INTEGRATIVE PRACTICES IN SUPPLY CHAINS: BUILDING RELATIONSHIPS FOR COMPETITIVENESS IN DYNAMIC ENVIRONMENTS

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ABSTRACT

Firms are increasingly relying on their supply-chain relationships to compete in an era of globalization and change. To this end firms integrate various processes and business activities with their supply chain partners. Supply chain integration (SCI) literature studies the performance benefits of such integration under different business conditions. Existing SCI research takes a black-box view of integration where different integrative practices are studied as one integration construct. This black-box view has limited applications because it masks the differences in SCI practices. In this dissertation we answer the following questions: what are the different elements that comprise the integration construct? What are the important differences between these elements in their relationships with performance and with environmental dynamism?

We follow a rigorous and reproducible qualitative analysis procedure to identify the constructs that makeup the black-box of integration. We define the new elements of integration and generate measurement scales for them that are pre-tested using Q-sort. We then empirically verify our new conceptualization of integration by collecting survey data from manufacturers in North America. The survey results are analyzed using exploratory and confirmatory factor analysis to yield reliable and valid measurement scales.

The survey data is used to analyze the performance impact of the various integration elements. We find that basic communication elements are no longer order-winners and cannot be a source of increased profitability. We also find that operational excellence elements and knowledge generation elements both increase profits but only the knowledge generation elements are able to increase competitive advantage over rivals. These results provide an

explanation for the inconsistent findings in the literature on the integration performance relationship.

We also test how environmental dynamism impacts the relationships between the elements of integration and performance. Our results show that knowledge generation elements are more useful in highly dynamic conditions, while operational excellence elements are more useful in stable conditions.

This dissertation makes significant contributions in providing conceptual synthesis and extension of theory as well as empirical verification of new insights. Our work is relevant to practitioners as it can assist them in making relationship level decisions regarding integration under various business conditions.

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1. INTRODUCTION

In the current era, marked by specialization and global competition, firms rely more than ever on their supply chain partners to meet customer expectations and to differentiate themselves from competitors. For example Apple depended on Samsung to introduce high-resolution retina displays that were a unique feature of its smartphones and computers (Smith, 2012). Apple did not have capabilities in-house to design or produce retina displays, but was able to rely on Samsung to gain competitive advantage (Lessin et al., 2013). Similarly Boeing relied heavily on suppliers to reduce time-to-market and development costs of its Dreamliner 777 airplane. However in the case of Boeing poor management of key suppliers led to numerous quality problems. In the end the Dreamliner was several years late and a few billion dollars over budget (Hiltzik, 2011; Kotha & Srikanth, 2013). These examples illustrate that successful management of key supply chain relationships could be the difference between success and failure even for well established firms like Apple and Boeing.

Supply chain integration (SCI) and buyer-supplier relationship (BSR) literatures have both looked at supply chain (SC) relationships. SCI literature studies what happens to the profitability of focal firms that implement various integrative practices with many suppliers and customers (Flynn et al., 2010; Frohlich & Westbrook, 2001). BSR literature looks at the relational requirements of integration such as trust (Johnston et al., 2004) and outcomes such as satisfaction (Nyaga et al., 2010). Both literatures capture the relationship using a host of integrative practices. Some of these practices are fundamentally very different from others, such as sharing operational data versus working on new product development. The dominant view in the literature is to treat supply chain integration like a black box comprising of a host of diverse integrative practices such as information sharing, joint forecasting, and new product development. The integrative practices are treated as homogenous or exchangeable as a focal firm could be high on integration by doing some of these practices intensively or a larger number of them moderately. While the existing literature has done a commendable job to highlight the importance of integration, it has its limitations. We do not know which integrative practices are order winners and which are merely order qualifiers as empirical studies only give the average effect of a large number of practices. Firms also do not know if some practices are pre-requisites of others, or if there is an order in which the practices should be established in a relationship. The large body of empirical work on environmental conditions, that make integration more or less desirable, is also of limited use as the conditions may impact some integrative practices very differently than others.

The objective of this dissertation is to address these gaps by identifying the structure of the integration conceptual space. Using qualitative and quantitative techniques, we address the following research questions:

RQ1: What are the building blocks (constructs) that make up the supply chain integration black box?

RQ2: What are the effects of these building blocks on profitability and competitive advantage?

RQ3: What is the effect of environmental dynamism on the relationships between these building blocks and performance?

In this dissertation, the elements or building blocks of integration are identified and empirically verified to address RQ1. We identify some elements that have no direct effect on performance and have a supporting role only. We also show which elements of integration are order winners by testing their effects on profitability and competitive advantage (RQ2). For example we show that some elements of integration are only order qualifiers and do not lead to performance differentials over rivals. Since we don't expect our elements of integration to behave uniformly under various environmental conditions, we use environmental dynamism to empirically test this. We show that some elements of integration that are focused on creating knowledge become more valuable in dynamic conditions, while others that are focused on operational improvements become less valuable (RQ3).

The findings of our work have profound implications for designing supply chain relationships. Firms will know which elements of integration are order qualifiers and which ones contribute to competitiveness. Firms will also be able to take relationship level decisions by combining the results from this research with knowledge of the elements implemented in a particular relationship. This is in contrast to previous work that only provided guidance about the average level of integration with all supply chain partners. Knowledge of how the performance benefits of the elements vary with environmental conditions, like dynamism, will allow firms to act more prudently when implementing those elements in important relationships.

This dissertation has two major parts. The first part addresses RQ1 and is presented in chapters 2 to 5. In chapter 2, we use a structured literature review to identify 138 integrative practices that comprise supply chain integration. We then use qualitative analysis to identify the constructs that represent those integrative practices. We call these constructs the elements (or building blocks) of integration. In chapter 3 we develop measurement scales for our newly identified elements of integration. We also do pre-testing to establish the reliability and validity of the measurement scales. In chapter 4 we explain our research design and data collection process. We collect survey data from manufacturing firms in North America. In chapter 5 we establish the measurement properties of our constructs using the survey data and provide empirical evidence for our elements of integration view of supply chain integration.

The second part of the dissertation is based on the elements of integration identified and empirically verified in the first part. In chapter 6 we develop hypotheses regarding RQ2 and RQ3. In chapter 7 we empirically test all hypotheses developed in chapter 6 and discuss the importance of our findings. Chapter 8 concludes the dissertation by delineating the implications of this work for research and practice.

2. IDENTIFYING ELEMENTS OF SUPPLY CHAIN INTEGRATION

In this chapter we address the first research question and identify the elements, or building blocks, of supply chain integration (SCI). The first research question is important because integration is fundamental to the study of supply chains. Several authors have defined supply chain management in terms of integration. “The term supply chain management extends the ‘concept of integration’ beyond the firm to all firms in the supply chain” (Ellram & Cooper, 1990; Min & Mentzer, 2004, p. 62). Similarly supply chain management is “to *integrate* and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers” (Mentzer et al., 2001, p. 6). Supply chain management is often understood as achieving or enacting supply chain integration (e.g. Narasimhan & Jayaram, 1998).

We first present a literature review to summarize the current understanding of SCI and to identify the integrative practices that have been studied as integration. We then highlight the limitations of the existing view of integration that can be ameliorated by our new conceptualization. That is followed by our qualitative analysis of integrative practices to identify the elements of integration. We conclude this chapter by showing how various theories used in supply chain research apply to the elements of integration.

2.1. Literature Review

A structured literature review was conducted to understand the supply-chain integration (SCI) construct, its dimensionalization, and its salient relationships with other constructs. Some authors consider studying published literature reviews to be a good source of developing overall insights about a body of literature (Parmigiani & Rivera-Santos, 2011). In that spirit, we also included published literature review articles in our literature review. The inclusion criteria for the literature review is as follows:

1. All articles on supply chain integration and buyer-supplier relationships that were published in *Journal of Operations Management* or *Journal of Supply Chain Management* between 2000 and 2012 were included (as long as they did not fall in the exclusion criteria explained below). Past literature reviews have shown that these two journals are the most prestigious (based on impact factors and research community acceptance) and most popular outlets for research in supply chain management (Giunipero et al., 2008). It is difficult to imagine that key issues or elements related to the SCI construct would have been missed completely by these two journals in the last 12 years. Studying papers in the last 12 years is justified because Terpend et al. (2008) show in their extensive literature review covering 1986 to 2005 that constructs have grown and researchers have only added to the integrative practices being studied for BSRs without taking anything away from what was identified by the pre-2000 research. Also the goal of this dissertation is to develop and empirically test theory that is relevant for the present context of business. An emphasis on studies from a distant time with a very different economic and business climate can bias the theory development too strongly towards explaining the past.
2. To broaden the scope of the literature review, bibliographies of the following literature reviews of supply chain management or buyer-supplier relationships were examined and relevant articles included: (Carter & Ellram, 2003; Croom et al., 2000; Appendix A of Flynn et al., 2010; Giannakis & Croom, 2004; Giunipero et al., 2008; Ho et al.,

2002; Ketchen Jr. & Giunipero, 2004; Terpend et al., 2008; van der Vaart & van Donk, 2008). This step resulted in influential articles being included from journals that were not directly examined.

Articles focusing narrowly on the following areas were excluded: electronic data interchange (EDI) or a particular IT technology, transportation issues, supply-chain risk, supply chain disruptions, purchasing, sustainability and environmental issues. Sustainability is an important area in itself it is not within the scope of this dissertation. The rationale behind these exclusions was that such papers did not inform us about the integrative practices being used in supply chains. Rather they focused on other important issues in supply chains that are not in the scope of this study. From the buyer-supplier relationship (BSR) literature stream articles that described or measured what practices are used in a relationship or what the relationship consists of were included.

The inclusion and exclusion criteria described above led to 123 articles and 11 literature review articles. These articles are listed in tables A1 and A2 in appendix A.

2.1.1. Existing View of Supply Chain Integration

Our literature review shows that the content domain of the SCI construct has grown over time. Initially SCI was studied from the logistics and purchasing orientations which included managing the flow of materials, strategic purchasing and supplier management as part of SCI (Ellram & Cooper, 1990; Frohlich & Westbrook, 2001; Tan, 2001). More recent work has added new product development, strategic partnership and knowledge generation to the SCI construct’s domain. For example Flynn et al. (2010) define SCI as "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes” (Flynn et al., 2010, p. 59). High levels of supply chain integration are described as “supply chain partners can work (by collaborating) as if they were a part of a single enterprise” (Cao & Zhang, 2011, p. 165). In Table 2.1 we list several popular definitions of SCI, to give an overall picture of the theoretical domain of this construct.

Table 2.1
Existing Definitions of SCI

Paper	Definition
(Zhao et al., 2008, p. 374)	SCI is “the degree to which a firm can strategically collaborate with its supply chain partners and collaboratively manage the intra- and inter-organization processes to achieve effective and efficient flows of product and services, information, money and decisions with the objective of providing maximum value to customers at low cost and high speed.”
(Cooper et al., 1997, p. 2)	“Supply chain management is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers”
(Simatupang & Sridharan, 2005, p. 258)	SCI is “the close cooperation among autonomous business partners or units engaging in joint efforts to effectively meet end customer needs with lower costs”
(Flynn et al., 2010, p. 59)	SCI is "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes”
(Cao & Zhang, 2011, p. 166)	SCI is “a partnership process where two or more autonomous firms work closely to plan and execute supply chain operations towards common goals and mutual benefits”

SCI has been usually been studied at the focal firm level, with integration being the average level of integration of the focal firm with major suppliers and customers (Cooper et al., 1997; Lambert & Cooper, 2000; van der Vaart & van Donk, 2008). The literature consistently treats SCI as being composed of customer, supplier and internal integration (Das et al., 2006; Flynn et al., 2010). This approach has been useful in highlighting the benefits of integrating both upstream and downstream. Firms not only need to treat purchasing as strategic but also need to collaborate with their customers. Our goal is to improve our understanding of integration by taking a more fine-grained level of analysis where we consider what integrative practices are being implemented at the relationship level. We refer to the existing view of SCI as the black-box view of integration because all types of different integrative practices are grouped together under supplier and customer integration constructs, and only the average level of integration of potentially very different supply chain relationships is measured.

Terpend et al (2008) show in their extensive literature review covering the years 1986 to 2005 that the number and variety of integrative practices implemented between buyer and suppliers have increased. Recent studies have added new practices to the same constructs resulting in the integrative constructs getting broader in scope. In addition to having a wide list of integrative practices that make up the supplier and customer integration constructs, papers do not measure these integrative practices consistently. Our literature review revealed 138 different supply chain integrative practices that were measured as supplier and customer integration by the various empirical studies. These practices are listed in table A3 in appendix A. Figure 2.1 shows a word cloud of these integrative practices, with the size of each word proportional to its frequency of occurrence. Studies pick and choose their own unique combinations of integrative practices to measure supplier and customer integration, making comparing research findings difficult (Ho et al., 2002). This view of SCI is of limited help to practitioners who need to make decisions regarding individual supply-chain relationships and do not have the time and resources to implement the long list of 138 integrative practices in each relationship.

Figure 2.2 graphically shows the difference between the current black-box view of integration and our proposed conceptualization that is detailed later in this chapter.

Figure 2.1. Word cloud of the 138 integrative practices discovered in the literature review

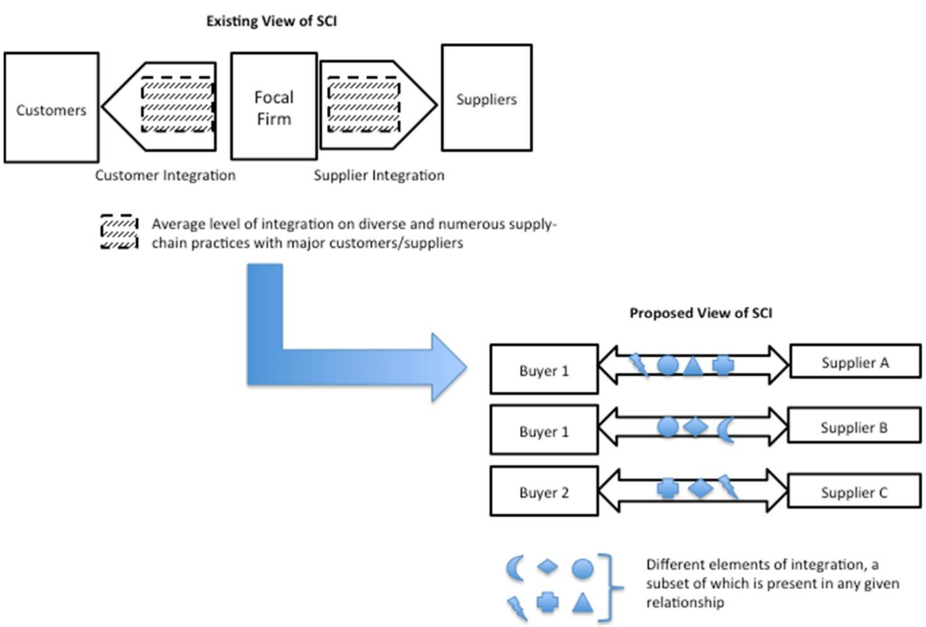


Figure 2.2. Overview of Existing and Proposed Conceptualization of SCI

2.1.2. Dimensions of SCI in Existing Literature

The SCI concept is often measured and studied as three constructs: customer integration, supplier integration, and internal integration. Customer and supplier integration capture whether integration is done upstream or downstream by the focal firm, while internal integration deals with the internal workings of the focal firm.

2.1.2.1. Internal Integration

"Internal integration refers to the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes" (Zhao et al., 2011, p. 19).The value and need for internal integration and avoiding functional silos has been acknowledged by literature in strategy, organizational theory, and operations management. The early classic by Lawrence and Lorsch (1967) is one of the influential works on this topic. Lawrence and Lorsch (1967) highlight the need for benefiting from the gains from functional specialization (differentiation) as well as from functional integration. In the operations literature many studies have shown the benefits of internal integration on new product development, operations performance and firm performance (Narasimhan and Jayaram, 1998; Scott W. O'Leary-Kelly and Flores, 2002; Pagell, 2004; Rosenzweig et al., 2003a; Song and Swink, 2009; Swink et al., 2007, 2005; Zhao et al., 2011).

Internal integration builds absorptive capacity in the firm (Zhao et al., 2011) to benefit from external sources of new information and knowledge, and a coordinative capability to benefit from external relationships and joint activities with other firms

(Hillebrand & Biemans, 2003; Lane et al., 2006; Takeishi, 2001). Due to this capability building nature of internal integration it is often treated as an "enabler" of inter-firm integration. Lack of internal integration can be a barrier to inter-firm integration or reduce the benefits of inter-firm integration because multiple sub-units of a firm are exposed to its supply chain partners. If these sub-units of the firm are not integrated, they will hinder cooperation and joint initiatives with the supply chain partner or at least reduce the efficiency of such joint initiatives. Previous research has found support for the moderating role of internal integration in the inter-firm integration to performance relationship (Droge et al., 2004; Germain & Iyer, 2006).

The focus of this dissertation is on inter-firm (external) integration for two reasons: (1) most firms recognize the benefits of internal integration, including strategic integration and functional integration, and strive for it while the same cannot be said for inter-firm integration (Fabbe-Costes & Jahre, 2008; Fawcett & Magnan, 2002; Mahajan et al., 1994; Malhotra & Sharma, 2002; Swink et al., 2007), (2) internal integration concepts have been well developed by multiple research traditions over several decades while the same cannot be said for inter-firm supply-chain integration (Lawrence & Lorsch, 1967; Swink et al., 2007; Zhao et al., 2011a).

2.1.2.2. Suppler and Customer Integration

The existing literature has done a commendable job of highlight the benefits of SCI. It has changed the discourse from exploiting power in supply chain relationships (Kraljic, 1983) to collaborating with supply chain partners. In the SCI literature inter-firm integration is consistently conceptualized as supplier integration and customer integration (Frohlich & Westbrook, 2001).

In the existing view of SCI there is no fundamental difference between supplier and customer integration other than the location of the supply-chain link that is being referred to i.e. a focal firm integrating with upstream partners versus downstream partners. All of the 138 integrative practices we found were used as customer and supplier integration in the literature. A specific study may have some differences in the list of integrative practices it uses for customer and supplier integration but over the entire literature the two constructs cover the same content. The difference between integrating upstream or downstream from the focal firm perspective disappears when we consider integration between a supply chain dyad (a pair of buyer and supplier firms).

The SCI literature for the most part agrees that supply chain integration is beneficial. The focal firm's operational and financial performance is positively affected by supplier and customer integration (Frohlich & Westbrook, 2001; Rosenzweig et al., 2003a; Swink et al., 2007; Zhou & Benton Jr, 2007a). Closer relationships with supply chain partners lead to trust and reduce the threat of opportunism. Relationship specific investments can subsequently be made (Das et al., 2006). Additionally researchers have highlighted the reduction in administrative costs for the buyer and supplier by having to deal with fewer other firms if order volumes are split between fewer firms. The benefits of supplier involvement in new product development have been well established (Handfield et al., 1999; Petersen et al., 2005). Closer relationships also provide easier coordination (Kulp et al., 2004), and transfer and creation of new knowledge which can prove useful for both parties (Craighead et al., 2009; Krause et al., 2007a).

The empirical findings for the performance benefits of customer and supplier integration, however, are inconsistent. Some studies find customer integration to be significant (Flynn et al., 2010; Germain & Iyer, 2006), others find supplier integration to be significant (Devaraj et al., 2007), while others still find both to be significant (Frohlich & Westbrook, 2001, 2002; Swink et al., 2007). Some authors have argued that existing empirical results about the benefits of integration should be interpreted with caution due to the lack of consistency in empirical findings and in the operationalizations of supplier and customer integration (Fabbe-Costes & Jahre, 2008).

2.1.3. Limitations of the Existing View of SCI

The SCI construct has been growing over time though its current dimensionalization does not reflect that. The definitions of SCI, as shown in table 1, stress on collaboration, which can take many forms. Researchers have used different sets of integrative practices to measure the same construct (see table 2). Burgess et al. (2006) show in their review of supply chain management that in 58 out of the total 100 articles no definitions were proffered. Wacker (1998, 2004, 2008) has pointed out that theory building without good definitions will not yield reliable results. Fabbe-Costes and Jahra conclude that: “definitions and measures of SCI and performance are diverse to the extent that a conclusion such as the more SCI the better (the performance) cannot be drawn” (Fabbe-Costes & Jahre, 2008, p. 130).

The numerous integrative practices studied as SCI are qualitatively different. For example information sharing has very different requirements in terms of costs and requisite trust as well as very different objectives and benefits than joint new product development. Bundling such different practices in the same construct reduces precision, interpretability of results, generalizability and practical application. Since the dominant view in the literature is to conceptualize SCI as the average level of integration with all major suppliers and customers, the normative suggestion seems to be that all firms should establish many integrative practices with all of their major suppliers and customers, clearly a daunting and costly task. Fabbe-Costes and Jahre also highlight this issue and state that “it is [...] difficult to provide managers with normative advice over how and what to integrate, the cost of integration, and its possible negative consequences” (Fabbe-Costes & Jahre, 2008, p. 131). This issue also leads to the “apparent contradiction in the literature between promised benefits and still limited evidence of extensive implementation" (Power, 2005, p. 261).

Defining SCI at the focal firm level has some important limitations. For most firms the supply chain looks “less like a pipeline or chain than an uprooted tree, where the branches and roots are the extensive network of customers and suppliers,” (Lambert & Cooper, 2000, p. 69). Hence the level and type of integration between the focal firm and its many partners varies. Supply chain researchers have traditionally not given much attention to selecting the appropriate level of integration for different relationships (McCutcheon & Stuart, 2000a), which is an important omission (Goffin et al., 2006). Gimenez and Ventura conclude that “we cannot assign a global level of external integration to a firm; there is a need to consider the level of integration in each particular supply chain relationship” (Gimenez & Ventura, 2005, p. 23). Since SCI is studied as the average level of integration with suppliers and customers it is not possible to accurately study the impact of relational attributes, like trust, on integration.

The existing view of SCI is limited to studying the average effect of contextual factors like environmental uncertainty on integration with major suppliers or customers. It is unlikely that contextual factors like environmental uncertainty affect all types of supply-chain integrative practices uniformly. For example the need for sharing demand related data to reduce the bullwhip effect (Lee et al., 1997a) remains even when environmental uncertainty is low. Since some supply-chain integrative practices are not affected by uncertainty, while others are, when they are combined in one construct the effect of uncertainty on such a mixed bundle of practices cannot be accurately determined. This is why some studies find environmental uncertainty to increase the effect of integration on performance (Wong et al., 2011b), while others find the reverse (Iyer et al., 2009), and others still find no moderating role of uncertainty (Koufteros et al., 2005). In this dissertation we identify elements of integration such that each element is comprised of related supply-chain practices. The various elements of integration are expected to behave differently to contextual factors. This leads to a more nuanced and useful understanding because we can then determine which elements of integration are moderated by certain contextual factors and which elements are not.

Table 2.2 provides quotes from several influential literature reviews of SCI that agree with the issues we have pointed out and that have called for work to rectify them.

Table 2.2
Other Literature Reviews of SCI with Similar Conclusions

Paper	Definition
(van der Vaart & van Donk, 2008, p. 43)	"if we looked at all the surveys on integration, a large list of seemingly different constructs and measurements could be drawn up"
(Ho et al., 2002, p. 4415)	"it is important to note the fact that there is little consistency about the basic definition and content of the SCM construct among these studies"
(Fabbe-Costes & Jahre, 2008)	"Definitions and measures of SCI and performance are diverse to the extent that a conclusion such as the more (SCI) the better (the performance) cannot be drawn" (p. 130) "our analysis does, indeed, support the statement by Kahn and Mentzer (1996) and confirmed by others almost a decade later, on the conceptual vagueness of supply chain integration" (p. 143) "Our research also supports the idea that a differentiated approach of SCI is of interest and can help companies to identify and focus on a limited number of key integration elements." (p. 146)
(de Leeuw & Fransoo, 2009a, p. 733)	"In general there is no coherent view in the literature as to the conditions for close supply collaboration"

In this dissertation we extend existing research by developing and empirically testing a new relationship (dyad) level conceptualization of SCI that is composed of elements of integration. Identifying and defining distinct elements of integration avoids merging the wide range of integrative practices into one construct. We also show in later chapters that important environmental factors like dynamism do not affect all the elements of integration uniformly.

2.2. Developing the New Conceptualization of SCI

We follow a systematic process that relies on the findings of our literature review to identify, define and empirically test a new conceptualization of SCI. The process is summarized in Figure 2.3 and is based on well-established methodological guidelines (Anderson & Gerbing, 1991; Menor & Roth, 2007; Nunally & Bernstein, 1994). In our new conceptualization SCI is defined at the relationship (dyad) level and elements of integration are identified to capture what integration entails. Each element of integration is composed of related integrative practices that are homogenous and hence can be treated as one bundle. Different elements of integration may have different relationships with performance, relational variables like trust and environmental contingencies.

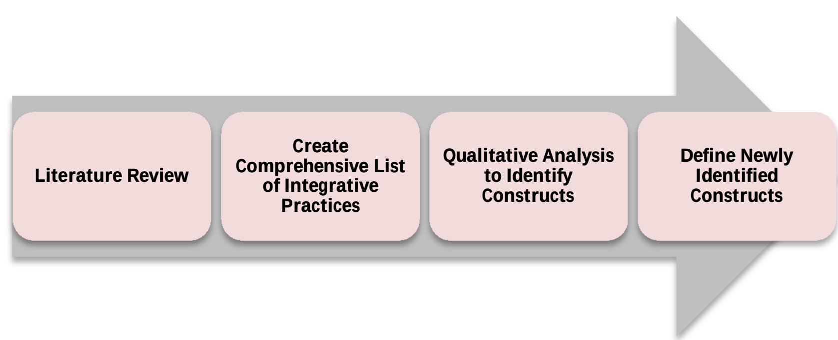


Figure 2.3. Process to identify and define new integration constructs

2.2.1. Defining Inter-firm Supply Chain Integration

Wacker (2008) suggests that researchers should redefine constructs to improve prior definitions and when existing definitions are no longer adequate due to changing times or increased knowledge about the domain. "The 'previous definitions are precise enough' assumption leads to ill-defined concepts being assumed to be adequate" (Wacker, 2008, p. 8). We need to redefine inter-firm supply chain integration because past definitions have not been improved as the SCI construct has grown over time. Also we are changing the level of analysis of integration from a focal firm to the relationship and that requires updating the definition.

Examination of the operationalizations of the SCI construct in existing studies makes it clear that the term SCI is generally used in the literature to describe various supply-chain integrative practices. An example of an integrative practice is joint forecasting, in which personnel from both firms come together to create forecasts that drive production plans. Thus, based on the analysis of the existing literature in the past section, we define inter-firm integration in terms of supply-chain integrative practices:

A supply-chain integrative practice is a joint activity or shared process between a buyer firm and a supplier firm, with the aim of creating greater value for both firms than what could be achieved without such joint action.

A process represents a set of tasks that recurs continuously, such as day-to-day operations. The nature of the task does not change much from one period to the next.

An activity represents tasks done for a special event or occasion, such as a new store launch, holiday season preparations, or annual strategic review.

A buyer-supplier dyad's level of integration can be determined based on the use of supply-chain integrative practices.

We use value in the same way it is used in strategy literature and in the resource based theory (RBT), that is value is the difference between what the end customer of the buyer-supplier dyad is willing to pay and the total economic cost of the good or service produced (Peteraf & Barney, 2003). A good definition should not be so narrow so as to describe a particular context only, nor too broad so as to be indistinguishable from other organizational phenomenon (Wacker, 2004). This definition of inter-firm SCI allows a broad range of phenomenon to fall under it. We provide more precision when we identify the elements of SCI. This new definition distinguishes the SCI concept from unilateral supply management decisions of the focal firm such as deciding to source each component from two suppliers, or top management focus on supplier integration, which has not been done by some previous definitions and operationalizations of the construct. It distinguishes SCI from some aspects of purchasing; for example having a strategic orientation to purchasing does not necessarily mean integrated buyer-supplier dyads. A firm with a strategic orientation to purchasing may still have many transactional relationships. It defines the scope of the construct to be between two firms, a buyer and a supplier, (i.e. inter-firm SCI is a dyad level construct) so the confusion regarding integration being the average of a group of supply-chain relationships is resolved. Also the rather artificial distinction between supplier and customer integration is removed by defining inter-firm SCI to be a dyadic construct.

2.2.2. Creating List of Integrative Practices

The literature review was used to identify what practices are measured as integration in the empirical literature on SCI. We found 138 integrative practices that are shown in Table

A3 in Appendix A. This list of practices forms an empirical dataset that captures the domain of supply chain integration comprehensively.

2.2.3. Qualitative Analysis to Identify Constructs

We used the 138 supply chain practices identified in the literature review as an empirical data set. Qualitative analysis was used to discover the underlying constructs. We followed the guidelines of Miles and Huberman (1994) in analyzing textual data. The steps followed are illustrated in Figure 2.4 below.

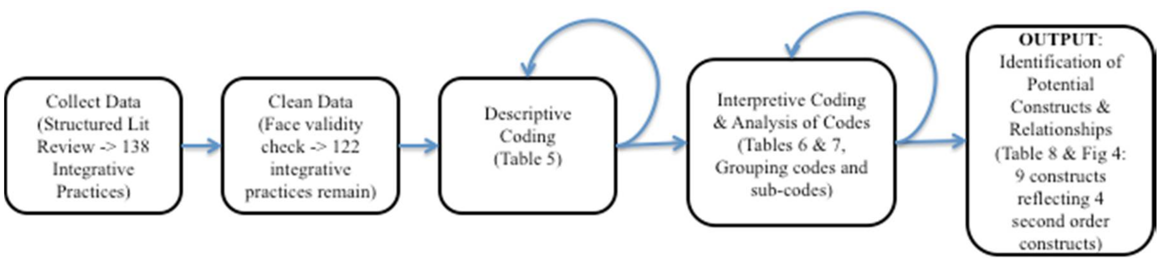


Figure 2.4. Qualitative analysis steps.

After the data had been collected in the structure literature review phase, the data was cleaned by checking all the integrative practices for face validity. The face validity check compared the integrative practices with our definition of inter-firm integration from section 4.1. Practices that were unilateral decisions of one firm were discarded, as they do not represent integration between two firms. For example a firms decision to select suppliers based on quality rather than price would not be integration as it is a unilateral policy decision of the buyer. This initial cleanup based on face-validity of the practices reduced the list to 122 practices.

Miles and Huberman (1994) recommend that after collecting and cleaning the data, the next step is to code the data using descriptive codes. This coding summarizes the data; and using an inductive approach to develop the codes lets the data speak for itself. The next step is more interpretive in which pattern codes are found. Pattern codes capture “sets, themes, or constructs” in the data (Miles & Huberman, 1994, p. 69). We generated descriptive codes using a grounded or inductive approach (Miles & Huberman, 1994; Strauss & Corbin, 1990). The advantage of this approach is that it does not bias the researcher to existing views and expectations about the data. It also lets the data speak on its own terms as otherwise data can often be forced to fit a preconceived set of codes.

Each practice was examined by considering what activities were being done and what the intended objectives were. This allowed us to group together similar practices. Table 4 shows the codes that emerged from the first pass of coding and the number of practices coded with each code. If a practice seemed applicable to more than one code it was assigned multiple codes, which is why the total in column 3 of Table 3 exceeds 122. As we describe next, these first pass codes were subjected to several rounds of refinement and validation. Two researchers did the coding. After each round of coding results were compared and any discrepancies resolved through discussion and mutual agreement.

Table 2.3
Codes that Emerge from first pass of descriptive coding

Codes (High Level)	Description	Number of Practices Coded
COMM-HOW	Communication How: Communication is broad term that captures sharing intangible resources. How refers to different types of activities under which communication takes place.	25
COMM-WHAT	Communication What: Communication is broad term that captures sharing intangible resources. What refers to what type of information and knowledge is shared.	64
RES-SHARE	Sharing Tangible Resources: Captures sharing and pooling together physical and concrete resources.	12
BUS-PRATICES	Business Practices: Various business practices that involve working together of buyer and supplier firms.	67
LT-ORIENT	Long Term Orientation: Long-term collaborative arrangements or types of collaboration that suggest long-time horizon of working together	15

A second pass of descriptive coding was done by examining each group from Table 2.3 and coding the practices in that group using more descriptive codes. Again the same method was followed where the practices were examined and codes generated to reflect similar practices with similar business objectives. The results of the second round of descriptive coding are shown in Table 2.4.

Table 2.4

Codes from further descriptive coding

Code	Description	Number of Practices
COMM-HOW	Communication How	
- F2F	- High Level Face to Face Communication, such meetings, facility visits	13
- CompMed	- Computer Mediated Communication: use of emails, IT systems, EDI, and electronic information sharing	9
- CommFreq	- Communication Frequency: ensuring frequent and timely communication	6
- Teams	- Using Inter-organizational Teams	9
COMM-WHAT	Communication What	
- PerfFeedback	- Sharing performance assessments and providing feedback	24
- OpsComm	- Operational (day to day) communication to coordinate material flows and manage production and logistics related processes	34
- KnowComm	- Sharing knowledge	10
- NPDComm	- Communication related to New Product Development (NPD)	2
- StratComm	- Long-term sensitive and strategic communication	26
RES-SHARE	Sharing Tangible Resources	
- Fin&Tech	- Sharing financial and technological resources	6
- LogRes	- Sharing logistics related resources	6
BUS-PRACTICES	Business Practices	
- P&C	- Planning and control of logistics, material flows, and manufacturing related activities	25
- JIT-Lean	- JIT and lean related practices that involve supply-chain partners	6
- Quality-CI	- Quality and continuous improvement activities that involve supply-chain partners	22
- NPD	- Jointly conducting new product development (NPD)	8
- Teams-P&C	- Use of Teams for Planning and Control	7
- Teams-NPD	- Use of Teams for New Product Development	5
- Teams-OpsImp	- Use of Teams for Operational Improvement	11
LT-ORIENT	Long Term Orientation	
- CollabOrient	- Maintaining and strengthening collaborative orientation and a long-term relationship perspective	9
- StratPlan	- Strategic planning with supply-chain partners	7

Examination of the data after the second pass of descriptive coding revealed no new descriptive codes. This indicated that we had described the data on its own terms.

Before proceeding to the next more interpretive stage of finding pattern codes and constructs we wanted to ensure that we had not over-coded the data. When inductive coding is used, there is a risk that too many codes are generated with some codes essentially duplicating others. We examined all the codes and the practices in them and found two instances where codes were duplicating what had already been captured in other codes. The first instance was the COMM-HOW code as all the practices under COMM-HOW were also assigned other more appropriate codes as well. Each supply chain integrative practice requires an appropriate communication mechanism that is suitable for it. In that sense the communication medium employed is an attribute of the integrative practice and not another type of integrative practice by itself. Conceptually COMM-HOW should be treated as an attribute of integration and not as a type of integration. Thus we removed COMM-HOW from further analysis. This did not result in any of the practices being dropped as all practices coded as COMM-HOW also had other codes assigned to them. A second instance was that of the Teams codes under Business Practices. Just like COMM-HOW, teams are a communication and collaboration mechanism that is often employed by many types of integrative practices. It is an attribute of some integrative practices that require close collaboration with face-to-face communication. Thus for reasons similar to the instance of COMM-HOW all of the Teams codes (Teams-P&C, TeamsNPD, TeamsOpsImp) were removed. This did not result in any practices being dropped from the analysis as all practices under those codes also had other codes assigned to them.

We then proceeded to the next stage of finding patterns or leitmotivs. Pattern codes are "explanatory or inferential codes, ones that identify an emergent theme, configuration or explanation" (Miles & Huberman, 1994, p. 69).This stage is more interpretive where the researcher must move from the descriptive codes to the underlying constructs (Miles & Huberman, 1994). We make use of data displays to map the descriptive codes along various dimensions related to integration to identify the inter-relationships between the codes. An important part of this stage is "unfreeze and reconfigure" (Miles & Huberman, 1994, p. 70) codes as constructs and relationships between them emerge. We examined the descriptive codes by creating data displays using tables to see if they exhibited any patterns.

As a first cut we wanted to see which theoretical perspectives were represented by the codes. We examined the practices in each code to determine if they reflected one or more of the theoretical perspectives used by supply chain integration literature. SCI literature relies on the system dynamics view (Forrester, 1958; Lee et al., 1997a), the relational view along with the extended resource based view (Flynn et al., 2010; Swink et al., 2007), transaction cost economics (TCE) (Das et al., 2006), and the knowledge based view (KBV) (Hult et al., 2006). Table 2.5 shows the results of mapping the codes to the appropriate theoretical perspectives. A summary of these theoretical perspectives that shows how the various elements map to these theories is presented in a separate section at the end of this chapter to avoid digressing from the qualitative analysis here. For a code to be reflective of a theoretical perspective the integrative practices coded by it must address the theoretical rationale for integration provided by that perspective. For example resource sharing reduces chances of opportunism as both sides have a cost for behaving opportunistically i.e. loss of access to shared resources. Some codes capture more than one theoretical perspective and are illustrated off the diagonal of Table 2.5. The location of the codes, in terms of which column and row they lie in, shows which theoretical perspectives they relate to. These four perspectives underlie the motivations and reasons for supply chain integration and also explain why integration is beneficial for firms. Table 2.5 validates our assessment that the broad construct of integration taps into more than one theoretical perspective and hence is a broad multi-faceted construct.

