The Impact of IT Platform and Relational Capabilities on Supply Chain Integration: A Social Capital Perspective

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Abstract

The importance of managing supply chains is a recurrent theme today for firms seeking to improve profitability and gain competitive advantage. Building on prior work that identifies the value creation capabilities of integrated digital platforms and relational conditions, we draw on social capital theory to propose an integrative framework to develop supply chain integration capabilities. Social capital, as defined in this study, is the actual and potential resources available to a firm through its network of relationships. Approaching the topic from a social capital perspective, we assert that IT platform and relational capabilities resident in a focal firm’s supply chain network constitute social capital that is available to the firm. Firms can draw upon this social capital to significantly improve the performance of their supply chains. A research model is developed and empirically validated to examine first the impact of specific facets of social capital on supply chain integration, and then consider the effects of supply chain integration on firm performance. Data from 110 manufacturing and retail firms is used to provide empirical support for the proposed research model.

Keywords: Social Capital, Inter-organizational Information Systems, IT-enabled Supply chains, Supply Chain Relationships

1. Introduction

The success of firms like Wal-Mart, Dell, Toyota, TESCO, and others in the marketplace is often attributed to leadership, innovation and effective management of their supply chains. This has prompted other firms try to emulate their success by seeking improved performance from their supply chains (Simchi-Levi et al. 2002, Sambamurthy et al. 2003, Reilly 2004). One analysis suggests that U. S. manufacturers could realize $488 billion in operating margins if they improved the management of their supply chains (Reilly 2004). The increasing emphasis on supply chain management (SCM) as a competitive imperative requires firms to look beyond their organizational boundaries to manage the extended enterprise (Lambert et al. 1998, Evans and Wurster 1999). The emergent model of competition is considered to be one where networks of firms, or supply chains, compete against each other...
in contrast to the traditional view of individual firms competing in the marketplace. In recognition of the new ‘global business architecture’ (Parkhe et al. 2006), firms are launching initiatives to coordinate their supply networks and integrate end-to-end supply chains -- from lower tier suppliers to the final consumer (Lee et al. 2000, Ramdas and Spekman 2000).

Integrating supply chain processes and resources is considered essential for effective SCM. The emphasis is evident in most definitions of SCM. For instance the Global Supply Chain Forum defines SCM as “the integration of key business processes from end user through original suppliers that provides products, services, and information that add value to customer and other stakeholders,” (Lambert et al. 1998). Integrated supply chains provide operational visibility, coordinated plans, and a streamlined flow of goods, which collectively compress the cycle time between order placement and fulfillment (Teo et al. 1995, Hult et al. 2004). To realize these outcomes, a considerable amount of attention has been devoted to managing inventories (Lee 2000) and sharing information (Simchi-Levi D. et al. 2000, Ho et al. 2002). Another dominant approach has been the application of information technologies to promote information sharing and integrate inter-firm processes (Cachon and Fisher 2000, Mehmet et al. 2002, Gunasekaran and Ngai 2004, Rai et al. 2006). In order to implement such practices, firms form collaborative relationships (Dyer and Singh 1998, Dyer 2000) with supply chain partners where partner resources and network membership constitute key resources for improved performance and competitive advantage (Christopher and Juttner 2000, Dyer 2000, Hoyt and Huq 2000, Patnayakuni et al. 2006). Others have argued that focusing primarily on efficiency and effectiveness does not necessarily lead to improved supply chain performance or competitive position in the market place (Lee 2004). There is a need to delve deeper into this issue and theorize an organizational framework that considers the network context of the phenomenon, and integrates multiple perspectives prevalent in the literature to develop a better theoretical and practical understanding of how to manage supply chains.

The centrality of networks and emphasis on collaborative relationships in contemporary supply chains has common basis with social capital theory. Social capital is a simple and elegant concept that is based on the premise that the network of relationships in which a social unit is embedded constitutes a valuable asset (Bourdieu 1986, Walker et al. 1997, Leana and van Buren 1999) that provides access to partner resources (Nahapiet and Ghoshal
1998). Originally used to describe relational resources rooted in personal networks of individuals in social communities (e.g. Bourdieu 1986), subsequent research has applied it to a wider range of phenomena in social and organizational settings, such as family relations (Coleman 1988), intra-firm and inter-firm relations (Burt 1992), economic performance of firms (Baker 1990), and prosperity of nations (Fukuyama 1995).

