefore, H5 was supported.

Table 25. Hierarchical regression test

Independent variable	Dependent variable: Operational performance		
	Model 1	Model 2	Model 3
Constant	**5.39** (.074)	**5.42** (.072)	**5.36** (.073)
Firm Size	0.04 (.026)	0.02 (.025)	0.03 (.025)
Customer strategic coordination (StraC)		**0.13** (.038)	**0.15** (.038)
Customer operational coordination (OperC)		0.05(.038)	0.05 (.037)
StraC*OperC			**0.08 (.023)**
R^2	0.005	0.061	0.091
Change in R^2	0.005	0.056	0.030
F	1.983	8.792	10.196
Change in F	1.983	12.143	13.588
p-value	0.160	0.000	0.000

The standard errors for each unstandardized parameter estimate are shown in parentheses. Significant parameter estimates are set in bold.

Besides, we found that cross-functional process coordination generates a more significant effect on customer operational coordination than cross-functional system coordination (chi-square difference equals to 6.78). Customer strategic coordination has more significant impact on operational performance than customer operational coordination (chi-square difference equals to 47.92).

4.6 Discussion

Our results indicate that cross-functional team and process coordination are positively related to customer strategic coordination. Cross-functional system and process coordination are positively associated with customer operational coordination. These conclusions are in accordance with those of previous studies that cross-functional coordination could effectively enhance coordination with customers (Chiang et al., 2015; Huo, 2012; Koufteros et al., 2005; Koufteros et al., 2010; Vickery et al., 2013). Besides, we also found that cross-functional team coordination had no significant relationship with customer operational coordination. A possible explanation could be that customer operational coordination, which is a firm-level practice, requires strategic alliance between manufacturers and customers for a long-term period. Most cross-functional teams are regularly formed to solve specific problems in a short-term interval (Holland et al., 2000). Katz (1982) suggested that R & D teams with a longer tenure had declined performance. Therefore, cross-functional team coordination might be less helpful in attaining long-term organizational purposes, such as customer operational coordination. Cross-functional system coordination does not significantly affect customer strategic coordination. Internal enterprise information systems could only provide information that is specific, certain, and easy to be codified. Customer strategic coordination, which addresses future issues via forecast, highly relies on information such as SC manager's tacit experience and customer demand. This information is vague and difficult to be codified, thus cannot be transmitted by cross-functional system coordination. Subsequently, cross-functional system coordination is not beneficial for customer strategic coordination. Compared with customer strategic coordination, customer operational coordination, which deals with ongoing projects, requires real-time operations information provided by enterprise systems to make better decisions. Our results confirm the positive relationship between cross-functional system coordination and customer operational coordination.

We also found that both customer strategic and operational coordination are positively associated with operational performance. This finding is consistent with that of many studies that revealed positive relationships between customer coordination and operational performance (Flynn et al., 2010; Wong et al., 2011). Also, we found a more significant effect of customer strategic coordination on operational performance than customer operational coordination. Practices and previous studies also suggested the importance of supply chain planning related activities. SCOR model raises the critical foundation role that planning acts for all other activities along the supply chain (Lockamy III and McCormack, 2004). Zhou et al. (2011) found that plan procedure increased source, make, and deliver procedures. With the increasingly uncertain environment, firms on the supply chain cannot easily forecast the market demand (Wang et al., 2015). Manufacturers and customers need to unite to make plans closely related to customer demands. Besides, the interaction of customer strategic and operational coordination enhances operational performance. Thus, manufacturers should not only cooperate with customers in the plan and idea formation stage but also collectively participate in inter-firm procedures with customers to produce better operational outcomes.

This study made three significant theoretical contributions. First, it differentiates three dimensions of cross-functional coordination (i.e., cross-functional system, process, and team coordination), contributing to cross-functional coordination literature. Existing studies only provide evidence that cross-functional coordination acts as a whole to strengthen customer coordination (Huo, 2012; Koufteros et al., 2005; Koufteros et al., 2010; Vickery et al., 2013; Zhao et al., 2011). Our distinction enables us to understand various roles that different cross-functional coordination practices play to enhance various kinds of customer coordination. As our results show, cross-functional team coordination can only improve customer strategic coordination. Cross-functional system coordination could only advance customer operational coordination. Cross-functional process coordination can boost both customer strategic and operational coordination. Their various effects on different customer coordination practices corroborate the necessity of our differentiation of the concept. Existing studies that regard cross-functional coordination as an entire concept may mislead managers and scholars to that all types of cross-functional practices are beneficial for coordination with customers.