Table 2.5

Theoretical perspectives and integrative practices

	System Dynamics	Relational/ Extended RBV	TCE	KBV
System Dynamics	COMM-WHAT: OpsComm BUS-PRACTICES: P&C			
Relational/ Extended RBV	BUS-PRACTICES: P&C	COMM-WHAT: PerfFeedback BUS-PRACTICES: JIT-Lean, Quality-CI		
TCE	RES-SHARE: LogRes LT-ORIENT: CollabOrient	RES-SHARE: Fin&Tech, LogRes LT-ORIENT: CollabOrient, StratPlan COMM-WHAT: StratComm	RES-SHARE: Fin&Tech, LogRes LT-ORIENT: CollabOrient, StratPlan	
KBV	BUS-PRACTICES: JIT-Lean, Quality-CI	BUS-PRACTICES: NPD	LT-ORIENT: CollabOrient	COMM-WHAT: KnowComm, NPDComm BUS-PRACTICES: NPD

To understand the relationships and differences between these codes, which represent groups of related integrative practices, we compared them on their requirements for the mode of communication, contractual trust, and goodwill trust. Table 2.6 shows a 2x2 matrix that shows which codes require what type of trust and communication medium. We take the idea of contractual verses goodwill trust from existing literature (Ring & Van De Ven, 1994). Contractual trust is based on the idea of control where contracts are used to govern the relationship and contract enforceability though not perfect is sufficient to provide confidence in the behavior of the partner. On the other hand goodwill trust is required for more intimate forms of collaboration where the outcomes are uncertain and hard to quantify up front. Contracts cannot be written or are too costly to write and implement. In such situations trust stems from knowledge of the partner's intentions, past history, behavioral disposition and shared fate.

Table 2.6

Comparison of the codes on communication medium and trust

	Electronics (IT mediated) Communication	**Face to Face Communication**
Contractual Trust: confidence in partner behavior due to control (governance through contracts and contract enforceability)	COMM-WHAT: PerfFeedback, OpsComm BUS-PRACTICES: P&C	RES-SHARE: Fin&Tech COMM-WHAT: PerfFeedback
Goodwill Trust: confidence based on knowledge of partner's intentions, relationship strength, and past history	RES-SHARE: LogRes	COMM-WHAT: KnowComm, NPDComm, StratComm BUS-PRACTICES: JIT-Lean, Quality-CI, NPD LT-ORIENT: CollabOrient, StratPlan

Tables 2.5 and 2.6 provide a good basis to analyze the practices captured by each code and move towards identifying constructs.

2.2.3.1. COMM-WHAT to Basic Communication

Tables 2.5 and 2.6 show some of the codes under the COMM-WHAT category are very different from each other. For example PerfFeedback and OpsComm do not require face-to-face communication or goodwill trust where as KnowComm and StratComm require both. This means that the COMM-WHAT code is capturing more than one construct as it is.

We identified "Basic Communication" as the most important construct captured by COMM-WHAT. Basic communication comprises of those aspects of communication that can exist (or be implemented) without any of the other higher-level integrative practices taking place. Essentially *Basic Communication* consists of those elements of communication that are required from the system dynamics perspective to manage material flows more efficiently. We realized that the other types of communication were all already part of various other codes. For example COMM-WHAT/StratComm is captured by LT-ORIENT/StratPlan. To make a collaborative strategic plan by definition involves some level of strategic communication. This was done to reduce the the scope of COMM-WHAT and allow for greater precision and uniqueness in the emerging constructs.

Since *Basic Communication* does not capture some of the codes in COMM-WHAT, those codes were moved. The practices coded as KnowComm and NPDComm were moved from COMM-WHAT to a new code called *Knowledge Generation*. Similarly COMM-WHAT/StratComm was moved to StratPlan under LT-ORIENT.

Thus the construct *Basic* Communication captures the codes PerfFeedback and OpsComm only.

2.2.3.2. BUS-PRACTICES to Operational Excellence

As already explained the sub-groups regarding teams under BUS-PRACTICES were removed as the use of teams is a mechanism used by many integrative practices and does not provide information about the type of integration. Making a construct to capture use of teams is not required if the integrative practices that involve use of teams are present.

After examining all of the remaining codes and the practices they represent, it becomes clear that all of these integrative practices have a common goal: that of *Operational Excellence*. They also aim to achieve this goal with a common operational improvement methodology. As such as we can define a construct called *Operational Excellence* that captures the codes of BUS-PRACTICES/P&C, BUS-PRACTICES/JIT-Lean, and BUS-PRACTICES/Quality-CI.

We noticed that sharing logistics resources is often a part of *Operational* Improvement as it reduces costs and helps in planning and control of logistics. *Thus* we also assigned the code RES-SHARE/LogRes to the newly identified construct of *Operational Excellence.*

Operational Excellence is a higher order construct as it captures three types of efficiency related integrative practices: planning & control, JIT-Lean-Quality practices, and logistics resource sharing. Therefore we identify *Operational Excellence* as having 3 sub-constructs, namely: *Planning & Control, Collaborative Improvement,* and *Logistics Resource Sharing*. Collaborative Improvement captures JIT, Lean and quality improvement initiatives all of which share similar goals and methodologies. The literature on these initiatives has also included working with suppliers as a key part of the Lean, JIT and quality paradigms (Flynn et al., 1995; Shah & Ward, 2003, 2007) and thus it is no surprise that we find these constructs in the context of integration.

2.2.3.3. Knowledge Generation

Three codes almost exclusively deal with creating new knowledge, and they are: COMM-WHAT/NPDComm, COMM-WHAT/KnowComm and BUS-PRACTICES/NPD. New product development activities in a supply chain dyad necessarily create new knowledge, as the two firms must learn new technologies, do research, develop prototypes and eventually manufacturing techniques for the new products. Often new products require changes in manufacturing processes, as well as sales and distribution processes. Supply chain partners are often involved in NPD efforts to benefit from their knowledge (Koufteros et al., 2007). The end result of NPD efforts is the design, prototype and processes of a new product all of which is new knowledge.

In addition to new product development supply chain partners also develop new knowledge about the business environment, about technologies, and processes. For example manufacturers often work with downstream firms to develop knowledge regarding customers, and with suppliers to develop knowledge about new materials and improvements to components.

To capture new product development and other knowledge generation efforts we identify the *Knowledge Generation* construct. It is comprised of practices that were coded as KnowComm, NPDComm or just NPD. Since new product development efforts can often be distinguished from other knowledge initiatives by their rather well defined scope, time, and investment limits we identify two sub-constructs in *Knowledge Generation* and they are: *New Product Development* and *Other Knowledge Generation.*

2.2.3.4. LT-ORIENT to Strategic Partnership

When we examined the LT-ORIENT code, we saw that the sub-code of CollabOrient captured the two partners intention to have a long-term collaborative relationships. As such CollabOrient is an antecedent of integration but not integration itself for intentions are not always translated into action. Also collaborative orientation is a firm level attribute that does not indicate any joint activities taking place. Hence it does not pass the face validity test to be part of inter-firm integration.

The StratPlan sub-code captured joint strategic planning where both partner recognize that their firms have a shared fate and they should work together on long-term initiatives to improve their strategic position as a supply chain. Often such strategic planning involves planning for acquiring and sharing financial and technological resources that are required to achieve the strategic vision. RES-SHARE/Fin&Tech code is related to the StratPlan code as the kind of resource sharing captured by Fin&Tech can only be done when a relationship is deemed to be strategically important and treated as a formal or informal partnership. The two related codes of RES-SHARE/Fin&Tech and LT-ORIENT/StratPlan when put together strongly suggest a *Strategic Partnership* construct.

We identify the *Strategic Partnership* construct that is comprised of the following two codes that capture essential attributes of this construct: (1) Strategic Planning (LT-ORIENT/StratPlan), and (2) Sharing of Financial and Technological Resources (RES-SHARE/FIN&TECH).

2.2.3.5. RES-SHARE

This code RES-SHARE no longer exists after the above steps were taken as both of its sub-codes were used with other codes to generate new constructs. The code RES-SHARE/LogRes was used to form *Operational Excellence* and the code RES-SHARE/Fin&Tech was used to form *Strategic Partnership.*

2.2.3.6. Constructs Identified through Qualitative Analysis

Our qualitative analysis has identified four now higher order constructs: *Basic Communication, Operational Excellence, Strategic Partnership* and *Knowledge Generation*. In the analysis stage the codes that remain under each higher-order code identify the sub-constructs that comprise the higher order constructs. Figure 2.5 shows these constructs with the smaller boxes representing the sub-constructs.

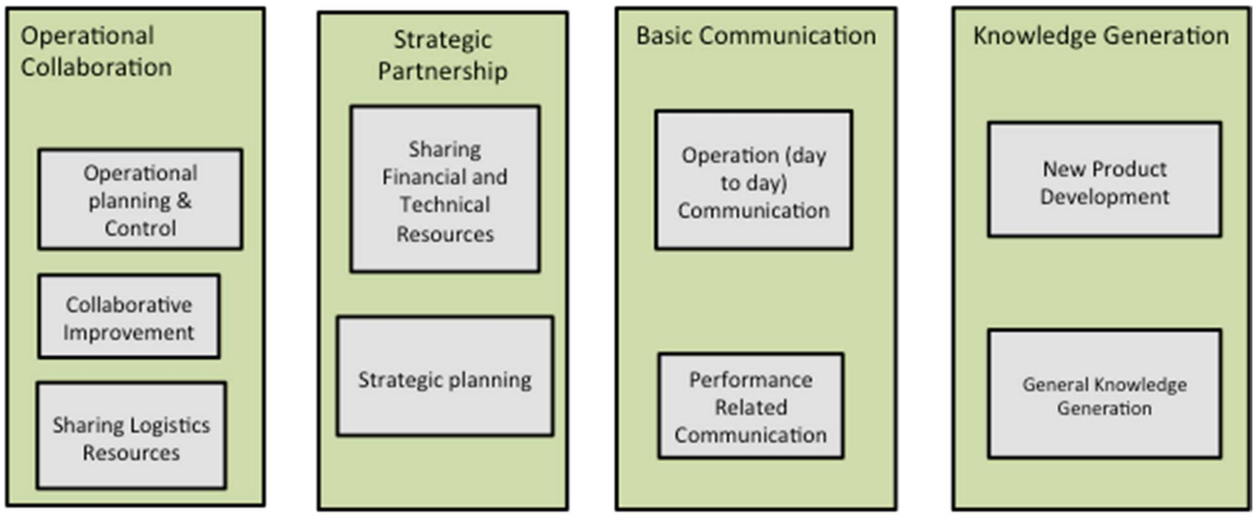


Figure 2.5. Constructs that emerge from the qualitative analysis stage

The higher order constructs have important differences, as they require different levels of trust and communication richness. Also they represent the different theories that explain SCI. *Basic Communication* and *Operational Collaboration* are rooted in the system dynamics perspective. For example, they increase efficiencies by sharing information and joint planning to mitigate the bullwhip effect and buffer inventories along the supply chain. *Operational Excellence* depends on the extended RBV as relationship specific assets are created when supply chain partners use Lean, JIT and quality management principles to improve their processes. For example, reducing inventories using just-in-time requires both sides to redesign and align their planning and inventory management processes. *Strategic partnership* reduces transaction costs as both partners acknowledge their shared fate, i.e. their success depends on each other's actions, and plan to achieve competitiveness together. Knowledge generation represents the KBV perspective, acknowledging the central role of knowledge in generating competitive advantage and the need for collaboration to increase the productivity of generating new knowledge.

The practices that are part of each code can be considered a representative sample of the theoretical domain of the newly identified construct, as our literature review was representative of the empirical work done in SCI. Thus the qualitative analysis has allowed us to identify new constructs that map out the landscape of the broad inter-firm integration construct. These constructs are called termed *elements of integration* because a given supply chain relationship may have one or more of these elements. In this manner these elements represent the building blocks of supply chain relationships that are characterized by inter-firm integration.

We now define these new constructs. Our coding of the integrative practices provides a useful map of the theoretical domain of each construct, which guides our definitions. The definitions are listed in Table 2.7.

Table 2.7
Results of qualitative analysis: elements of integration and their definitions

Construct	Definition
Operational Communication	Operational Communication refers to sharing routine data between the buyer and supplier firms that is used in day to day decision making, like inventory levels, sales forecasts, delivery and order information, logistics data, capacity and production related data.
Performance Related Communication	Performance Related Communication refers to sharing of performance metrics, performance score-cards and similar feedback between the supply chain dyad members.
Operational Planning & Control	Operational Planning & Control refers to buyer and supplier firms jointly planning and synchronizing recurring tasks and activities and systematically reacting to environmental signals related to production and flow of goods and services.
Collaborative Improvement	Collaborative Improvement refers to the buyer-supplier dyad jointly establishing continuous improvement programs and quality practices.
Sharing Logistics Resources	Refers to sharing of transportation, storage and distribution resources to improve efficiency of logistics operations.
New Product Development	New Product Development is collaboration by the buyer and supplier firms to research, design and commercialize products that are new for the supply chain dyad.
General Knowledge Generation	General Knowledge Generation is collaboration by buyer and supplier firms to generate new relevant knowledge outside of new product development efforts such as acquiring or developing new capabilities and technologies.
Sharing Financial and Technological Resources	Refers to pooling together of financial and technological assets usually for strategic and long-term gains.
Strategic Partnership	Strategic partnership refers to a buyer and supplier dyad developing and implementing business strategy together such that their fate (success or failure) is intimately tied.

2.3. The Elements of Integration and Performance

Integration aims to create greater value than the buyer and supplier firms could create without working together (Dyer & Singh, 1998). In this section we define three constructs that can be used to measure the performance impacts of the elements of integration. In the subsequent chapters we will develop measurement scales for the elements of integration as well as for these performance related constructs. Then in chapter 6 we will develop hypotheses to link the elements of integration to the performance related constructs defined here.

Since integration is a relationship level construct, the value it generates is simply the contribution of the relationship to the total value generated by each firm. Elements of integration can contribute towards economic value, and / or competitive value.

Economic value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the profitability of that firm.

Competitive value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the favorable differentiation of the firm from its competitors i.e. the competitive advantage of the firm.

In addition to the value contribution form the relationship, sustainability of the relationship is also important. Existing studies argue that when the value generated by a relationship is highly asymmetric for the two partners, such that one partner enjoys most of the benefits, then the relationship will not be sustainable (Ambrose, 2010; Frazier et al., 2009; Nyaga et al., 2013). We measure the robustness, i.e. ability to survive adverse conditions, of the relationship through our relationship quality construct.

Relationship quality is the robustness and strength of the relationship between the buyer and supplier firms.

2.4. Theoretical Perspectives and the Elements of Integration

In this section we show how some of the theoretical perspectives researchers have used to explain and justify the aggregate view supply chain integration apply to our proposed view. We discuss the system dynamics view, the relational view along with the extended resource based view, transaction cost economics, and the knowledge based view. Our proposed view of integration provides greater precision as the each theory applies to some of the elements of integration. Future researchers can select the appropriate elements of integration for their studies based on the theoretical lens they use.

2.4.1. System Dynamics Perspective

One of the earliest theories that calls for integration between supply chain partners is the system dynamics view. In a supply chain the company closest to the end consumer caters to the fundamental demand for the product or service. Upstream firms face derived demand that comes from the inputs required by downstream firms. The system dynamics view shows that if firms that comprise a supply chain work independently using only market-based transactions then they will perform sub-optimally. One of the reasons for sub-optimal performance is double marginalization (Spengler, 1950). Inventory policies are set to maximize profit by balancing the risk of lost sales and excess stock. If inventories are set based on the profit margin of individual firms in a supply chain then it can be shown that the suboptimal profits are earned as it firm does not consider the linkage between its sales and the gross margins earned by downstream firms.

A second reason for sub-optimal outcomes was shown by Forrester (1958, 1961) in his theory of industrial dynamics. Forrester noted that fluctuations, oscillations and unpredictable changes in demand would affect inventory levels and operations in the entire chain of production. In addition to fluctuations in demand or supply, just the lack of information sharing across the supply chain also adversely affects inventories and production! Sahin and Robinson (2002, pg 506) conclude that "delays, amplifications, and oscillations in *the flow of demand information* adversely affect supply chain operations, most noticeably inventory levels and production rates" (emphasis added). This idea was later developed be Lee et al. (1997a, 1997b) as the bullwhip effect which shows that without integration supply chains can suffer with huge inventory build-ups upstream which increase the cost of delivering the product or service to the end consumer. This is a fundamental challenge to the economic thinking of price as an efficient coordinating mechanism in markets based on classical economics models that did not consider multiple stages of intermediate goods all being regulated by the demand for the final product.

If customer demand for the end product increases, it will result in price increases in the short term as the firms supplying that product ramp up their production. The short term price increase will signal all firms supplying the end product to increase production and hence increase orders of intermediate goods which will increase their price in the short-term and signal all manufacturers of intermediate goods to increase supply. Similar effects will occur along the value chain, until supply is increased at all stages. As supply is being increased, firms at each level of the value chain will add buffer inventory to their orders in anticipation of increased demand and to get favorable deliveries if suppliers start rationing orders. If customer demand for the end product does not continue to rise, but falls after a certain time the whole value chain will left inundated with excess inventories (Chen et al., 2000; Lee et al., 1997a).

This idea that demand variations and information about them are crucial to efficient working of the supply chain forms the basis of product classification into functional and innovative products by Fisher (1997). Ramdas and Speckman (2000) found greater inter-firm integration in innovative product supply chains than functional product supply chains, thus supporting Fisher's (1997) recommendations.

Another finding of the system dynamics perspective, that is distinct from the bullwhip effect, is that whenever inventory buffers are used in a supply chain they cause the derived demand for the next level to become more lumpy and variable (Ballou, 2003). The greater the number of inventory buffers between a firm and the end consumer the greater the variability and sudden changes in demand this firm will experience even though the fundamental consumer demand may not be highly variable! Dealing with sudden jumps in demand and high variability is costly and can only be avoided by greater integration in manufacturing, planning, and logistics processes with upstream and downstream partners.

The system dynamics view explains the rationale for the following elements: operational communication, performance and feedback related communication, and planning and control. These elements are directly relevant for solving the kinds of problems highlighted by the system dynamics view. It applies whenever demand is not deterministic (i.e. not known a priori) and hence applies to a wide range of business situations. It shows that firms in a supply chain must work together to manage material flows, inventories, and production to meet end consumer demand efficiently.

2.4.2. Relational View and the Extended Resource Based View

The traditional resource based view (RBV) considers differences in rents generated by firms in the same industry due to their idiosyncratic resources and capabilities (Barney, 1991). The purview of RBV is the firm and its internal resources and capabilities and hence is sufficient to explain contexts that are comprised of independent firms. However SCI seeks to explain performance of firms that are deeply coupled with upstream and downstream firms in their supply chains. Researchers (Lavie, 2006) have since combined the relational perspective of Dyer and Singh (1998) with the traditional RBV (Barney, 1991) to come up with the '*Extended Resource Based View*' that can be used to explain the competitive advantage of inter-linked firms. Inter-linked firms have access to resources and capabilities of their partner firms, which are sometimes called network resources (Gulati, 1998). These network resources allow them to achieve greater rents than they could in the absence of collaborative inter-firm relationships.

According to traditional RBV firms secure rents by protecting their scarce and valuable resources from being imitated or acquired by others (Barney, 1991). The relational view argues that firms earn additional relation rents from idiosyncratic inter-firm linkages. Dyer and Singh (1998) show that for a relationship to generate additional rents, it must have one or more of the following features: relationship-specific assets, substantial exchange of knowledge, combining of complementary assets and capabilities, and lowering of transaction costs owing to more effective governance mechanisms

When two firms share resources and capabilities they aim to create additional rents. If the resources shared are similar then it is a pooling relationship where the additional rents accrue from the increase of scale or less costly access to greater resources. If however the resources and capabilities shared are different then additional rents come from complementarity and synergy of the combination. Afuah (2000) showed that technological changes that affected the capabilities of supplier firms affect the competitive advantage of the customer firms. Stuart (2000) showed that growth and innovation of firms was influenced by the capabilities of their partner firms. SCI literature focuses on inter-firm relationships between firms in a supply chain. Supply chain partner firms are able to generate greater rents by combining resources and capabilities and following cooperative strategies.

The extended RBV and the relational view provide theoretical rationale for collaborative improvement, sharing logistics resources, sharing financial and technological resources, new product development and general knowledge generation. All of these elements provide access to partner resources, integrate resources across the supply chain dyad, and assist in creating new capabilities (Amit & Schoemaker, 1993). It is not surprising that a large number of elements apply to this theory as the RBV is known to have wide applicability due to the generic nature of 'resources and capabilities' (Peteraf & Barney, 2003).

2.4.3. Transaction Cost Economics

Williamson (1981, 1985) shows that inter-firm transactions are structured to minimize transaction costs that arise from agency problems and opportunism. When firms need to invest in relationship specific assets or specialize their resources and capabilities for the exchange the risk of opportunism arises. It can be reduced by internalizing the transaction i.e. vertical integration or by using hybrid mechanisms. Hybrid mechanisms involve developing trust, having long term relationships or contracts, or having reciprocal relationship specific investments. For example when two firms in a supply chain modify and link processes for better execution of inter-related tasks they are both doing relationship specific investments which reduces the risk of opportunism.

Transaction cost economics (TCE) explains that firms are able to avoid vertical integration in supply-chains and specialize in their core competencies instead while benefiting from upstream and downstream partners (Williamson, 2008). They are able to achieve this by reducing transaction costs using integrative practices that create relationship specific processes and assets on both sides of the relationship (Das et al., 2006). Transaction costs are just a part of the costs firms try to minimize and do not capture the potential superior rents from collaboration, and hence TCE is only one of the reasons for the widespread use of integrative mechanisms in supply chains.

The strategic partnership element takes its theoretical rationale from TCE. Strategic partnership creates a shared strategy and hence a sense of shared fate. This reduces opportunism directly as both partners acknowledge and institutionalize dependence on each other for long-term success. Also it requires the supply chain partners to take a long-term view of the relationship which reduces transaction costs (Das et al., 2006). TCE also apples to sharing of financial and technological resources and sharing of logistics resources if each partner has a resource the other one wants access to. In such reciprocal situations the shared resources increase the cost of breaking the relationship and thereby reduce transaction costs.

2.4.4. Knowledge Based View

The knowledge based view (KBV) treats the firm as an institution for acquiring, integrating and exploiting knowledge (Grant, 1996). Although the original theory talks about firms it has successfully been applied to the supply-chain context to talk about knowledge in supply chain dyads (Hult et al., 2004, 2006). It recognizes that the basis of creating value and competitive advantage is knowledge. Even physical assets like machines are embodiments of knowledge. In that sense explicit knowledge, such as that embodied in machines, can sometimes be acquired or transferred at much less cost than tacit knowledge. Grant argues that integrating knowledge is less costly than acquiring knowledge. For example the knowledge of two experts can be integrated by creating a team comprising them, while acquiring the knowledge of those two experts might take years of learning (Grant, 1996). This has important implications for SCI as supply chain partner firms can integrate their knowledge bases by working together and thus increase their competitiveness. That is a much more efficient way of exploiting diverse and complementary knowledge bases and entering learning races where each partner tires to acquire the knowledge of the others (Hult et al., 2006).

Absorptive capacity limits the capacity of learning of a firm and that often leads to the need to integrate knowledge from other firms. In addition to aggregating knowledge firms are also concerned with developing new knowledge to increase differentiation over rivals (Hult et al., 2003). New knowledge leads to better processes, new business models, or new products. New product development efforts often include supply chain partners to benefit from their complementary knowledge (Koufteros et al., 2007). The knowledge based view emphasis knowledge flows, knowledge acquisition and knowledge aggregation through collaboration. Knowledge is one of the widely prevalent motives and reasons for SCI, especially for new product development efforts and in dynamic business conditions (Koufteros et al., 2005).

The KBV talks about knowledge that has the potential to lead to competitive advantage. Several authors have noted that the KBV extends the RBV to include intangible and knowledge related assets (Deeds & Decarolis, 1999). As such the knowledge considered by KBV must have to some extent the properties of value, rareness, inimitability and nonsubstitutability that the RBV literature requires (Eisenhardt & Santos, 2002; Kogut & Zander, 1992). This means that not all knowledge in the firm is meant when the KBV is used to talk about knowledge. Some mundane types of knowledge such as how to create annual financial statements may have no relevance for competitiveness as such knowledge can easily be acquired from the market.

The KBV provides theoretical rationale for the new product development, general knowledge generation and collaborative improvement elements. These elements of integration leverage the knowledge bases and absorptive capacities of both partners for generating new knowledge that can yield strategic advantages to the supply chain dyad (Hult et al., 2006).

3. Scale Development

One of the important contributions of this dissertation is generating and testing survey instruments to measure the elements of integration that were identified in the previous chapter. We use psychometric methods to assess our instruments and demonstrate their reliability and validity. This allows future research to incorporate the newly identified elements of integration in their hypotheses without having to worry about measurement issues for these new constructs.

We follow a systematic process to built measurement instruments for all the new constructs in our study and test them for reliability and validity. A measurement instrument is a set of survey questions, called items. Appropriate respondents answer those survey questions by selecting values on a Likert scale. A measurement instrument is also referred to as a measurement scale or simply a scale as it helps translate a latent construct into likert scale values. The process is summarized in Figure 3.1 and is based on well established methodological guidelines in the literature (Anderson & Gerbing, 1991; Menor & Roth, 2007; Nunally & Bernstein, 1994). In this chapter we focus on the first two steps in the process which Menor and Roth (2007) call the front-end of scale development. The front-end of scale development focuses on generating multiple items for each construct, and pre-testing them using the Q-sort sorting process. The back-end of scale development is explained in the next chapter that deals with testing psychometric measurement properties based on user responses to the measurement items.

Figure 3.1. Process to develop and test measures

3.1. Constructs for Measurement

In the last chapter we identified 9 elements of integration. These nine elements are inter-related and most of the information about a relationship can be captured by measuring the six most important elements. For example sharing of logistics resources reduces operational costs and often goes hand in hand with operational planning and control. If a supply chain dyad has implemented operational planning and control then it is likely that sharing of logistics resources would have been considered and implemented if feasible in the particular circumstances. Similarly if the elements under knowledge generation and operational collaboration have all been implemented then it is evident that strategic partnership is most likely in place. Thus measuring the following six elements allows us to capture almost all of the information about the relationship: operational communication, performance related communication, operational planning and control, collaborative improvement, new product development and general knowledge generation.

Research on surveys shows that the longer the survey length the lower the response rate (Dillman, 2007) as respondents drop out without completing the survey. A survey that is too long may not get a reasonable response rate and sample size is important for the statistical methods that establish desirable psychometric properties of the measurement scales. We decided to proceed with scale development and empirical testing for the six elements of integration identified above to keep the survey length reasonable while still capturing all the important aspects of the supply chain relationships. Sharing logistics resources, sharing financial and technical resources and strategic partnership were not empirically tested. The remaining six constructs collectively capture most of the domain of inter-firm integration, while keeping the empirical model parsimonious enough to be tested in one study. We expect future research to address the remaining three constructs.

After identifying the elements of integration it is also important to consider how their performance impacts can be measured. From the extended resource based view (eRBV) (Lavie, 2006) and relational view (Dyer & Singh, 1998) perspectives the value from a buyer-supplier relationship comes from being able to create together what the two firms were unable to do separately. The relationship may assist both members to increase their profits by reducing costs for example, or assist them to compete better by differentiating their products from competitors. The benefits for both partners will not be symmetric in general. We capture these contributions of the relationship by defining two firm level constructs: (1) economic value generated, and (2) competitive value generated. Similar constructs about contribution to value of a relationship have been used in prior buyer-supplier relationship research as well (Jap, 2001; Jap & Anderson, 2003; Johnston et al., 2004; Nyaga et al., 2010).

Economic value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the profitability of that firm.

Competitive value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the favorable differentiation of the firm from its competitors i.e. the competitive advantage of the firm.

It is important to capture both of these types of value as some integrative practices are aimed at going beyond profit impacts to innovating so as to capture market share or even create new markets. Researchers have shown that buyer-supplier collaboration can improve firm level outcomes and impact performance (Daugherty et al., 2006; Nyaga et al., 2010). The impact of buyer-supplier collaboration on differentiation and on creating competitive advantage has not been given due attention in the existing literature. It is important to identify which integrative practices lead to competitive advantage as firms facing highly competitive environments can improve by placing greater importance on them. Although improving competitive advantage may also be reflected in increased profitability, "financial performance and strategic performance are not perfectly correlated" (Jap & Anderson, 2003, p. 1686).

In addition to capturing the effects on value for each firm, we are also interested in attributes of the relationship itself. Some integrative practices will influence the strength and quality of the relationship. For example firms are less likely to squeeze those suppliers for price discounts who are an integral part of innovation and new product development. Firms are also more likely to ensure the continuity of suppliers whose knowledge and skills they rely on. To capture such effects of certain elements of inter-firm integration we define a relationship quality construct that exists at the level of the buyer-supplier dyad.

Relationship quality is the robustness and strength of the relationship between the buyer and supplier firms.

Table 3.1 shows the final list of constructs for which measurement scales were developed along with their definitions. The six elements of integration and relationship quality are relationship level constructs while economic and competitive value are at the firm level constructs.

Table 3.1

Constructs for which measurement scales were developed

Construct	Definition
Operational Communication	Operational Communication refers to sharing routine data between the buyer and supplier firms that is used in day to day decision making, like inventory levels, sales forecasts, delivery and order information, logistics data, capacity and production related data.
Performance Related Communication	Performance Related Communication refers to sharing of performance metrics, performance score-cards and similar feedback between the supply chain dyad members.
Operational Planning & Control	Operational Planning & Control refers to buyer and supplier firms jointly planning and synchronizing recurring tasks and activities and systematically reacting to environmental signals related to production and flow of goods and services.
Collaborative Improvement	Collaborative Improvement refers to the buyer-supplier dyad jointly establishing continuous improvement programs and quality practices.
New Product Development	New Product Development is collaboration by the buyer and supplier firms to research, design and commercialize products that are new for the supply chain dyad.
General Knowledge Generation	General Knowledge Generation is collaboration by buyer and supplier firms to generate new relevant knowledge outside of new product development efforts such as acquiring or developing new capabilities and technologies.
Economic Value	Economic value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the profitability of that firm.
Competitive Value	Competitive value generated, for a given firm in the supply-chain dyad, is the contribution of the relationship to the favorable differentiation of the firm from its competitors i.e. the competitive advantage of the firm.
Relationship Quality	Relationship quality is the robustness and strength of the relationship between the buyer and supplier firms.

3.2. Item Generation and Face Validity Testing

A list of items (survey questions) was generated for all constructs identified in Table 3.1 above. The items were generated after reading the definition of the construct and trying to capture the theoretical domain of the construct by a set of survey questions. The generated items were checked by three researchers for face validity and for clarity and precision of language. The items were revised to incorporate the recommendations of the reviewers.

These newly generated items were then compared to similar items found during the literature review (see Table A4 in Appendix A). This was done to ensure that our items were grounded in the supply-chain practices that existing empirical studies had measured. This ensured that we did not come up with items that measured something that was remote to the supply-chain domain.

The items finalized after this process are shown in Table A4 in Appendix A along with references of supply chain management papers that have comparable items. Table 3.2 gives a summary of the items generated for each construct.

Table 3.2
Summary of measurement items

Construct	Number of Items	Item Codes
Operational Communication	10	OCM1 to OCM10
Performance Related Communication	7	PCM1 to PCM7
Operational Planning & Control	10	OPC1 to OPC10
Collaborative Improvement	13	CID1 to CID3, CII1 to CII4, CII5.1, CII5.2, CII5.3, CIQ1 to CIQ3
New Product Development	8	NPD1 to NPD8
General Knowledge Generation	7	GKW1 to GKW7
Economic Value	5	EVL1 to EVL5
Competitive Value	5	CVL1 to CVL5
Relationship Quality	10	RQ1 to RQ10

3.3. Pretesting Measurement Items using Q-Sort

A pretest was done using judges who had work experience in supply chain management roles to filter out items that don't belong to the constructs and refine the wording of those items that are appropriate. Prior to this stage the construct definitions and their operationalizations had been built and checked for face validity by researchers only. This stage is important because it validates those operationalizations by getting the input of practitioners who deal with supply chain integration related issues in real life. The widely accepted Q-sort method was followed in this stage (McKeown & Thomas, 1988; Menor & Roth, 2007).

The Q-sort method relies on judges that have knowledge of the relevant content domains to provide feedback in a systematized fashion regarding the measurement scales for the constructs of interest. Their feedback can be statistically analyzed and compared to various cut-off values to determine if the items have 'substantive validity' (Anderson &

Gerbing, 1991). "Substantive validity of a measure is defined as the extent to which that measure is judged to be reflective of, or theoretically linked to, some construct of interest" (Anderson & Gerbing, 1991, p. 732).The statistical analysis checks whether the various judges agree with each other, and whether the judges agree with the researchers who came up with the constructs and survey items. Agreement between judges is evidence of inter-rater reliability that shows that the judges agree on what the items measure. Agreement between judges' assignments and the researchers view is evidence of substantive validity (Anderson & Gerbing, 1991) because it shows that the items measure the content domain of their intended constructs.

The Q-sort procedure that is recommended by Anderson and Gerbing (1991) and Nunnally (1978) was followed. The first step was to select appropriate judges. Masters of Business Administration (MBA) students from the Schulich School of Business who had at least 2 years of relevant work experience were selected. A total of 26 different judges took part, 9 in each of the first two rounds, and 8 in the third and final round of Q-sort. No judge was used more than once. The average work experience of the judges was 4.8 years (min 2 years, max 10 years). The industries in which the judges had worked are shown in Table 3.3 (the count in Table 3.3 sums to greater than 26 as some judges had worked in more than one industry).

Table 3.3
Industries represented by Q-Sort judges

Industry	Count
Automotive	2
Consumer Goods/ Products Manufacturing	2
Food Products	5
Heath Care	4
Industrial Machinery, Mechanical & Engineering	4
Information Technology	6
Other	3
Pharmaceutical	1
Retail	5
Textiles and Apparel	1

At the beginning of each round written instructions about the Q-sort process were given to all the judges participating in that round and read out aloud. Any questions about the process were answered. Then the judges were given a page with a list of construct definitions. The definitions were read out and the judges were given a few minutes to go over them and ask any questions about the definitions. Once the judges were ready to begin, each judge was given a list of the items in a random order in an Excel file. The judges worked independently without talking to each other or consulting with anyone else. Each judge went through the list of items one by one and assigned each item to the construct it best reflected by entering a code word for the appropriate construct in front of the item text. Judges would enter N/A if they felt an item did not reflect any of the constructs. Once a judge was done assigning all the items, he/she would use a facility in Excel to group the items by their construct assignments. In this manner the judge could see all the items he/she had assigned to each construct and reconfirm his/her assignments.

Once all the judges had assigned all the items and re-confirmed the assignments the judges were asked to consider whether the content domain of each construct had been adequately captured by the items or not. In all three rounds there were no concerns by the judges about the items missing out on an important area of any construct. In fact two judges, with significant work experience with automobile and consumer goods manufacturers, stated that the items were very comprehensive in covering the kind of activities they did with their suppliers.

After each round of Q-sort two statistics were computed to measure inter-rater reliability, and three statistics were computed to measure substantive validity (i.e. to check if the items measure their intended constructs) (Anderson & Gerbing, 1991). To measure inter-rater reliability Cohen's kappa (Cohen, 1960), and Perrault and Leigh's I_r (Perreault & Leigh, 1989) were computed. I_r corrects issues with Cohen's kappa such as kappa being overly conservative in estimating agreement between judges (Brennan & Prediger, 1981). Since Cohen's kappa is widely reported, it was computed in this dissertation as well to aid comparison with other empirical studies. For substantive validity assessment, Moore and Benbasat's (1991) item placement ratio (IPR), and Anderson and Gerbing's (1991) proportion of substantive agreement and coefficient of substantive agreement were used. IPR is computed at the construct level and measures how many items belonging to a given construct were correctly assigned by the judges versus how many assignments (judgments) were made (Moore & Benbasat, 1991). For example if there are 10 judges, and 5 items for a construct, a theoretical maximum of 10x5 = 50 correct assignments may be made. When a Q-sort round finishes it may turn out that 45 correct assignments were made so the IPR would be 45/50 = 0.90 or 90%. Anderson and Gerbing's (1991) proportion of substantive agreement and coefficient of substantive agreement are computed for each item and indicate whether the item belongs to the intended construct or not. Table 3.4 shows the formulas for these five statistics.