Social capital has been characterized variously in terms of social relationships (Bourdieu 1986), network location (Burt 1992), strength of ties (Granovetter 1992) and norms and values (Coleman 1988, Putnam 1993). Characterized in this manner, we can consider social capital to be embedded in the nature of ties, connections, and inter-organizational exchange platforms a firm has with its partners in the context of SCM. McGrath and Sparks (2005) describe social capital as the ‘relational glue’ that forms the basis for effective supply chains. It therefore provides an organizational theoretical framework to identify and leverage resources resident in a focal firm’s supply network. Adopting the social capital perspective to study supply chain networks, we define the social capital of a focal firm as the actual and potential resources resident in the firm’s supply network. Social capital comprises both network ties and the assets that may be mobilized through the network; thus emphasizing both the resource and structural aspects of networks, in addition to their relational aspects (Nahapiet and Ghoshal 1998, Tsai and Ghoshal 1998).

We draw upon prior research on technology-enabled integration of supply chain processes (Rai et al. 2006) and relational orientation for information integration (Patnayakuni et al. 2006), to develop our theoretical arguments and propose a research model. We consider structural, relational, and cognitive (Nahapiet and Ghoshal 1998) facets of social capital available to a focal firm in a supply chain. This allows us to theorize how technology and relationships collectively provide resources to integrate supply chain processes, which, should then result in improved firm performance. Our model identifies digitization of supply chain processes, cross-functional application integration and relational asset specificity as structural social capital, long-term orientation as relational social capital, and data consistency and relational interaction routines as cognitive social capital. Analysis of the collected data provides strong support for the research model. The results show that the three aspects of social capital have significant positive association with supply chain integration and collectively explain 52.6% of the variance in supply chain integration and 19.5% of the variance in firm performance.
The paper makes the following contributions to current research on supply chains, it: (1) integrates alternate research streams by using the social capital perspective to capture network capabilities and establish the importance of leveraging social capital for network capabilities like the integration of supply chain processes, (2) goes beyond the traditional emphasis on relational facets of networks to highlight the importance of structural and cognitive facets of network resources, (3) provides an alternative conceptualization of structural facets of networks in terms of IT platform capabilities and relationship specific investments, and (4) identifies that shared data codes and representations, along with interaction routines as the cognitive facet of social capital which has a strong influence on supply chain network capabilities. The study extends prior work on supply chain integration to reconcile the roles of IT capabilities and relational capabilities under the social capital perspective and, provides a more comprehensive framework for future research on supply chain related phenomena.

In the next section, we examine social capital theory and its applicability to the integration of supply chains. We then develop the research model and corresponding relationships. This is followed by an explanation of the research methods employed for data collection and analytical techniques used to validate the measurement of constructs and test the research model.

2. Supply Chain Networks: A Social Capital Perspective

Even though the core ideas behind social capital are simple and intuitive, there is no single definition of social capital to which researchers widely subscribe. In fact, it is argued that social capital is an ‘umbrella concept’ and often means different things to different people (Adler and Kwon 2002). Traditionally, researchers investigating social capital phenomena have focused on relationships as a resource for social action (Bourdieu 1986, Nahapiet and Ghoshal 1998, Adler and Kwon 2002) and this relational view has dominated much of the research on social capital. This focus on relational aspects, is perhaps based on the initial articulation of social capital as networks of mutual acquaintance and recognition. For example, Bourdieu (1986) points to the durable obligations arising from feelings of gratitude, respect, and friendship in a social network. In contrast, some researchers limit the concept of social capital to the structure of networks (Baker 1990). Other researchers favor a more specific definition of social capital that considers both the network and the assets that can be mobilized through the network (Burt 1992, Nahapiet and Ghoshal 1998). In this vein, Nahapiet and Ghoshal (1998) define social capital as “the sum of the
actual and potential resources embedded within, available through and derived from the network of relationships (p. 243)”, a definition that is increasingly favored in recent research, such as Wasko and Faraj (2005) and Stam and Elfring (2008)

The concept of social capital has been applied in a variety of social science disciplines to address a broad range of questions (Adler and Kwon 2002). It has been applied to investigate problems related to growth and performance at multiple levels of analysis. For example, in some research social capital has been specified as a resource available to individuals by virtue of their location in a network (Burt 1997) and in other research defined more broadly as characteristic of nations (Fukuyama 1995). At the organizational level, it has been used to examine organizational employment practices (Leana and van Buren 1999), the formation of business networks, and industry growth (Walker et al. 1997). In the context of inter-organizational relationships, it has been shown to strengthen supplier relations (Uzzi 1997), promote inter-firm learning (Kraatz 1998, Nahapiet and Ghoshal 1998), and shape the relationship between entrepreneurial orientation and firm performance (Stam and Elfring 2008).

Prior research suggests that the availability of social capital to a firm is dependent on the organization’s position in the network structure and the nature of its ties with its partners (Walker et al. 1997). Some of the dominant themes in supply chain management are (1) network-based competition (Parkhe et al. 2006), (2) the primacy of managing relationships with supply chain partners (Dyer 2000, Patnayakuni et al. 2006), and (3) relational and IT capabilities between firms and their supply chain partners (Teo et al. 2003, Patnayakuni et al. 2006, Rai et al. 2006) all of which have common basis with the core precepts of social capital. Thus, conceptualizing social capital as resources resident in the nature of ties, connections and inter-organizational platforms provides a useful basis for theorizing and investigating supply chain capabilities and firm performance.