In addition, our classification logic is consistent with the framework of information processing theory. Cross-functional coordination represents firms' capabilities to process information (Liu et al., 2012; Swink and Schoenherr, 2015; Williams et al., 2013). Based on information processing theory, firms should invest in building information systems or lateral relationships to enhance their abilities of information processing (Galbraith, 1973). Cross-functional system coordination stresses the utilization of enterprise information management systems to integrate information from diverse functions. Both the cross-functional process and team coordination lead to more interactions and connections among people with various skills from different domains.

Second, we separate customer strategic and operational coordination, enriching existing knowledge towards customer coordination. We did a post-hoc analysis to further comprehend the indirect effect of cross-functional coordination on operational performance through various customer coordination practices. The indirect effect from cross-functional team coordination to operational performance via customer strategic and operational coordination is not significant (Sobel test, $p>0.05$). Cross-functional process coordination did not generate indirect effects on both operational performance via customer strategic coordination and through customer operational coordination (Sobel test, $p>0.05$). Cross-functional system coordination has an indirect effect on operational performance via customer strategic coordination (Sobel $z=2.62$, $p<0.05$), does not indirectly affect operational performance via operational coordination (Sobel test, $p>0.05$). Our conclusions denote both similarities and differences between customer strategic and operational coordination. On the one hand, both customer strategic and operational coordination could enhance operational performance. On the other hand, customer strategic coordination plays a more critical role in the customer coordination-operational performance relationship. It not only yields a more significant direct impact on operational performance but also mediates the relationship between cross-functional system coordination and operational performance. Our further division of cross-functional coordination and customer coordination enables us to see the influence of various types of supply chain coordination (SCC) on operational performance, providing explanations for inconsistent conclusions about SCC-performance relationships from existing studies.

Third, we applied the organizational capability theory to construct and explain our theoretical model. This theory, to the best of our knowledge, was firstly used by Huo (2012) to illustrate relationships between various SCC activities and firm performance. We deem cross-functional coordination as operational capabilities which ensure firms to earn a living (Winter, 2003), reckon customer coordination as dynamic capabilities (Teece et al., 1997) which allow firms to attain superior performance. Organizational capability theory stresses that both sorts of capabilities are critical for firms to win competitive advantages (Karna et al., 2016). Therefore, we include both cross-functional coordination and customer coordination in our conceptual model. Most of our findings support the theoretical lens that operational capabilities establish foundations for dynamic capabilities (Collis, 1994). All our conclusions confirm the lens that dynamic capabilities boost firm performance (Zott, 2003). Our study presents empirical applications for organizational capability theory under the supply chain context and enriches theoretical explanations for relationships between SCC and operational performance.

Our study also has significant practical values for firms. Strategically, we suggest that managers understand both cross-functional coordination and customer coordination as practices that could be achieved by various activities. To well coordinate various internal functions, firms could establish cross-functional teams, connect inter-functional processes, and invest in enterprise information systems. To obtain a more integrated relationship with customers, firms could cooperate with customers in both planning-related issues or jointly work with them on specific projects. A systematic and multiple-method approach should be operated to facilitate coordination practices both inside and outside of firm boundaries.

Operationally, each coordination activity works differently. First, we suggest that managers form cross-functional teams to make inter-firm plans with customers. Second, firms should connect internal procedures and assure synergy among functions to better coordinate with customers. They can implement joint planning and standardized measurements among functions. Third, we suggest that firms adopt enterprise information management systems, such as ERP, EDI, and CRM, to integrate internal information. This will lead to better cooperation between manufacturers and customers in operational issues. Fourth, firms should not only coordinate with customers in planning phases but also collectively build inter-firm processes with customers, both leading to better operational performance.

4.7 Conclusions and future research directions

Based on organizational capability theory, this study investigates relationships between cross-functional coordination, customer coordination, and operational performance. It divides cross-functional coordination into the cross-functional team, process, and system coordination, customer coordination into customer strategic and operational coordination. We collected data from 410 Chinese manufacturers and adopted the SEM method to test our theoretical model. Results indicate that both cross-functional team and process coordination are positively related to customer strategic coordination. Cross-functional process and system coordination are positively associated with customer operational coordination. Customer strategic, operational coordination and their interaction enhance operational performance. Customer strategic coordination mediates relationships between cross-functional process coordination and operational performance.