Table 3.4
Formulas and cut-off values for the statistics used to analyze Q-Sort results

Statistic	Formula	Suggested Cut-offs
Cohen's Kappa	$k = \frac{p_o - p_c}{1 - p_c}$ p_o is proportion of agreement between a pair of judges, and p_c is proportion of agreement between that pair expected by chance. When more than two judges are used the average for all pairs of judges is computed.	Cohen's kappa of 0.65 or greater is considered good reliability (Moore & Benbasat, 1991).
Perrault & Leigh's Inter-rater reliability I_R	$I_R = \sqrt{\left[\frac{F_0}{N} - \frac{1}{k}\right]\left[\frac{k}{k-1}\right]}\ for \frac{F_0}{N} \geq \frac{1}{k}$ $I_r = 0\ for \frac{F_0}{N} < \frac{1}{k}$ F_0 is the observed % agreement between two judges	Values 0.65 or larger indicate good reliability (maximum possible value is 1) (Perreault & Leigh, 1989).
Item Placement Ratio (IPR)	IPR = [# of hits] / [# of possible correct assignments]	IPR ≥ 0.7 indicates substantive validity is good (Moore & Benbasat, 1991)
Proportion of Substantive Agreement p_{sa}	$p_{sa} = \frac{n_c}{N}$ n_c is the number of times that item was assigned to its intended construct. N is the number of judges.	$p_{sa} \geq 0.69$ indicates adequate to high validity $p_{sa} \leq 0.3$ indicates lack of validity (item should be discarded) (Anderson & Gerbing, 1991)
Substantive Validity Coefficient c_{sv}	$c_{sv} = \frac{n_c - n_o}{N}$ n_o is the highest number of times that item was assigned to one of the constructs it was not intended for.	$c_{sv} \geq 0.4$ indicates adequate to high validity $c_{sv} \leq 0.0$ indicates lack of validity (item should be discarded) (Anderson & Gerbing, 1991)

Results of round 1 of Q-sort showed adequate levels of inter-rater reliability which improved further in rounds 2 and 3. With 9 judges 36 possible pairs can be made to check for agreement. In round 1, the average I_R for these 36 pairs was 0.84, the average Cohen's Kappa was 0.71 and the average agreement percentage was 74%. Agreement percentage is the percentage of items for which 2 specific judges had the exact same assignments. In round three these statistics had improved to average IR of 0.95, average Cohen's Kappa of 0.91 and agreement percentage of 0.92. The statistics for all pairs of judges on these reliability indices are shown in Table 3.5.

Table 3.5

Inter-rater reliability across the three rounds of Q-sort

Judge Pair	Round 1 Agreement%	Round 1 IR	Round 1 Cohen's Kappa	Round 2 Agreement %	Round 2 IR	Round 2 Cohen's Kappa	Round 3 Agreement %	Round 3 IR	Round 3 Cohen's Kappa
J(1,2)	0.92	0.95	0.91	0.91	0.95	0.90	0.96	0.97	0.95
J(1,3)	0.85	0.91	0.83	0.87	0.93	0.86	0.94	0.97	0.93
J(2,3)	0.87	0.93	0.86	0.81	0.89	0.78	0.93	0.96	0.92
J(1,4)	0.72	0.83	0.69	0.90	0.94	0.88	0.93	0.96	0.92
J(2,4)	0.69	0.81	0.66	0.84	0.91	0.83	0.91	0.95	0.90
J(3,4)	0.68	0.80	0.65	0.83	0.90	0.81	0.91	0.95	0.90
J(1,5)	0.85	0.91	0.83	0.97	0.99	0.97	0.93	0.96	0.92
J(2,5)	0.80	0.88	0.78	0.91	0.95	0.90	0.91	0.95	0.90
J(3,5)	0.80	0.88	0.78	0.88	0.93	0.87	0.90	0.94	0.88
J(4,5)	0.72	0.83	0.69	0.90	0.94	0.88	0.88	0.93	0.87
J(1,6)	0.74	0.84	0.71	0.95	0.97	0.94	0.93	0.96	0.92
J(2,6)	0.74	0.84	0.71	0.90	0.94	0.88	0.91	0.95	0.90
J(3,6)	0.72	0.83	0.68	0.84	0.91	0.83	0.90	0.94	0.88
J(4,6)	0.59	0.74	0.54	0.91	0.95	0.90	0.88	0.93	0.87
J(5,6)	0.71	0.82	0.67	0.95	0.97	0.94	0.88	0.93	0.87
J(1,7)	0.67	0.80	0.63	0.88	0.93	0.87	0.96	0.97	0.95
J(2,7)	0.66	0.79	0.62	0.86	0.92	0.84	0.94	0.97	0.93
J(3,7)	0.65	0.78	0.61	0.81	0.89	0.78	0.96	0.97	0.95
J(4,7)	0.56	0.72	0.52	0.86	0.92	0.84	0.91	0.95	0.90
J(5,7)	0.67	0.80	0.63	0.88	0.93	0.87	0.91	0.95	0.90
J(6,7)	0.62	0.76	0.58	0.86	0.92	0.84	0.91	0.95	0.90
J(1,8)	0.76	0.86	0.74	0.81	0.89	0.78	0.93	0.96	0.92
J(2,8)	0.79	0.87	0.76	0.81	0.89	0.78	0.91	0.95	0.90
J(3,8)	0.81	0.89	0.79	0.74	0.84	0.71	0.96	0.97	0.95
J(4,8)	0.64	0.77	0.60	0.78	0.87	0.75	0.90	0.94	0.88
J(5,8)	0.74	0.84	0.71	0.81	0.89	0.78	0.88	0.93	0.87
J(6,8)	0.69	0.81	0.66	0.79	0.88	0.77	0.90	0.94	0.88
J(7,8)	0.62	0.76	0.58	0.74	0.84	0.71	0.94	0.97	0.93
J(1,9)	0.88	0.93	0.87	0.88	0.93	0.87	N.A.	N.A.	N.A.
J(2,9)	0.86	0.92	0.84	0.87	0.93	0.86	N.A.	N.A.	N.A.
J(3,9)	0.86	0.92	0.84	0.81	0.89	0.78	N.A.	N.A.	N.A.
J(4,9)	0.74	0.84	0.71	0.84	0.91	0.83	N.A.	N.A.	N.A.
J(5,9)	0.87	0.93	0.86	0.90	0.94	0.88	N.A.	N.A.	N.A.
J(6,9)	0.74	0.84	0.71	0.87	0.93	0.86	N.A.	N.A.	N.A.
J(7,9)	0.68	0.80	0.65	0.84	0.91	0.83	N.A.	N.A.	N.A.
J(8,9)	0.76	0.86	0.74	0.73	0.83	0.70	N.A.	N.A.	N.A.
Average	**0.74**	**0.84**	**0.71**	**0.85**	**0.91**	**0.84**	**0.92**	**0.95**	**0.91**

Item placement ratio (IPR) and item level validity statistics point out items that need improvement. Table 3.6 shows the IPR statistics. The IPR value for Operational Planning & Control was below the suggested cut-off of 0.7 in the first round, but improved to 0.92 by round 3.

Table 3.6
Item placement ratio statistics from Q-sort

Construct	Round 1 Item Placement Ratio	Round 2 Item Placement Ratio	Round 3 Item Placement Ratio
Operational Communication	0.84	0.93	1.00
Performance Related Communication	1.00	1.00	1.00
Operational Planning & Control	0.62	0.86	0.92
Collaborative Improvement	0.79	0.82	0.95
New Product Development	0.92	0.90	0.93
General Knowledge Generation	0.76	0.89	0.95
Economic Value Generated	0.89	1.00	0.93
Competitive Value Generated	0.79	0.93	0.88
Relationship Quality	0.82	0.96	0.97

After the first round poorly performing items were dropped and some items were revised as shown in tables A6 and A7 in Appendix A. Care was taken to ensure that the content domains of the constructs were still adequately represented. Round 2 showed improved performance for all items that were re-worded after round 1. This is shown in Table 3.7 below. For the exact wordings used in rounds 1 and 2 of these items refer to table A7 in Appendix A.

Table 3.7
Improvement in item level validity statistics for re-worded items in round 2

Item ID	Round 1 p_{sa}	Round 1 c_{sv}	Round 2 p_{sa}	Round 2 c_{sv}
CVL3	0.44	0.00	0.78	0.56
CID1	0.67	0.44	0.78	0.67
OPC5	0.67	0.44	1.00	1.00
RQ4	0.67	0.56	0.89	0.78
DP5	0.56	0.22	0.89	0.78
NPD7	0.67	0.56	0.67	0.44
OPC10	0.56	0.33	0.67	0.44
OCM1	0.67	0.44	0.56	0.33
GKW7	0.44	0.22	0.67	0.56
GKW3	0.56	0.33	1.00	1.00
GKW4	0.67	0.56	1.00	1.00
OPC1	0.67	0.56	0.67	0.33

After the second round no items were performing poorly. At this stage some items were dropped for being redundant (see table A8 in Appendix A). This is because at the beginning of Q-sort several similar items were included in constructs to find out which version had the best wording. When round 2 ensured that all items were adequately performing, the best version of similar items was retained and redundant versions discarded. Some items were also re-worded slightly at the end of round 2 to improve clarity based on judges' comments. Round 3 was done as a final check and its results showed that all items and constructs were in a good state. The final version of the items used in round 3 along with the item level substantive validity coefficients from round 3 results are shown in table A9 in Appendix A. Since round 3 results were very encouraging in terms of inter-rater reliability, and substantive validity of the constructs no further Q-sort rounds were conducted. The items shown in table A9 are the results of the Q-sort stage.

The Q-sort process gives us initial evidence that our items are valid and reliable. However the Q-sort exercise relies on qualitative judgment of a small pool of domain experts.

To generalize our findings that these items measure our constructs for a broad range of firms in North America further empirical testing is required. This was done by collecting survey responses from managers in manufacturing firms in North America, and is described in the next two chapters.

4. DATA COLLECTION

The purpose of data collection is to sample supply chain relationships in the North American context to establish the psychometric properties of our measurement instruments and then later test hypotheses involving them. In the last chapter we used Q-sort to do initial pretesting. Empirical data would allow us to conduct more rigorous statistical tests to check for reliability and validity of our measures. The survey method was used for data collection.

Case studies are often used in the initial stages of a field or sub-field of research where existing literature cannot guide formation of specific hypothesis that can be tested with quantitative methods (Meredith, 1998). The goal of case studies is often exploration and discovery of interesting insights by a rigorous study of a few firms and their contexts. Supply-chain integration has a large body of literature that was used to develop the elements of integration constructs. The focus of this dissertation is to extend existing literature given the same context that has been used in the past studies i.e. supply-chain integration in 'goods' oriented firms in North America. Hence the focus is to rigorously test proposed hypotheses so that the findings can be generalized to the entire context rather than discover novel phenomenon in a restricted setting. For these reasons we do not pursue the case-study method in this dissertation.

Secondary data analysis is appropriate when the constructs are objective measures of commonly reported outcomes such as sales or volume of trade between firms. This dissertation however includes constructs that include what integrative practices are implemented by a buyer-supplier dyad and these are not reported in secondary sources of data. Given the lack of appropriate secondary data and the latent nature of some constructs being studied survey methodology is the most appropriate method for this dissertation.

Survey based empirical research is a well-developed 'science' with a method for developing measures for latent constructs, and a method for sampling and conducting the actual survey. We followed established methodological guidelines (cf. Dillman, 2007) in making the survey and collecting information form respondents.

4.1. Survey Design

The most important decisions regarding survey design are who to survey (i.e. defining the target population), how to survey (the medium), and what the target sample size should be. This research builds on previous supply-chain integration work, and hence it is prudent to test the new conceptualization and the new hypothesis in a similar context to previous studies. This would allow comparison with previous results and exclude change of context as an alternative explanation for the results. The target population is goods oriented for-profit manufacturers in North America (USA and Canada) with at least 50 employees. We exclude service firms and not-for-profits because we expect salient differences between them and for-profit manufacturers. We also exclude firms with less than 50 employees because such small firms often have less developed management systems and operate differently from medium to large sized firms (Welsh & White, 1981). Our target respondents were middle to senior level operations, supply-chain or purchasing executives and general managers.

The complete survey is shown in Appendix B.

4.1.1. Sampling Frame

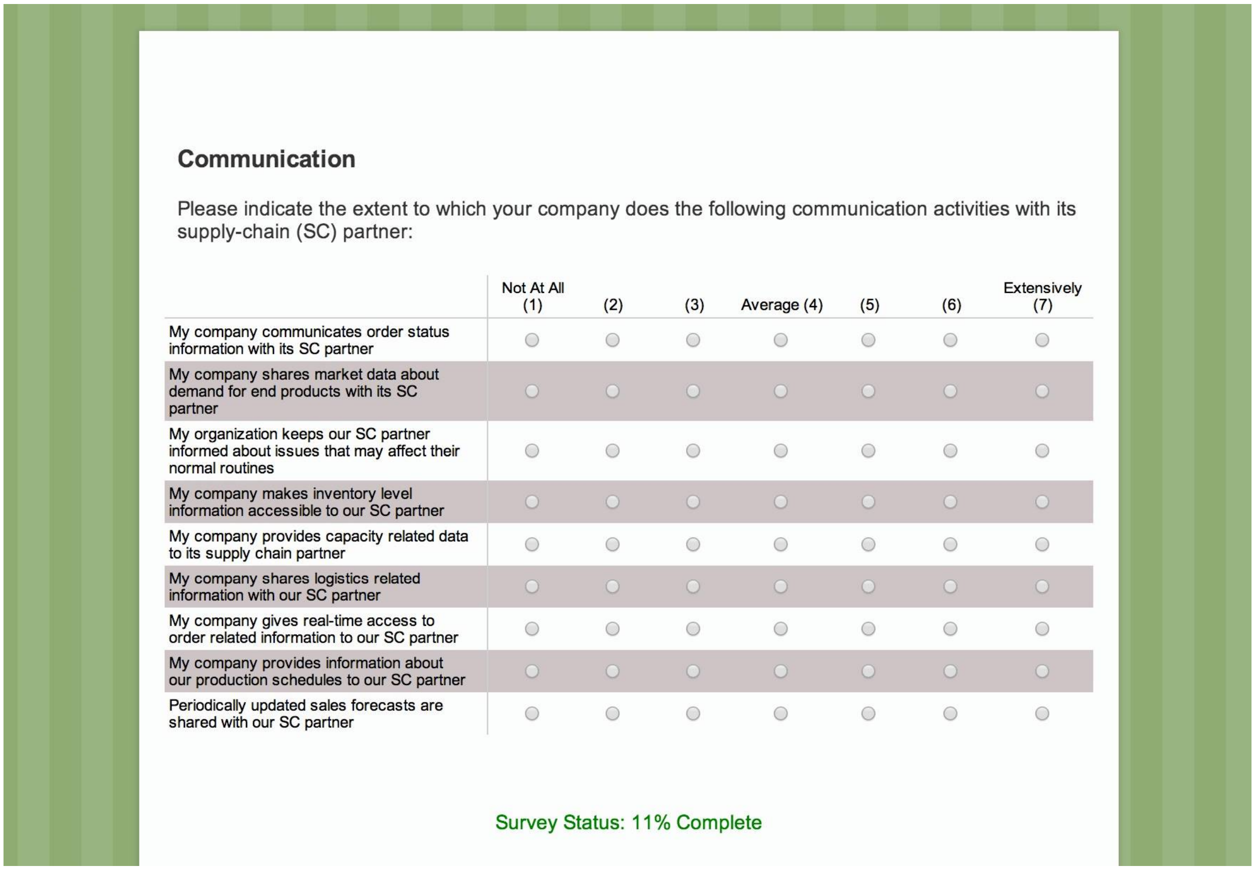
A sampling frame of 6500 executives in Canadian and US manufacturing firms with at least 50 employees was compiled. Manufacturing firms were selected by only considering those firms that were classified in industries with NAICS codes beginning with 31, 32 or 33. Since the unit of analysis was a supply-chain relationship care was taken to include only those executives that would know about the important supply-chain relationships of their company. For this reason only executives related to supply chain management were selected by ensuring that the job title reflected a senior or mid-level role in purchasing, operations, supply chain, logistics or manufacturing. The sampling frame consisted of 5000 contacts purchased from Scotts-Directories and a list of 1500 appropriate members of Supply Chain Management Association of Canada (www.scma.ca). About 2800 contacts were Canadian and 3700 contacts were based in the United States. The 5000 contacts from Scotts-Directories were randomly selected from their entire master list of manufacturing firms that met our criteria. Scotts-Directories has maintained lists of businesses in North America for a long time and their master list can be considered to be exhaustive. Sampling frames from supply chain related professional organizations and Scotts Directories have been widely used to conduct survey research in supply chain management by other researchers as well (Cao & Zhang, 2011; e.g. Kristal et al., 2010).

4.1.2. Survey Medium

An online survey was used that worked on computers, tablets, or smartphones. There are several advantages of using online surveys. Other than cost effectiveness and ease of use, perhaps the biggest advantages are that online (web-based) surveys enjoy better item completion rates (i.e. less missing data) (Klassen & Jacobs, 2001).

The online survey platform of Qualtrics (www.qualtrics.com), a leading online survey provider, was used to conduct the actual web-based survey. Potential respondents were contacted over email with an invitation link to do the survey. The following features were built into the online-survey:

1. The survey showed a progress indicator bar so that respondents know how far along in the survey they are. This helps avoid respondents giving up when they are very close to end.
2. The survey allowed the respondent to close the survey at any point and resume from there by revisiting the invitation link.
3. The survey showed the York university logo to highlight to demonstrate that ethical standards of the university were being followed in the research. It also comforted the respondents that they were partaking in university research as opposed to research from a marketing firm that may sell information to others.
4. Care was taken to ensure a readable and professional design of the survey (see Figure 4.1 for a sample screenshot). Dillman (2007) has stressed the importance of readability and professional looking surveys.
5. The survey automatically randomized the order in which items are displayed for each construct. While it is common practice to ask all items regarding one construct as a group, the items belonging to the same construct should be shown in a randomized order to preclude any item-order biases.



Communication

Please indicate the extent to which your company does the following communication activities with its supply-chain (SC) partner:

	Not At All (1)	(2)	(3)	Average (4)	(5)	(6)	Extensively (7)
My company communicates order status information with its SC partner	○	○	○	○	○	○	○
My company shares market data about demand for end products with its SC partner	○	○	○	○	○	○	○
My organization keeps our SC partner informed about issues that may affect their normal routines	○	○	○	○	○	○	○
My company makes inventory level information accessible to our SC partner	○	○	○	○	○	○	○
My company provides capacity related data to its supply chain partner	○	○	○	○	○	○	○
My company shares logistics related information with our SC partner	○	○	○	○	○	○	○
My company gives real-time access to order related information to our SC partner	○	○	○	○	○	○	○
My company provides information about our production schedules to our SC partner	○	○	○	○	○	○	○
Periodically updated sales forecasts are shared with our SC partner	○	○	○	○	○	○	○

Survey Status: 11% Complete

Figure 4.1 Screenshot of online survey

The survey offered a $2 donation to a charity on behalf of the respondent if he/she completed the survey. Although small monetary incentives have worked in the past (Armstrong, 1975), they have mostly worked with consumer research and it is unlikely that earning a dollar or two would be sufficient incentive for a middle to senior manager in North America. The reasoning behind offering a charity donation is to differentiate our survey from the many survey invitations managers get these days. This shows that the research is important enough that the researchers are willing to fund it with money, and also adds a social desirability factor in the decision to complete the survey because not completing the survey now becomes equivalent to depriving a charity of much needed money.

4.2. Survey Data Collection

Email invitations were sent to the executives in our sampling frame. On average 85% of the emails were successfully sent in each attempt. This reduced the effective size of the sampling frame to 5500. We were unable to determine how many of the 5500 emails actually ended up in the inbox and how many were caught by spam filters. Since our email invitation had a link to a survey hosted on a third party (Qualtrics) website, we suspect the effective sampling frame size was significantly smaller than 5500 as many spam filters catch emails that invite readers to click on a link. After sending the initial invitation, two more reminders were sent. In each email we offered the respondents a summary of our results including a benchmark of their responses with the average responses from our data collection. We also offered the respondents the ability to pick a charity at the end of the survey to which $2 would be donated on their behalf to increase the social costs of declining the survey request.

The online survey was conducted from January to April 2014. We obtained 210 usable responses and that makes the response rate come out to 3.8% (210/5500). We believe 3.8% is a pessimistic estimate of our true response rate as we are unable to know how many emails ended up in spam folders. Several recent studies have reported response rates as low as 6% (e.g. Cao & Zhang, 2011; Koufteros et al., 2010). This is an indication of growing survey fatigue that affects all survey studies in recent times. Our response rate was deflated due to the following factors:

1. Spam filters often catch emails that ask the reader to click on a link because malware and adware are distributed by asking people to click on links. We had no way to know

how many of the emails went to spam and this negatively impacts our response rate calculation.

2. Our email invitation was in HTML format with logos of York University at the top of the email to show that this was university related research and not a commercial survey request. However most email clients block access to images, showing the text only version, and the user must click on a button to allow remote images to load. Many recipients who did open our emails did not see the university affiliation of our research and this negatively impacted the percentage that went on to take the survey. We did write about our university affiliation in the text but most people don't read the entire text of an email invitation.
3. The vast majority of our email invitations were not opened as executives get a plethora of emails daily. If they do not know the email sender and the email title is not directly related to their job they are highly likely to ignore the email and not open it. A physical letter has a greater chance of being opened than an email. Hence studies that use physical letters to send invitations are likely to have better response rates.

4.3. Data Description

We targeted manufacturing firms from the US and Canada in our sampling frame. The majority of the responses are from Canada (77%), with only 23% being from the US. In Chapter 5 we describe tests for measurement equivalence to verify that the data from the two countries can be pooled together. The industries represented in our responses are shown in Table 4.1. We can see that most manufacturing industries are well represented. Table 4.2

shows the job titles of the respondents. We have a good mix of middle to senior level managers from the supply chain and purchasing areas. This shows that our respondents were the right people to report on a supply chain relationship of their company.

Table 4.1

Industry breakdown of respondents

Industry	Count
Aerospace and Defense	8
Automotive or Automotive Parts	12
Chemical and Petrochemicals	21
Consumer Products	9
Electronics / High Tech Manufacturing	15
Food Products Manufacturing	9
Furniture and Home Related Goods Manufacturing	3
Health Care Related Products and Instruments Manufacturing	4
Industrial Machinery and Equipment Manufacturing	19
Medical Devices Manufacturing	7
Metal, Mechanical and Engineering	38
Textiles and Apparel Manufacturing	2
Transportation, Warehousing and/or Logistics	7
Wholesale and Retail of Manufacturing Goods	15
Utilities	7
Other	23
Missing	11
Total	210

Table 4.2

Job Titles of Respondents

Respondent Title	Count
Vice President	6
Director	18
General Manager	3
Supply Chain Manager or Operations Manager	44
Purchasing Manager, Buyer	105
Plant Manager	4
Supply Chain Analyst or Logistics Coordinator	12
Merchandising Manager, Product Manager	3
Other	4
Missing	11
Total	210

The size of the firms in our sample shows good variation between small, medium and large firms. A histogram of the number of employees is shown in Figure 4.2. The average size for firms in our sample is 9700 employees. As shown in figure 2.4 our sample represents a wide range of medium to large manufacturers (50 to 10,000 employees) we cannot generalize our findings to very large manufacturers (> 50,000 employees) or to very small ones (< 50 employees).

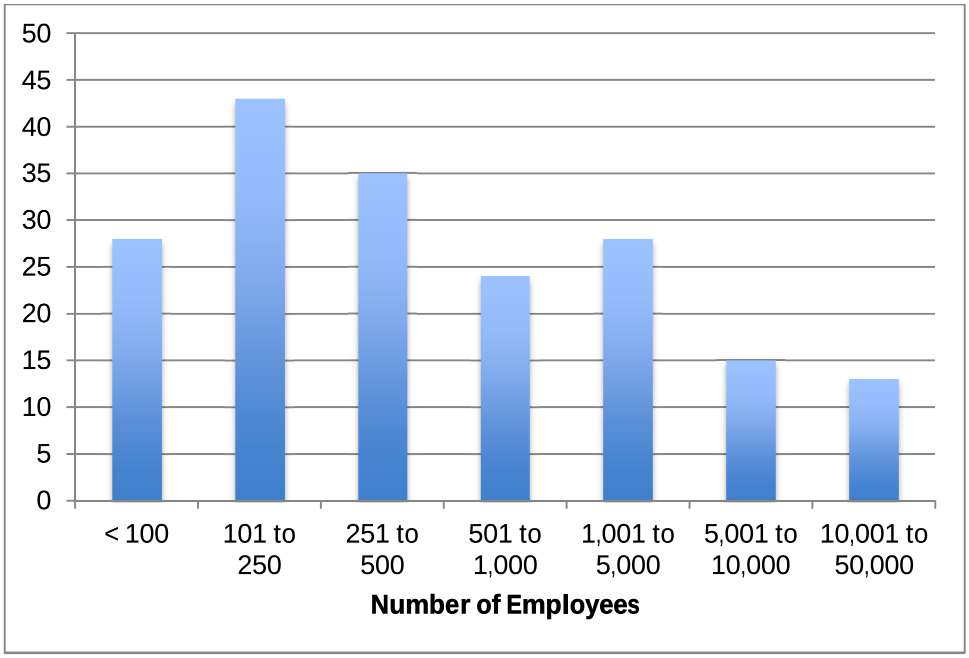


Figure 4.2. Histogram of number of employees for respondents

4.4. Tests for Non Response Bias

To check for non-response bias we compared a random sample of 120 non-respondent firms from our sampling frame to respondent firms on number of employees and annual sales. We used the Lexis-Nexis database to find data on the sales and number of employees of the non-respondent firms. There were no signification differences between the two groups on sales and number of employees. This shows that our response represent the sampling frame adequately.

Additionally we also conducted the Armstrong and Overton (1977) test as a further check for non-response bias. We split our sample into early and late respondents based on date of answering the survey. We did ANOVA tests for all of the constructs to compare the two groups. There was no significant difference between early and late respondents for any of our constructs.

We also checked the industry representation in our sampling frame and our respondents to check if the responses were biased towards any particular industry group. The results are shown in Table 4.3. The majority of our sample is from NAICS code 33, which reflects the sampling frame. In terms of percentage composition there are differences between the sample and the sampling frame for NAICS codes 31 and 32.

Table 4.3

Comparison of industry distribution for respondents and the sampling frame

NAICS	Description	Sampling Frame	Sample (Respondents)
31	Food, Textile, Leather, Wood	6%	14%
32	Paper, Plastics, Glass, Chemical, Petroleum	32%	13%
33	Metal, Machinery, Electrical, Motor	62%	73%

We compared our sample to our target population as large differences between a sample and the target population can suggest an insufficient sampling frame or non-response bias. The size distribution of US and Canadian manufacturers is shown in Figures 4.3 and 4.4 based on data from Statistics Canada[1] and the US Census Bureau[2]. The percentage calculations only included firms that our in our target population, i.e. manufacturers with at least 50 employees. The data shows that in our target population about 90% of the US manufacturers and 83% of the Canadian manufacturers have fewer than 500 employees. In our sample only 57% of the manufacturers have less than 500 employees. This shows that our sample has a higher percentage of large manufacturers than the target population.

[1] http://www.ic.gc.ca/eic/site/061.nsf/eng/02804.html
[2] http://www.census.gov/epcd/susb/latest/us/US31.HTM

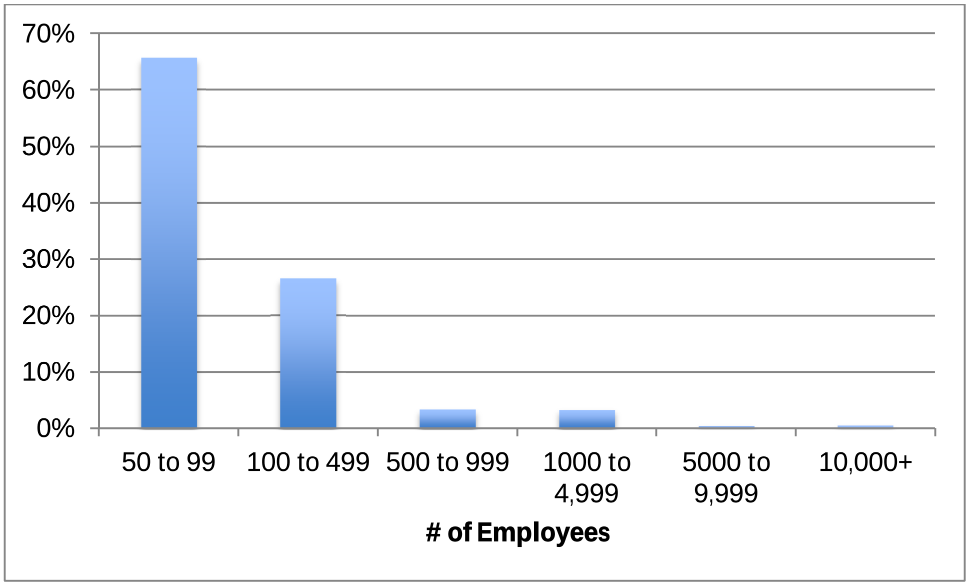


Figure 4.3. Size distribution of US manufacturers

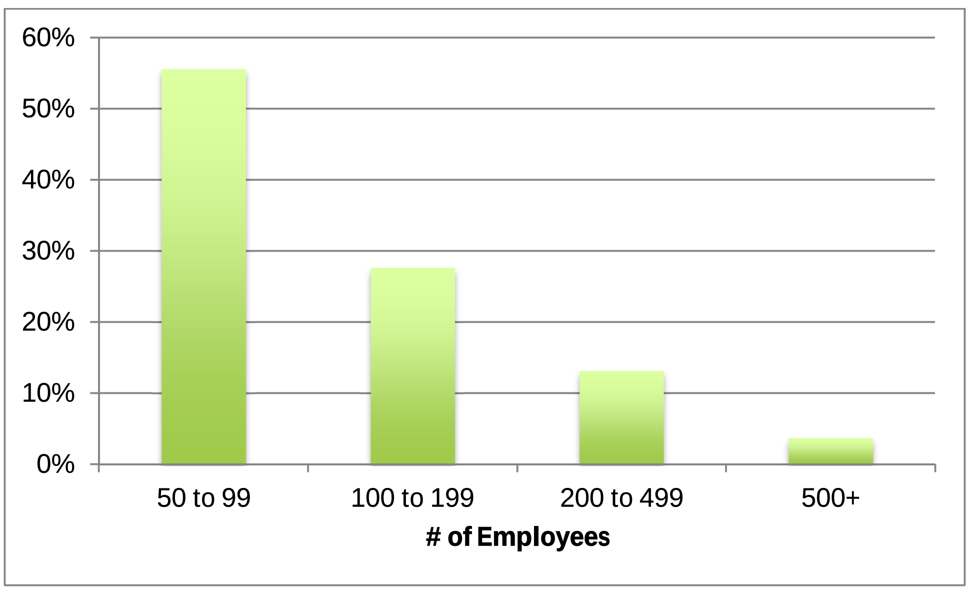


Figure 4.4. Size distribution of Canadian manufacturers

To summarize, our sample has differences in the industry composition when compared to the sampling frame, and has fewer percentage of small manufacturers than the target population. Thus we do not claim that our sample is strictly representative of the target population.

4.5. Test for Common Method Bias

Common method bias results when the method chosen has systematic effects on the measurements of such a magnitude so as to change the results of the study. Harmon's single factor test for common method bias was used (Harmon, 1976; Podsakoff et al., 2003). Podsakoff et al. (2003) state that the basic assumption behind the one factor test is to see whether a substantial amount of method variance is present. If common method bias is an issue then a single factor would emerge with a large eigen value which captures the strength of that factor. The first factor did not explain the majority of the variance, 30 eigenvalues were greater than 1 and parallel analysis revealed the same number of dimensions as the number of our intended constructs (i.e. nine constructs). This is strong evidence that common method bias is not an issue in our data.

4.6. Missing Data

Some of our survey responses do contain missing data and this is inevitable in empirical studies. Little's MCAR (Little, 1988) test shows no pattern among the missing values in the dataset so they can be treated as missing completely at random (chi-sq= 71.96, df=69, p-value=0.38). Missing completely at random means that discarding the missing values when running statistical tests will not bias our results.

4.7. Limitations of the Data

It is important to recognize the limitations of the sample, so that the reader can make an informed judgment about the generalizability of the results. Our sample is not a true random sample from the entire population as we rely on two organizations to generate our sampling frame and there is no evidence that the two organizations have contact information for all the manufacturers in US and Canada. When a true random sample cannot be obtained, as is the case for most survey research in operations management, the sample must be accurately described. The description of the sample shows how close the sample is to the target population. An argument may be made for some level of generalizability of the results if the sample characteristics closely follow the target population.

Our sample is far from the target population on some measures and moderately close to the target population on others. It is farthest from the target population in terms of country representatives. Our sample has a majority of Canadian respondents, while the target population has a majority of US manufacturers. Thus our sample is heavily biased towards Canada. Our sample is also different from the target population in terms of firm size and industry. As shown in table 4.3 our sample over represents firms in NAICS 31 and 33, and under represents firms in NAICS 32. Also our sample has a fewer percentage of firms with less than 500 employees than in the population.

These differences between our sample and the target population mean that we cannot generalize our results to small firms. Also the generalizability of our findings to US manufacturers and manufacturers in NAICS 32 industries is questionable.

4.7.1. Buyer and Supplier Views on Integration

There is some empirical evidence in the literature that buyer and supplier perspectives on integration differ (e.g. Nyaga et al., 2013). The initial research design was to collect data from both the buyer and the supplier firms that are engaged in a relationship. The survey asked the first respondent to provide contact information about their supply-chain partner so that data could be collected from the other side of the relationship as well. However respondents were not cooperative about providing details of their supply chain partner. In a few cases where these details were provided, the supply chain partners did not wish to respond to the survey. Dyadic data is difficult to collect and hence we are unable to do a dyadic analysis in this dissertation. The remaining chapters do the analysis from the buyer firm’s perspective only. Future research can use different research designs, such as case studies and measuring relationships of one large firm with several suppliers, to investigate the supplier firms’ perspective.

5. MEASUREMENT MODEL

An important contribution of this work is to show that inter-firm integration is multidimensional and to empirically verify its dimensionality. In the first part of this chapter (sections 5.1 and 5.2) we demonstrate reliability and validity for all of our constructs using psychometric analysis methods. In the second part (section 5.3) we test hypotheses about the higher order structure of the elements of integration. In chapter two, qualitative analysis found that certain elements of integration were related indicating the possibility of higher order constructs. For example *operational communication* and *performance and feedback communication* are elements that are part of *Basic Communication*. In this chapter we hypothesize and test if groups such as *Basic Communication* actually represent higher order constructs or not. This chapter provides empirical evidence for RQ1 of the dissertation. The analysis in this section answers the following related questions about the six elements of integration that were measured in the survey:

1. For which elements of integration do we have reliable and valid measurement instruments?
2. Are the six elements of integration distinct constructs?
3. Are the six elements of integration reflecting three higher order constructs as suggested by the qualitative analysis?

To answer the first two questions, we follow best practice which entails randomly splitting the sample and performing exploratory factor analysis (EFA) on one half of the sample, and then verifying the results by performing a confirmatory factor analysis (CFA) on the other half. In exploratory factor analysis each item (survey question) is allowed to reflect (i.e. load on) all of the constructs under consideration. If it has a high loading on its intended construct and low loadings on others, then that is seen as evidence of it measuring the intended construct (Fabrigar et al., 1999). Also various EFA related techniques like eigen-value decomposition of the covariance matrix and parallel analysis are employed to determine the number of constructs present.

To answer the third question, we hypothesize about the higher order constructs based on the results of our qualitative analysis that was presented in chapter 2. We then test those hypotheses by using confirmatory factor analysis.

5.1. Exploratory Factor Analysis

The first step in EFA is to determine how many constructs are represented in the data. This is because the number of factors must subsequently be provided to factor extraction methods. We split our sample in half by generating random numbers such there was equal probability for any observation to be picked for the EFA sample. We used the randomly picked EFA sample to determine the number of constructs reflected by the inter-firm integration survey items. Valicer and Jackson (1990) recommend using a scree plot and parallel analysis to determine the number of constructs. Figure 5.1 shows the scree plot for inter-firm integration items. In a screen plot eigen values above one represent distinct constructs (Hair et al., 2009). Six eigen values are clearly above 1, while the seventh eigen value is 1.01. This shows that empirical evidence supports 6 constructs, which is what was expected based on our qualitative and q-sort results.