Several researchers have put forth the idea that social capital is a multidimensional construct (Nahapiet and Ghoshal 1998, Adler and Kwon 2002). In addition to the conventional focus on structural and relational characteristics of social capital, they have examined the unique abilities of networks to create, share and transfer knowledge (Kogut 2000). Developing on these ideas, Nahapiet and Ghoshal (1998) identify three distinct, albeit related, facets of social capital as structural, relational and cognitive. Accordingly, we characterize a focal firm’s social capital in terms of the structural, relational, and cognitive characteristics of its supply chain network. Next, we
elaborate on each of the three aspects of social capital

2.1 Relational Social Capital.

Perhaps the most recurrent theme in social capital is the bond created by relationships within a network, community, or collective (Bourdieu 1986, Nahapiet and Ghoshal 1998). Sometimes referred to as relational capital, this aspect focuses on the specific relations people have as members of a network and the access it provides to resources and opportunities. Relational social capital refers to those assets that are created, leveraged, and reinforced through relationships based on a history of transactions that benefit both the community and its members (Coleman 1990). When relational social capital has accrued, members identify strongly with their network and perceive an obligation to cooperate with other members (Coleman 1990, Leana and van Buren 1999). As opposed to structural capital, relational social capital captures the behavioral embeddedness of a network member (Granovetter 1992). Key constructs traditionally used to capture relational capital include identification (Hakansson and Snehota 1995), trust (Fukuyama 1995) norms, sanctions, and commitment (Coleman 1990, Putnam 1993). The current emphasis on collaborative relationships (Dyer and Singh 1998, Dyer 2000) and on taking advantage of partner resources (Christopher and Juttner 2000, Hoyt and Huq 2000, Patnayakuni et al. 2006) to manage supply networks maps well to this aspect of social capital.

2.2 Structural Social Capital.

Each facet of social capital has two characteristics in common: (1) they constitute some aspect of social structure, and (2) they facilitate the actions of individuals within the structures (Coleman 1990). Structural embeddedness of a firm in a network is characterized by the processes, systems and network of contacts that provides a platform1 for future appropriation by partner firms and their personnel (Lawson et al. 2008). Making the distinction between structural and relational embeddedness, Granovetter (1992) considers structural social capital to be the configuration of linkages among members emphasizing access to resources rather than the relational nature of ties. Simply described, structural social capital captures ‘who you can reach and how you can reach them’ (Nahapiet and Ghoshal 1998, pg. 244) and consequently ‘what you can do’ with the capability. Key characteristics of

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1 The term platform here is used to describe general-purpose capabilities that enable the creation and implementation of processes, systems and second order capabilities between partner firms. We apply the term here in a manner similar to Fichman (2004) in describing IT platforms and by Taudes (2000) for software platforms.
Structural social capital used in prior research are the presence or absence of ties, network configuration, characteristics of ties and their potential appropriability.

In this vein, structural social capital can also be characterized by the capabilities of the inter-organizational IT infrastructure that enable access to resources, interact with partner firm personnel, create and establish processes and use as a platform to develop and/or implement new applications. In other words, the nature of IT platform between partner firms can range in capability from the simple ability to ‘access’ partner firms’ resources, e.g. communication using e-mail to proprietary integrated inter-organizational systems to develop, implement and coordinate idiosyncratic exchange processes. These ties represent the structural characteristics of a network in terms of the IT platforms that exist between firms and their partners. These IT platforms provide network members with access to resources that can be potentially appropriated (Adler and Kwon 2002) in new and unique ways to generate digital options (Sambamurthy et al. 2003). In addition to the IT based ties between partner firms, firms can make other relationship specific investments in non-IT resources, such as location of facilities, production equipment, and business processes, that provide their partners with access to resources, customized assets and knowledge (Subramani 2004). Traditionally, structural social capital has been captured in terms of network characteristics such as density and centrality, and sometimes in terms of the extent of interaction between partner units (Lawson et al. 2008). Characterizing structural capital in terms of IT platform and relationship specific investments underscores the capabilities of ties between network members and their appropriability, providing a novel way of understanding and capturing structural ties in a supply chain network.