This research remains some limitations which provide opportunities for future research. First, this study only collected data from China. Future studies could obtain data from various countries and regions in the world to improve the generalizability of our findings. Second, this study utilized the cross-sectional data and the key informant method, which might cause common method bias concerns. Future studies could acquire longitudinal data to make up for this defect. Third, this study only centers on the manufacturer and the downstream of the supply chain. Future studies might add the upstream to obtain a more comprehensive perspective.

CHAPTER 5 SUMMARY OF THIS DISSERTATION

This thesis mainly focuses on two core concepts in SCM domain, SCIS and SCC, regarding their theoretical and practical value. For SCIS, this thesis centers on customer information sharing and considers its two dimensions, customer structured and unstructured information sharing. Customer structured information sharing mainly shares information that is highly structured, such as inventory information, via enterprise information management systems. Customer unstructured information sharing shares unstructured information, such as feedback information, via inter-firm social channels.

For SCC, this dissertation takes into account the cross-functional coordination and customer coordination. Three cross-functional coordination dimensions are considered, cross-functional team, process, and system coordination. Cross-functional system coordination emphasizes using computer information systems to coordinate cross-functional information flow. Cross-functional process coordination sheds light on seamless connections and synergy between different internal functions. Cross-functional team coordination could make better use of firms' internal human resources with the forms of team management. As for customer coordination, this thesis considers customer operational and strategic coordination. Customer strategic coordination stresses inter-firm planning related issues between manufacturers and customers. Customer operational coordination underlines that both the manufacturer and customer should get involved into the inter-firm procedures.

It can be seen from the above discussion that this thesis consider sub-dimensions of the critical concepts including customer information sharing, customer coordination, and cross-functional coordination. Through more in-depth consideration of these important variables, this dissertation could deepen the understanding of them and provide more detailed directions for firms' practices.

Based on the combined perspective of both socio-technical system view and extended resource-based view, this thesis explores the social, the customer relationship commitment, and the technical, the information system connectivity, antecedents of customer structured and unstructured information sharing and considers their various impacts on supply chain performance. We found that establishing information system connectivity between the manufacturer and the customer could promote both customer structured and unstructured information sharing. Promoting customer relationship commitment could only enhance customer unstructured information sharing but not customer structured information sharing. Both customer structured and unstructured information sharing is beneficial for SCP. We suggest the firms to enhance their both types of information sharing abilities, IS via systems and IS via communication, since both of them are proven to improve the SCP. To facilitate IS via systems, the establishment of inter-firm IT systems should be given priority. To enhance IS via communication, both inter-firm IT systems and relationship commitment should be stressed.

Based on the information processing theory, this dissertation constructs the theoretical model including customer structured and unstructured IS, customer operational and strategic coordination, demand uncertainty, and SCP. Customer structured and unstructured IS are considered as firms' capabilities to process information. Demand uncertainty is deemed as the environmental information processing demand for SC firms. Two types of customer coordination is regarded as the outcome of the information processing and is assumed to have direct relationship with the SCP. Both customer structured and unstructured IS could enhance customer strategic coordination, only customer structured IS improves customer operational coordination. Customer strategic coordination enhances customer operational coordination and SCP. We suggest the managers that to invest in both IS via systems and IS via communication to enhance strategic cooperation between customers and manufacturers. Regarding the enhancement of operational collaboration between customers and manufacturers, firms should invest more in IS via systems. To promote SCP, firms should cooperate with their customers for more strategic issues.

Demand uncertainty plays a positive moderating role between the relationships between customer unstructured IS and customer strategic coordination and between customer structured IS and customer operational coordination. Demand uncertainty plays a negative moderating role between customer structured IS and customer strategic coordination. When the customer demand becomes highly uncertain, the positive impact of the unstructured IS on strategic coordination, and the positive impact of customer structured IS on operational coordination will be magnified, the positive influence of customer structured IS on strategic coordination will be decreased.