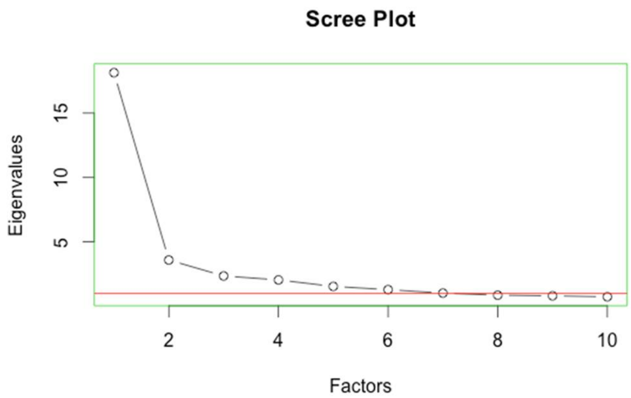


Figure 5.1. Scree plot to determine number of factors underlying inter-firm integration items

Parallel analysis and Velicer's minimum average partial (MAP) test are more advanced and robust methods to determine the number of factors (Wood et al., 1996; Zwick & Velicer, 1982, 1986). These methods have been shown to consistently determine the correct number of factors. In parallel analysis the eigen values from data with an underlying factor structure are compared with eigen values from random data of the same size (same number of observations and variables). If there is underlying factor structure then the real data should give greater eigen values than random data. In Velicer's MAP test factors are successively removed from the data until the noise or unsystematic variance dominates the remainder (Velicer, 1976). In our analysis Velicer's MAP test achieves a minimum value of 0.02 with six factors, and parallel analysis also finds six eigen values to be consistently greater than the eigen values found in many samples of randomly generated data. Thus we have strong empirical support that the six elements of integration that were measured do in fact represent six constructs.

We use common factor analysis with maximum likelihood estimation, as recommend by Hair et al. (2009) and others (Gorsuch, 1990, 1997), to extract the six factors. We used oblique rotation because we expect the six constructs to have some correlation between them.

We tried both promax and oblimin rotations and found no difference between the solutions obtained from them. Factor extraction provides factor loadings of each item on each of the six constructs as well as an estimate of communality. The communality is the proportion of variance in an item explained by the factors. Velicer and Fava (1998) and Tabachnick and Fidell (2006) provide the following rules for pruning items based on loadings and communalities from an exploratory common factor analysis (EFA):

1. Communalities of ≥ 0.4 indicate good items; one may keep items with communality less than 0.4 for theoretical reasons.
2. Loadings of ≥ 0.32 on intended construct are adequate
3. Items that load on 2 or more constructs with ≥ 0.32 should be discarded

The above guidelines were used to identify possible cases of concern in terms of cross-loading items. Brown (2012) recommends a statistical test to check if cross-loadings identified by EFA are signification. In Brown’s test two models are fitted: one with the cross-loading and one without. If there is significant improvement in model fit by allowing the cross-loading to remain then the cross-loading is significant and the item should be removed or treated as belonging to both constructs. Table 2.13 shows three items that were discarded after using the above guidelines and Brown’s (2012) test.

Table 5.1

Items removed due to cross-loadings

Item Code	Item Text	Comments
OCM3	My organization keeps our SC partner informed about issues that may affect their normal routines	Cross-loads on 3 constructs
CII4	Process re-engineering is done jointly by my company and our supply chain partner	Cross-loads equally on two constructs
NPD7	Targets regarding the commercial success of new products (e.g. sales targets) are jointly agreed upon	Cross-loads equally on two constructs

The EFA results using oblique rotation after removing the cross-loading items are shown in Table 5.2. In Table 5.2 three cross-loadings remain. OPC10 and OPC4 cross-load on the operational communication construct, and OPC10 also cross-loads on the collaborative improvement construct. These cross-loadings were not found to be significant according to Brown’s test. These items were retained at the end of the EFA analysis and were checked in more detail in the subsequent confirmatory factor analysis stage.

Table 5.2

EFA results for integration constructs (with oblique rotation)

ItemID	Item Text	F1	F2	F3	F4	F5	F6	Communality
OCM1	My company shares market data about demand for end products with its supply chain partner	**0.45**	0.14	-0.14	0.01	0.02	0.26	0.46
OCM2	Periodically updated sales forecasts are shared with our SC partner	**0.59**	0.17	-0.04	-0.13	-0.04	0.19	0.5
OCM4	My company makes inventory level information accessible to our SC partner	**1.00**	-0.12	0.00	-0.11	0.05	-0.13	0.82
OCM5	My company shares logistics related information with our SC partner	**0.45**	0.23	-0.17	0.11	0.00	0.05	0.39
OCM6	My company communicates order status information with its SC partner	**0.33**	0.21	0.25	-0.07	0.02	0.01	0.43
OCM7	My company gives Real-time access to order-tracking information to our SC partner	**0.77**	0.11	-0.04	-0.06	-0.01	-0.03	0.57
OCM8	My company provides Information about our production schedules to our SC partner	**0.63**	-0.17	0.03	0.21	0.07	-0.04	0.50
OCM9	My company provides capacity related data to its supply chain partner	**0.83**	-0.02	0.03	-0.02	-0.05	-0.02	0.65
PCM1	Performance related feedback is given to our SC partner	-0.06	**1.00**	0.15	-0.19	-0.06	-0.03	0.84
PCM4	My company shares data that our SC partner needs to evaluate its performance	0.05	**0.86**	0.01	0.03	-0.13	0.07	0.82
PCM5	Performance metrics that extend across our supply-chain dyad are shared with our SC partner	0.06	**0.52**	-0.09	0.25	0.19	-0.07	0.58
PCM6	Performance evaluations are reported to our SC partner	-0.06	**0.79**	-0.06	0.22	0.08	-0.13	0.73
PCM7	My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad	-0.10	**0.51**	0.00	0.29	0.07	0.11	0.60
OPC1	We coordinate activities regarding marketing campaigns and associated operations support across both companies	-0.10	0.09	**0.38**	0.15	-0.01	0.25	0.42
OPC10	We jointly develop demand forecasts with our supply chain partner	0.43	-0.25	**0.26**	0.37	0.04	-0.04	0.59
OPC2	Policies regarding inventories are made after mutual consultation and cooperation	0.11	-0.2	**0.64**	0.19	-0.2	0.22	0.67
OPC4	We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services	0.36	0.03	**0.42**	0.18	-0.06	-0.14	0.57
OPC5	My company and our SC partner work together to synchronize production	-0.04	0.13	**0.92**	-0.24	-0.05	0.09	0.72
OPC7	We mutually implement mechanisms for coordinating responses to atypical demand or supply related events	0.06	-0.03	**0.5**	0.15	0.31	-0.07	0.62
OPC9v1	We have implemented joint forecasting and planning systems with our supply chain partner to achieve quick replenishment	0.04	0.20	**0.57**	0.10	0.25	-0.30	0.65
CID1	We collaboratively improve processes to reduce delivery lead times of the end-products	-0.12	0.14	0.19	**0.76**	-0.05	-0.03	0.76
CID2	We cooperatively improve the delivery reliability of our supply chain	-0.15	0.01	0.31	**0.74**	-0.06	0.05	0.77
CII2	We help each other in improving processes	0.01	0.18	-0.01	**0.71**	-0.08	0.03	0.67
CII3	Continuous improvement programs have been jointly established	0.07	-0.02	-0.1	**0.78**	0.01	0.11	0.68
CII5_3	We implement best practices together	-0.01	0.2	0.03	**0.63**	-0.07	0.07	0.66
CIQ1	Cross-organizational teams are used for working on quality related projects	-0.01	-0.04	-0.28	**0.89**	0.07	0.03	0.58
CIQ3	My company and our SC partner assist each other in improving quality	0.01	-0.17	-0.06	**0.93**	-0.07	0.15	0.74
NPD1	Requirements and specifications of new products are jointly developed by my company and our SC partner	-0.09	0.06	0.08	-0.1	**0.88**	0.01	0.75
NPD2	We work together in all stages of new product development	0.05	0.00	-0.05	0.00	**0.96**	-0.06	0.86
NPD3	Research for new products is done collaboratively	-0.07	0.01	-0.11	-0.08	**0.86**	0.18	0.72
NPD4	In designing new products there is close cooperation between my company and our SC partner	0.10	-0.09	-0.02	-0.03	**0.98**	-0.07	0.86

NPD5	Processes for producing & delivering new products are designed jointly	0.12	-0.11	0.1	-0.06	**0.75**	0.16	0.75
NPD6	We pool together expertise and knowledge for new product development	-0.07	0.01	-0.02	0.06	**0.87**	0.11	0.86
GKW1	We collaborate on creating new knowledge	-0.11	-0.22	-0.09	0.33	0.1	**0.87**	0.90
GKW2	My company and our supply chain partner cooperate to search and acquire new and relevant knowledge	0.01	-0.07	0.00	0.14	0.11	**0.78**	0.82
GKW3	We work together to learn about new and emerging business opportunities	-0.08	0.05	-0.04	0.11	0.00	**0.92**	0.91
GKW4	We jointly create knowledge regarding the intentions and capabilities of our competitors	0.23	0.10	0.07	-0.22	-0.09	**0.73**	0.65
GKW5	We assist knowledge development efforts by sharing knowledge with each other	-0.04	0.09	0.09	0.01	0.07	**0.78**	0.81
GKW7	We work together to discover the future trends in the preferences of end-consumers	-0.08	0.04	0.24	-0.03	0.00	**0.72**	0.68

The exact same EFA process was followed on the three dependent constructs: relationship quality, competitive value, and economic value. The scree plot, shown in Figure 5.2, and Velicer's MAP test reveal the presence of three constructs corresponding. Velicer's MAP test reveals a minimum value for the MAP criteria of 0.03 with 3 constructs. Using the guidelines and Brown's test mentioned above RQ2 and RQ3 items were removed due to significant cross-loadings. The results of the EFA solution for dependent constructs are shown in Table 5.3.

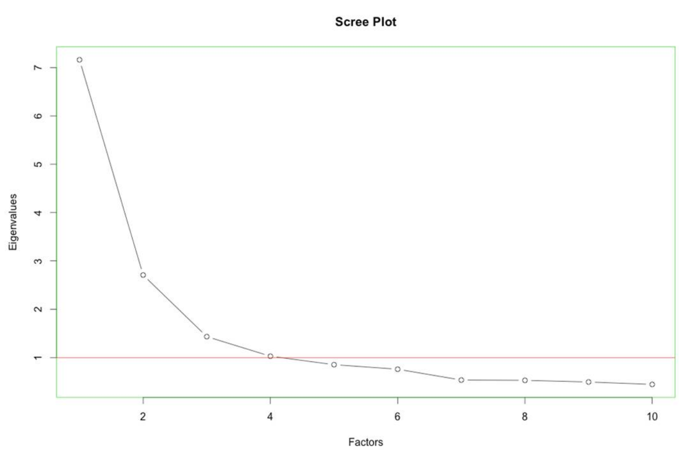


Figure 5.2. Scree plot to determine number of factors underlying items for dependent constructs

Table 5.3

EFA Results for dependent constructs (with oblique rotation)

Items	Item Text	F1	F2	F3	Communality
EVL1	This relationship contributes positively to the profitability of our company	**0.74**	0.11	-0.14	0.53
EVL2	For us the benefits of this relationship greatly exceed the costs of maintaining the relationship	**0.37**	0.28	0.14	0.42
EVL3	This SC relationship has contributed greatly to reduction in our costs	**0.56**	-0.08	0.13	0.37
EVL4	The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant	**0.75**	0.16	-0.11	0.61
EVL5	The assistance of this SC relationship in achieving my company's financial targets has been commendable	**0.84**	-0.05	0.01	0.68
CVL1	This relationship has positively contributed to our company's competitive advantage	0.25	**0.72**	-0.07	0.72
CVL3	This relationship has positively contributed towards achieving our strategic goals	-0.02	**0.73**	0.21	0.64
CVL4	This relationship has allowed my company to distinguish itself from competitors based on unique/differentiated products and services	0.01	**0.8**	-0.06	0.63
CVL6	This relationship has helped my company provide more value to customers than our competitors	-0.04	**0.83**	0.03	0.67
RQ10	The duration of the relationship is longer relative to other supply-chain relationships of my company	-0.15	0.02	**0.88**	0.66
RQ3	We don't have major disagreements because we agree on strategic issues	0.24	-0.21	**0.34**	0.22
RQ4	This relationship will survive even if the people on both sides that liaise with each other left their jobs	0.14	0.00	**0.52**	0.37
RQ6	The relationship will survive even if we had low sales due to adverse economic conditions	0.06	-0.06	**0.67**	0.47
RQ7	We expect this relationship to continue for a long time	0.11	-0.22	**0.69**	0.51
RQ8	This relationship is characterized by high levels of commitment from both sides	-0.22	0.28	**0.73**	0.53
RQ9	We would characterize this relationship as exemplifying a quality relationship	-0.01	0.08	**0.84**	0.75

The results of the EFA are very encouraging. All items, other than RQ3, meet the criteria for communality, loadings and cross loadings (Tabachnick & Fidell, 2006; Velicer & Fava, 1998). RQ3's highest loading is on the intended construct and greater than the suggested cutoff of 0.32. Also all of its cross-loadings are lower than the suggested cut-off of 0.32. Based on acceptable loadings, we have retained RQ3 even though its communality is less than the suggested cut-off of 0.4. To summarize, the EFA results agree with the qualitative analysis and Q-sort results that the six elements of integration are distinct, albeit interrelated, constructs.

5.2. Confirmatory Factor Analysis

We employed confirmatory factor analysis (CFA) on the other half of the sample that was left untouched during the EFA analysis. The main objective of this stage is to confirm the results of EFA by checking for unidimensionality, reliability, and convergent and discriminant validity (Brown, 2012; Byrne, 1998; Cao & Zhang, 2011; Menor & Roth, 2007). Our EFA solution provides strong evidence for the unidimensionality of our constructs. As a further check the CFA model fit indices were examined for each construct, as shown in Table 2.16. All constructs have a good model fit confirming unidimensionality (Menor & Roth, 2007). Mardia, Harzing and Shapiro tests for multivariate normality reveal that our data is not strictly multivariate normal. This is often the norm for survey data as multivariate normality tests assume continuous variables while our survey data is likert-scale data with seven possible outcomes. We have very minor and ignorable skew in our variables (between 0.3 and -0.2 for most variables) and a moderate level of kurtosis (between -1.2 and -1 for most variables). The negative values of kurtosis indicate that our variable distributes are flatter (or fatter) than the normal distribution. To ensure fit indices and chi-square difference tests are robust to non-normality of the data, all CFA models were estimated using Maximum Likelihood estimation with the Satorra-Bentler correction, also referred to as robust maximum likelihood (Satorra, 2000; Satorra & Bentler, 1994, 2001).

Table 5.4

CFA model fit and reliability indices

Construct	Items	χ^2 / df	χ^2 p-value	GFI	CFI	RMSEA	CR	AVE	Cronbach's α
Ops Comm	8	1.39	0.12	0.978	0.98	0.059	0.88	0.47	0.87
Perf Ralted Comm	5	1.34	0.25	0.996	1.00	0.056	0.93	0.72	0.93
Ops Planning & Control	7	0.85	0.63	0.979	0.98	0.031	0.91	0.60	0.91
Collaborative Improv.	7	1.36	0.17	0.973	0.99	0.057	0.95	0.74	0.95
New Prod. Dev.	6	0.52	0.86	0.981	1.00	0.050	0.97	0.83	0.97
General Knowledge Gen	6	0.73	0.66	0.987	1.00	0.024	0.96	0.82	0.97
Economic Value	5	0.52	0.77	0.998	1.00	0.020	0.89	0.62	0.89
Competitive Value	4	0.80	0.45	0.998	1.00	0.060	0.94	0.79	0.93
Relationship Quality	7	1.55	0.09	0.990	0.98	0.072	0.92	0.62	0.91

Table 5.4 shows that all χ^2 per df values are less than 2, and the chi-sq test is not significant for any of the constructs. This shows excellent model fit. RMSEA values are also less than the suggested cut-off of 0.08 (Browne & Cudeck, 1993), with many less than or equal to 0.05, showing adequate to good levels of model fit as well (Hu & Bentler, 1999). The fit-indices and chi-square tests reflect unidimensionality validity because if any of the constructs was composed of more than 1 dimension than such good fit could not have been achieved without correlating multiple error terms. The three reliability measures show excellent levels of reliability. With the exception of operational communication, average variance extracted (AVE) shows that on average the items share anywhere from about 60% to 84% of their variance with their intended constructs. The AVE value of operational communication is 0.47 which is marginally less than the suggested cut-off of 0.5 (Hair et al., 2009). The composite reliability (CR) of operational communication is 0.88 (greater than the suggested cut-off of 0.7). The CFA factor loadings for the items measuring operational communication are all above 0.6, except the 0.56 loading of OCM6. Hair et al. state that “a good rule of thumb is

that standardized estimates should be 0.5 or higher, and ideally 0.7 or higher"(Hair et al., 1998, pg 709). Items with loadings in the 0.6 or 0.5 range should be kept if there are theoretical reasons to do so. OCM6 asks about the company communicating order status information with its supply-chain partner, and this is a common integrative practice that has been measured by past studies (e.g. Zhou & Benton Jr, 2007b). We kept OCM6 as we feel excluding it would not measure an important part of operational communication.

The factor loadings obtained from CFA for the six integration constructs are shown in Table 5.5 and those for the three dependent constructs are shown in Table 5.6. These factor loadings show that the items load on their intended constructs and that the items for any given construct are highly correlated. All factor loadings in Tables 5.5 and 5.6 were highly significant with p-values less than 0.001. All of the factor loadings are greater than 0.6, with the exception of OCM6 which has been discussed above. Every construct has four or more loadings greater than 0.7. Thus the data provides strong evidence of convergent validity.

Table 5.5
CFA factor loadings for the integration constructs

Item ID	Item Text	Op Comm	Perf Comm	Op PnC	Collab. Imp.	NPD	Gen. Knw.
OCM1	My company shares market data about demand for end products with its supply chain partner	0.76					
OCM2	Periodically updated sales forecasts are shared with our SC partner	0.66					
OCM4	My company makes inventory level inormation accessible to our SC partner	0.71					
OCM5	My company shares logistics related information with our SC partner	0.69					
OCM6	My company communicates order status information with its SC partner	0.56					
OCM7	My company gives Real-time access to order-tracking information to our SC partner	0.65					
OCM8	My company provides Information about our production schedules to our SC partner	0.70					
OCM9	My company provides capacity related data to its supply chain partner	0.76					
PCM1	Performance related feedback is given to our SC partner		0.91				
PCM4	My company shares data that our SC partner needs to evaluate its performance		0.90				
PCM5	Performance metrics that extend across our supply-chain dyad are shared with our SC partner		0.80				
PCM6	Performance evaluations are reported to our SC partner		0.94				
PCM7	My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad		0.66				
OPC1	We coordinate activities regarding marketing campaigns and associated operations support across both companies			0.74			
OPC2	We jointly develop demand forecasts with our supply chain partner			0.85			
OPC4	Policies regarding inventories are made after mutual consultation and cooperation			0.77			
OPC5	We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services			0.64			
OPC7	My company and our SC partner work together to synchronize production			0.81			
OPC9v 1	We mutually implement mechanisms for coordinating responses to atypical demand or supply related events			0.79			
OPC10	We have implemented joint forecasting and planning systems with our supply chain partner to achieve quick replenishment			0.82			
CID1	We collaboratively improve processes to reduce delivery lead times of the end-products				0.90		
CID2	We cooperatively improve the delivery reliability of our supply chain				0.83		
CII2	We help each other in improving processes				0.89		
CII3	Continuous improvement programs have been jointly established				0.87		
CII5_3	We implement best practices together				0.88		
CIQ1	Cross-organizational teams are used for working on quality related projects				0.80		
CIQ3	My company and our SC partner assist each other in improving quality				0.84		
NPD1	Requirements and specifications of new products are jointly developed by my company and our SC partner					0.91	
NPD2	We work together in all stages of new product development					0.93	
NPD3	Research for new products is done collaboratively					0.85	
NPD4	In designing new products there is close cooperation between my company and our SC partner					0.92	
NPD5	Processes for producing & delivering new products are designed jointly					0.93	
NPD6	We pool together expertise and knowledge for new product development					0.93	
GKW1	We collaborate on creating new knowledge						0.93
GKW2	My company and our supply chain partner cooperate to search and acquire new and relevant knowledge						0.95
GKW3	We work together to learn about new and emerging business opportunities						0.90
GKW4	We jointly create knowledge regarding the intentions and capabilities of our competitors						0.84
GKW5	We assist knowledge development efforts by sharing knowledge with each other						0.93
GKW7	We work together to discover the future trends in the preferences of end-consumers						0.87

All factor loadings are significant at the α= 0.01 level.

Table 5.6
CFA factor loadings for the performance related constructs

Item ID	Item Text	Econ Value	Competitive Value	Rel. Quality
EVL1	This relationship contributes positively to the profitability of our company	0.80		
EVL2	For us the benefits of this relationship greatly exceed the costs of maintaining the relationship	0.76		
EVL3	This SC relationship has contributed greatly to reduction in our costs	0.76		
EVL4	The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant	0.75		
EVL5	The assistance of this SC relationship in achieving my company's financial targets has been commendable	0.87		
CVL1	This relationship has positively contributed to our company's competitive advantage		0.89	
CVL3	This relationship has positively contributed towards achieving our strategic goals		0.87	
CVL4	This relationship has allowed my company to distinguish itself from competitors based on unique/differentiated products and services		0.91	
CVL6	This relationship has helped my company provide more value to customers than our competitors		0.88	
RQ3	The duration of the relationship is longer relative to other supply-chain relationships of my company			0.67
RQ4	We don't have major disagreements because we agree on strategic issues			0.85
RQ6	This relationship will survive even if the people on both sides that liaise with each other left their jobs			0.64
RQ7	The relationship will survive even if we had low sales due to adverse economic conditions			0.76
RQ8	We expect this relationship to continue for a long time			0.78
RQ9	This relationship is characterized by high levels of commitment from both sides			0.88
RQ10	We would characterize this relationship as exemplifying a quality relationship			0.86

All factor loadings shown above are significant at the α= 0.01 level.

We checked for discriminant validity by running CFA on pairs of constructs, once with a freely estimated correlation between the constructs, and once with the correlation fixed to 1.0. If the two constructs were actually one construct then there would be no significant loss in model fit by constraining the correlation to 1.0 (Menor & Roth, 2007). Table 5.7 shows the results of this analysis. All pairs of integration related constructs showed highly significant loss in model fit for the constrained model showing that all integration constructs are distinct constructs.

Table 5.7

Discriminant validity check for each pair of integration constructs

Pairs of Constructs	Base Model χ^2	Base Model df	Constrainted Model χ^2	Constrained df	Satorra-Bentler Scaled χ^2 Diff	p-value
OCM - PCM	111.603	63	195.18	64	84.88	0.000
OCM - OPC	123.99	89	171.76	90	60.33	0.000
OCM - CLB	113.33	89	193.54	90	91.80	0.000
OCM - NPD	98.333	76	272.14	77	175.78	0.000
OCM - GKW	85.694	75	246.63	76	198.00	0.000
PCM - OPC	75.409	52	241.65	53	266.53	0.000
PCM - CLB	69.285	52	187.10	53	177.05	0.000
PCM - NPD	39.044	42	302.35	43	3796.00	0.000
PCM - GKW	68.749	41	290.09	42	47.94	0.000
OPC - CLB	94.723	76	143.05	77	52.43	0.000
OPC - NPD	71.671	64	214.57	65	109.87	0.000
OPC - GKW	49.206	63	192.63	64	685.96	0.000
CLB - NPD	58.412	64	398.49	65	392.87	0.000
CLB - GKW	61.655	63	281.51	64	32.26	0.000
NPD - GKW	48.637	52	240.33	53	21.48	0.000

The CFA results have confirmed the findings of the earlier stages that the six elements of inter-firm integration are separate and distinct constructs and the scales we have developed for them provide valid and reliable measurements.

5.3. Overall Measurement Model

In the previous section we have demonstrated the validity and reliability of all the constructs developed in this study by using randomly split samples for EFA and CFA analysis. In this section we test a complete measurement model over the entire sample for sake of completeness. This is a suggested step according to some methodological experts (Hair et al., 2009).

For the sake of organization, we also include here measurement properties of the environmental dynamism construct in this section. We will use this construct in chapters 6 and 7 in hypotheses regarding the moderating role of environmental dynamism. This construct was not developed in this study. We use the definition as well as the measurement items for environmental dynamism from Ward and Duray (2000). Environmental dynamism refers to "the degree of turbulence in products, technologies, and demand for products in a market" (Ward & Duray, 2000, pg 124). Since our survey respondents were representing the buyer firm in the supply chain dyad, environmental dynamism was measured for the buyer firm's business environment. The measurement items for environmental dynamism are listed in table 5.9 below along with the factor loadings.

The overall measurement model consisted of ten constructs: six elements of integration described above, the three dependent constructs described above, and the environmental dynamism construct. All ten constructs were allowed to be correlated to each other. No cross-loadings or correlations between error terms from different constructs were used. The CFA model was estimated using Maximum Likelihood estimation with the Satorra-Bentler correction, also referred to as robust maximum likelihood (Satorra, 2000; Satorra & Bentler, 1994, 2001). The model fit for the overall measurement model was as follows: χ^2=2090.9, df=1605, χ^2/df = 1.3, CFI = 1.0, TLI = 1.0, RMSEA = 0.039, 90% RMSEA C.I. = 0.035 to 0.043, SRMR = 0.05. The fit statistics indicate good fit as they are well within the suggested cut-off levels. The factor correlation matrix obtained from the measurement model is given in Table 5.8 below.

Table 5.8

Construct correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Operational Communication	1.00									
(2) Performance Related Comm.	0.71	1.00								
(3) Operational Planning & Control	0.80	0.66	1.00							
(4) Collaborative Improvement	0.72	0.76	0.83	1.00						
(5) New Product Development	0.50	0.44	0.63	0.56	1.00					
(6) General Knowledge Generation	0.63	0.50	0.68	0.73	0.67	1.00				
(7) Relationship Quality	0.41	0.34	0.49	0.49	0.44	0.50	1.00			
(8) Competitive Value	0.38	0.26	0.46	0.39	0.42	0.49	0.73	1.00		
(9) Economic Value	0.43	0.40	0.46	0.48	0.34	0.43	0.70	0.51	1.00	
(10) Environmental Dynamism	0.26	0.29	0.27	0.29	0.33	0.36	0.23	0.25	0.15	1.00

All correlations are significant at the 0.05 level, with the exception of Relationship quality and Env Dynamism which is significant at the 0.1 level.

The factor loadings for the environmental dynamism items were above 0.6 as shown in table 5.9. The construct reliability of 0.79 is greater than the suggested cut-off of 0.7, and the AVE is slightly less than the suggested cut-off of 0.5.

Table 5.9

CFA results for environmental dynamism

Environmental Dynamism (CR = 0.79, AVE = 0.49)	Std. factor loading
The rate of change of tastes or preferences of customers in your industry	0.61
The rate of innovation of new products or services	0.85
The rate of innovation of new operating processes	0.62
The rate at which products and services become out-dated	0.70

5.4. Measurement Equivalence

Our survey responses were collected from manufacturing firms in the United States and Canada. The two countries are very similar in their economic and business related cultural norms, and both of them are often treated as the region of North America. In this section we empirically test measurement equivalence of our constructs across the two countries to ensure our results can be generalized to both contexts. Methodology literature suggests that calibration, translation and metric equivalence should be established for constructs when data is collected from multiple countries (Mullen, 1995; Rungtusanatham et al., 2005).

Calibration equivalence ensures that units of measurement are the same across countries, e.g. temperature is in either Celsius or Farenheit but not both. The survey questions required responses on seven point Likert scales. Likert scales with anchors clearly labeled are well understood and do not require any further calibration (Rungtusanatham et al., 2005).

Translation equivalence is about ensuring that the survey items are still measuring the same latent constructs when translated into different native languages. The survey was in the English language, which is the official language for both countries. Thus no translation was required. The familiarity of the respondents with Likert sales and their comfort with the English language is a given as the respondents were managers or similarly qualified personnel.

Metric equivalence is about ensuring that the responses from multiple groups (countries) have similar psychometric properties. As suggested by Rungtusanatham et al. (2005) we examine the reliability of the constructs across the two countries to establish metric equivalence. Table 5.10 shows the Cronbach's alpha for Canada and the United States. For all constructs the Cronbach's alpha is higher than the suggested cut-off of 0.7 in both countries. Also for any construct the difference in the Cronbach'a alpha values for Canada and the United States is less than 0.1 showing that our constructs are equally reliable in both countries.

Table 5.10

Reliability (Cronbach's Alpha) in Canada and the United States

Construct	Canada	United States
Operational Communication	0.881	0.888
Performance Related Communication	0.918	0.942
Operational Planning & Control	0.911	0.866
Collaborative Improvement	0.939	0.955
New Product Development	0.962	0.964
General Knowledge Generation	0.962	0.960
Relationship Quality	0.889	0.915
Competitive Value	0.903	0.953
Economic Value	0.874	0.851
Environmental Dynamism	0.787	0.777

To further support the case for metric equivalence we use Generalizability theory. There are two dominant approaches in the literature to establish metric equivalence. The CFA approach requires a sample size of at least 100 to 400 in each group (country) (Brown, 2012; Malhotra & Sharma, 2008; Steenkamp & Baumgartner, 1998). This large sample size requirement renders CFA unsuitable for our dataset as we have only 41 responses from the United States. Generalizability theory (G theory), by contrast, is effective with substantially smaller sample sizes (Malhotra & Sharma, 2008). It allows the researcher to examine whether measurement scales can be generalized across groups after their measurement properties have been established.

In our study, the respondents (firms) were nested within countries. All respondents answered all of the survey items, and hence, items and respondents were crossed. In G theory terminology, we employed a respondents (subjects) nested in groups (countries) and crossed with items design (Shavelson & Webb, 1991). In such a design, G theory estimates five sources of variation: items, groups, subjects nested in groups, items-groups interaction, and error variation (Malhotra & Sharma, 2008; Shavelson & Webb, 1991). A smaller the percentage of variation from the items-groups interaction and error indicates greater generalizability for the items across the groups. We present our estimation of the various sources of variation and the generalizability coefficients (GCs) for our multi-item constructs in Table 5.11. All of the GCs were between 0.79 and 0.96, indicating a high level of generalizability across the two countries (Malhotra & Sharma, 2008). We were thus able to pool our data from Canada and United States for the analysis.

Table 5.11

Measurement Equivalence using G Theory

Construct	Number of Items	Items %	Groups %	Subjects within groups %	Items x Groups %	Error plus other %	Generalizability Coefficient
Operational Communication	8	5.8%	0.9%	45.1%	0.0%	48.2%	0.884
Performance Related Communication	5	9.6%	0.9%	62.8%	0.1%	26.7%	0.922
Operational Planning & Control	7	6.2%	0.0%	53.3%	0.1%	40.4%	0.902
Collaborative Improvement	7	2.1%	1.8%	67.1%	0.1%	28.9%	0.943
New Product Development	6	0.5%	0.0%	80.5%	0.0%	19.1%	0.962
General Knowledge Generation	6	0.7%	0.0%	79.9%	0.3%	19.1%	0.961
Relationship Quality	7	2.3%	0.0%	52.5%	0.0%	45.1%	0.891
Competitive Value	4	3.2%	0.3%	69.0%	0.3%	27.2%	0.910
Economic Value	5	1.4%	1.7%	54.9%	0.4%	41.7%	0.870
Environmental Dynamism	4	2.9%	1.0%	46.0%	0.0%	50.1%	0.789

5.5. Higher Order Constructs and Elements of Integration

Higher order constructs are also sometimes called multidimensional constructs. They refer to “several distinct but related dimensions treated as a single theoretical concept” (Edwards, 2001, p. 144). Higher order constructs are pervasive in management research. For example socially responsible practices are so broad that researchers use second order constructs to club related more narrower constructs together (Shafiq et al., 2014). Similarly learn management practices can be treated as a second order construct comprised of several first order latent constructs (Shah & Ward, 2007). It is not a surprise then that the broad phenomenon of integration may also have higher order constructs that group together the various elements of integration.

The qualitative analysis tage suggested that some of these elements of integration were related. The operational communication and performance related communication constructs are both "basic communication" albeit about different matters. The both increase the visibility in the supply chain and improve decision-making. Thus they are conceptualized as belonging to a higher order "Basic Communication" construct. Similarly operational planning & control and collaborative improvement both aim to improve operational efficiencies. Operational planning & control focuses on synchronization of activities while collaborative improvement focuses on fundamental process improvement and re-engineering business processes. Both of these constructs aim to achieve greater operational excellence and hence are conceptualized as belonging to higher order "Operational Excellence" construct. New product development generates new knowledge by developing new products and their associated manufacturing technologies (Koufteros et al., 2005, 2007). Similarly generating knowledge about capabilities, competencies and the competitive environment involves very similar processes and organizational knowledge processing capabilities (Hult et al., 2004, 2006). These two constructs are conceptualized as belonging to a higher order "Knowledge Generation" construct. Figure 5.3 shows the three higher order constructs and the elements of integration. We follow the methodology used by Hult et al. (2002) in creating hypotheses about our second order constructs and testing them using confirmatory factor analysis (CFA) techniques. Thus we hypothesize:

H-m1a: Basic Communication is positively reflected by Operational Communication.

H-m1b: Basic Communication is positively reflected by Performance Related Communication.

H-m2a: Operational Excellence is positively reflected by Operational Planning and Control.

H-m2b: Opertional Excellence is positively reflected by Collaborative Improvement.

H-m3a: Knowledge Generation is positively reflected by New Product Development.

H-m3b: Knowledge Generation is positively reflected by General Knowledge Generation.

The six hypotheses above define a structure for the broad concept of integration that is illustrated in Figure 5.3.

Figure 5.3. Model 1 showing higher order structure of elements of integration

The recommended approach to test for a second order factor structure (i.e. existence of higher order constructs) is to compare the higher order construct model with a model with just first order constructs that are correlated with each other (MacCallum et al., 1993; Malhotra & Mackelprang, 2012). The higher order model (shown in Figure 5.3) has fewer parameters to estimate and is a nested model in the full first factor model (shown in Figure 5.4) with all possible correlations between the first order factors. We can statistically test whether the data supports the structure shown in Figure 5.3 (model 1) or not by comparing it with the model shown in Figure 5.4 (model 2). If there is no significant reduction in model fit in going from the model 2 (Figure 5.4) to model 1 (Figure 5.3), then model 1 is preferred for being a more parsimonious representation of the data. The chi-square test gives us a p-value which can allow us to determine if the hypothesis about second order factors is supported.

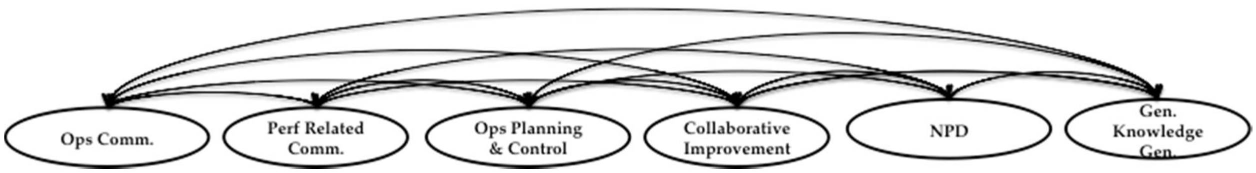


Figure 5.4. Model 2 without higher order constructs

A robust chi-square difference test was done to compare the two models. The Satorra-Benlter scaled chi-square difference was 9.0942 with six degrees of freedom, which gives a p-value of 0.17. The high p-value shows that there is no significant difference in model fit between models 1 and 2. Thus model 1 is preferred for being a more parsimonious (with six less parameters) depiction of the empirical data.

We also test the hypotheses H-m1 to H-m3 individually by testing the significance of the factor loadings in model 1. The results shown in Table 5.10 below show strong support for all of the H-m1 to H-m2 hypotheses.

Table 5.10

Results for hypotheses regarding higher order factor structure

Hypothesis	Factor Loading	P-value of Factor Loading
H-m1a	0.856	< 0.001
H-m1b	0.787	< 0.001
H-m2a	0.911	< 0.001
H-m2b	0.919	< 0.001
H-m3a	0.750	< 0.001
H-m3b	0.900	< 0.001

5.6. Discussion

In this chapter we have empirically tested the results from the qualitative analysis by analyzing results of our survey that asked questions about six elements of integration. We found that the six elements of integration are indeed distinct constructs and they reflect three second-order constructs. Research studies that are constrained in measuring six constructs to capture integration can work at the level of the three second-order constructs. The results of this chapter allow us to build hypotheses using the new elements of integration conceptualization of supply chain integration.