### 2.3 Cognitive Social Capital

Nahapiet and Ghoshal (1998) propose a third aspect of social capital, the cognitive, which is based on the shared representation, interpretations, and systems of meaning that exist among network members. This is based upon earlier work that describes social capital in terms cognitive elements such as shared codes, language and narratives (Cicourel 1973, Orr 1990). The premise is that there needs to be some level of shared understanding between network members in order to have meaningful exchange of information and knowledge. Shared language and vocabulary (Cicourel 1973, Nahapiet and Ghoshal 1998) are not only a frame of reference for individuals to have meaningful conversations and interpret the environment, but also enable firms and their partners to conduct routine
transactions and exchange data and information. For instance, supply networks may promote certain inter-
organizational standards that enable them to develop more cooperative and long-lasting relationships with their trading partners. Adopting, promoting and co-opting network members in such initiatives has given firms the technical ability to simultaneously engage in both highly efficient and highly flexible partnering arrangements (Malhotra et al. 2005). Cognitive social capital develops as network members interact with each to share practices, skills, and specialized knowledge. Firms and their partners develop an understanding of each other’s business and practices and provide them with access to specialized knowledge that is unique to the relationship (Subramani 2004).

2.4 Benefits of Social Capital.

While social capital provides the basis for consideration of network assets and resources, we are also interested in the potential outcomes for network members. Two distinct consequences of social capital are ‘allocative’ efficiency, which is the increase efficiency of action, and ‘adaptive’ efficiency, which supports creativity and learning among members (Nahapiet and Ghoshal 1998). Since social capital is likely to inhibit opportunistic behavior and to reduce the need for monitoring the actions of partners, from an efficiency perspective, high levels of social capital can reduce the cost of transactions, and improve firm performance. Given that our focus is on supply chain integration, we focus on social capital’s impact on allocative efficiency in terms of physical flow integration and information flow integration.

The impact of social capital on adaptive efficiency, especially in the context of adaptive supply chains, would likely provide valuable and interesting insights. The focus of such an investigation would be on outcomes such as creativity, learning, and new forms of cooperative association which is beyond the scope of our present research and is not included in the scope of our current investigation.

We have reviewed prior literature on social capital and SCM to explore, apply and define social capital and its dimensions to the context of supply chain networks. We now illustrate their value as a conceptual framework and an analytical tool for studying supply chain networks with a short case of a firm’s ability to exploit social capital for attaining performance objectives. The example we use is service parts supply chain of the automaker Saturn (Lee 2004). Saturn created a centralized system that allows Saturn and all its dealers to view inventory levels at Saturn and all dealerships. At a basic level, this represents connectivity that enables Saturn and its dealers to access
inventory information (structural capital). The system is used to make stocking and replenishment decisions as well as track the performance of the supply chain in terms of off-the-shelf availability of parts, profitability for dealers, and the number of emergency orders placed by dealers. By having access to network wide inventory of service parts, if a dealer does not have a specific part, Saturn can transfer the part from another dealer who has it.

Making the system work not only requires connectivity, but also acceptable processes that define the roles and responsibilities of network members and the alignment of incentives to maximize supply chain performance. The responsibility for making stocking and replenishment decisions for dealers rests with Saturn even though Saturn holds its managers and dealers jointly responsible for the quality of service provided to Saturn car owners. The trust needed to share the responsibility for service, access to inventory data, and the long-term orientation to work together to provide a superior service experience for Saturn owners is one of the key building blocks of such an arrangement (relational social capital). One of the first steps to create the service part supply chain was to standardize the way data about forecasts, sales, and plans was captured (cognitive social capital). Now that Saturn’s approach to its service parts supply chain is established, Saturn’s dealers now have 92.5% off-the-shelf availability of spare parts as compared to the industry norm of 70-80%. In building one of the best service parts supply chains in the automobile industry, Saturn demonstrated the importance of not only building systems, but also building trust and creating a mindset where each member of the network has the same objective -- that of providing the best service experience to customers.


Our research framework is motivated by social capital theory and anchored on the premise that social capital accrued by a focal firm by virtue of its ties with its supply chain partners is a resource that can be leveraged by the firm (Figure 1). Characterized in terms of structural, relational and cognitive capital, social will influence the ability of a firm to integrate its supply chain activities with network members and consequently firm performance. The impact of social capital will be evident in supply chain capabilities and specifically, in the context of this research model by extent to which two key supply chain flows – informational and physical - are integrated. Integrated supply chain processes in turn should result in positive firm performance outcomes. We identify constructs for each of the dimensions of social capital as well as supply chain integration and firm performance and develop the hypotheses for
In managing the extended enterprise, firms must develop capabilities to acquire, integrate, reconfigure and release resources that are embedded in their supply networks. Building social capital is a long-term process that requires firms to make a series of linked strategic decisions and moves related to, their investments in assets and relationships, so as to build structural, relational, and knowledge resources. As social capital resides in networks, members invest in building network capabilities with implications of joint ownership and access. Unlike assets that depreciate over time, social capital accrues value with usage and exchange that cannot be traded and easily (Burt 1992) provides member firms with potential sources of competitive advantage. Therefore, the accrual of social capital can provide firms with valuable and inimitable resources that make it possible to achieve outcomes that are otherwise difficult to realize or can be only realized at considerable cost. The supply chain network provides a structure to facilitate action by establishing a pattern of linkages that provide the platform for exchange among members (Bourdieu 1986, Coleman 1990). We suggest that specific IT platform and relational capabilities can engender structural, relational, and cognitive social capital that can be leveraged by a focal firm in a supply chain network.