Based on the organizational capability theory, this dissertation considers three types of cross-functional coordination as firms' operational capabilities, two kinds of customer coordination as dynamic capabilities. We construct the theoretical model that cross-functional team, process, and system coordination as the antecedents of customer strategic and operational coordination, and operational performance as the consequences. Cross-functional team and process coordination promotes customer strategic coordination. Cross-functional process and system coordination enhances customer operational coordination. Both customer strategic and operational coordination increases operational performance. To promote strategic collaboration between the customer and the manufacturer, firms should establish cross-functional teams and coordinate inter-function processes. To facilitate inter-firm operational cooperation between the manufacturer and the customer, firms should connect the cross-functional processes and build internal information systems. Coordinating between the manufacturer and the customer in both strategic and operational issues is beneficial for the improvement of operational performance.

As with most research, our research also has some limitations, which provide directions for future studies. In our studies, the SCP is measured by self-reported indicators from the manufacturer. In the future, the SCP could be cross-validated by both the manufacturer and other SC members. There might be relationships between the operational performance and the supply chain performance. Future research could construct the further theoretical model to test their relationships.

APPENDIX

Variable	Code	Item
Customer IS system	CIS1	The extent of our linkage with our major customer through information network 通过信息网络与主要客户连接的程度
	CIS2	The extent of order computerization with our major customer. 主要客户订货过程电脑化的程度
	CIS3	The establishment of a quick ordering system with our major customer 为主要客户建立快速订货系统
Customer relationship commitment	CRC1	The relationship that our firm has with our major customer is something our firm is very committed to 公司对于与主要客户的关系很珍重及投入
	CRC2	The relationship that our firm has with our major customer is something our firm intends to maintain indefinitely 公司打算长期维持与主要客户的关系
	CRC3	The relationship that our firm has with our major customer deserves our firm's maximum effort to maintain 公司与主要客户的关系值得公司尽最大的努力去维持
Customer Structured IS	CSIS1	Our major customer shares POS with us 主要客户与我们共享销售(POS) 信息
	CSIS2	Our major customer shares demand forecast with us 主要客户与我们共享需求预测信息
	CSIS3	We share our inventory availability with our major customer 公司与主要客户共享库存信息
	CSIS4	We share production plan information with our major customer 公司与主要客户共享生产计划信息
Customer unstructured IS	CUIS1	Our level of communication with our major customer 与主要客户沟通的程度
	CUIS2	Our follow-up with our major customer for feedback 跟进主要客户以收取反馈
	CUIS3	The frequency of our contacts with our major customer 与主要客户频繁的定期接触
Supply chain performance	SCP1	Our supply chain has the ability to quickly modify products to meet customers’ requirements 我们的供应链能够迅速调整产品，以满足客户的需求

	SCP2	The length of our supply chain is getting shorter 我们的供应链的流程正逐步缩短
	SCP3	We are satisfied with the speediness of our supply chain 我们对供应链流程的运作速度感到满意
	SCP4	Based on our knowledge of our supply chain process, we believe that it is efficient 基于我们对供应链流程的认识，我们认为我们的供应链流程简短而且有效率
	SCP5	Our supply chain has an outstanding record of on-time delivery 我们的供应链有非常好的准时交货的记录
	SCP6	Our supply chain provides a high level of customer service 我们的供应链提供高水平的客户服务
Customer operational coordination	COC1	We jointly create new products with our major customer 我们和主要客户共同创造新产品
	COC2	The level of participation by our major customer in our product design 主要客户在设计阶段的参与程度
	COC3	We monitor business processes together with our major customer 我们和主要客户一起监控商业流程
Customer strategic coordination	CSC1	We jointly develop strategic plans in collaboration with our major customer 我们和主要客户共同建立战略计划
	CSC2	We collaborate in forecasting and replenishment planning with our major customer 我们与主要客户在预测和物料补充计划方面合作
	CSC3	We collaborate in production plan, operations, purchase, order treatment, engineering modification and design with our major customer 我们在生产计划、运作、采购、订单处理、工程更改与设计方面跟主要客户合作
Customer demand uncertainty	CDU1	Customer requirements for our products vary dramatically 客户对我们的产品的需求变动很大
	CDU2	Customer demand for us fluctuates drastically from week to week 客户对我们的供给的需求每周都变动很大
	CDU3	The volume of our customers’ demand is difficult to predict 很难预测客户需求的数量