6. Conceptual Model for the Elements of Integration and Performance

Building theory involves defining constructs and identify the relationships between them with any requisite boundary conditions (Choi & Wacker, 2011; Wacker, 1998). Chapter 02 of this dissertation was focused on identifying the constructs that make up the integration black-box through a systematic and replicable process. We then empirically verified the structure of the integration black-box by showing the validity of our new elements of integration constructs in Chapter 5. The next step is to identify relationships between the elements of integration and other constructs of interest such as performance benefits. To this end, in this chapter we hypothesize and test how the various elements of integration provide benefits to profitability and competitiveness of each partner and how these performance benefits change under dynamic business conditions. This chapter builds the hypotheses that are then tested to answer RQ2 and RQ3 of the dissertation.

When identifying salient relationships involving the elements of integration it is important to recognize the contingent nature of most business related theory (Drazin & Van de Ven, 1985; Hofer, 1975). Researchers have commented that fast technological change means that companies can no longer operate with the assumption that business conditions will remain stable (D'Aveni et al., 2010). Dynamic conditions are the hallmark of many industries in today's global and fast changing world. It is thus important to understand how the performance implications of these elements of integration change in rapidly changing business conditions.

The relationships hypothesized in this chapter highlight the differences of the elements of integration. We argue that not all elements of integration are important for competitiveness. Also the various elements of integration react different to changing business conditions. The empirical results of testing these hypotheses will assist firms in taking relationship level decisions about what elements of integration to implement. For example given a firm's objectives for a particular relationship and the business conditions it experiences, it can pick the most appropriate elements of integration. This is an important contribution to the prevailing wisdom that the more integration the better for all of the important supply chain relationships.

6.1. Performance Benefits of Integration

Performance benefits are often the central rationale for firms to practice supply-chain integration (SCI). Many empirical studies have tested the performance benefits of the average level of integration of a focal firm with major suppliers and customers (Frohlich & Westbrook, 2001; Vickery et al., 2003). Our new conceptualization of inter-firm integration suggests a change in the perspective from that of a single construct for integration at the focal firm level to the various elements of integration at the relationship level. We need to revisit the integration-performance relationship for these elements of integration, as we cannot automatically assume the past results for the focal firm's average level of integration with major supply-chain partners will hold for all the elements of integration at the relationship level.

The empirical results on the integration-performance relationship have not been consistent, though the majority of scholars agree on the positive performance benefits of integration (Droge et al., 2004; Fawcett et al., 2012; Terpend et al., 2008). The mixed empirical evidence combined with the lack of widespread implementation of SCI by companies leads some authors to question whether integration always leads to performance (Fabbe-Costes & Jahre, 2008). We show in this chapter that these differing views about the performance benefits of integration can be resolved if our elements of integration view is considered. It is possible that some elements of integration have no direct effect on performance themselves, but are implemented as they support or enable other elements of integration. Other elements of integration could be the basis of performance differentials over rivals, or in other words *order winners*. Since existing studies measure a mix of integrative practices from the various elements of integration, the results are inconsistent. This is evident in studies in which only one of customer or supplier integration is found to have a significant effect on performance (e.g. Droge et al., 2004; Flynn et al., 2010). That is unexpected from a theoretical standpoint because supplier and customer integration both refer to integration between companies at two different points in the supply chain.

The elements of integration create value through several mechanisms. The system dynamics perspective tells us that integration can lead to better forecasts, reduce inventories and optimize the flow of materials in the supply chain. All of these increase the profitability as costs are reduced. Also increased availability of products positively impacts sales (Stank et al., 2003). The quality management literature and lean management both include working with supply chain partners to improve processes and reduce waste (Kaynak, 2008). Similarly improved quality can lead to differentiation of the product over rivals' products. Supply chain partners benefit from combining their knowledge bases with each other when innovating (Hult et al., 2006).

In this section we present arguments for relationships between the three higher-order integration constructs and the economic value, competitive value, and relationship quality constructs. The three performance related constructs of economic value, competitive value and relationship quality were defined in chapter 2. We summarize our empirically verified structure of the integration concept in Figure 6.1.

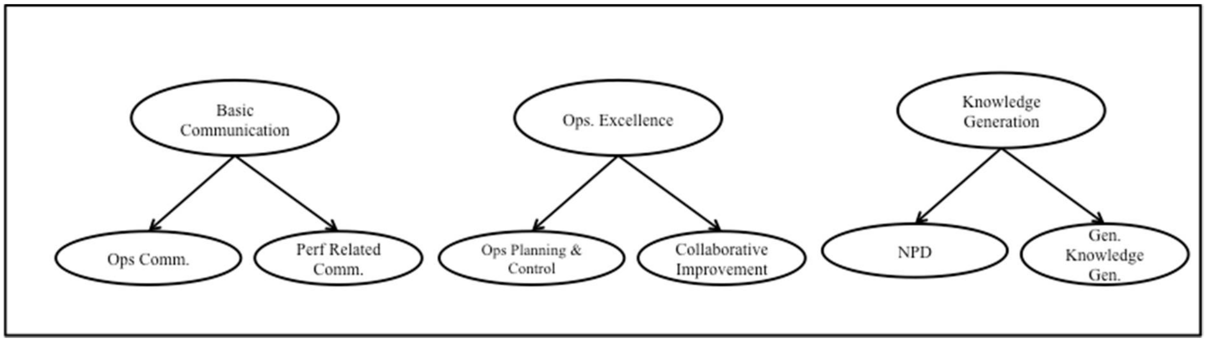


Figure 6.1. Conceptual structure of inter-firm integration

Our hypotheses are developed at the level of the second order constructs. This is because the elements that belong to a second order construct are expected to behave very similarly to each other. The number of hypotheses grows exceeding large at the level of the individual elements of integration and that poses much higher sample size requirements for the empirical testing. We have already shown using empirical tests in the last chapter that the second order constructs describe the integration related data well.

6.1.1. Basic Communication

Basic communication includes two elements of integration: operational communication and performance related communication. Operational communication improves sharing information about day-to-day activities, movement of goods, production planning and so forth. Performance related communication enables feedback to move in both directions in the supply chain dyad and allowing each partner to adapt its operations to ensure the other is satisfied.

Both types of communication are essential for the dyad to establish before the operational activities in the dyad can be improved. Operational excellence comprises of operational planning and control and collaborative improvement. Operational planning and control cannot be implemented if operational information is not shared. Studies on the bull-whip effect also demonstrates that sharing operational information enables reducing the bull-whip effect through joint planning and control (Lee et al., 1997a). Collaborative improvement uses paradigms like TQM, JIT and Lean to improve the supply chain operations. These methodologies require baseline measurements on various operational metrics to be established so improvement efforts can be measured and this is greatly assisted if operational data is shared. Similarly firms may prioritize certain areas of operational improvement based on feedback and assessment from their supply chain partners. Shah and Ward (2007) show that feedback related communication with suppliers is important for implementing lean. There is support in the literature for the positive impact of information sharing on operational improvement in supply chains (Iyer, 2011). Thus we argue that basic communication is an antecedent of operational excellence. Supply chain dyads can only implement operational excellence and reap its benefits if basic communication is in place.

H1: Basic communication positively affects operational excellence.

Basic communication does not include more intimate forms of communication where two firms may jointly learn and understand customer requirements or changing customer needs and develop new products in response. When inter-organizational teams are employed by supply-chain dyads to learn about new technologies, capabilities and to develop new products they are usually not concerned with sharing operational data on day-to-day production and logistics activities. In many situations operational communication regarding new products may only be established once the new product has progressed from the development and testing stage to the manufacturing stage. Hence new product development efforts and learning about the new technologies and capabilities is not dependent on basic communication. That is why we don't hypothesize a direct effect of basic communication on knowledge generation. Basic communication may lead to relational outcomes like increased trust for the buyer and supplier firms. This build-up of trust could enable the partners to implement knowledge generation. Future research should explore the relationship between basic communication and the other elements of integration by considering mediating variables like trust and shared understanding that capture the relational positives that could result from basic communication.

Basic communication also does not affect economic value or competitive value generated from the relationship. Advances in information and communication technologies, business-to-business (B2B) data-sharing standards, and enterprise resource planning (ERP) systems have automated much of the communication. Off the shelf solutions can quickly bring supply chain partners up to speed in sharing data and information that can be digitalized. Performance metrics, dashboards, and supplier evaluations are often updated electronically and sometimes in real-time. Also over time the cost of these off-the-self solutions has come down with many alternatives available. The development of cloud based solutions where enterprise software is sold as a service has brought down the large fixed expense associated with these technologies so that even small and medium sized manufacturers can pay for what they use without any large capital investment. Rai et al.

(2006) show that IT investments in sharing information in the supply chain do not directly yield performance advantages over rivals but assist building higher level supply chain capabilities. Their finding lends credence to our argument that basic communication leads to higher forms of integration (i.e. operational excellence) but does not by itself lead to performance advantage over rivals. Thus we expect basic communication to have a supporting role and not directly affect performance. That is why we do not expect to basic communication to have any direct effect on economic value or competitive value.

H2a: Basic communication does not directly affect economic value.

H2b: Basic communication does not directly affect competitive value.

Basic communication on the other hand can improve relationship quality. This is because sharing data and information can create an environment of transparency, openness, and trust in the relationship. Since operational data is available to both partners it is easy to see the role and contribution of each partner and this engenders perceptions of fairness. Firms can make decisions based on hard facts rather than perceptions and also have confidence regarding what the supply chain partner is actually doing. Nyaga et al. (2010) found a positive effect of information sharing on commitment and trust in relationships, both of which improve relationship quality.

H2c: Basic communication positively affects relationship quality.

6.1.2. Operational Excellence

Operational excellence is primarily concerned with improving supply chain operations by utilizing the information and capabilities of both supply chain partners. Operational planning and control aims to synchronize the supply chain better so that production and logistics activities happen in a timely fashion, the bullwhip effect is minimized, and goods flow through the supply-chain dyad without any delays (Sahin & Robinson, 2002). Collaborative improvement utilizes established quality management, lean and just-in-time methodologies to improve business processes. For example lean, total quality management (TQM), and just-in-time (JIT) processing all include as part of their methodology working with downstream or upstream firms (Barker & Emery, 2006; Shah & Ward, 2007). These two elements of integration improve outcomes such as on time delivery, quality of products and services, flexibility of the supply-chain dyad in meeting demand or supply changes, and the efficiency of logistics and production processes. These operational outcomes become the basis of increased profitability and competitiveness of the supply-chain dyad.

Operational excellence is not easy to replicate. It builds relationship specific routines, mutual understanding of processes that span firm boundaries, and a shared improvement culture. These relational outcomes cannot be acquired in factor markets and are characterized by time diseconomies (Dierickx & Cool, 1989; Hult et al., 2003). For these reasons we expect the implementation of elements of operational excellence in a supply-chain dyad to contribute to both economic and competitive value.

H3a: Operational Excellence positively affects economic value.

H3b: Operational Excellence positively affects competitive value.

Integrative elements of operational excellence will positively affect the quality of the relationship. This is because cooperative behaviors and a history of collaboration lead to increased trust, commitment and satisfaction (Johnston et al., 2004; Johnston & Kristal, 2008). Through these integrative elements both partners will understand each other better, have greater knowledge of each others processes, and experience each others commitment to improving the supply-chain dyad.

H3c: Operational Excellence positively affects relationship quality.

6.1.3. Knowledge Generation

The primacy of knowledge in generating competitive advantage for firms has been well established by the Knowledge Based View (KBV) (Grant, 1996; Nickerson & Zenger, 2004). Some researchers have also shown knowledge to play a key role in creating value in supply chains (Hult et al., 2006) and networks of firms (Dyer & Nobeoka, 2000). However empirical research on supply chain integration has not treated knowledge creation as a separate construct or type of integration. Knowledge generation consists of two integrative elements: new product development and general knowledge generation. Often a limited perspective on new product development is used that limits its scope to generating a new product. We consider new product development to be an activity primarily dealing with generating new knowledge. New products are the outcome of a knowledge intensive exercise that includes assimilating diverse knowledge bases, organizational learning, and experimentation. It results in producing not just new products but knowledge about components and materials used in the new product, knowledge of the efficacy of the new product and possible extensions, capabilities to manufacture the new product, as well as knowledge of many alternative methods and prototypes that do not work. Thus new product development is more aptly treated as a form of knowledge generation.

The element of general knowledge generation refers to learning about new technologies, capabilities, and business models that are relevant to the competitive landscape in which the products and services of the supply-chain dyad compete. Supply chain partners often collaborate on knowledge intensive projects that do not directly aim to create a new product. For example Metro collaborated with its major consumer goods suppliers and RFID technology firms to learn, test and develop the RFID technology and its related standards for use in the retail industry (Collins, 2004; Tajima, 2007). RFID technology is neither a product for Metro nor a product for its suppliers of consumer goods etc. It is a technological capability that allows it to gain competitive advantage over other retailers.

Knowledge generation impacts both economic and competitive value. New products are an important source of re-generating competitive advantage in changing business conditions (Koufteros et al., 2007). In fact timely and effective new product development has been said to provide a dynamic capability that increases competitiveness (Teece et al., 1997). New product development and general knowledge generation complement each other. General knowledge generation ensures that firms are not caught in the competency trap where they release successive new versions with incremental improvements to their products while continuing to serve the exact same customer base (Christensen, 1997). General knowledge generation enables the firm to identify new markets, new customers, changing customer preferences, as well as discontinuous technological jumps. General knowledge generation ensures that both supply chain partners develop a culture where knowledge is valued and new knowledge is constantly sought. This provides greater readiness to rapid changes in technologies and business conditions as well as sometimes the ability to preempt such rapid changes.

H4a: Knowledge generation positively affects economic value.

H4b: Knowledge generation positively affects competitive value.

Knowledge generation also improves relationship quality as both partners have a sense of shared fate. Success in their knowledge generation efforts would benefit both, while failures would mean lost investment of resources and time for both. Knowledge generation also fosters greater commitment to the relationship as both partners see the benefit of the knowledge and skills of the other. Strong relationships characterized by intimate forms of integration like knowledge generation are in a sense close partnerships as the firms move beyond operational and process issues to strategic concerns. Such relationships are characterized by expectations of continuity on both sides (Jap, 2001).

H4c: Knowledge generation positively affects relationship quality.

6.2. Integration and the Role of Environmental Conditions

A lot of supply chain management literature is devoted to studying business conditions and environmental factors that make integration more or less desirable (Iyer, 2011; Wong et al., 2011b; Wong & Boon-itt, 2008). In the previous section we argued for the varied impacts of the various elements of integration on performance. Now we show that we expect the elements of integration to behave differently under different environmental conditions.

To being we summarize the contingencies studied by the existing SCI literature in Table 6.1. The table shows that a lot of effort has been spent on trying to determine when the broad construct of integration is more important and when it is less important.

Table 6.1
Summary of literature on the moderators of the integration-performance relationship

Paper	Contingencies	Summary
(Stonebraker & Liao, 2006)	Product Life Cycle Environmental Complexity Environmental Munificence	Theory paper that argues that SCI intensity depends on 3 contingencies
(Wong et al., 2011b)	Environmental Uncertainty	Empirical paper that shows that empirical uncertainty strengthens the effect of supplier and customer integration on various types of operational performance
(Wong et al., 2011a)	Product Type Product Complexity Environmental Complexity Environmental Munificence	Empirical paper that shows that information integration is beneficial in high munificence and low uncertainty environments. Information integration is also more beneficial when product complexity is high.
(Iyer et al., 2009)	Demand Unpredictability Product Turbulence	Integration is helpful for financial performance in stable and predictable environments and not in chaotic ones. Integration has a positive effect on operational performance in both stable and chaotic environments but the effect is greater in stable environments.
(Iyer, 2011)	Technological Turbulence Market Turbulence IT Analytic Capability	IT analytic capability and technological turbulence are antecedents to downstream (customer) integration. The greater the technological turbulence the greater is the effect of IT analytic capability on downstream integration.
(Parker et al., 2008)	Strategic importance of product Technological Newness Relationship Strength	Unite of analysis is the new product development project with supplier involvement. The 3 factors identified are antecedents to extent of supplier integration.
(Koufteros et al., 2005)	Uncertainty Equivocality Platform Strategy	Empirical results show that uncertainty does not moderate the various relationships between integration and performance. Supplier integration is beneficial in low equivocality environments. Customer integration has a greater benefit in high equivocality environments.
(Robles, 2011)	Environmental Uncertainty Environmental Similarity	Theory paper that argues that export channel integration is beneficial under conditions of environmental similarity and either high or low uncertainty.
(Peng et al., 2013)	Product clockspeed	Product clockpseed positively moderates the relationship between supplier and customer integration and plant level capabilities for innovation.
(Souder et al., 1998)	Market Uncertainty Technical Uncertainty	Market and technical uncertainty moderate the relationship between R&D integration with customers and success of new product development.
(Danese & Romano, 2013)	Fast Supply Network Structure	Supply network structure moderates the effect of customer integration on performance
(Danese, 2011)	Goals of collaboration Demand elasticity Product diversity Supply network spatial complexity	10 case studies used. Four contextual factors are identified that affect the level of SCI.
(Danese et al., 2013)	International Suppliers	Use of international suppliers positively moderates effect of external integration on performance
(van Donk & van der Vaart, 2004)	Business conditions: complex vs simple	Case studies show that in complex business conditions, greater integration is required vs simple business conditions.
(Terjesen et al., 2012)	Modularity Based Manufacturing Practices	Fit between SCI and modularity based manufacturing practices yields greater operational performance

Uncertainty is a common theme that emerges from Table 6.1. Some authors have focused on demand volatility while others on environmental uncertainty or dynamism. Forrester (1958, 1961) in his theory of Industrial Dynamics noted that fluctuations, oscillations and unpredictable changes in demand would affect inventory levels and operations in the entire chain of production. The idea was later developed be Lee et al. (1997a, 1997b) as the bullwhip effect and formed the basis of product classification into functional and innovative products by Fisher (1997). Ramdas and Speckman (2000) found greater inter-firm integration in innovative product supply chains than functional product supply chains, thus supporting Fisher's (1997) recommendations. Later empirical work has focused on environmental uncertainty, which includes unpredictability of demand, supply and competitor actions, as a contingency (Wong et al., 2009, 2011b; Wong & Boon-itt, 2008).

All of the papers summarized in table 6.1, with the exception of Parker at al (2008), are at the focal firm level with SCI being conceptualized as the average level of integration with major suppliers or customers. It is unlikely that contextual factors like environmental uncertainty affect all types of supply-chain integrative practices uniformly. For example the need for sharing demand related data to reduce the bullwhip effect (Lee et al., 1997a) remains even when environmental uncertainty is low. Since some supply-chain integrative practices are not affected by uncertainty, while others are, when they are combined in one construct the effect of uncertainty on such a mixed bundle of practices cannot be accurately determined. This is why some studies find environmental uncertainty to increase the effect of integration on performance (Wong et al., 2011b), while others find the reverse (Iyer et al., 2009), and others still find no moderating role of uncertainty (Koufteros et al., 2005).

In this chapter we highlight that the elements of integration respond in different ways to environmental dynamism. In fact we find that operational excellence elements of integration reach in an opposite way to environmental dynamism than knowledge generation elements of integration. This explains why some studies that take a black-box view of integration find contradictory results. Our approach if replicated for other environmental conditions will lead to a more nuanced and useful understanding where the impact of the various elements of integration under different business conditions is known. Such an understanding can be used to design effective supply chain relationships.

6.2.1. Elements of Integration and Environmental Dynamism

Environmental dynamism is rapid and often discontinuous change in consumer preferences, technologies, competitors and/or regulation such that accurate information is unavailable and the future is highly unpredictable (Bourgeois & Eisenhardt, 1988; Dess & Beard, 1984; Ward et al., 1995). Ward and Duray (2000) define environmental dynamism as “the degree of turbulence in products, technologies, and demand for products in a market” (Ward & Duray, 2000, pg 124). In this section we hypothesize about the role of environmental dynamism in the buyer firm’s environment. In a supply chain dyad the demand for the supplier firm’s products and services is derived from the demand faced by the buyer firm. The turbulence in the demand faced by the buyer firm is primary and drives the turbulence in the demand faced by the supplier. If dyadic data cannot be collected for both the buyer and supplier firms, then it is more important to measure environmental conditions that affect demand for the buyer firm. In this study we measure environmental dynamism for the buyer firm only, using measures of environmental dynamism from Ward and Duray (2000) that are listed in chapter 5.

Dynamism leads to ambiguity (also called equivocality) in the task environment and hence makes decision making difficult. Ambiguity is lack of clarity about future states and the factors important for success in the future (Carson et al., 2006). Environmental dynamism makes it difficult for firms to predict the basis of competitive advantage in the next round of competition. For example Steve Jobs indicated that his company has to create products for needs that don't yet exist or are still unknown to the consumers themselves (Carland & Carland, 2003). Similarly firms face difficulties when they are unsure of which technology to invest in or which capabilities will be important in determining 'winners' and 'losers' in future. Environmental dynamism is different from volatility in demand as volatility can exist in non-dynamic environments as well. For example clothing is a mature and stable industry in terms of technologies and products yet the demand for fashion items is highly volatile.

The consequences for firms and their supply chain partners for ignoring environmental dynamism or not putting up an appropriate response can be disastrous. For example strong incumbent firms often do not see new technologies that can displace their products and render their capabilities obsolete (Christensen, 1997). In industries where such shifts happen at a fast pace, firms must expose a lot of sensors to the environment, and be open and receptive to change (Mintzberg et al., 2002; Roberts & Eisenhardt, 2003).

In the previous section we developed hypotheses regarding the effects of operational excellence and knowledge generation on the value contribution of the relationship from the buyers perspective. In this section, we argue that the moderating effect of environmental dynamism on operational excellence is in an opposite direction to its moderating effect on knowledge generation. As environmental dynamism increases the returns from operational excellence elements of integration decrease, while the returns from knowledge generation elements of integration increase.

6.2.2. Operational Excellence and Environmental Dynamism

Operational excellence leads to process improvement, and greater synchronization of activities across the buyer-supplier dyad. The kinds of improvement initiatives it captures, such reducing waste and streamlining inventory, are applicable even when the environment is not dynamic. In stable environments cost advantage from operating efficiency becomes the source of competitive advantage because the dominant design has emerged and innovation is incremental and slow paced.

When environmental dynamism is high, operational excellence loses some of its importance and the return on investment on operational excellence efforts is comparatively lower (Prajogo & Sohal, 2001; Sitkin et al., 1994). This is because innovation becomes the dominant driver of competitiveness. Also since sudden and rapid change is the dominant characteristic of the environment, operational improvement initiatives have a short life span over which they stay relevant. After some time the improvements need to be revisited to address the changing business conditions. Thus the payback period for operational improvements is reduced. This is why Fuentes-Fuentes et al. (2004) found through empirical testing that higher environmental dynamism did not lead to greater continuous improvement initiatives in TQM. A lower return on effort and resources invested in operational excellence combined with the higher returns from innovation make operational excellence less relevant in highly dynamic business conditions.

Organizational theorists have long argued that learning plays an important role in adaptation in response to dynamic environments (Cohen & Levinthal, 1989; Cyert & March, 1963). Many researchers have shown that structured improvement initiatives, such as those captured by operational excellence, hinder double loop learning, trap organizations in incremental changes, hinder creativity through standardization, and cause organizations to be narrow minded through a strict measurable cost-benefit regime (Prajogo & Sohal, 2001). Sitkin et al. (1994) also point out that improvement initiatives like total quality management are not suited to high uncertainty task environments due to their structured approach and lack of explorative and learning oriented mechanisms.

H5a: Under low environmental dynamism, operational excellence has a greater effect on economic value than its effect under high environmental dynamism.

H5b: Under low environmental dynamism, operational excellence has a greater effect on competitive value than its effect under high environmental dynamism.

We expect effect of operational excellence to decrease with increasing environmental dynamism. In some situations the effect may decrease to an extent that operational excellence may no longer be relevant, while in others it may decrease but still remain a significant positive effect.

6.2.3. Knowledge Generation and Environmental Dynamism

Knowledge generation allows supply chain dyads to adapt to disruptive changes in the business environment faster. Conditions of dynamism are often marked by technological heterogeneity because dominant designs don't exist and any standards need to be frequently revised. Such conditions increase the information gathering and processing requirements on firms (Cyert & March, 1963). Supply chain dyads characterized by knowledge generation integration elements can have greater information search and processing ability than individual firms. This is even more relevant when information useful for a particular level of the supply chain is located upstream or downstream. Knowledge generation allows dyads to jointly conduct information assimilation and processing increasing the likelihood of relevant information being discovered, processed, and used to undertake appropriate responses (Hult et al., 2004).

The greater diversity present within a dyad compared to an individual firm allows for a greater range of interpretations and possible responses to the environment (Huber, 1991). In the strategy literature this is referred to as adaptive capacity. Adaptive capacity (Gulati et al., 2005) is the increased ability to react to Schumpeterian shocks (Roberts & Eisenhardt, 2003), disruptive innovations (Christensen, 1997), and changes in the competitive landscape, or in other words a 'dynamic capability' to develop, reorganize, and redeploy assets and capabilities under changing environments (Teece et al., 1997). Knowledge generation allows for quick transfer of relevant knowledge and quick reconfiguration of resources (Gulati et al., 2005). Since knowledge generation enables dyads to find better solutions and implement them more effectively it is an important driver of performance in dynamic environments. Ragatz et al. (2002) have shown that supplier integration becomes more useful for new product development under conditions of technology uncertainty. However due to the black-box approach to integration they are unable to point out if certain elements of integration are more useful than others.

On the other hand, the costs the implementing knowledge generation elements of integration can be higher than the benefits in stable conditions. Knowledge generation requires intimate relationships as both firms jointly explore new possibilities. The returns from such explorative efforts are uncertain and unknown (March, 1991). Complete contracts can't be written or enforced so trust based mechanisms guide the relationship (Fawcett et al., 2012; Gulati et al., 2005). In stable environments firms can get more certain and immediate returns through efficiency improvements and incremental changes in products, and hence would not be inclined to invest in knowledge generation. Several existing studies support our argument. Thornhill (2006) shows that knowledge assets are more important for innovation and firm performance in high-tech industries verses low-tech industries. Similarly Uotila et al. (2009) find that knowledge generation has a strong relationship with financial performance of firms in dynamic environments.

H6a: Under high environmental dynamism, knowledge generation has a greater effect on economic value than its effect under low environmental dynamism.

H6b: Under high environmental dynamism, knowledge generation has a greater effect on competitive value than its effect under low environmental dynamism.

The theoretical model developed in this chapter is illustrated in figures 6.2, 6.3 and 6.4 below.

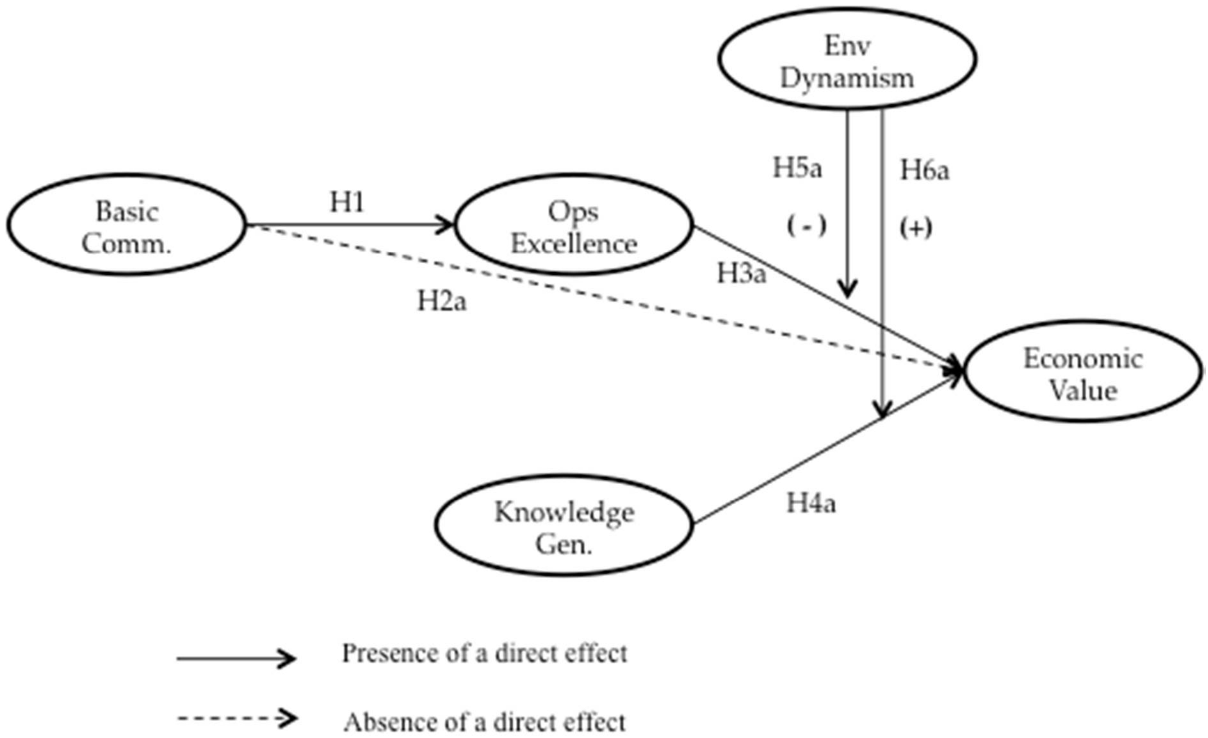


Figure 6.2. Theoretical model for economic value

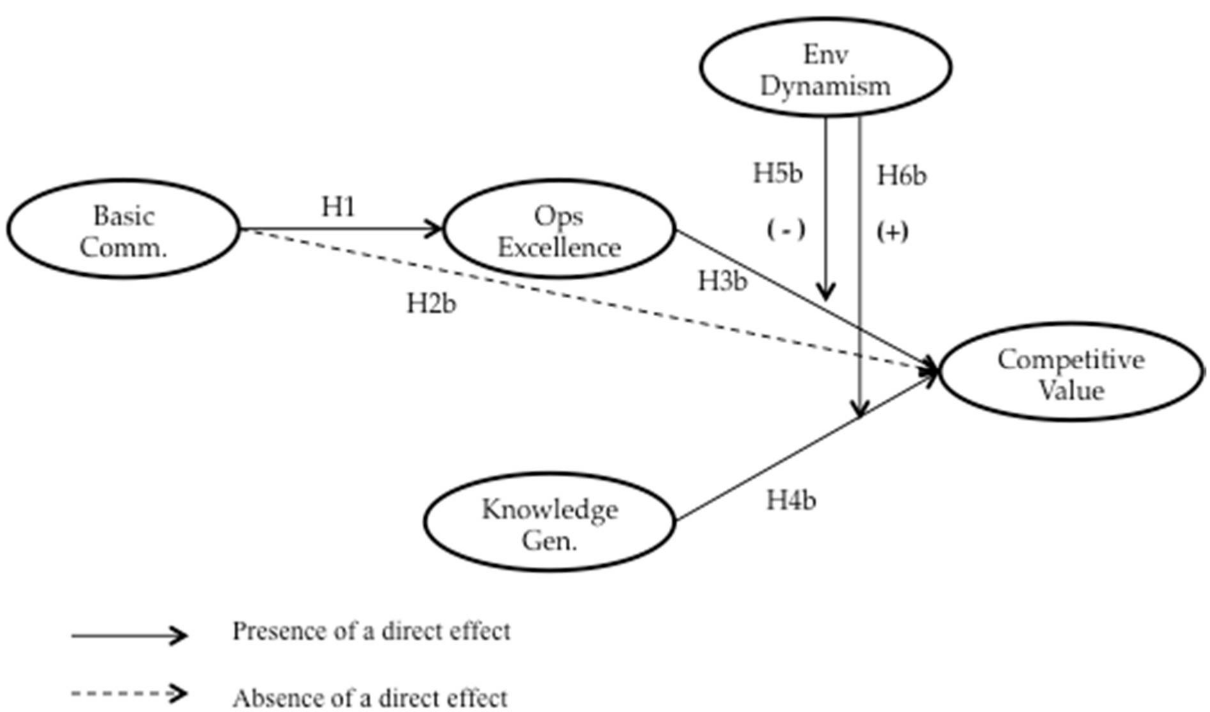


Figure 6.3. Theoretical model for competitive value

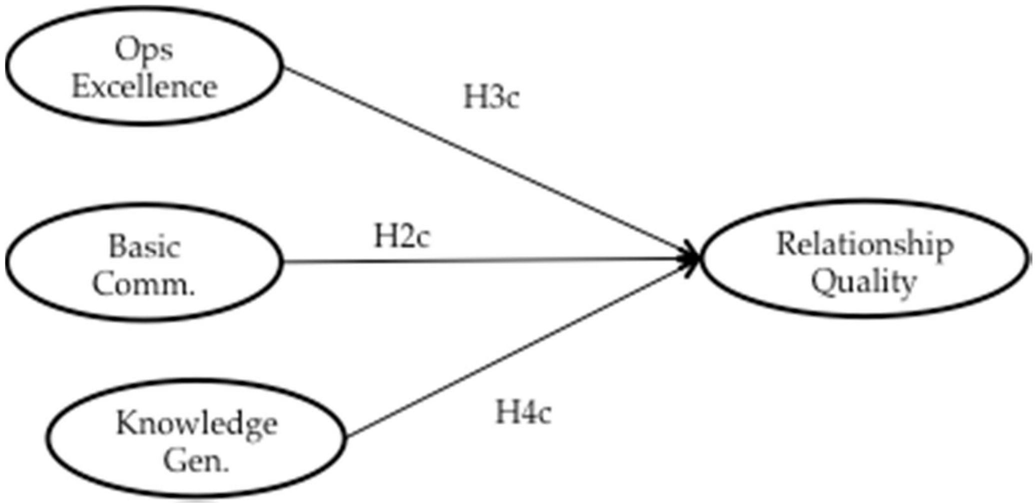


Figure 6.4. Theoretical model for relationship quality

6.3. Buyer's Perspective in Hypotheses Testing

Hypotheses H2 to H6 deal with three dependent variables: economic value, competitive value and relationship quality. Economic value and competitive value can be different for each partner in the supply-chain dyad, so they are firm level constructs. On the other hand relationship quality is a dyad-level construct as it is an attribute of the relationship (Kenny et al., 2006). Since our data sample consists of buyer firms reporting on their relationship with supplier firms, we only test the hypotheses regarding economic and competitive value for the buyer firm. For hypotheses regarding relationship quality we test them using data from the buyer's perspective only. Environmental dynamism is measured for the buyer firm's environment.

7. Model Estimation and Analysis

In this chapter we use statistical techniques like structural equation modeling (SEM) to test the hypotheses developed in chapter 6. In chapter 5 we have already done the measurement analysis and shown the empirical evidence for the reliability and validity of our constructs.

The survey methodology used to collect the data and the measurement properties of all the constructs have already been discussed in chapter 4. Since some respondents did not provide data on the dependent constructs, the sample size used to test the models in this chapter was 163. As shown in the last chapter Little's MCAR test shows missing values can be treated as missing completely at random. We did not detect any signs of non-response bias or common method bias as discussed in chapter 4. Structural equation modeling was used to test the hypotheses as it allows explicitly specifying the structure of higher order constructs and testing relationships between higher order constructs and other latent variables. As discussed in chapter 4, low to moderate levels of kurtosis make our data violate multivariate normality. We used robust maximum-likelihood with the Satorra-Bentler (Satorra, 2000; Satorra & Bentler, 2001) correction to ensure all fit statistics and p-values were adjusted for non-normality of the data.

7.1. Control Variables

We control for relationship importance, industry and firm size. Relationship importance is the percentage of buyer's total purchase volume that is accounted for by this relationship. Since respondents are more likely to give positive ratings for relationships that account for a large percentage of their purchases, controlling for relationship importance ensures that we measure the true effect of integration. Size is based on number of employees. Industry is an un-ordered categorical variable hence entering it into a structural equation model (SEM) model without a mean-structure does not affect any of the relationships estimated by SEM (Brown, 2012). We tested and found no difference in the dependent variables for the various industries in the sample. Controlling for size and industry ensures that we can generalize the results of the analysis to our entire sampling frame.

7.2. Results for the Performance Effects of Elements of Integration

Our first model (model 1) tests for relationships between the three higher order integration constructs and economic value. Basic communication’s effect on operational excellence is positive and significant, so H1 is supported. We also find the effects of operational excellence and knowledge generation on economic value to be significant (H3a and H4a). These results are shown in figure 7.1. The loadings between the second order constructs and the elements of integration were all above 0.7 and significant at the α=0.05 level. These loadings are now shown in figure 3.1 to avoid clutter. The fit indices for model 1 indicate good fit of the model to the data (X^2/df = 1.5, RMSEA = 0.057, CFI=0.914, TLI=0.91) (Hair et al., 2009; Hu & Bentler, 1999). In all of the following tables and figures, * indicates p-value < 0.1, ** indicates p-value < 0.05, and *** indicates p-value < 0.01.