Firms can develop IT-based ties with their partners by creating, investing, and developing integrated digital platforms that can play a key role in integrating supply chain activities (Teo et al. 1997, Rai et al. 2002a, Boyer et al. 2004). In order to develop such well-integrated platforms, firms and their partners need to negotiate and implement standards for the integration of data, applications, and processes (Weill and Broadbent 1998, Ross 2003). These become the basis for information sharing and can be appropriated to increase orchestration of the supply chain network (Broadbent et al. 1999). In addition to developing IT capabilities, firms can establish partnership structures that enhance their ability to respond to market conditions. For instance, the agreement between Wal-Mart and Proctor & Gamble for collaborative replenishment practices set the foundation for their pioneering partnership to coordinate supply chain activities. Motivated by the objective to make the supply chain more efficient and effective, these firms established capabilities to share information and coordinate resources that led to reduced cycle times and cost structures (Copacino and Byrnes 2001). Similarly, based on an extensive review of the literature in information
systems, operations management, and marketing, Patnayakuni et al. (2006) specify that supply chain relationships can be characterized in terms of: (a) investment by the supplier in relationship specific assets, (b) the extent of interaction and information exchange between the customer and supplier, and (c) long-term orientation of the relationship. Firms derive benefits from these relationships with their supply chain partners by gaining the ability to sense supply and demand signals across the supply chain, to stage inventory, and to orchestrate fulfillment. Thus, the nature of a firm’s partnership will likely influence the extent to which it is able to integrate its supply chain with network members (Patnayakuni et al. 2006, Rai et al. 2006). We now identify specific capabilities of firms’ partnerships with their supply chain members that use of social capital in terms of the three specific facets – structural, relational, and cognitive – and develop our logic for how they facilitate integration of resource flows in supply chain networks.

1.1 Structural Social Capital

Structural capital refers to the nature and configuration of linkages among members that provides access to resources in the network. It is characterized by processes, systems, and connections that provide a platform for member firms to access resources as well as appropriate structural linkages to develop, implement and manage new processes and systems (Nahapiet and Ghoshal 1998, Lawson et al. 2008). The structure of linkages in a network provides the platform for actions of members within such structure and affordances for collective action by members (Burt 1992, Putnam 1993). Structural capital, traditionally characterized in terms of network characteristics like centrality and density, can also be considered in terms of the pattern of connections, with a focus on who you can reach, how you can reach them, and how the structural linkages can be exploited (Nahapiet and Ghoshal 1998). This is similar to the framing of IT infrastructure platform by the reach and range of its capabilities and ability to enable business functionality (Keen 1991, Broadbent et al. 1999). Where, reach refers to the connectivity of the IT infrastructure, range refers to the variety of information resources that can be exchanged by the IT infrastructure. Viewed as an enabler of collective action, the network specific structural connections among members will determine what information can be exchanged and the variety of processes they perform, and consequently determine the extent to which they can integrate their resource flows.

We examine a focal firm’s structural social capital in terms of the structure of its linkages that are
characterized by reach, range and specificity. Specifically, we consider: (a) digitization - the ability of a focal form to execute supply chain processes online, (b) applications integration - the ability of applications across functions and organizations to communicate in real-time, and (c) specificity of relational assets. Collectively, they represent the structural social capital of the focal firm as they enable interactions with partners that differ based on the connectivity and capability of their structural linkages with their partners. Such capabilities provide the focal firm with the ability to operate in a network-centric fashion and represent capabilities that can be appropriated in novel ways over time.

3.1.1 Digitization as Structural Social Capital. Digitization is defined as the degree to which the focal firm conducts its inbound, outbound and intra-organizational supply chain processes online. While there is no formal universally accepted formal definition of what it means to be 'online,' we use the term in the commonly accepted sense that data pertaining to events and transactions are captured, transmitted, and shared across the supply chain through the Internet. Digitization of core supply chain processes - including procurement, manufacturing, inventory management, logistics, distribution, transportation, and sales - can have a significant impact on coordinating resources across the supply chain and, consequently, organizational performance.