Cross-functional system coordination	SYSTEMC1	Data integration among internal functions (Data collected from different sources is combined. Users can get a unified view of this data and query a number of information sources to help make decisions or support operations) 公司内部各职能部门之间的数据整合（将从不同来源搜集回来的数据结合在一起。使用者可以从一个统一查看界面来查询几个不同讯息来源的数据，从而帮助作出决策或协助营运)
	SYSTEMC2	Enterprise application integration among internal functions (The integration of different software applications used in different functional units, which enables information sharing and business processes integration among units. The result is efficient operations and flexible delivery of services to the customers.) 不同职能部门之间的应用软件系统整合(enterprise applications integration，整合不同职能部门所用不同的应用软件系统，使部门间能够进行讯息交流和业务流程整合，从而使企业能有效率营运和灵活地给客户提供优质服务)
	SYSTEMC3	Integrative inventory management (There is a computer system that enables users to make inventory management decision by checking inventory kept in multiple locations and taking into consideration of demand from multiple sources) 一体化的库存管理（一个电脑系统让使用者在做库存决定时查询不同地点的库存水平，并考虑多个来源的需求)
	SYSTEMC4	Real-time searching of inventory data (real-time searching) 库存的实时跟踪（real-time searching）
	SYSTEMC5	Real-time searching of logistics-related operating data 物流运作数据的实时跟踪（real-time searching）
Cross-functional process coordination	PROCESSC1	The extent of strategic partnership among different internal functions 不同部门之间的战略合作关系
	PROCESSC2	Different internal functions jointly develop strategic plans in collaboration with each other 不同部门共同制定战略计划
	PROCESSC3	Different internal functions monitor business processes together 不同部门一起监控商业流程
	PROCESSC4	Different internal functions jointly develop and

		maintain measurement systems 不同部门共同建立并维护绩效评估体系
Cross-functional team coordination	TEAMC1	The use of periodic interdepartmental meetings among internal functions 定期的跨部门会议的采用
	TEAMC2	The use of cross-functional team in process improvement 在流程改善中，跨职能团队的采用
	TEAMC3	The use of cross-functional teams in new product development 在新产品研发中，跨职能团队的采用
Flexibility	Fle1	Our company can quickly modify products to meet our customers' requirements 我们公司能够迅速调整产品,以满足我们客户的需求
	Fle2	Our company can quickly introduce new products into the market 我们公司能够迅速向市场引进新产品
	Fle3	Our company can quickly respond to changes in market demand 我们公司能够迅速回应市场需求的变化
Delivery	Del1	Our company has an outstanding record of on-time delivery to our customers 我们公司有非常好的准时交货给客户的记录
	Del2	Our company has an outstanding record of reliable delivery to our customers 我们公司有非常好的可靠地交货给客户的记录
	Del3	The lead time for fulfilling customer orders (the time which elapses between the receipt of a customer's order and the delivery of the goods) is short 完成客户订单 (从收到客户订单到送货) 所需的时间短
	Del4	Our company provides a high level of customer service to our customers 我们公司为客户提供高水平的客户服务
	Del5	Our company's inventory level is low 我们公司的库存水平低
Firm Size	Size	The total number of employees of your company is: O < 50 O 50-99 O 100-199 O 200-499 O 500-999 O 1,000-4,999 O 5,000 or more 贵公司的员工总人数是： ( ) < 50 人 ( ) 50-99 人 ( ) 100-199 人 ( ) 200-499 人 ( ) 500-999 人 ( ) 1,000-4,999 人 ( ) 5,000 人或以上

Industry	Industry	The industry type of your company is: O Arts & Crafts O Building Materials O Chemicals & Petrochemicals O Electronics & Electrical O Food, Beverage, Alcohol & Cigarettes O Jewelry O Metal, Mechanical & Engineering O Pharmaceutical & Medicals O Publishing & Printing O Rubber & Plastics O Textiles & Apparel O Toys O Wood & Furniture O Others (Please specify) 贵公司所属的行业类型： ( ) 美术与工艺 ( ) 建筑材料 ( ) 化学制品与石油化工 ( ) 电子产品与电器 ( ) 食品、饮料、酒精与香烟 ( ) 珠宝首饰 ( ) 金属、机械与工程 ( ) 制药 ( ) 出版与印刷 ( ) 橡胶与塑料 ( ) 纺织品与服饰 ( ) 玩具 ( ) 木材与家具 ( ) 其它：

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