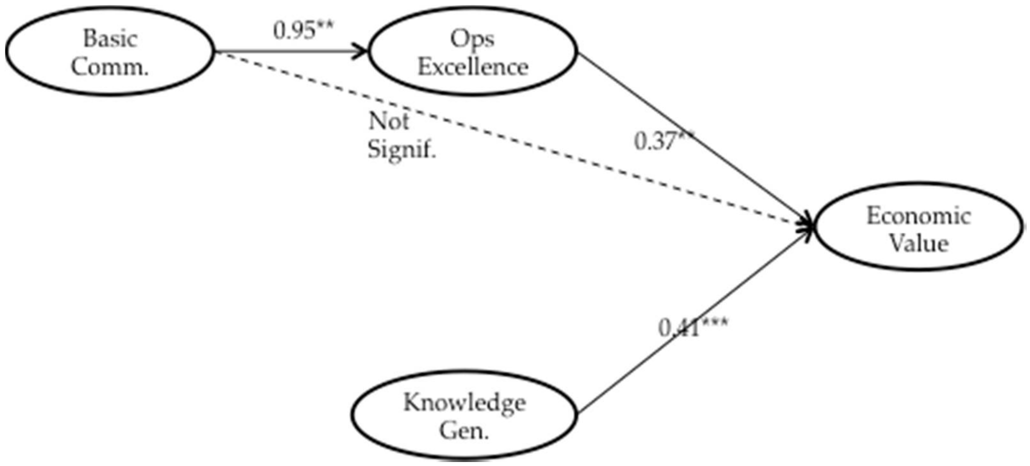


Figure 7.1. Model 1 showing relationships with economic value

A second model (model 2) was run using competitive value as the dependent construct. The results are shown in figure 7.2. Again, all the loadings between the second order constructs and the first order elements of integration were above 0.7 and significant at the α=0.05 level. The fit indices for model 2 indicate good fit of the model to the data (X^2/df = 1.49, RMSEA = 0.051, CFI=0.937, TLI=0.933).

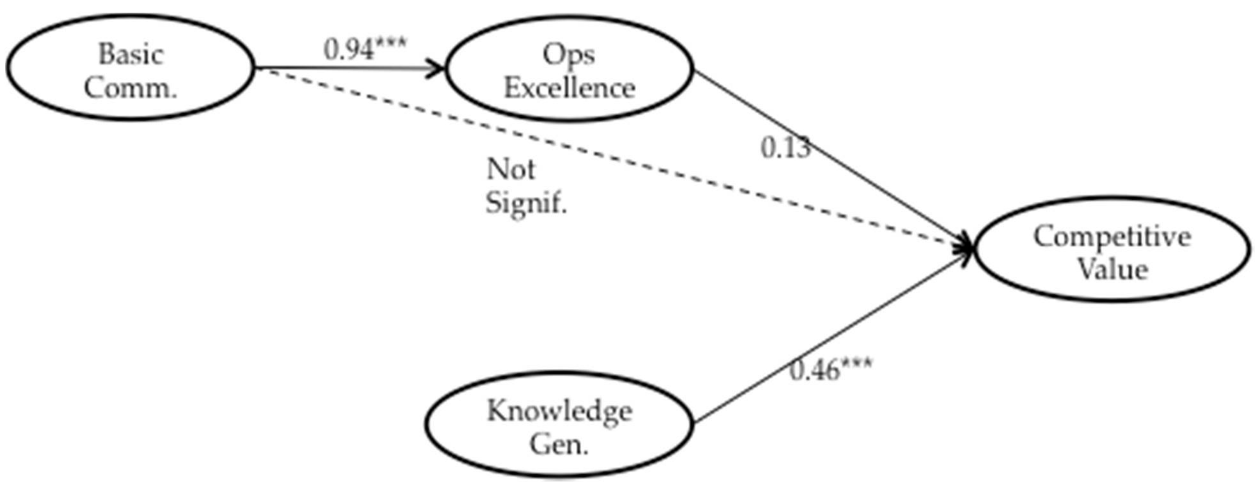


Figure 7.2. Model 2 showing relationships with competitive value

H3b is not supported, as operational excellence does not have a significant effect on competitive value. This is a somewhat surprising result that is discussed later on. H4b is supported as knowledge generation has a strong positive effect on competitive value.

To test hypotheses H2a and H2b, we ran models 1 and 2 by allowing a direct effect of basic communication on economic value and competitive value. The data supports H2a and H2b as in both cases there was no change in model fit i.e. the effect of basic communication was not significant. For the economic value dependent variable the X^2 test p-value=0.153 and for the competitive value dependent variable X^2 test p-value=0.804. Since the p-values are much greater than 0.05 there is no empirical evidence for the effect of basic communication on economic value or competitive value.

A third model was run with relationship quality as the dependent construct. Figure 7.3 shows the results. The fit indices for model 3 indicate good fit of the model to the data (X^2/df = 1.63, RMSEA = 0.061, CFI=0.90, TLI=0.90). H2c, H3c and H4c are supported as all three higher order integration constructs have positive and significant effects on relationship quality.

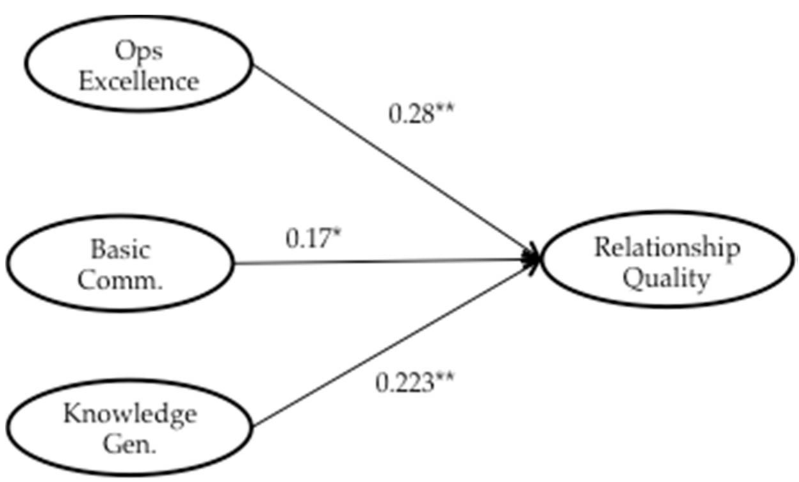


Figure 7.3. Model 3 showing relationships with relationship quality

The results of models 1, 2 and 3 are summarized in Table 7.1.

Table 7.1
Results of Models 1, 2 and 3

Relationship	Model 1 DV: Economic Value	Model 2 DV: Competitive Value	Model 3 DV: Relationship Quality
Operational Excellence → DV	0.367**	0.122	0.284***
	(2.263)	(1.52)	(2.991)
Knowledge Generation → DV	0.41***	0.460***	0.228**
	(3.684)	(5.02)	(2.435)
Basic Communication → DV			0.157*
			(1.692)
Basic Communication → Operational Excellence	0.959** (2.426)	0.949*** (3.439)	
Size → DV	-0.067	-0.126	-0.087
	(-0.889)	(-1.63)	(-1.129)
Rel. Importance → DV	0.059	0.052	-0.01
	(0.683)	(0.753)	(-1.23)

Significance: * < 0.1, ** < 0.05, *** < 0.01. (t-values for the effects are shown in brackets)

7.3. Results for the Moderation of Environmental Dynamism

The moderation effects of environmental dynamism are tested using interaction terms (Hair et al., 2009). Regression analysis was used to test the hypotheses H5 and H6, as it is more appropriate for testing interaction effects. Structural equitation modeling (SEM) is a large sample technique the minimum suggested sample size for testing direct effects is approximately 200 observations (Byrne, 1998; Kline, 2011). Since testing interactions with SEM requires splitting the sample into two groups, each group must have a sample size close to the desired 200, which is not possible with our data.

To test the moderation hypotheses we run two regression models, the first without interaction terms, and the second with the interaction terms. This is the recommended approach and is sometimes referred to as hierarchical regression, as the interaction terms are added after running the base model (Aiken & West, 1991; Cohen et al., 2002). The partial F-test for the change of R^2 between the two models indicates whether the moderation is significant or not. Each particular interaction term is also individually tested for moderation using the t-test (Wooldridge, 2008).

Table 7.1 shows the results for economic value (H5a and H6a). The improvement in R^2 in model 2 as compared to model 1 is significant at α=0.01 level (ΔF-value=4.51, df_n = 3 df_d=130, p-value=0.004) (Hair et al., 2009). This shows that dynamism is indeed a moderator. As shown in Table 7.2 only the interaction term for knowledge generation is significant. This shows that we only have support for H6a. H5a is not supported. Figures C1, C2, and C3 in Appendix C show various plots of residuals from model 2 to show that the assumptions of regression analysis are satisfied.

Table 7.2

Regression Results for H5a and H6a

	Economic Value			
	Model 1		Model 2	
	Estimate	Sig.	Estimate	Sig.
Intercept	3.85	***	4.93	***
Size	0.01		0.04	
Relationship Importance	0.03		0.03	
Oprational Excellence	0.25	***	-0.32	
Knowledge Generation	0.15	**	0.57	**
Env Dynamism			-0.55	**
Env Dynamism x Operational Excellence			-0.13	
Env Dynamism x Knowledge Generation			0.25	***
Industry Dummies (not shown)				
R-Square	45%		51%	
R-Square (adjusted)	38%		42%	
ΔR^2	6%			
Significance: * < 0.1, ** < 0.05, *** < 0.01				

To take a closer look at the case of operational excellence we evaluated its effect when environmental dynamism is one standard deviation above its mean value. For this high level of environmental dynamism, the marginal effect of operational excellence on economic performance is 0.068 with a p-value of 0.61. This suggests that as environmental dynamism increases, operational excellence loses its effectiveness. However the change (from being effective at low levels of dynamism to reduced effectiveness at higher levels) is not large enough to be significant at the $\alpha = 0.05$ level. Interaction terms require large sample sizes for adequate power to measure their statistical significance due to their collinearity they have with the direct terms in the regression model. It is quite possible that with a larger sample size we would have detected a significant change (Wooldridge, 2008).

Table 7.3 shows the results of both models for competitive value (H5b and H6b). The improvement in R^2 in model 2 as compared to model 1 is significant at α=0.01 level (ΔF-value=3.1, df_n = 3 df_d=130, p-value=0.003) (Hair et al., 2009). This shows that dynamism is indeed a moderator. Figures C4, C5, and C6 in Appendix C show various plots of residuals from model 2 to show that the assumptions of regression analysis are satisfied.

Table 7.3

Regression Results for H5b and H6b

	Competitive Value			
	Model 1		Model 2	
	Estimate	Sig.	Estimate	Sig.
Intercept	3.60	***	4.13	***
Size	-0.06		-0.03	
Relationship Importance	0.00		0.01	
Operational Excellence	0.23	**	0.83	**
Knowledge Generation	0.22	**	-0.75	**
Env Dynamism			-0.15	
Env Dynamism x Operational Excellence			-0.22	*
Env Dynamism x Knowledge Generation			0.34	***
Industry Dummies (not shown)				
R-Square	35%		40%	
R-Square (Adjusted)	26%		30%	
ΔR^2	5%			

Significance: * < 0.1, ** < 0.05, *** < 0.01

As shown in Table 7.2 both interaction terms are significant and their signs are in accordance with H5b and H6b. Figures 7.4 and 7.5 illustrate the results from Table 7.2 graphically. The effects of operational excellence and environmental dynamism on competitive value were computed for the low environmental dynamism scenario and the high environmental dynamism scenario. Low and high values of environmental dynamism were taken to be one standard deviation below the mean and one standard deviation above the mean respectively.

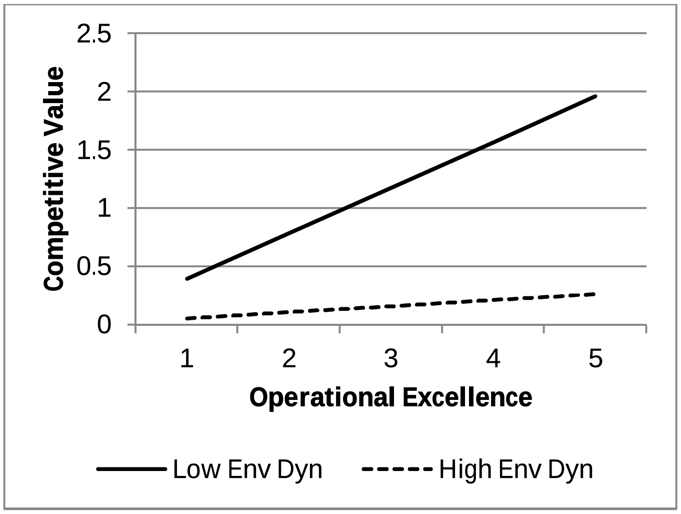


Figure 7.4. Effect of operational excellence on competitive value moderated by environmental dynamism

Figure 7.4 shows how the effect of operational excellence on competitive value reduces when conditions change from high to low dynamism. Figure 7.5 shows how knowledge generation has a negative effect on competitive value for low dynamism conditions and how that effect changes to a strong positive effect for high dynamism conditions.

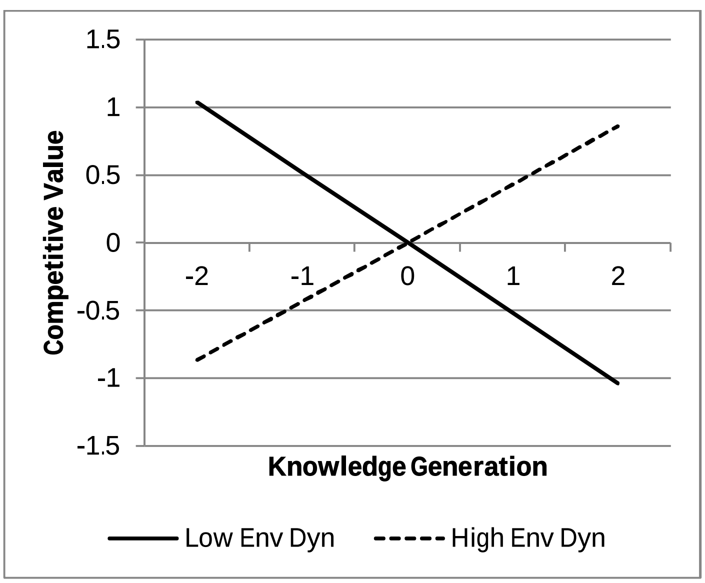


Figure 7.5. Effect of knowledge generation on competitive value moderated by environmental dynamism

The differences in the effect sizes for low vs high dynamism conditions are significant for both operational excellence (Δ=0.34, p-value = 0.08) and knowledge generation (Δ=0.52, p-value = 0.003). These results support both of our hypotheses regarding moderation with competitive value as the dependent variable (H5b and H6b).

A summary of all the hypotheses tests is provided in Table 7.4 below.

Table 7.4

Summary of results

Hypothesis	Result
H1: Basic Communication -> Operational Excellence	Supported
H2a: Basic Communication does not effect Economic Value	Supported
H2b: Basic Communication does not effect Competitive Value	Supported
H2c: Basic Communication -> Relationship Quality	Supported
H3a: Operational Excellence -> Economic Value	Supported
H3b: Operational Excellence -> Competitive Value	Not Supported
H3c: Operational Excellence -> Relationship Quality	Supported
H4a: Knowledge Generation -> Economic Value	Supported
H4b: Knowledge Generation -> Competitive Value	Supported
H4c: Knowledge Generation -> Relationship Quality	Supported
H5a: Environmental Dynamism negatively moderates Operational Excellence -> Economic Value relationship	Not Supported
H5b: Environmental Dynamism positively moderates Knowledge Generation -> Economic Value relationship	Supported
H6a: Environmental Dynamism negatively moderates Operational Excellence -> Competitive Value relationship	Supported
H6b: Environmental Dynamism positively moderates Knowledge Generation -> Competitive Value relationship	Supported

7.4. Discussion of the Results

The results of our analysis generally support the hypotheses. The data provides evidence that operational excellence and knowledge generation increase the economic value generated from the relationship from the buyer's perspective. Knowledge generation leads to increased competitive value from the relationship for the buyer. Basic communication, operational excellence and knowledge generation all lead to increased relationship quality.

A surprising result was the lack of a significant effect of operational excellence on competitive value (Figure 7.2). The regression results, shown in Table 7.3, suggest that the effect of operational excellence on competitive value is in fact significant. This difference in the results is caused by collinearity between basic communication and operational excellence. When both constructs are in the model, as is the case with the SEM model presented in Figure 7.2, the effect of operational excellence loses its significance. When basic communication is not in the model, as is the case for the results in table 7.3, we do see a significant effect on operational communication. Collinearity between a pair of variables reduces the power to detect their individual effects when both variables are in a model (Mason & Perreault Jr, 1991). The only way to resolve this is to have a bigger sample size (Aiken & West, 1991; Hair et al., 1998). As collinearity reduces power, only large effects can be detected as significant. Thus, had the effect size of operational excellence been as large as that of knowledge generation it would have been significant in the SEM model (Figure 7.2) as well. This suggests that in the manufacturing sector operational excellence, though important for profitability, has a lesser effect on competitiveness than knowledge generation. This effect is not significant in our model when basic communication is included, but future studies with bigger samples are likely to find it to be significant.

These results improve the existing understanding of integration considerably. When one construct is used to capture the average level of integration, most of the items measure basic communication and operations excellence related activities. According to the results of this study, these activities don't lead to competitive advantage in the manufacturing sector, and this could explain the confusion regarding the importance of integration to strategic objectives (Fabbe-Costes & Jahre, 2008; Goffin et al., 2006). Our elements of integration approach avoids such pit-falls by clearly identifying which elements of integration are important for competitive advantage, which ones are important for profitability, and which ones only have a supporting role with no direct effect on performance.

The importance of these results can be gauged by comparing them to the understanding of SCI prevalent in the literature. In the existing understanding of SCI greater inter-firm integration with suppliers and customers led to greater focal firm performance. This meant that all firms should increase all types of inter-firm integration activities with their supply chain partners. Contrary to the research findings most supply chain relationships in practice were not highly integrated (Fabbe-Costes & Jahre, 2008; Fawcett & Magnan, 2002). Literature was unable to explain this gap between research results and actions of firms. Our results show that it is not always optimal for firms to implement all elements of integration. For example under dynamic environments knowledge based elements are more useful than others. Some integrative elements only increase profitability while some lead to competitiveness. Basic communication has no effects on performance but helps implement the other elements of integration. The relational requirements for the different elements of integration are different, and they have different objectives. Thus we don’t expect to find all the elements of integration in all supply chain relationships.

The results of our analysis also support the moderation hypotheses regarding environmental dynamism. The data provides strong evidence that operational excellence becomes less important in highly dynamic conditions, while knowledge generation becomes more important in such conditions. Some authors have argued that high levels of integration can be costly (Villena et al., 2011). Our results add to that view by showing that it is not advantageous to implement some elements of integration in stable conditions. Also relying on operational elements alone in dynamic conditions will not be advantageous either.

The black-box view of integration recommends higher levels of integration to deal with dynamism and uncertainty in the environment. However our results show that under dynamic environments some elements of integration should be reduced and some increased. Our results also provide an explanation for the contradictory findings of existing studies that find integration to be moderated by environmental uncertainty sometimes positively, sometimes negatively and sometimes not at all (Iyer et al., 2009; Koufteros et al., 2005; Wong et al., 2011b).

8. CONCLUSION

In this dissertation we make several significant contributions to the theory of supply chain integration. We highlight the weaknesses in the existing way of conceptualizing integration. We then provide a new definition and conceptualization of inter-firm integration using a rigorous, reproducible, and structured process. We provide empirical evidence in support of our view of integration. We also show how this view of integration provides greater insight into the performance implications of integration. We conclude the dissertation by showing how existing contradictory findings regarding the moderating role of environmental dynamism can be resolved through our proposed view of integration. The insights gained from this dissertation have great relevance to practitioners, and these are detailed later in this chapter. This dissertation has provided a sufficient foundation to move towards designing effective supply chain relationships according to the business conditions and buyer-supplier characteristics. It also opens several avenues for future research that are discussed below.

8.1. Theoretical Contributions

Theory relies on constructs and relationships between them to explain phenomenon. Empirical research builds theory by operationalizing the constructs so that they can be measured and so that relationships between them can be estimated. In this process, it is crucial that the conceptual space comprised of the constructs and their definitions accurately captures the phenomenon of interest. Constructs can get outdated as the phenomenon evolves and knowledge about the phenomenon grows. In this dissertation we revisit the conceptual space of supply chain integration (SCI) and find that the existing SCI constructs of upstream and downstream integration do not do justice to the phenomenon they seek to represent. Researchers have struggled with this limitation by broadening the scope of the constructs. As a result empirical studies on supply chain integration examine different aspects of the integration phenomenon using different theoretical perspectives and different measures of integration while using the same terminology. The most fundamental contribution of this dissertation is to start a discussion on what constructs are needed to represent the supply chain integration phenomenon. We worked backwards from a host of operationalizations of SCI constructs to update the SCI conceptual space. By doing so we inform both the supply chain integration and buyer-supplier relationship literatures.

Elements of Integration and the Supply Chain Integration Literature

A large number of empirical studies on the topic of SCI focus on establishing the performance benefits of upstream and downstream integration, as well as the moderating role of contingencies like environmental uncertainty (Burgess et al., 2006). After recognizing the positive effects of integration in supply-chains (Frohlich & Westbrook, 2001), researchers have moved towards establishing boundary conditions such as conditions under which integration is more or less useful. The results tend to show that in complex and dynamic conditions the more integration the better (Flynn et al., 2010; van Donk & van der Vaart, 2004; Wong et al., 2011b).

Some recent studies are challenging many of the taken for granted things about supply chain integration. Researchers (Goffin et al., 2006; Ho et al., 2002; van der Vaart & van Donk, 2008) are beginning to doubt the one-size-fits-all approach that argues for greater integration. Even the integration-performance relationship is being challenged on the basis of contradictory findings by various empirical studies (Fabbe-Costes & Jahre, 2008). As some researchers have noted, the studying the average level of integration between a focal firm and all-important suppliers or customers limits our understanding of the integration phenomenon (Gimenez & Ventura, 2005; Goffin et al., 2006; Ho et al., 2002). The average level of integration is an indication of the general approach of the focal firm, or in other words the affinity towards integrating. Integration involves implementing many different integrative practices in the various supply chain relationships. The a priori assumption that all these integrative practices have similar effects on all types of performance, and also react in a homogenous way to environmental factors severely limits the researcher from a deeper understanding of the integration phenomenon.

We advance theory on SCI by giving a new way to think about the concept of integration. We used a structured literature review to gather operationalizations of SCI. These operationalizations consisted of integrative practices that empirical studies had measured. We employed a repeatable and structured qualitative analysis process on this empirical dataset of 138 integrative practices to identify the constructs underlying them. We identified 9 elements of integration that capture the space spanned by the 138 integrative practices. We provided definitions for elements of integration and followed methodological best practices to empirically verify six of the elements of integration. Future research can use these elements of integration to focus on specific parts of SCI that are relevant to the research question at hand. Mapping out the conceptual space of SCI allows researchers to discern the different aspects of the phenomenon instead of using a broad and undifferentiated construct of integration.

Supply chain researchers have used different theoretical perspectives in their studies, including transaction cost economics (TCE), the knowledge based view (KBV) and the extended resource based view (eRBV) (Chen & Paulraj, 2004a; Das et al., 2006). Not all of the theoretical perspectives are relevant to all parts of the broad integration construct. Thus hypotheses that depend on a particular theoretical perspective cannot be accurately tested while using the broad integration construct. As shown in chapter 2, conceptualization of SCI as elements of integration allows researchers to pick the relevant elements based on their theoretical perspective. By matching the elements of integration to the theory being used researchers will have greater precision in testing hypotheses based on that theory.

Another important contribution to existing theory on supply chain integration is to demonstrate that not all elements of integration affect performance in the same manner. We provide empirical evidence that the tacit assumption of homogenous performance effects of 'all of integration' is untenable. We show that *Basic Communication* elements have a supporting role in today's competitive environment, as they enable other elements of integration to be established but do not directly improve performance themselves. *Operational Excellence* elements have a positive effect on productivity but do not have a significant contribution towards competitiveness. On the other hand knowledge related elements of integration positively effect profitability and lead to greater competitiveness based on differentiation from rivals. Elements like *New Product Development* are difficult to implement and build relationship specific capabilities and assets and hence can be a source of competitive advantage. This is an important contribution as past research has been troubled by inconsistent results of the integration performance relationship (Fabbe-Costes & Jahre, 2008). Studies that do not find significant links between integration and performance need to rethink what they are measuring as integration. A lot of existing constructs are too focused on sharing of information, which, according to our results, plays a supporting role for other integrative practices, and does not itself improve performance.

This research also increases our understanding of how integration behaves in different environmental conditions. In previous work on SCI, the aggregate construct of integration was tested for being more or less beneficial under various business conditions (Wong et al., 2011b). The general conclusion of the literature was that uncertain and complex conditions required greater integration (Iyer, 2011; Koufteros et al., 2005). We enrich this literature by showing that environmental conditions do not impact different parts of the broad integration construct in the same manner. We use environmental dynamism as an example to illustrate how the various elements of integration behave differently under different environmental factors. In dynamic environments knowledge generation gains importance while integrative elements aimed at operational excellence lose importance. Since the elements of integrations can behave in opposing ways to environmental contingencies conclusions like "contingency X requires greater integration" are no longer sufficient. Researchers must identify which elements of integration are more useful and which ones less so under specific environmental conditions.

Elements of Integration and Buyer-Supplier Relationship Literature

Although we did not measure constructs like trust, or dependence that are important in the buyer-supplier relationship (BSR) literature, our results raise important questions and insights that can be tested by future studies. The buyer-supplier relationship (BSR) literature has looked at the issues of power, trust and dependence in supply chain relationships (Benton & Maloni, 2005; Ireland & Webb, 2007). It often uses integration like constructs to characterize the collaborative efforts in the relationship (Johnston et al., 2004; Yeung et al., 2009). The BSR literature has not explored how the different integrative practices implemented in a relationship will interact with other constructs like trust, power and dependence. Our newly identified constructs represent *elements of integration*, and a supply chain relationship can implement one or more of these elements. The elements selected for implementation are likely to vary between relationships because not all relationships have the same objectives or the same strategic importance. Since these elements have different relational requirements and have different objectives the set of elements selected would have important implications for the relationship. This leads to a range of new questions about supply chain relationships that future BSR research can explore. For example, the BSR literature can now examine how different levels and types of trust may be required in a relationship depending on what elements of integration are being implemented.

The analogy of elemental atoms combining to make molecules in chemistry applies here. Just like changing the selection of atoms that comprise a molecule changes the molecule's properties, changing the *elements* used to construct a supply-chain relationship will change how that relationship functions. The choice of elements of integration can influence what inputs are required from each partner to make the relationship work, what outcomes to expect and whether the relationship will build goodwill trust for future time periods or not. The form of governance in the relationship, and the mix of trust and contracts used may well depend on which elements of integration are present. Thus the *elements of integration* view promises to improve our understanding of fundamental issues in buyer-supplier relationships such as the role of trust and the optimal governance mechanism.

Elements of Integration and Design of Supply Chain Relationships

To appreciate the significance of the results of this dissertation we need to consider what the natural extensions of this work enable us to accomplish. The elements of integration view, along with an understanding of the performance effects of the elements and their response to various environmental conditions is the first half of the puzzle. When this is combined with future research on how the elements of integration interact with constructs like trust, and relational governance then we can move towards frameworks and models that help design supply chain relationships. Such models can enable firms to determine the optimal configuration of the elements of integration to employ in a given relationship based on buyer and supplier characteristics, the present levels of trust, and the desired outcomes from the endeavor. Designing supply chain relationships by considering the elements that will be used to build them has the promise to resolve the “apparent contradiction in the literature between promised benefits and still limited evidence of extensive implementation" (Power, 2005, p. 261).

Results in the Light of Theories used in Supply Chain Research

In this section we discuss how the four theories commonly used to explain the performance benefits of integration apply to our results. These four theories, as discussed in chapter 2, are: system dynamics, transaction cost economics, the extended resource based view, and the knowledge based view.

Our results show a relationship between basic communication and operational excellence. According to the system dynamics view, changes in one part of the supply chain can have serious consequences for upstream or downstream parts (Forrester, 1961; Lee et al., 1997b). Thus if the operational performance of the supply chain at any point has to be improved information from other parts of the supply chain must be acquired. Our results align with the system dynamics view, as they show that operational improvements require information from other parts of the supply chain.

Transaction cost economics and the extended resource based view both help explain the performance effects of operational excellence. According to transaction cost economics, initiatives that reduce the threat of opportunism reduce costs and can help performance (Williamson, 2008). In operational excellence the buyer and supplier firms work together to jointly create processes for operational improvements. Such processes reduce the threat of opportunism because they increase the cost of breaking the relationship for both parties. Some of the transaction cost economics literature refers to this phenomenon as mutual hostage taking or “lock-in” (Young-Ybarra & Wiersema, 1999). A hostage setup reduces the threat of opportunism as the other party has an interest in the well-being of the hostage. If a process or operational capability depends on both the buyer and supplier firms, and this process or capability is of interest to both partners then this will act like a hostage preventing acts of opportunism. Since the threat of opportunism is reduced both parties do not need to invest in expensive governance mechanisms resulting in cost savings.

The extended resource based view (eRBV) argues that jointly created resources or capabilities by partner firms can lead to competitive advantage if the resources or capabilities cannot easily be imitated by rivals (Lavie, 2006). Operational excellence creates capabilities that require input from both partners to increase the operational performance of the supply chain dyad. These new capabilities will be specific to the buyer-supplier firms involved and hence will not be easily replicated (Amit & Schoemaker, 1993; Hoopes et al., 2003). They will also be costly to imitate by others due to time-compression diseconomies (Dierickx & Cool, 1989). Thus we expect to see a positive effect of operational excellence on profitability and competitiveness. Due to our small sample size and collinearity with basic communication we did not observe a significant positive effect of operational excellence on competitive value. Future studies should explore this link further.

The TCE and eRBV apply simultaneously to the integration phenomenon. This is illustrated by the significant positive impacts of basic communication, operational excellence and knowledge generation on relationship quality. TCE suggests that these variables increase relationship quality as mutual efforts induce trust which reduces the threat of opportunism. Also these practices increase the cost of breaking the relationship, which provides a "lock-in" mechanism that ameliorates concerns of opportunism. The extended resource based view suggests that operational excellence and knowledge generation create inter-firm resources and capabilities that provide value to both companies. This increased value results in greater commitment to continue the relationship and hence the increase in relationship quality. It is important to note that these theories work in a complemantary fashion to explain the effects of integrative practices on performance measures and relationship quality. Integration simultaneously aligns with these theoretical perspectives.

The knowledge based view (KBV) explains the strong positive effect of knowledge generation on economic and competitive value. According to the KBV the competitive advantage of a firm depends on knowledge creation and problem solving (Nickerson & Zenger, 2004). New solutions and knowledge are generated based on the existing pool of knowledge and expertise. When both the buyer and supplier firms pool together their existing knowledge based resources and problem solving capabilities they can achieve more than what each firm could achieve individually. New products are developed faster and commercialized with greater success with such collaboration (Koufteros et al., 2010).

In dynamic environments the need to reconfigure existing resources and capabilities and to develop new ones is far greater than in stable environments (Thornhill, 2006). In such environments explicit collaboration on knowledge generation will lead to superior performance (Narasimhan et al., 2006). The absorptive capacity of the buyer-supplier dyad will be greater than the individual absorptive capacities allowing both firms to quickly learn new techniques and capabilities as technology and customer preferences change. This explains why we find the performance benefits of knowledge generation to be much greater when environmental dynamism is high.

Summary of Theoretical Contributions

To summarize the contributions of this research, a comparison of what we knew before this research along with what we have learned is presented in Table 8.1.

Table 8.1

Comparison of what we knew and what we have learned

What we knew before this research	What we have learned
Integration is one construct	Integration is comprised of several related but distinct constructs. Measuring integration as one construct can hide important details. The conceptual space of integration has been mapped and found to be composed of several elements of integration.
Firms should integrate with major suppliers and customers.	Firms should decide what elements of integration should be implemented in each supply chain relationship. Relationships will behave differently depending on the elements implemented in them. Not all elements are suitable for all relationships.
Integration will leads to superior performance.	The elements of integration have different implications for performance outcomes. Some elements only play a supporting role, enabling other elements to be implemented. Knowledge generation and operational excellence are both important for profitability, though when it comes to competitiveness knowledge generation is more important.
When there is environmental dynamism, firms should integrate more with major suppliers and customers.	It depends. Integration efforts should be increased for relationships characterized by knowledge based elements. Increasing integration efforts for relationships characterized by operational excellence elements may not help as much.
We are not able to give recommendations about how to make relationship level decisions about integration.	Relationships between the elements of integration and relational variables like trust and dependence can be examined by future research. Such extensions of this work would provide frameworks on designing supply chain relationships based on partner attributes and relational requirements.

8.2. Measurement and Scale Development Contribution

This dissertation contributes to the body of knowledge that deals with measuring theoretical constructs. We provide reliable and valid scales to measure six of the nine elements we identify that comprise inter-firm integration. However many studies are constrained by the number of constructs they can measure and test hypotheses for. We show that inter-firm integration is made up of three second-order constructs. Hence future studies can work on the level of the second order constructs and measure integration using three constructs instead of six.

8.3. Managerial Contributions

Managers are often confused by what integration really means for them. They are unable to translate the vast domain of the integration concept from research studies to their practical day-to-day decision making. A large part of this chasm is the fact that research has often treated integration as the average level between a focal firm and many supply-chain partners whereas managers must make decisions on a relationship level. This makes a lot of headway in bridging this gap. It highlights that we need to move towards a relationship level contingent theory of designing supply-chain relationships. It contributes to that end by showing that inter-firm integration at the relationship level is made of up six elements of integration. Each relationship may have different levels or amounts of these six elements. Determining which elements to establish for a given relationship requires considering environmental conditions, performance objectives, and partner characteristics. In this dissertation we show which elements are relevant for profitability objectives and which ones are relevant for increasing competitive advantage. We also show which elements are useful under environmental dynamism. These provide important guidelines for managers making relationship level strategic decisions about integration with supply-chain partners.

8.4. Limitations of this Work

This work has several limitations. We were only able to collect data from one side of the buyer-suppler relationship dyad. It is possible, and perhaps even expected, that the buyers view of the relationship will be biased or not capture the concerns of the supplier. Due to the practical limitations of the survey method in today's age, such as survey fatigue amongst managers and the costs of collecting data from dyads, we were unable to do a dyadic study in one research project. An entire research program with multiple researchers participating and pooling resources has a greater chance of achieving a dyadic study of this nature.

Due to limitations on resources and time, some important areas of research in supply chain literature were not included in the scope of this work. This work did not study important constructs from the buyer-supplier relationship (BSR) literature, such as trust and dependence. Thus it could not contribute towards understanding how these relational constructs interact with the elements of integration. This study also did not cover sustainability and corporate social responsibility. Increasingly the sustainability and social issues are defining supply-chain relationships. We also had to draw boundaries around what was the scope of this project. Excluding sustainability and social issues is a limitation that we hope future studies will address.

We were limited by our sample to studying manufacturers in North America. Our sample was not entirely representative of the target population as explained in section 4.7. More research is needed to replicate our findings with larger and more representative samples. Future research should also expand the scope of our findings to Europe, Asia, Latin America as well. We also did not consider service firms or relationships in which the supplier provided a service. Thus we are not able to provide any results for service-based supply chain relationships.

8.5. Opportunities for Future Research

This research provides a foundation over which many future studies can be built. An important area of investigation is to check whether the elements of integration are related to attributes of the component or part being exchanged between the buyer and supplier firms. For example, do buyer firms only do knowledge generation initiatives with suppliers of critical parts or are these initiatives applicable for any buyer-supplier relationship? Similarly the volume of trade between the buyer supplier firms may influence what elements of integration are implemented in the relationship.

Future researchers should look to build incrementally on this dissertation by using the six elements of integration and studying them with various environmental contingencies and supplier characteristics. This would result in a framework that will enable managers to design effective supply chain relationships. Future research can also add to our findings by taking a dyadic perspective and testing whether the contributions of the six elements of integration are similar for suppliers or different. If any differences are found they would significantly impact the managerial implications of our findings. Future research must also consider social and sustainability issues. These issues are impacting not only supplier selection but also how firms work with their suppliers.