Digitization enables firms to improve their supply-chain wide processes by reducing asset intensity and operating costs while improving responsiveness to customers (Slywotzky et al. 2000). For example, United Parcel Service (UPS) provides online on-demand package tracking to the customer, while reducing the cost of tracking each transaction. Online tracking enables UPS and its customers to reduce resources assigned to call centers and other conventional forms of processing. Digitization of supply chain processes also provides the visibility required to integrate segmented processes and improve resource utilization for the execution of physically intensive processes. For example, digitization of inbound and outbound logistics provides inventory visibility across the supply chain that enables optimal placement of components and finished goods inventory so as to minimize costs and improve responsiveness. Dell Computers is a well-known example of a firm that uses information to leverage physical flows and achieve dramatic results in its asset productivity and working capital efficiency (Magretta 1998). The company developed its web-enabled supply chain capabilities so that on average it maintains four days of inventory, and streamlined its financial flows to achieve negative cash conversion cycles (Fields 2002).

Based on the above discussion, we propose that the extent of digitization between a focal firm and its
supply chain partners represents a resource that contributes to the structural social capital of the firm.

**3.1.2 Cross-Functional SCM Application Systems Integration as Structural Social Capital.** Cross-functional SCM application systems integration is defined as the degree of real-time communication that a focal firm’s function-specific SCM applications have with each other and related ERP and CRM applications (Rai et al. 2006). Integration of a firm’s systems with its supply chain partners who have with such capabilities represent an asset for the management of cross-functional process dependencies (Rai et al. 2002a, Rai et al. 2002b).

We consider two classes of applications: supply chain planning applications and supply chain execution applications (Kalakota and Robinson 1999). Planning applications support critical planning processes such as procurement, production, transportation and warehousing. Execution applications support critical execution processes such as order management, replenishment, production and distribution. Integrated execution applications enable visibility of supply chain processes and coordination with partner firms. Integration of planning and execution applications enables close coordination of planning and execution processes and the ability to make responsive adjustments.

The connectivity afforded by such application integration further provides the focal firm with the ability to coordinate supplier-facing (inbound) processes and customer facing (outbound) with its SCM processes. The platform created by application connectivity and integration provides the firms’ with the ability to integrate information flows and coordinate physical flows across the supply chain. Based on this discussion, we suggest that the extent of cross-functional SCM application systems integration is a resource that contributes to the structural social capital of the firm.

**3.1.3 Relational Asset Specificity as a Form of Structural Social Capital.** Relational asset specificity is defined as the degree to which a firm makes partner-specific investments in tangible physical resources and intangible resources. Tangible resource investments include location-specific investments in production facilities such as customized tools and machinery and/or building facilities close to the partner firm (Williamson 1985). Intangible resource investments are directed at developing knowledge related to a partner’s procedures, culture, and technological know-how. Both domain-specific and business-process specific knowledge may be considered to be relationship-specific intangible assets (Subramani 2004). Such assets tend to be specific to firm-partner ties that
facilitate interactions in a manner that is more likely to be inimitable as compared to physical assets. These relationship specific assets not only provide access to inimitable partner resources but can also provide the opportunity to be deployed in new and unique ways by partner firms. Based on this discussion, we suggest that both tangible and intangible relationship specific investments are forms of structural social capital in supply chain networks.

We identified three modalities of structural social capital in our research model (see Figure 2) – digitization, cross-functional SCM applications integration and relationship specific investments – that enable the focal firm to improve the integration of supply chain processes with its partners. Accordingly we hypothesize;

\[ H_1: \text{Structural social capital of a focal firm, characterized as Digitization, Cross-Functional SCM Applications Integration, and Relationship Specific Investments, has a positive association with supply chain integration.} \]

<Insert Figure 2 about here>

1.2 Relational Social Capital

Relational social capital is based on the nature of relationships among network members, due to their history of interactions with each other (Granovetter 1992, Nahapiet and Ghoshal 1998). It refers to assets resident in relationships that are based on behavioral, as opposed to structural, embeddedness (Lindenberg 1996) and is, sometimes referred to as “actor bonds” (Hakansson and Snehota 1995). Relational assets in a network are often represented by notions of trust and trustworthiness (Fukuyama 1995, Tsai and Ghoshal 1998), obligations and expectations (Granovetter 1985, Coleman 1990), and norms and sanctions (Coleman 1990), among others. Relational social capital allows for partner relations (Dyer and Chu 2003) to be governed by informal arrangements and self-reinforcement as opposed to strict formal contracts. This aspect of social capital is characterized in this study by long-term orientation of the focal firm’s relationship with its supply chain partners.
3.2.1 Long-Term Orientation as Relational Social Capital. Long-term orientation is defined as the extent to which long-term considerations, mutual gains, and informal governance characterize a focal firm’s relationships with its partners (Ganesan 1994). Relationships that are governed by self-reinforcing mechanisms and informal governance are considered to be more effective and less costly than formal governance mechanisms (Hill 1995). Additionally, relationships based on long-term orientation focus on mutual benefit and have an expectation of continued interaction and exchange (Noordewier et al. 1990) -- characteristics that are also used to describe relational social capital. Coleman (1990) suggests that this relational aspect of social capital facilitates action within the structure and therefore in the context of supply chains enables integration of resource flows that benefits both the network and its members. Based on the discussion, we propose the hypothesis;

\[ H_2: \text{Relational social capital of a focal firm, characterized by its long-term orientation for supply chain partners,} \]
\[ \text{has a positive association with supply chain integration.} \]