9. APPENDIX A: SUPPORTING TABLES FOR CHAPTER 2

Table A1

Papers included in literature review (in alphabetical order)

1	(Barker & Emery, 2006)	42	(Goffin et al., 2006)	83	(Narasimhan et al., 2010)
2	(Barratt, 2004)	43	(Griffith et al., 2006)	84	(Nyaga et al., 2010)
3	(Barratt & Barratt, 2011)	44	(Han et al., 1993)	85	(O'Leary-Kelly & Flores, 2002b)
4	(Barratt & Oke, 2007)	45	(Handfield & Bechtel, 2002)	86	(Pagell, 2004)
5	(Benton & Maloni, 2005)	46	(Handfield et al., 1999)	87	(Park & Hartley, 2006)
6	(Braunscheidel & Suresh, 2009)	47	(Handfield et al., 2009)	88	(Parsons, 2002)
7	(Cagliano et al., 2006)	48	(Heide & John, 1990)	89	(Paulraj & Chen, 2007)
8	(Cai et al., 2010)	49	(Hillebrand & Biemans, 2003)	90	(Petersen et al., 2005)
9	(Caniëls & Gelderman, 2007)	50	(Hult et al., 2003)	91	(Petroni & Panciroli, 2002)
10	(Cao & Zhang, 2011)	51	(Hult et al., 2004)	92	(Ragatz et al., 2002)
11	(Carter, 2000)	52	(Hult et al., 2007)	93	(Ramdas & Spekman, 2000)
12	(Chen & Paulraj, 2004b)	53	(Ireland & Webb, 2007)	94	(Rosenzweig et al., 2003b)
13	(Cheung et al., 2010)	54	(Jap, 1999)	95	(Saeed et al., 2005)
14	(Claycomb & Frankwick, 2004)	55	(Jap, 2001)	96	(Sahin & Robinson, 2002)
15	(Cousins & Menguc, 2006)	56	(Johnson, 1999)	97	(Sanders & Premus, 2005)
16	(Craighead et al., 2009)	57	(Johnston & Kristal, 2008)	98	(Sengupta et al., 2006)
17	(Danese, 2006)	58	(Johnston et al., 2004)	99	(Song & Swink, 2009)
18	(Das et al., 2006)	59	(Kalwani & Narayandas, 1995)	100	(Stank et al., 2001)
19	(de Leeuw & Fransoo, 2009b)	60	(Kaynak & Hartley, 2008)	101	(Stanley & Wisner, 2001)
20	(De Treville et al., 2004)	61	(Ketchen & Hult, 2007)	102	(Swink et al., 2005)
21	(Devaraj et al., 2007)	62	(Koufteros et al., 2005)	103	(Swink et al., 2007)
22	(Droge et al., 2004)	63	(Koufteros et al., 2007)	104	(Takeishi, 2001)
23	(Elmuti, 2002)	64	(Koufteros et al., 2010)	105	(Tan, 2002)
24	(Fabbe-Costes & Jahre, 2007)	65	(Krause, 1999)	106	(Tan & Kannan, 1998)
25	(Fawcett & Magnan, 2002)	66	(Krause et al., 2007b)	107	(Terpend et al., 2008)
26	(Fisher et al., 1997)	67	(Kulp et al., 2004)	108	(Vachon & Klassen, 2006)
27	(Flynn et al., 2010)	68	(Kwon & Suh, 2004)	109	(van der Vaart & van Donk, 2006)
28	(Foster, 2008)	69	(Lambert & Cooper, 2000)	110	(van der Vaart & van Donk, 2008)
29	(Frazier et al., 2009)	70	(Lau et al., 2010)	111	(van Donk & van der Vaart, 2004)
30	(Frohlich & Westbrook, 2001)	71	(Lee et al., 1997a)	112	(Vickery et al., 2003)
31	(Frohlich & Westbrook, 2002)	72	(Lee et al., 2007)	113	(Wagner & Hoegl, 2006)
32	(Fugate et al., 2006)	73	(Li et al., 2005)	114	(Welker et al., 2008)
33	(Fynes & Voss, 2002)	74	(McCutcheon & Stuart, 2000b)	115	(Whipple & Frankel, 2000)
34	(Fynes et al., 2004)	75	(Mentzer et al., 2001)	116	(Wong & Boon-itt, 2008)
35	(Fynes et al., 2005)	76	(Min & Mentzer, 2004)	117	(Wong et al., 2009)
36	(Ganesan, 1994)	77	(Miyamoto & Rexha, 2004)	118	(Wong et al., 2011b)
37	(Germain & Iyer, 2006)	78	(Morash & Clinton, 1998)	119	(Xu & Beamon, 2006)

38	(Germain et al., 2008)	79	(Narasimhan & Das, 2001)	120	(Yeung, 2008)
39	(Giannakis & Croom, 2004)	80	(Narasimhan & Jayaram, 1998)	121	(Zhao et al., 2008)
40	(Gimenez & Ventura, 2005)	81	(Narasimhan & Kim, 2002)	122	(Zhao et al., 2011a)
41	(Gimenez et al., 2012)	82	(Narasimhan & Nair, 2005)	123	(Zhou & Benton Jr, 2007b)

Table A2
Existing Literature Reviews Incorporated in the Literature Review

1	(Giunipero et al., 2008)
2	(Ho et al., 2002)
3	(Burgess et al., 2006)
4	(Carter & Ellram, 2003)
5	(Croom et al., 2000)
6	(Fabbe-Costes & Jahre, 2008)
7	(Flynn et al., 2010, Appendix A)
8	(Giannakis & Croom, 2004)
9	(Ketchen Jr. & Giunipero, 2004)
10	(Terpend et al., 2008)
11	(van der Vaart & van Donk, 2008)

Table A3
List of SCI Practices from Literature Review

Index	SCI Practice
1	Information Exchange
2	Sharing POS data
3	Sharing Demand forecasts
4	Sharing market information
5	Sharing inventory mix/levels data
6	Sharing production schedule/plan
7	Sharing production capacity data
8	Sharing delivery/order information
9	Frequent exchange (of information)
10	Real-time sharing of production schedule and other data
11	Cost Information Sharing
12	Use of total costs (in operations decisions)
13	Sharing other product information
14	Open two-way communication
15	Informal /face-to-face communication

16	Sharing sensitive and/or propriety information
17	Inform in advance about changing needs
18	Establishing computerized and/or quick order systems
19	EDI for ordering, order tracking
20	Establishing Order tracking systems
21	Real-time access to inventory
22	Real-time access to operations data
23	Real-time access to logistics data
24	Communicate about planned promotions
25	Communicate about other activities that may affect SC partner
26	Giving SC partner feedback on performance and/or how to improve
27	Conduct audits of SC partners facilities
28	Customer satisfactions surveys shared in org
29	Sharing data on partner satisfaction frequently (i.e. giving feedback to each other)
30	High level corporate level communication on important issues
31	Stable procurement (order quantities)
32	Develop and employ performance metrics that extend across the supply chain
33	Co-develop systems to evaluate and publicize each other's performance
34	Set reliability & responsiveness standards (for each member of the dyad)
35	Share future expectations
36	Spend time discussing future needs of SC partners
37	Determine SC partners' future needs
38	Frequent deliveries (Small batches, frequent replenishment)
39	Delivery on JIT basis
40	Developing JIT production systems, aiding SC partners in developing/implementing JIT
41	Implement Reliable Delivery system
42	Logistics activities are closely coordinated
43	(Deploying) Green Logistics (across the dyad)
44	(Deploying) Reverse Logistics (across the dyad)
45	Sharing logistics equipment/containers
46	Common use of 3PL services
47	Participation in procurement and production
48	Joint Order Management
49	Joint production and inventory management
50	Customized service (e.g. customized packaging)
51	Joint Forecasting
52	Joint Planning or Collaborative Planning (CPFR)
53	Access to planning systems
54	Joint Production Planning and/or Production Scheduling
55	Joint problem solving
56	Informal team work

57	(Working together for) Recovery from operational problems
58	Inter-organizational teams
59	Help (each other to) improve processes
60	Work to seamlessly integrate processes
61	Joint development of logistics processes
62	Joint process re-engineering
63	Increased standardization of SC processes
64	Improvement of SC processes
65	Share knowledge of core business practices (important business practices)
66	Rapid response systems (VMI, QR)
67	Joint development and implementation of CRP, ECR (continuous and rapid replenishment)
68	Training (of SC partner) in Quality or otherwise
69	Help (each other to) improve quality
70	Require SC partner to participate in Cost and Quality improvement
71	(Working together for) Flexibility improvement
72	Help us improve on operational performance
73	Continuous improvement programs with SC partner
74	Improve response times across SC
75	Joint implementation of best practices through benchmarking etc
76	Joint Process engineering
77	Joint business systems design
78	Use of cross-organizational teams for process design
79	Use of cross-organizational teams for process improvement
80	Joint Problem Solving
81	(SC partners) Willing to make cooperative changes
82	Provide Training (to SC Partner)
83	Frequently review likely effect of changes (anywhere) on the SC and SC partners
84	Formal routines exist to uncover faulty assumptions about the SC
85	Establishing Long Term Relationships
86	Having Long Term Orientation (towards the relationship)
87	Dedicated personnel to management SC collaboration with SC partners
88	Jointly develop requirements /specifications of products and components
89	Involvement in design, early invovlement
90	Involvement in NPD process
91	Face to face visits to discuss NPD issues
92	Interaction of product dev team with SC partner
93	SC partner has major influence on new products
94	Consensus in focal firm that SC partners involvement is needed
95	SC Partner involved in establishing technical performance measures/targets
96	SC partner involved in establishing business performance measures/targets
97	Project engineering of component parts done by SC partner

98	Developing (Designing) component parts and/or whole sub-assemblies by SC partner
99	Using SC partner's knowledge and expertise in NPD/innovation projects
100	Sharing Technological information
101	Technological assistance
102	Extent of technology sharing
103	We share equipment
104	We pool non-financial resources
105	Joint Investments
106	Facility co-location
107	Jointly decide facility location
108	Financial assistance
109	Pooling financial resources
110	SC Partner Development
111	Top level commitment for supplier development
112	Use of buyer-supplier councils or similar mechanisms
113	Strategic Partnership
114	Establishing cooperative relationship
115	Close relationships with limited pool of suppliers
116	SC partner input in corporate strategy
117	Shared risks and rewards (agreements for that)
118	Degree of mutual trust
119	Concern for SC partner earning fair profit
120	Granting supplier performance awards and rewards
121	Goal Congruence—Agreement on goals and plans
122	Joint Knowledge Creation
123	Jointly search and acquire new and relevant knowledge
124	We jointly assimilate and apply relevant knowledge
125	We jointly identify new needs
126	We jointly discover new and emerging markets
127	We jointly learn the intentions and capabilities of our competitors
128	(Joint) Knowledge acquisition
129	Knowledge distribution (the SC dyad)
130	Having few suppliers (# of suppliers)
131	Formal internal customer satisfaction program
132	Selecting suppliers on quality
133	Formal supplier evaluation procedures
134	Frequent supplier evaluation
135	Frequently determine future customer expectations
136	Periodically evaluate importance of relationship
137	Require certification of suppliers on key materials
138	Contract with one or two suppliers on key materials

Table A4
Items for New Constructs and Comparable Items in Existing Literature

Item Code	Item	Refence Paper(s)	Reference Item
OCM1	My company shares information regarding demand of our products and services	Flynn et al 2010	We share our demand forecasts with our major supplier.
		Flynn et al 2010	The level of sharing of market information from our major customer
		Flynn et al 2010	Our major customer shares Point of Sales (POS) information with us
		Flynn et al 2010	Our major customer shares demand forecast with us
		Braunscheidel and Suresh, 2009	Demand levels are visible throughout the supply chain
		Flynn et al 2010	The level of information exchange with our major supplier through information networks.
		Flynn et al 2010	The level of linkage with our major customer through information networks
		Frohlich & Westbrook 2001	Access to planning systems
		Lau et al. 2010	Share marketing information
		Zhou & Benton Jr. 2007	Information sharing with major customer: Future demand forecasting information
OCM2	Periodically updated sales forecasts are shared with our SC partner	Devaraj et al. 2007	My company provides the following information to the supplier: Sales forecast
		Flynn et al 2010	We share our demand forecasts with our major supplier.
		Flynn et al 2010	Our major customer shares demand forecast with us. 0.66
		Devaraj et al. 2007	The customer provides the following information about its final product to my company: Sales forecast
		Zhou & Benton Jr. 2007	Information sharing with major customer: Future demand forecasting information
OCM3	My organization keeps our SC partner informed about issues that may affect their normal routines	Li et al. 2005	We inform trading partners in advance of changing needs
		Li et al. 2005	We and our trading partners keep each other informed about events or changes that may affect the other partners
		Vachon & Klassen 2006	Informs our primary suppliers about events or changes that may affect them.
		Chen & Paulraj 2004	We keep each other informed about events or changes that may affect the other party.
OCM4	Access to information about our inventory levels is provided to our SC partner	Flynn et al 2010	We share our inventory levels with our major supplier.
		Flynn et al 2010	We share our available inventory with our major customer
		Braunscheidel and Suresh, 2009	Our inventory levels are shared with our suppliers
		Frohlich & Westbrook 2001	Knowledge of inventory mix/levels
		Braunscheidel and Suresh, 2009	Inventory levels are visible throughout the supply chain

		Devaraj et al. 2007	My company provides the following information to the supplier: The inventory status
		Lau et al. 2010	Share inventory mix/level information
		Zhou & Benton Jr. 2007	Information sharing with major customer: Inventory level information
OCM5	Logistics related information is shared by my company with its SC partner	Braunscheidel and Suresh, 2009	Joint planning with customers is important in logistics
		Morash & Clinton 1998	frequent contacting of customers by logistics managers
		Vachon & Klassen 2006	Exchanges operational and logistical information with primary suppliers.
		Chen & Paulraj 2004	Interorganizational logistic activities are closely coordinated.
		Chen & Paulraj 2004	Our logistics activities are well integrated with the logistics activities of our suppliers.
OCM6	My company communicates order status information with its SC partner	Zhou & Benton Jr. 2007	Information sharing with major customer: Order status information
		Zhou & Benton Jr. 2007	Information sharing with major customer: Changes in purchase order information
		Zhou & Benton Jr. 2007	Information sharing with major customer: Planned order information
		Zhou & Benton Jr. 2007	We have a single point of contact for all order inquiries
		Zhou & Benton Jr. 2007	We have real time visibilities of order tracking
OCM7	Real-time access to order-tracking information is provided to our SC partner	Zhou & Benton Jr. 2007	We have real time visibilities of order tracking
		Zhou & Benton Jr. 2007	We use automatic identification during the delivery process to track order status
		Frohlich & Westbrook 2001	Joint EDI access/networks
		Narasimhan & Kim 2002	The level of computerization for customer ordering
		Zhou & Benton Jr. 2007	Information sharing with major customer: Order status information
		Vickery et al. 2003	Integrated electronic data interchange
		Vickery et al. 2003	Integrated information systems
OCM8	Information about our production schedules is provided to our SC partner	Flynn et al 2010	Our major supplier shares their production schedule with us.
		Flynn et al 2010	We share our production plan with our major customer.
		Frohlich & Westbrook 2001	Sharing production plans
		Devaraj et al. 2007	My company provides the following information to the supplier: Master production schedule
		Lau et al. 2010	Share production plans
		Swink et al. 2007	We share real time production schedule information with suppliers
		Zhou & Benton Jr. 2007	Information sharing with major customer: Production planning information

OCM9	Capacity related data is provided to our SC partner by my company	Flynn et al 2010	Our major supplier shares their production capacity with us.
		Zhou & Benton Jr. 2007	Information sharing with major customer: Production capacity information
OCM10	My company discloses cost information to our SC partner	Das et al. 2006	Cost information sharing by supplier
		Das et al. 2006	Cost information sharing with supplier
		Das et al. 2006	Use of total costs
		Swink et al. 2007	We share our cost information with our major suppliers
		Swink et al. 2007	We require cost information sharing by our suppliers
PCM1 PCM2 PCM3 PCM4 PCM6	Performance related feedback is given to our SC partner My organization makes performance metric data available to its SC partner Performance score-cards are shared with our SC partner My company shares data that our SC partner needs to evaluate its performance Performance evaluations are reported to our SC partner	Flynn et al 2010	Follow-up with our major customer for feedback.
		Braunscheidel and Suresh, 2009	We give our suppliers feedback on quality and delivery performance
		Das et al. 2006	Formal supplier evaluation procedures
		Das et al. 2006	Granting supplier performance awards and rewards
		Stank et al. 2001	my firm has developed performance measures that extend accross supply chain relationships
		Zhou & Benton Jr. 2007	Information sharing with major customer: Performance evaluation information
		Morash & Clinton 1998	frequently share performance results with suppliers
		Vachon & Klassen 2006	Visit our premises to help us to improve our performance.
		Narasimhan & Kim 2002	Follow-up with customers for feedback
PCM5 PCM7	Performance metrics that extend across our supply-chain dyad are shared with our SC partner My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad	Stank et al. 2001	my firm has developed performance measures that extend accross supply chain relationships
		Stanley & Wisner 2001	contacting the end users to get feedback
OPC1	We coordinate activities regarding promotional events	Cao & Zhang 2011	Our firm and supply chain partners jointly plan on promotional events
OPC2	Demand forecasts are developed jointly by my company and our SC partner	Cao & Zhang 2011	Our firm and supply chain partners jointly develop demand forecasts
		Wong et al. 2011	Have a high degree of joint planning and forecasting with major customers to anticipate demand visibility
OPC3 OPC4	Our SC partner provides input regarding decisions about levels of inventories Policies regarding inventories are made after mutual consultation and cooperation	Braunscheidel and Suresh, 2009	Joint planning with suppliers is important in purchasing
		Cao & Zhang 2011	Our firm and supply chain partners jointly manage inventory
		Stanley & Wisner 2001	involving SC in your product/service/marketing plans
		Wong et al. 2011	Have a high degree of joint planning to obtain rapid response ordering process (inbound) with

			suppliers
		Wong et al. 2011	Have a high degree of joint planning and forecasting with major customers to anticipate demand visibility
OPC5	We cooperate with each other to resolve supply disruptions	Stanley & Wisner 2001	REducing response times accross the supply chain
		Chen & Paulraj 2004	Information and materials flow smoothly between our supplier firms and us.
		Li et al. 2005	We frequently interact with customers to set reliability, responsiveness, and other standards for us
OPC6	We collectively set reliability and responsiveness standards for both of us are set	Li et al. 2005	We frequently interact with customers to set reliability, responsiveness, and other standards for us
		Wong et al. 2011	Have a high degree of joint planning to obtain rapid response ordering process (inbound) with suppliers
OPC7	My company and our SC partner work together to synchronize production	Handfield et al. 2009	The participation level of suppliers in the process of procurement and production.
		Flynn et al 2010	The participation level of our major supplier in the process of procurement and production.
		Braunscheidel and Suresh, 2009	Joint planning with suppliers is important in production
		Lau et al. 2010	Joint production operations
		Narasimhan & Kim 2002	The participation level of suppliers in the process of procurement and production
		Das et al. 2006	Direct communications between production
OPC8	The flow of goods and services between my company and our SC partner is coordinated by working together	Chen & Paulraj 2004	Interorganizational logistic activities are closely coordinated.
		Flynn et al 2010	The participation level of our major supplier in the process of procurement and production.
		Narasimhan & Kim 2002	The participation level of suppliers in the process of procurement and production
		Braunscheidel and Suresh, 2009	Joint planning with customers is important in logistics
		Chen & Paulraj 2004	Our logistics activities are well integrated with the logistics activities of our suppliers.
		Chen & Paulraj 2004	We have a seamless integration of logistics activities with our key suppliers.
OPC9 v1 OPC9 v2	We mutually implement mechanisms for coordinating responses to atypical demand or supply related events Mechanisms for coordinating responses to unexpected and sharp changes in demand or supply have been mutually implemented	Lee at al. 2007	Our company has a rapid response ordering processing system with our suppliers.
		Gimenez & Ventura 2005	Joint planning to anticipate and resolve operative problems
		Braunscheidel and Suresh, 2009	Our supply chain employs rapid response initiatives (e.g., continuous replenishment (CR) or vendor managed inventory (VMI)
OPC10	We have implemented suitable systems for quick replenishment (for example: continuous replenishment systems, or collaborative	Devaraj et al. 2007	My company authorizes the supplier to automatically replenish the inventory of the component
		Braunscheidel and Suresh, 2009	Our supply chain employs rapid response initiatives (e.g., continuous replenishment (CR)

	planning, forecasting and replenishment systems or their variants)		or vendor managed inventory (VMI)
		Devaraj et al. 2007	The customer authorizes my company to automatically replenish the inventory of the product my company supplies
		Gimenez & Ventura 2005	Established work team for the implementation and development of continuous replenishment program (CRP) or other ECR practice
		Wong et al. 2011	Have a high degree of joint planning to obtain rapid response ordering process (inbound) with suppliers
		Lee at al. 2007	Our company has a rapid response ordering processing system with our suppliers.
CID1	Our SC partner helps us in improving the delivery lead times of the end products of our SC dyad	Stanley & Wisner 2001	increasing your firms JIT capability
		Stanley & Wisner 2001	aiding suppliers to increase their JIT capability
		Braunscheidel and Suresh, 2009	Our key suppliers deliver to our plant in a JIT basis
		Narasimhan & Kim 2002	The agility of ordering process
CID2	We cooperatively improve the delivery reliability of the end products of our SC dyad	Lee at al. 2007	Our company has a supplier network that assures reliable delivery.
		Flynn et al 2010	We help our major supplier to improve its process to better meet our needs.
CID3	We have taken steps to move towards frequent deliveries in this relationship	Frohlich & Westbrook 2001	Delivery frequencies
		Braunscheidel and Suresh, 2009	Our key suppliers deliver to our plant in a JIT basis
		Stanley & Wisner 2001	aiding suppliers to increase their JIT capability
CII1	Production and operations related problems are solved cooperatively in this relationship	Li et al. 2005	We regularly solve problems jointly with our suppliers
		Vachon & Klassen 2006	Help us in process improvement activities (e.g. value analysis, cost reduction, problem solving).
		Gimenez & Ventura 2005	Joint planning to anticipate and resolve operative problems
		Das et al. 2006	Joint problem solving with supplier
CII2	We help each other in improving processes	Stank et al. 2001	my firm benchmarks best practices/processes and shares results with suppliers
		Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
		Vachon & Klassen 2006	Help us in process improvement activities (e.g. value analysis, cost reduction, problem solving).
		Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
CII3	Continuous improvement programs have been jointly established	Li et al. 2005	We have continuous improvement programs that include our key suppliers
		Flynn et al 2010	We help our major supplier to improve its process to better meet our needs.
		Braunscheidel and Suresh, 2009	We work with our suppliers to seamlessly integrate our inter-firm processes (e.g., order

			placement)
		Braunscheidel and Suresh, 2009	We work with our customers to seamlessly integrate our inter-firm processes (e.g., order entry)
		Gimenez & Ventura 2005	Joint decisions about ways to improve cost efficiencies
		Swink et al. 2007	We require major suppliers to contribute to cost/quality improvement
		Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
CII4	Process re-engineering is done jointly by my company and our SC partner	Lau et al. 2010	Joint process engineering
		Flynn et al 2010	We help our major supplier to improve its process to better meet our needs.
		Gimenez & Ventura 2005	Joint development of logistics processes
		Gimenez & Ventura 2005	Joint decisions about ways to improve cost efficiencies
		Swink et al. 2007	We require major suppliers to contribute to cost/quality improvement
		Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
CII 5.1 CII 5.2 CII 5.3	We find best practices together We learn best practices together We implement best practices together	Stank et al. 2001	my firm benchmarks best practices/processes and shares results with suppliers
		Lau et al. 2010	Joint process engineering
		Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
CIQ1	Cross-organizational teams used for working on quality related projects	Cao & Zhang 2011	Our firm and supply chain partners use cross-organizational teams frequently for process design and improvement
		Vickery et al. 2003	Cross-functional teams
		Vachon & Klassen 2006	Visit our premises to help us to improve our performance.
CIQ2	We jointly implement quality related best practices	Stank et al. 2001	my firm benchmarks best practices/processes and shares results with suppliers
		Das et al. 2006	Training in quality to supplier
CIQ3	My company and our SC partner assist each other in improving quality	Li et al. 2005	We have helped our suppliers to improve their product quality
		Swink et al. 2007	We require major suppliers to contribute to cost/quality improvement
		Swink et al. 2007	We have a formal ‘‘customer satisfaction’’ program in place
NPD1	Requirements and specifications of new products are jointly developed by my company and our SC partner	Koufteros et al. 2005 AND Koufteros et al. 2010	Our suppliers are involved in the early stages of product development
		Lee at al. 2007	Our company involves suppliers during the design stage for our new products.
		Chen & Paulraj 2004	Our key suppliers have major influence on the design of new products.

		Vachon & Klassen 2006	Collaborate in the design of new products or new product lines to be introduced at our plant.
		Li et al. 2005	We actively involve our key suppliers in new product development processes
		Koufteros et al. 2005 & Koufteros et al. 2010	We ask our suppliers for their input on the design of component parts
		Braunscheidel and Suresh, 2009	We jointly develop new products/services with our suppliers
		Koufteros et al. 2005 & Koufteros et al. 2010	We make use of supplier expertise in the development of our products
NPD2	We work together in all stages of new product development	Braunscheidel and Suresh, 2009	We jointly develop new products/services with our suppliers
		Li et al. 2005	We actively involve our key suppliers in new product development processes
		Koufteros et al. 2005 & Koufteros et al. 2010	We make use of supplier expertise in the development of our products
		Koufteros et al. 2005 & Koufteros et al. 2010	Our suppliers develop whole subassemblies for us
NPD3	Research for new products is done collaboratively	Hult et al. 2007 (SMJ)	We do a lot of in-house research on products we may need.
		Hult et al. 2007 (SMJ)	We emphasize research and development and technological leadership.
		Cao & Zhang 2011	Our firm and supply chain partners jointly search and acquire new and relevant knowledge
		Chen & Paulraj 2004	We share sensitive information (financial, production, design, research, and/or competition).
		Chen & Paulraj 2004	We involve key suppliers in the product design and development stage.
NPD4	There is close cooperation in designing new products between my company and our SC partner	Koufteros et al. 2005 & Koufteros et al. 2010	We make use of supplier expertise in the development of our products
		Koufteros et al. 2005 & Koufteros et al. 2010	We ask our suppliers for their input on the design of component parts
		Swink et al. 2007	We emphasize early supplier involvement in product design
		Hult et al. 2007 (SMJ)	We meet regularly to find out what products we need in the future.
		Chen & Paulraj 2004	We involve key suppliers in the product design and development stage.
		Wong et al. 2011	Our suppliers are involved in our product development processes
NPD5	Processes for producing & delivering new products are designed jointly		

NPD6	We pool together expertise and knowledge for new product development	Koufteros et al. 2005 & Koufteros et al. 2010	We make use of supplier expertise in the development of our products
		Koufteros et al. 2005 & Koufteros et al. 2010	We ask our suppliers for their input on the design of component parts
		Cao & Zhang 2011	Our firm and supply chain partners jointly search and acquire new and relevant knowledge
		Cao & Zhang 2011	Our firm and supply chain partners jointly assimilate and apply relevant knowledge
NPD7	Business performance targets (e.g. sales and profitability targets) for new products are mutually agreed upon	Peterson et al 2005	Business performance targets were clearly defined and agreed upon by both parties
		Peterson et al 2005	the supplier was invovled in establishing business performance targets
NPD8	Technical specifications for new products are developed jointly	Peterson et al 2005	technical performance targets were clearly defined and agreed upon by both parties
		Peterson et al 2005	the supplier was invovled in establishing technical performance targets
		Peterson et al 2005	the supplier was involved in establishing technical performance measures
GKW1	We collaborate on creating new knowledge	Hult et al. 2007 (SMJ)	We emphasize research and development and technological leadership.
		Hult et al. 2007 (SMJ)	We actively seek innovative supply management ideas.
		Hult et al. 2007 (SMJ)	Innovation in our supply management process is encouraged.
GKW2	My company and our SC partner cooperate to search and acquire new and relevant knowledge	Cao & Zhang 2011	Our firm and supply chain partners jointly search and acquire new and relevant knowledge
GKW3	We work together to discover new and emerging markets	Cao & Zhang 2011	Our firm and supply chain partners jointly discover new or emerging markets
		Hult et al. 2004 (AMJ)	KNW Acquisition: We meet regularly to find out what products we need in the future.
		Hult et al. 2004 (AMJ)	KNW Acquisition: We do a lot of in-house research on products we may need.
GKW4	We jointly learn about intentions and capabilities of our competitors	Cao & Zhang 2011	Our firm and supply chain partners jointly learn the intentions and capabilities of our competitors
GKW5	We assist knowledge development efforts by sharing knowledge with each other	Cao & Zhang 2011	Our firm and supply chain partners share technical supports
GKW6	My company and our SC partner jointly assimilate and apply relevant knowledge	Cao & Zhang 2011	Our firm and supply chain partners jointly assimilate and apply relevant knowledge
GKW7	We work together to identify future needs of the end-customers of our supply-chain dyad	Cao & Zhang 2011	Our firm and supply chain partners jointly identify customer needs
		Hult et al. 2004 (AMJ)	KNW Acquisition: We meet regularly to find out what products we need in the future.
		Hult et al. 2007 (SMJ)	We spend time discussing future supply management needs.
EVL1	This SC relationship	Jap & Anderson	They have generated a lot of profits together

	contributes positively to the profitability of our company	2003	
		Jap & Anderson 2003	They have achieved a high level of joint profits between them.
		Nyaga et al. 2010	My firm is satisfied with this relationship in terms of: profitability. market share. sales growth.
		Johnston et al. 2004	To what extent has each of the following possible performance objectives of this buyer–supplier relationship been met? (1) Long-term profitability, (2) net profits over past year,
EVL2	For us the benefits of this relationship greatly exceed the costs of maintaining the relationship		
EVL3	This SC relationship has contributed greatly to reduction in our costs	Johnston et al. 2004	To what extent has each of the following possible performance objectives of this buyer–supplier relationship been met? (5) lower long-term costs, (6) lower short-term costs
EVL4	The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant	Nyaga et al. 2010	My firm is satisfied with this relationship in terms of: profitability. market share. sales growth.
		Johnston et al. 2004	To what extent has each of the following possible performance objectives of this buyer–supplier relationship been met? (3) growth, (8) increased product/service base
EVL5	The assistance of this SC relationship in achieving my company's financial targets has been commendable	Jap & Anderson 2003	Perf of Other:The buyer/supplier leaves a lot to be desired from an overall performance standpoint. (R)
		Jap & Anderson 2003	They have achieved a high level of joint profits between them.
CVL1	This relationship has positively contributed to our company's competitive advantage	Jap & Anderson 2003	They have gained strategic advantages over their competitors.
CVL2	This relationship has allowed my company to differentiate itself from our competitors based on greater value proposition for the customer	Johnston et al. 2004	To what extent has each of the following possible performance objectives of this buyer–supplier relationship been met? (7) increased quality
CVL3	This relationship has positively contributed towards achieving our strategic goals	Jap & Anderson 2003	The relationship has not resulted in strategically important outcomes. R
		Jap & Anderson 2003	The relationship has not resulted in strategic advantages for them. R
CVL4	This relationship has allowed my company to differentiate itself from competitors based on unique/differentiated products and services	Jap & Anderson 2003	They have gained benefits that enable them to compete more effectively in the marketplace.
CVL5	This relationship has helped my company achieve lower costs than competitors	Johnston et al. 2004	To what extent has each of the following possible performance objectives of this buyer–supplier relationship been met? (1) Long-term profitability, (2) net profits over past year, (5) lower long-term costs, (6) lower short-term costs

RQ1	The volume of trade between our company and this SC partner has increased compared to other buyer/supplier firms (or decreased less if all trade has decreased)	Frazier and Maltz 2009	Our trade area generates a significant portion of the supplier's sales and profits.
RQ2	Any conflicts or issues in this relationship are resolved in a timely and effective manner	Benton and Maloni 2005	Discussions within areas of disagreement are productive
RQ3	The duration of the relationship is longer relative to other supply-chain relationships of my company		
RQ4	Our company and our SC partner have a high degree of mutual agreement on strategic issues		
RQ5	Compared to our typical supply-chain relationship, we would characterize this relationship as much stronger		
RQ6	This relationship will survive even if the people on both sides that liaise with each other left their jobs		
RQ7	The relationship will survive even if we had low sales due to adverse economic conditions		
RQ8	We expect this relationship to continue for a long time	Benton and Maloni 2005	Would discontinue selling to XXX if could
RQ9	This relationship is characterized by high levels of commitment from both sides	Benton and Maloni 2005	Committed to preservation of good relationships with XXX
RQ10	We would characterize this relationship as exemplifying a quality relationship		

Table A5
Inter-rater Reliability Measures from Q-Sort

Judge Pair	Round 1 Agreement %	Round 1 IR	Round 1 Cohen's Kappa	Round 2 Agreement %	Round 2 IR	Round 2 Cohen's Kappa	Round 3 Agreement %	Round 3 IR	Round 3 Cohen's Kappa
J(1,2)	0.92	0.95	0.91	0.91	0.95	0.90	0.96	0.97	0.95
J(1,3)	0.85	0.91	0.83	0.87	0.93	0.86	0.94	0.97	0.93
J(2,3)	0.87	0.93	0.86	0.81	0.89	0.78	0.93	0.96	0.92
J(1,4)	0.72	0.83	0.69	0.90	0.94	0.88	0.93	0.96	0.92
J(2,4)	0.69	0.81	0.66	0.84	0.91	0.83	0.91	0.95	0.90
J(3,4)	0.68	0.80	0.65	0.83	0.90	0.81	0.91	0.95	0.90
J(1,5)	0.85	0.91	0.83	0.97	0.99	0.97	0.93	0.96	0.92
J(2,5)	0.80	0.88	0.78	0.91	0.95	0.90	0.91	0.95	0.90
J(3,5)	0.80	0.88	0.78	0.88	0.93	0.87	0.90	0.94	0.88
J(4,5)	0.72	0.83	0.69	0.90	0.94	0.88	0.88	0.93	0.87
J(1,6)	0.74	0.84	0.71	0.95	0.97	0.94	0.93	0.96	0.92
J(2,6)	0.74	0.84	0.71	0.90	0.94	0.88	0.91	0.95	0.90
J(3,6)	0.72	0.83	0.68	0.84	0.91	0.83	0.90	0.94	0.88
J(4,6)	0.59	0.74	0.54	0.91	0.95	0.90	0.88	0.93	0.87
J(5,6)	0.71	0.82	0.67	0.95	0.97	0.94	0.88	0.93	0.87
J(1,7)	0.67	0.80	0.63	0.88	0.93	0.87	0.96	0.97	0.95
J(2,7)	0.66	0.79	0.62	0.86	0.92	0.84	0.94	0.97	0.93
J(3,7)	0.65	0.78	0.61	0.81	0.89	0.78	0.96	0.97	0.95
J(4,7)	0.56	0.72	0.52	0.86	0.92	0.84	0.91	0.95	0.90
J(5,7)	0.67	0.80	0.63	0.88	0.93	0.87	0.91	0.95	0.90
J(6,7)	0.62	0.76	0.58	0.86	0.92	0.84	0.91	0.95	0.90
J(1,8)	0.76	0.86	0.74	0.81	0.89	0.78	0.93	0.96	0.92
J(2,8)	0.79	0.87	0.76	0.81	0.89	0.78	0.91	0.95	0.90
J(3,8)	0.81	0.89	0.79	0.74	0.84	0.71	0.96	0.97	0.95
J(4,8)	0.64	0.77	0.60	0.78	0.87	0.75	0.90	0.94	0.88
J(5,8)	0.74	0.84	0.71	0.81	0.89	0.78	0.88	0.93	0.87
J(6,8)	0.69	0.81	0.66	0.79	0.88	0.77	0.90	0.94	0.88
J(7,8)	0.62	0.76	0.58	0.74	0.84	0.71	0.94	0.97	0.93
J(1,9)	0.88	0.93	0.87	0.88	0.93	0.87	N.A.	N.A.	N.A.
J(2,9)	0.86	0.92	0.84	0.87	0.93	0.86	N.A.	N.A.	N.A.
J(3,9)	0.86	0.92	0.84	0.81	0.89	0.78	N.A.	N.A.	N.A.
J(4,9)	0.74	0.84	0.71	0.84	0.91	0.83	N.A.	N.A.	N.A.
J(5,9)	0.87	0.93	0.86	0.90	0.94	0.88	N.A.	N.A.	N.A.
J(6,9)	0.74	0.84	0.71	0.87	0.93	0.86	N.A.	N.A.	N.A.
J(7,9)	0.68	0.80	0.65	0.84	0.91	0.83	N.A.	N.A.	N.A.
J(8,9)	0.76	0.86	0.74	0.73	0.83	0.70	N.A.	N.A.	N.A.
Average	**0.74**	**0.84**	**0.71**	**0.85**	**0.91**	**0.84**	**0.92**	**0.95**	**0.91**

Table A6
Poor Performing Items that were Discarded After Round 1 of Q-sort

Item Text	Construct	p_{sa}	c_{sv}
Our SC partner provides input regarding our decisions about inventory levels	Ops planning & control	0.00	-0.89
Production and operations related problems are solved cooperatively in this relationship	Collaborative Improvement	0.11	-0.56
The volume of trade between our company and this SC partner has increased compared to other buyer/supplier firms (or decreased less if all trade has decreased)	Relationship Quality	0.11	-0.33
We have taken steps to move towards frequent deliveries in this relationship	Collaborative Improvement	0.22	-0.33
We collectively set reliability and responsiveness standards for both of us	Ops Planning & Control	0.22	-0.33
My company discloses cost information to our SC partner	Operational Communication	0.44	-0.11
This relationship has helped my company achieve lower costs than competitors	Competitive Value Generated	0.56	0.22
This relationship has greatly contributed to the innovation output of our company	Competitive Value Generated	0.67	0.44

Table A7
Items that were Re-worded after Round 1

Item ID	Original Wording (used in Round 1)	New Wording (for Round 2)
CVL3	This relationship has positively contributed towards achieving our strategic goals	This relationship has positively contributed towards gaining market share from competitors (Judges were having difficulty with the words 'strategic goals' as such goals could be anything)
GKW7	We work together to identify future needs of the end-customers of our supply-chain dyad	We work together to gain knowledge about the future trends in end-consumers preferences (Respondents stated the word "identification" did not hint towards knowledge. Need a more learning oriented verb there)
DP5	Any disruptions in this relationship will be very costly for our company	Our company cannot afford disruptions in this relationship
GKW3	We work together to discover new and emerging markets	We work together to learn about new and emerging business opportunities
OPC10	We have implemented suitable systems for quick replenishment (for example: continuous replenishment systems, or collaborative planning, forecasting and replenishment systems or their variants)	We have implemented joint forecasting and planning systems with our supply chain partner to achieve quick replenishment

CID1	Our SC partner helps us in improving the delivery lead times of the end products of our SC dyad	Our supply chain partner collaborates with us to reduce delivery lead times of the end-products by process improvement
GKW4	We jointly learn about intentions and capabilities of our competitors	We jointly create knowledge regarding the intentions and capabilities of our competitors
NPD7	Business performance targets (e.g. sales and profitability targets) for new products are mutually agreed upon	Targets regarding the commercial success of new products (e.g. sales targets) are jointly agreed upon
OCM1	My company shares information regarding demand of our products and services	My company shares market data about demand for end products with its supply chain partner (**Update**: *The new wording did not work well as shown in Table 7 below. Recommendation: Revert back to original wording used in round 1*)
OPC5	We cooperate with each other to resolve supply disruptions	We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services
OPC1	We coordinate activities regarding promotional events	We coordinate activities to avoid shortages when running promotional sales and discounts offers (Respondents commented that the word events was throwing them off because event sounded like a fair or a one-time publicity affair that had nothing to do with operations) (**Update**: *The new wording did not work well as shown in Table 7 below. Recommendation: Revert back to original wording used in round 1*)
RQ4	Our company and our SC partner have a high degree of mutual agreement on strategic issues	We don't have major disagreements because we agree on strategic issues

Table A8
Redundant Items that were Dropped After Round 2 of Q-sort

Item ID	**Item Wording**	**Construct**	**Round 2 p_{sa}**	**Round 2 c_{sv}**
CII5.2	We learn best practices together **(Remove due to redundancy, see CII5.3)**	Collaborative Improvement	0.67	0.44
CII5.1	We find best practices together (Remove due to redundancy, see CII5.3)	Collaborative Improvement	0.56	0.22
CIQ2	We jointly implement quality related best practices (Remove due to redundancy, see CII5.3)	Collaborative Improvement	0.89	0.78
CVL2	This relationship has allowed my company to differentiate itself from our competitors based on greater value proposition for the customer(Remove due to redundancy, see CVL6)	Competitive Value Generated	1.00	1.00
GKW6	My company and our SC partner jointly assimilate and apply relevant knowledge (Remove due to redundancy, see GKW2)	General Knowledge Generation	0.89	0.78

NPD8	Technical specifications for new products are developed jointly (Remove due to redundancy, see NPD1)	New Product Development	0.89	0.78
OPC8	The flow of goods and services between my company and our SC partner is coordinated by working together (Remove due to redundancy, see OPC5 and OPC7)	Operational Planning & Control	1.00	1.00
PCM3	Performance score-cards are shared with our SC partner (Remove due to redundancy, see PCM6)	Performance Related Communication	1.00	1.00
PCM2	My organization makes performance metric data available to its SC partner (Remove due to redundancy, see PCM1)	Performance Related Communication	1.00	1.00

Table A9
Validity Statistics for Items Used in Round 2 along with Changes Made for Round 3

Item ID	**Item Text**	**Construct**	p_{sa}	c_{sv}
CII5.3	We implement best practices together	Collaborative Improvement	1.00	1.00
CID1	Our supply chain partner collaborates with us to reduce delivery lead times of the end-products by process improvement	Collaborative Improvement	0.78	0.67
CII5.2	We learn best practices together **(Remove due to redundancy, see CII5.3)**	Collaborative Improvement	0.67	0.44
CII3	Continuous improvement programs have been jointly established	Collaborative Improvement	1.00	1.00
CII2	We help each other in improving processes	Collaborative Improvement	1.00	1.00
CIQ3	My company and our SC partner assist each other in improving quality	Collaborative Improvement	1.00	1.00
CID2	We cooperatively improve the delivery reliability of the end products of our SC dyad	Collaborative Improvement	0.67	0.44
CII5.1	We find best practices together **(Remove due to redundancy, see CII5.3)**	Collaborative Improvement	0.56	0.22
CIQ2	We jointly implement quality related best practices **(Remove due to redundancy, see CII5.3)**	Collaborative Improvement	0.89	0.78
CII4	Process re-engineering is done jointly by my company and our SC partner	Collaborative Improvement	0.78	0.67

CIQ1	Cross-organizational teams are used for working on quality related projects	Collaborative Improvement	0.78	0.67
CVL3	This relationship has positively contributed towards gaining market share from competitors	Competitive Value Generated	0.78	0.56
CVL1	This relationship has positively contributed to our company's competitive advantage	Competitive Value Generated	0.89	0.78
CVL6	This relationship has helped my company provide more value to customers than our competitors	Competitive Value Generated	1.00	1.00
CVL2	This relationship has allowed my company to differentiate itself from our competitors based on greater value proposition for the customer**(Remove due to redundancy, see CVL6)**	Competitive Value Generated	1.00	1.00
CVL4	This relationship has allowed my company to differentiate itself from competitors based on unique/differentiated products and services	Competitive Value Generated	1.00	1.00
EVL1	This SC relationship contributes positively to the profitability of our company	Economic Value Generated	1.00	1.00
EVL3	This SC relationship has contributed greatly to reduction in our costs	Economic Value Generated	1.00	1.00
EVL2	For us the benefits of this relationship greatly exceed the costs of maintaining the relationship	Economic Value Generated	1.00	1.00
EVL4	The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant	Economic Value Generated	1.00	1.00
EVL5	The assistance of this SC relationship in achieving my company's financial targets has been commendable	Economic Value Generated	1.00	1.00
GKW6	My company and our SC partner jointly assimilate and apply relevant knowledge **(Remove due to redundancy, see GKW2)**	General Knowledge Generation	0.89	0.78
GKW1	We collaborate on creating new knowledge	General Knowledge Generation	0.89	0.78
GKW5	We assist knowledge development efforts by sharing knowledge with each other	General Knowledge Generation	0.89	0.78
GKW2	My company and our SC partner cooperate to search and acquire new and relevant knowledge	General Knowledge Generation	0.89	0.78
GKW7	We work together to gain knowledge about the future trends in the preferences of end-consumers	General Knowledge Generation	0.67	0.56

GKW3	We work together to learn about new and emerging business opportunities	General Knowledge Generation	1.00	1.00
GKW4	We jointly create knowledge regarding the intentions and capabilities of our competitors	General Knowledge Generation	1.00	1.00
NPD8	Technical specifications for new products are developed jointly **(Remove due to redundancy, see NPD1)**	New Product Development	0.89	0.78
NPD2	We work together in all stages of new product development	New Product Development	0.89	0.78
NPD5	Processes for producing & delivering new products are designed jointly	New Product Development	1.00	1.00
NPD1	Requirements and specifications of new products are jointly developed by my company and our SC partner	New Product Development	0.89	0.78
NPD7	Targets regarding the commercial success of new products (e.g. sales targets) are jointly agreed upon	New Product Development	0.67	0.44
NPD6	We pool together expertise and knowledge for new product development	New Product Development	1.00	1.00
NPD3	Research for new products is done collaboratively	New Product Development	1.00	1.00
NPD4	There is close cooperation in designing new products between my company and our SC partner	New Product Development	0.89	0.78
OCM3	My organization keeps our SC partner informed about issues that may affect their normal routines	Operational Communication	0.89	0.78
OCM2	Periodically updated sales forecasts are shared with our SC partner	Operational Communication	0.89	0.78
OCM8	Information about our production schedules is provided to our SC partner	Operational Communication	1.00	1.00
OCM5	Logistics related information is shared by my company with our SC partner	Operational Communication	1.00	1.00
OCM9	Capacity related data is provided to our SC partner by my company	Operational Communication	1.00	1.00
OCM6	My company communicates order status information with its SC partner	Operational Communication	1.00	1.00

OCM4	Access to information about our inventory levels is provided to our SC partner	Operational Communication	1.00	1.00
OCM1	My company shares market data about demand for end products with its supply chain partner (**Revert back to original wording:** My company shares information regarding demand of our products and services)	Operational Communication	0.56	0.33
OCM7	Real-time access to order-tracking information is provided to our SC partner	Operational Communication	1.00	1.00
OPC4	Policies regarding inventories are made after mutual consultation and cooperation	Operational Planning & Control	0.89	0.78
OPC7	My company and our SC partner work together to synchronize production	Operational Planning & Control	1.00	1.00
OPC5	We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services	Operational Planning & Control	1.00	1.00
OPC9 **v1**	We mutually implement mechanisms for coordinating responses to atypical demand or supply related events	Operational Planning & Control	0.78	0.67
OPC2	Demand forecasts are developed jointly by my company and our SC partner	Operational Planning & Control	0.89	0.78
OPC10	We have implemented joint forecasting and planning systems with our supply chain partner to achieve quick replenishment	Operational Planning & Control	0.67	0.44
OPC8	The flow of goods and services between my company and our SC partner is coordinated by working together **(Remove due to redundancy, see OPC5 and OPC7)**	Operational Planning & Control	1.00	1.00
OPC1	We coordinate activities to avoid shortages when running promotional sales and discounts offers (**Revert back to original wording:** We coordinate activities regarding promotional events)	Operational Planning & Control	0.67	0.33
PCM4	My company shares data that our SC partner needs to evaluate its performance	Performance Related Communication	1.00	1.00
PCM3	Performance score-cards are shared with our SC partner **(Remove due to redundancy, see PCM6)**	Performance Related Communication	1.00	1.00
PCM1	Performance related feedback is given to our SC partner	Performance Related Communication	1.00	1.00

PCM6	Performance evaluations are reported to our SC partner	Performance Related Communication	1.00	1.00
PCM7**v2**	My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad	Performance Related Communication	1.00	1.00
PCM5	Performance metrics that extend across our supply-chain dyad are shared with our SC partner	Performance Related Communication	1.00	1.00
PCM2	My organization makes performance metric data available to its SC partner **(Remove due to redundancy, see PCM1)**	Performance Related Communication	1.00	1.00
RQ3	The duration of the relationship is longer relative to other supply-chain relationships of my company	Relationship Quality	0.89	0.78
RQ4	We don't have major disagreements because we agree on strategic issues	Relationship Quality	0.89	0.78
RQ6	This relationship will survive even if the people on both sides that liaise with each other left their jobs	Relationship Quality	1.00	1.00
RQ5	Compared to our typical supply-chain relationship, we would characterize this relationship as much stronger	Relationship Quality	1.00	1.00
RQ10	We would characterize this relationship as exemplifying a quality relationship	Relationship Quality	1.00	1.00
RQ7	The relationship will survive even if we had low sales due to adverse economic conditions	Relationship Quality	0.89	0.78
RQ8	We expect this relationship to continue for a long time	Relationship Quality	1.00	1.00
RQ9	This relationship is characterized by high levels of commitment from both sides	Relationship Quality	1.00	1.00
RQ2	Any conflicts or issues in this relationship are resolved in a timely and effective manner	Relationship Quality	1.00	1.00

Table A9
Final Items and their Substantive Validity Coefficients from Round 3 of Q-sort

Item ID	**Item Text**	p_{sa}	c_{sv}
CII5.3	We implement best practices together	0.88	0.75

CIQ1	Cross-organizational teams are used for working on quality related projects	0.88	0.75
CID2	We cooperatively improve the delivery reliability of our supply chain	0.88	0.75
CID1	We collaboratively improve processes to reduce delivery lead times of the end-products	1.00	1.00
CII3	Continuous improvement programs have been jointly established	1.00	1.00
CII2	We help each other in improving processes	1.00	1.00
CIQ3	My company and our SC partner assist each other in improving quality	1.00	1.00
CII4	Process re-engineering is done jointly by my company and our supply chain partner	1.00	1.00
CVL3	This relationship has positively contributed towards achieving our strategic goals	0.75	0.63
CVL1	This relationship has positively contributed to our company's competitive advantage	0.88	0.75
CVL6	This relationship has helped my company provide more value to customers than our competitors	0.88	0.75
CVL4	This relationship has allowed my company to distinguish itself from competitors based on unique/differentiated products and services	1.00	1.00
EVL2	For us the benefits of this relationship greatly exceed the costs of maintaining the relationship	0.75	0.50
EVL3	This SC relationship has contributed greatly to reduction in our costs	0.88	0.75
EVL1	This relationship contributes positively to the profitability of our company	1.00	1.00
EVL4	The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant	1.00	1.00
EVL5	The assistance of this SC relationship in achieving my company's financial targets has been commendable	1.00	1.00
GKW7	We work together to discover the future trends in the preferences of end-consumers	0.88	0.75

GKW1	We collaborate on creating new knowledge	1.00	1.00
GKW5	We assist knowledge development efforts by sharing knowledge with each other	1.00	1.00
GKW2	My company and our supply chain partner cooperate to search and acquire new and relevant knowledge	1.00	1.00
GKW3	We work together to learn about new and emerging business opportunities	1.00	1.00
GKW4	We jointly create knowledge regarding the intentions and capabilities of our competitors	1.00	1.00
NPD5	Processes for producing & delivering new products are designed jointly	0.88	0.75
NPD6	We pool together expertise and knowledge for new product development	0.88	0.75
NPD3	Research for new products is done collaboratively	0.88	0.75
NPD2	We work together in all stages of new product development	1.00	1.00
NPD1	Requirements and specifications of new products are jointly developed by my company and our SC partner	1.00	1.00
NPD7	Targets regarding the commercial success of new products (e.g. sales targets) are jointly agreed upon	1.00	1.00
NPD4	In designing new products there is close cooperation between my company and our SC partner	1.00	1.00
OCM3	My organization keeps our SC partner informed about issues that may affect their normal routines	1.00	1.00
OCM2	Periodically updated sales forecasts are shared with our SC partner	1.00	1.00
OCM8	My company provides Information about our production schedules to our SC partner	1.00	1.00
OCM5	My company shares logistics related information with our SC partner	1.00	1.00
OCM9	My company provides capacity related data to its supply chain partner	1.00	1.00

OCM6	My company communicates order status information with its SC partner	1.00	1.00
OCM4	My company makes inventory level inormation accessible to our SC partner	1.00	1.00
OCM1	My company shares market data about demand for end products with its supply chain partner	1.00	1.00
OCM7	My company gives Real-time access to order-tracking information to our SC partner	1.00	1.00
OPC2	We jointly develop demand forecasts with our supply chain partner	0.88	0.75
OPC1	We coordinate activities regarding marketing campaigns and associated operations support across both companies	0.88	0.75
OPC4	Policies regarding inventories are made after mutual consultation and cooperation	1.00	1.00
OPC7	My company and our SC partner work together to synchronize production	1.00	1.00
OPC5	We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services	1.00	1.00
OPC9 v1	We mutually implement mechanisms for coordinating responses to atypical demand or supply related events	1.00	1.00
OPC10	We have implemented joint forecasting and planning systems with our supply chain partner to achieve quick replenishment	1.00	1.00
PCM4	My company shares data that our SC partner needs to evaluate its performance	1.00	1.00
PCM1	Performance related feedback is given to our SC partner	1.00	1.00
PCM6	Performance evaluations are reported to our SC partner	1.00	1.00
PCM7v2	My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad	1.00	1.00

PCM5	Performance metrics that extend across our supply-chain dyad are shared with our SC partner	1.00	1.00
RQ6	This relationship will survive even if the people on both sides that liaise with each other left their jobs	0.88	0.75
RQ7	The relationship will survive even if we had low sales due to adverse economic conditions	0.88	0.75
RQ3	The duration of the relationship is longer relative to other supply-chain relationships of my company	1.00	1.00
RQ4	We don’t have major disagreements because we agree on strategic issues	1.00	1.00
RQ5	This relationship is much stronger than our typical supply chain relationship	1.00	1.00
RQ10	We would characterize this relationship as exemplifying a quality relationship	1.00	1.00
RQ8	We expect this relationship to continue for a long time	1.00	1.00
RQ9	This relationship is characterized by high levels of commitment from both sides	1.00	1.00
RQ2	Any conflicts or issues in this relationship are resolved in a timely and effective manner	1.00	1.00

10. APPENDIX B: SURVEY INSTRUMENT

Welcome to Supply Chain Management Research

Thank you for responding to our invitation to participate in this survey! This study is extremely important for management professionals like you in North America.

In appreciation of your participation we will send you a **benchmark report** that will allow you to compare your supply chain practices with the other top companies in North America

Please click the next button ">>" below to start the survey!

The privacy and confidentiality of your responses is ensured by the agreement between the researchers and the Research Ethics committee at York University. All information will be kept strictly confidential. No respondents or companies will ever be identified. Only summary statistics will be published.

If you have any questions about the study you may reach as at schain@yorku.ca (or +1-416-835-4275).
The complete ethics and privacy guidelines are:

Please understand that you (the respondent) do not have to participate in this research, and that you can terminate your participation at any time during the course of the research. In addition, once the research is finished, you have the right to ask us to not include your responses in our research. If you inform us of your wish to withdraw your responses, your survey data will be securely erased.

Your decision not to participate will not influence your relationship with researchers or with staff of York University either now or in the future.

All survey responses will be stored in a secure online database for an expected duration of 2 months (upto a maximum of 6 months). Afterwards it will be securely erased from the survey database and stored in a password protected computer. Any information that may identify you or your company will be securely deleted once data collection and analysis are complete.

This research is confidential and no individuals or organizations will be identified without their written consent. Confidentiality will be provided to the fullest extent possible by law. Any information that could reveal your identity or that of your organization will be excluded from any future papers or research reports that are written based on this research. We will destroy any data and notes at the end of this project. This research has been approved by the York University Human Participants Review Committee.

If you have any questions about the research in general or your role in the study please feel free to contact the research team (Email: supplychain@schulich.yorku.ca, Tel: +1-416-736-2100 x 44609).

This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, you may contact the Senior Manager and Policy Advisor for the Office of Research Ethics, 5 th Floor, York Research Tower, York University, telephone 416-736-5914 or e-mail ore@yorku.ca

Please click the *next ">>" button* below to fill out the online questionnaire.

If you do not wish to participate please simply close this webpage.

Note: You may use the Forward (>>) and Back (<<) Buttons to navigate in the survey.

This survey will ask you questions about a supply-chain relationship that is important for your company.

Please take a moment to consider a ***single*** *supply chain relationship that is important to your company. Answer all* *questions in the survey with respect to your chosen supply chain relationship, with the exception of some questions at the end that explicitly ask about your company only.*

In a supply-chain relationship, we refer to the company that supplies good and services as the **Supplier company**, and the company purchasing those outputs as the **Customer company**.

1) I would like to report about a supply chain relationship in which:

☐ I represent the CUSTOMER Company
---- This survey will refer to your Supplier as your "supply-chain partner"
☐ I represent the SUPPLIER Company
----- This survey will refer to your Customer company as your "supply-chain partner"

2) What is the duration (in years) of the supply chain relationship you have selected?

- <= 1 year
- 1 year 1 day to 2 years
- 2 years 1 day to 3 years
- 3 years 1 day to 4 years
- 4 years 1 day to 5 years
- 5 years 1 day to 6 years
- 6 years 1 day to 7 years
- 7 years 1 day to 8 years
- 8 years 1 day to 9 years
- 9 years 1 day to 10 years
- 10 years 1 day to 11 years
- 11 years 1 day to 12 years
- > 12 years

3) Approximately what percentage of your total purchase volume (in dollars) comes from this supplier (i.e. your supply-chain partner)?

OR

3) Approximately what percentage of your total sales (in dollars) are made to this customer (i.e. your supply-chain partner)?

---

4) Communication

Please indicate the extent to which your company does the following communication activities with its supply-chain (SC) partner:

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
My company communicates order status information with its SC partner							
My company gives real-time access to order related information to our SC partner							
My company provides capacity related data to its supply chain partner							
My company shares logistics related information with our SC partner							
My company shares market data about demand for end products with its SC partner							
Periodically updated sales forecasts are shared with our SC partner							
My company makes inventory level information accessible to our SC partner							
My company provides information about our production schedules to our SC partner							
My organization keeps our SC partner informed about issues that may affect their normal routines							

Please indicate the extent to which your company does the following performance feedback related activities with its supply-chain (SC) partner.

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
My company pools data with the SC partner to calculate and share performance metrics for our supply-chain dyad							
Performance related feedback is given to our SC partner							
Performance evaluations are reported to our SC partner							
My company shares data that our SC partner needs to evaluate its performance							
Performance metrics that extend across our supply-chain dyad are shared with our SC partner							

5) Coordination

Please indicate the extent to which your company does the following coordination related activities with its supply-chain (SC) partner. (“We” refers to your company and its supply-chain partner as a pair)

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
We have implemented joint forecasting and planning systems with our SC partner to achieve quick replenishment							
We coordinate activities regarding marketing campaigns and associated operations support across both companies							
We mutually implement mechanisms for coordinating responses to atypical demand or supply related events							
We coordinate purchasing and logistics related activities to mitigate disruptions in the flow of goods and services							
We jointly develop demand forecasts with our supply chain partner							
My company and our SC partner work together to synchronize production							
Policies regarding inventories are made after mutual consultation and cooperation							

6) Collaboration

Please indicate the extent to which your company does the following operational improvement activities with its supply-chain (SC) partner. ("We" refers to your company and its supply-chain partner as a pair)

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
We collaboratively improve processes to reduce delivery lead times of the end-products							
Continuous improvement programs have been jointly established							
Cross-organizational teams are used for working on quality related projects							
We implement best practices together							
We help each other in improving processes							
My company and our SC partner assist each other in improving quality							
Process re-engineering is done jointly by my company and our SC partner							
We cooperatively improve the delivery reliability of the end products of our supply chain							

7) New Product Development

Please indicate the extent to which your company does the following new product development activities with its supply-chain (SC) partner. ("We" refers to your company and its supply-chain partner as a pair)

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
In designing new products, there is close cooperation between my company and our SC partner							
We pool together expertise and knowledge for new product development							
Processes for producing & delivering new products are designed jointly							
Requirements and specifications of new products are jointly developed by my company and our SC partner							
We work together in all stages of new product development							
Research for new products is done collaboratively							
Targets regarding the commercial success of new products (e.g. sales targets) are jointly agreed upon							

8) Knowledge

Please indicate the extent to which your company does the following knowledge related activities with its supply-chain (SC) partner. ("We" refers to your company and its supply-chain partner as a pair)

	Not at all (1)	(2)	(3)	Avg. (4)	(5)	(6)	Extensively (7)
We collaborate on creating new knowledge							
We jointly create knowledge regarding the intentions and capabilities of our competitors							
My company and our SC partner cooperate to search and acquire new and relevant knowledge							
We assist knowledge development efforts by sharing knowledge with each other							
We work together to learn about new and emerging business opportunities							
We work together to discover the future trends in the preferences of end-consumers							

9) Contribution of the Relationship to Profitability

Please indicate your level of agreement or disagreement with the following statements about the contribution of the supply-chain (SC) relationship to your company's profitability.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
The assistance of this SC relationship in achieving my company's financial targets has been commendable							
The contribution of this SC relationship to revenue growth (or preventing revenue decline) has been significant							
This SC relationship contributes positively to the profitability of our company							
For us the benefits of this relationship greatly exceed the costs of maintaining the relationship							
This SC relationship has contributed greatly to reduction in our costs							

10) Contribution of the Relationship to Competitive Advantage

Please indicate your level of agreement or disagreement with the following statements about the contribution of the supply-chain (SC) relationship to your company's competitive advantage.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
This relationship has positively contributed to our company's competitive advantage							
This relationship has helped my company provide more value to customers than our competitors							
This relationship has positively contributed towards achieving our strategic goals							
This relationship has allowed my company to differentiate itself from competitors based on unique/differentiated products and services							

11) About the Relationship

Please indicate your level of agreement or disagreement with the following statements about your supply-chain (SC) relationship.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)

We don't have major disagreements because we agree on strategic issues							
This relationship is much stronger than our typical supply chain relationship							
This relationship will survive even if the people on both sides that liaise with each other leave their jobs							
This relationship is characterized by high levels of commitment from both sides							
Any conflicts or issues in this relationship are resolved in a timely and effective manner							
The relationship will survive even if we have low sales due to adverse economic conditions							
We expect this relationship to continue for a long time							
We would characterize this relationship as exemplifying a quality relationship							
The duration of the relationship is longer relative to other supply-chain relationships of my company							

12) About the Business Environment

Please indicate your perceptions about the rate of change of the following aspects of your company's business environment.

	Very slow (1)	Slow (2)	Avg. (3)	Rapid (4)	Very Rapid (5)
The rate at which products and services become outdated					
The rate of innovation of new products and services					
The rate of innovation of new operating processes					
The rate of change of tastes and preferences of customers in your industry					

Some Information About Your Company

13) What is the primary industry of your company?

Aerospace and Defense
Automotive or Automotive Parts Manufacturing
Chemical and Petrochemicals
Consumer Products manufacturing
Electronics / High Tech Manufacturing
Food Products Manufacturing
Furniture and Home Related Goods Manufacturing
Health Care Related Products and Instruments Manufacturing
Industrial Machinery and Equipment Manufacturing
Information & Communication Technology Manufacturing
Medical Devices Manufacturing
Metal, Mechanical and Engineering
Pharmaceutical
Retail
Textiles and Apparel Manufacturing
Transportation, Warehousing or Logistics
Wholesaler
Other (please specify):

14) My companies revenues:

☐ Mostly (>50%) come from selling products

□ Mostly (>50%) come from selling services

15)
The number of full-time employees in your company is:

< 100
101 to 250
251 to 500
501 to 1,000
1,001 to 5,000
5,001 to 10,000
10,001 to 50,000
> 50,000

16) Your title (position) in your company is most closely described by which of the following:

President, CEO, COO or Chairman
Vice President
Director
General Manager
Supply Chain Manager or Operations Manager
Purchasing Manager
Plant Manager
Other (please specify):

17) How long (in years) have you worked for your company?

<= 1 year
1 year 1 day to 2 years
2 years 1 day to 3 years
3 years 1 day to 4 years
4 years 1 day to 5 years
5 years 1 day to 6 years
6 years 1 day to 7 years
7 years 1 day to 8 years
8 years 1 day to 9 years
9 years 1 day to 10 years
10 years 1 day to 11 years
11 years 1 day to 12 years
> 12 years

18) How knowledgeable did you feel answering this questionnaire?

Very knowledgeable
Above average
Average
Below average
Not knowledgeable

This is the last page with survey questions. Please click Next (>>) to save your responses. We thank you for your cooperation.

Goodbye.

11. APPENDIX C: SUPPORTING FIGURES FOR CHAPTER 7

Figure C1
Density Plot of Residuals Compared to the Normal Distribution for Economic Value as the Dependent Variable

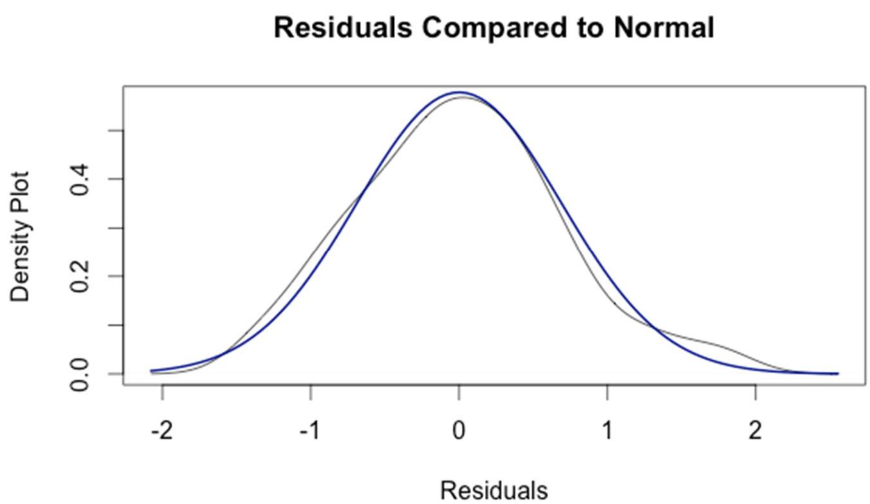


Figure C2
Histogram of Residuals Compared to Normal Distribution for Economic Value as the Dependent Variable

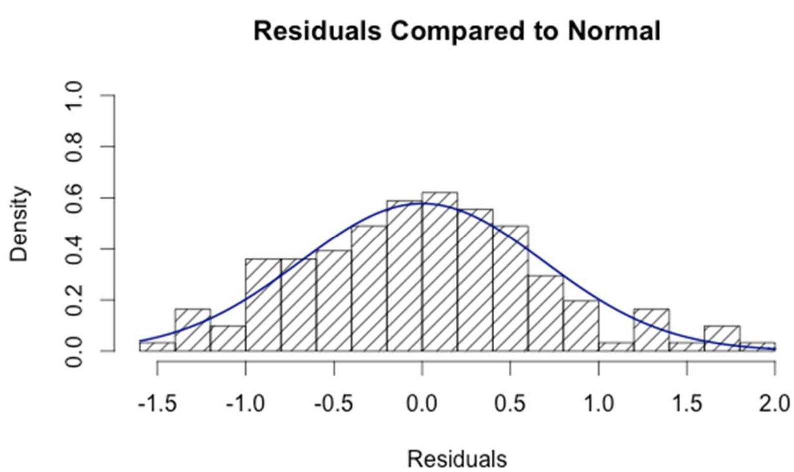


Figure C3
Residuals vs Fitted (Y-hat) Values for Economic Value as the Dependent Variable

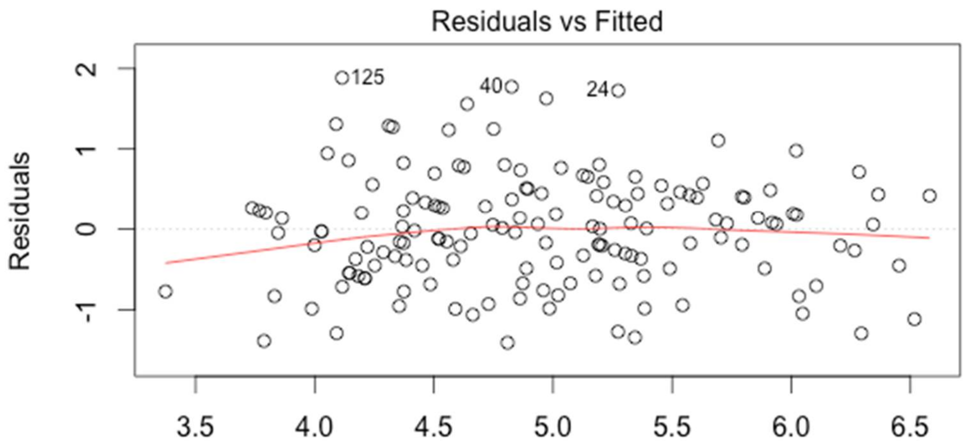


Figure C4
Density Plot of Residuals Compared to the Normal Distribution for Competitive Value as the Dependent Variable

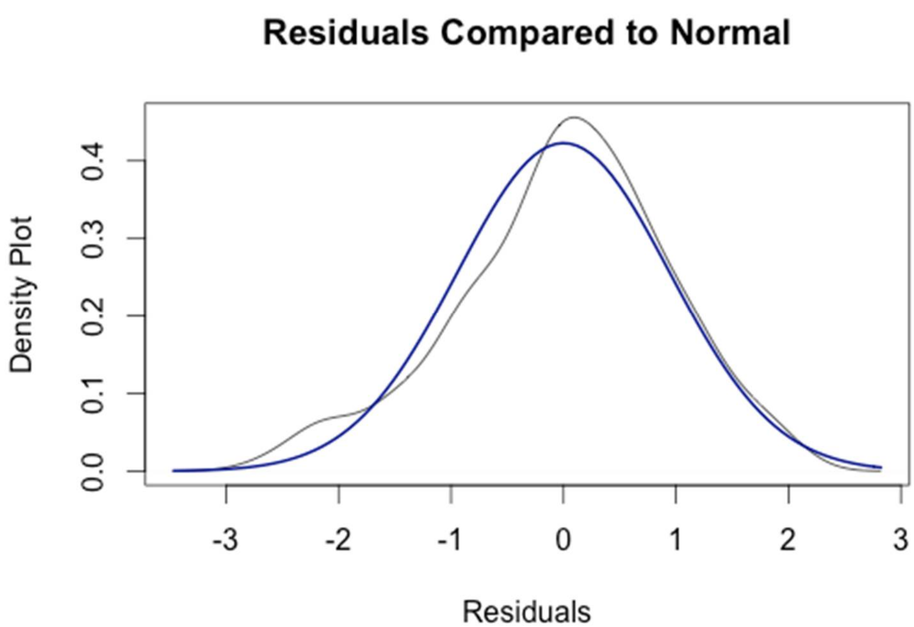


Figure C5
Histogram of Residuals Compared to Normal Distribution for Competitive Value as the Dependent Variable

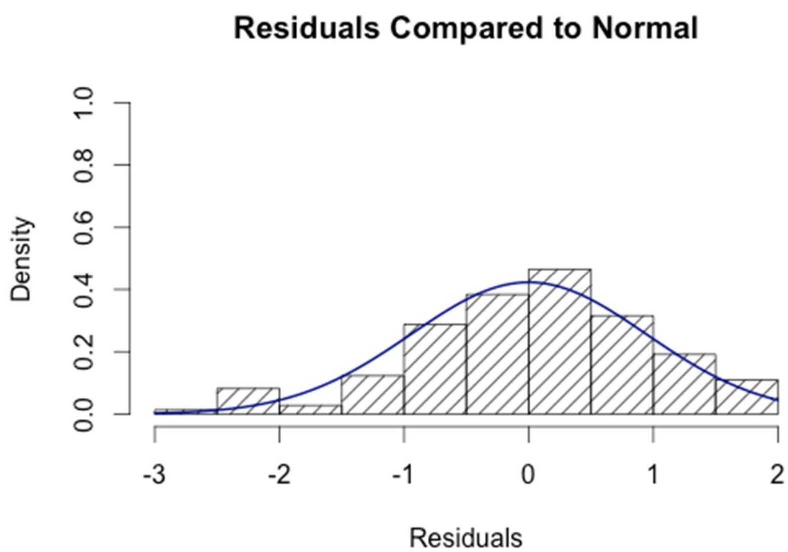
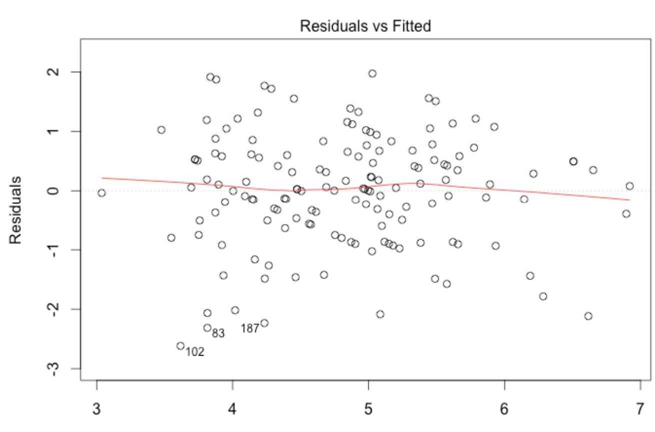


Figure C6
Residuals vs Fitted (Y-hat) Values for Competitive Value as the Dependent Variable



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