1.3 Cognitive Social Capital

Cognitive social capital represents the shared language, representation, interpretation, and meaning that is established among partners (Cicourel 1973, Nahapiet and Ghoshal 1998). It refers to the resources resident in shared interpretations and meanings based on a recurrent and meaningful exchange of knowledge (Nahapiet and Ghoshal 1998). Cognitive capital develops over time through interaction among network members that share practices and knowledge to develop a specialized discourse and norms of practice. Embodied in language, codes, narratives, and shared vision, cognitive social capital provides the basis to recognize and realize mutually beneficial outcomes (Tsai and Ghoshal 1998). A shared language or system of codes is a means for partners to exchange information and conduct transactions efficiently. In the context of supply chains, we suggest that data consistency and relational interaction routines represent forms of cognitive capital.

3.3.1 Data Consistency as Cognitive Social Capital. Data consistency is defined as the extent to which common data definitions and consistency in stored data have been established across a focal firm’s supply chain (Rai et al. 2006). Even within an organization, there are so many challenges to maintaining data consistency (Goodhue et al. 1992) that achieving such consistency with supply chain partners presents even greater challenges. Across
organizations, supply chains tend to resemble large distributed systems where individual systems are intermittently connected and data exchange is limited, so there is potential for significant data consistency problems (Pitoura and Bhargava 1999). A shared system of coding and capturing data in supply chains will depend on having common and consistent data definitions for key entities such as products, brands, geographical regions etc., as well as automated systems that promote accurate data capture at the source. The presence of a consistent definition for exchanging data represents an important asset that will enable process integration (Malone 1987, Huber 1990), promote visibility, and support better decision making.

3.3.2 Relational Interaction Routines as Cognitive Social Capital. Relational interaction routines are defined as the degree to which informal and formal mechanisms have been established between a focal firm and its partners for the exchange of information and knowledge (Patnayakuni et al. 2006). Such routines represent an important mechanism by which organizations create cognitive social capital as members interact with others to share norms, knowledge, and narratives that provide the basis for a common understanding of problems, solutions, and improved practices. Mechanisms for the regular exchange of information and knowledge provide for greater participation through shared decision making, collaborative practices and exchange of know-how (Dwyer et al. 1987). Such exchange of know-how and knowledge plays a key role in the creation of knowledge (Kogut and Zander 1996), that is ‘sticky’ and difficult to trade or replicate.

Well-developed interaction routines structure the coordination and communication between a focal firm and its supply chain partners that enable more information and knowledge to be revealed and combined. Interaction routines can also provide opportunities to identify and improve processes (Okhuysen and Eisenhardt 2002). Other researchers have noted that the partner-specific ability to absorb information and knowledge, through a shared knowledge base, is established through interactions routines (Dyer and Singh 1998). Formal interaction practices between supply chain partners that focus on know-how related to collaborative planning is known to have resulted in the integration of information flows (Siemieniuch et al. 1999). The ability of an organization to create a shared language, interpretation, system of meaning, and narrative can be attributed to the extent to which inter-organizational interaction routines exist between a firm and its supply chain partners.

In summary, data consistency and relational interaction routines as forms of cognitive social capital provide
firms with access to resources and put them in a better position to create and manage integrated resource flows in their supply chains. Accordingly, we propose that:

\[ H_3: \text{Cognitive social capital of a focal firm, characterized as data consistency and relational interaction routines, has a positive association with supply chain integration.} \]

1.4 Supply Chain Integration

The Global Supply Chain Forum considers integration of key business processes from original suppliers through the final customer as a key aspect of SCM. Similarly, Simchi-Levi et al. (2000) consider SCM as a set of approaches deployed to effectively integrate suppliers, manufacturers, warehouses, and stores, so that goods are produced and distributed in the right quantities, to the right locations, and at the right time. This minimizes system-wide cost without compromising service level requirements. Both academic research and evidence from practice suggest that supply chain integration requires partners to share information (Simchi-Levi D. et al. 2000, Ho et al. 2002) and optimize the staging and flow of materials (Lee 2000). The APICS Dictionary, eleventh edition, defines a supply chain as a “global network used to deliver product and services from raw materials to end customers through an engineered flow of information, physical distribution and cash.” In summary, the extent of supply chain integration is indicated by the extent to which upstream and downstream flows between a firm and its supply chain partners of three key resources – information, goods, and finances -- are integrated.

In this study, we define supply chain integration as the degree to which a focal firm has integrated the flow of information and materials with its supply chain partners (Rai et al. 2006). As noted earlier, financial flows also occur in supply chains (Mabert and Venkatraman 1998). Given that the dominating concern in supply chains has been in managing material flows (Stevens 1990) and the attendant information flows (Lee et al. 1997), we limit our attention to these two flows. Moreover, Lee and Whang (2001) point out that the integration of financial flows is often contingent on having integrated information flows and therefore can potentially confound the integration of the two flows. Similarly, other researchers have discussed knowledge flows (Carlile 2002); since their definition mostly overlaps to include information flows, we do not consider them as a distinct flow in this study. In this study, we consider supply chain integration to comprise of two key resource flows: information flow integration and physical
flow integration.

**3.4.1 Information Flow Integration.** Researchers suggest that the content and process of information and knowledge sharing in supply chain networks can constitute key sources of firm value (Gulati and Singh 1998, Gulati and Garguilo 1999, Kogut 2000, Malhotra et al. 2005). Collaboration among network members requires significant information exchange and is underpinned by the nature of relational ties among them (Gulati and Garguilo 1999). Knowledge and information in a supply chain is physically and temporally distributed and makes information sharing critical to managing the extended enterprise. Sharing information with supply chain partners leads to reduced levels of inventory, minimized delays in the flow of goods, and better synchronization of supply with demand. Despite these benefits, supply chains have traditionally operated in an environment characterized by sparse information (Sinclair et al. 1995). There is often imperfect, missing, omitted, or incorrect information, which is often further impeded by the absence of compatible infrastructure for communication (Siemieniuch et al. 1999). Coordination costs can be higher due to a lack of information sharing (Clemons and Row 1992) and can be reduced by sharing inventory, production, and sales data along with planning and forecasting information across the supply chain. Benefits of such coordination through information flow integration take the form of reduced operating costs, improved productivity, asset efficiency, higher revenues, and improved customer relationships (Tyndall et al. 1998, Lee 2000).

Integrated information flows across the supply chain imply that information about events, stocks, flows, and outcomes is available to members of the supply chain network. Accordingly, we define information flow integration in this study as the extent to which operational, tactical, and strategic information are shared between a focal firm and its supply chain partners (Rai et al. 2006). Firms can share information about operations, tactics, and strategy with their supply chain partners. Sharing operational information can leverage the economies of scale and expertise across organizations (Seidmann and Sundarajan 1997). For example, inventory holding information, when shared, can reduce total inventory in the supply chain (Lee et al. 1997). Similarly, production and delivery schedules can be shared to enhance operational efficiencies through improved coordination of allocated resources, activities, and roles across the supply chain (Lee et al. 2000). Tactical information can include performance metrics associated with the execution of tasks and their outcomes that can be shared. From a strategic perspective, a key capability for a supply chain is the ability of an organization to sense supply and demand signals and orchestrate the supply chain to
implement firm and supply chain strategy.

3.4.2 Physical Flow Integration. A primary outcome sought by firms from their supply chains is better management of inventory: minimizing costs while ensuring high levels of fulfillment at various stages in the supply chain. Traditional supply chains are particularly susceptible to the bullwhip effect, where the divergence between supply and demand gets amplified upstream in the supply chain and lead to either excessive inventory or stock outs. Organizations embark on supply chain initiatives to manage their inventory in a more efficient and effective manner. Such initiatives include just-in-time delivery (Lowson et al. 1999), automatic replenishment, vendor managed inventory programs (Daugherty et al. 1999, Ellinger et al. 1999), and contract logistics providers for inventory management services (Richardson 1999, van Hoek 2000). Optimally staging inventory across the supply chain is another approach to improve inventory management in the supply chain (Arntzen et al. 1995, Vidal and Goetschalckx 2000).

Integration of physical flows of raw materials, sub-assemblies, and finished goods across the supply chain is central to effective fulfillment (Enslow 2000). Physical flow integration can be assessed by the ability of a focal firm to deliver the goods demanded by customers in an efficient and cost effective manner. Problems in physical flow integration can manifest themselves as low inventory turns that have a negative impact on cost structures and working capital efficiencies, or as stock outs that lead to lost revenues and margins. We define physical flow integration as the degree to which a focal firm uses global optimization with its supply chain partners to manage the stocking and flow of materials and finished goods (Rai et al. 2006). This includes both downstream and upstream flows where downstream flows consist of raw material, subassemblies and finished goods, and upstream flows consist of products that are returned or need to be repaired. In this study, multi-echelon optimization of costs, just in time deliveries, joint management of inventory with suppliers and logistics partners and configuration of the distribution network for optimal staging of inventory are considered as indicative of physical flow integration.

Efforts to improve the performance of supply chain have sought to integrate end-to-end processes among firms, their suppliers and customers (Tyndall et al. 1998, Lee 2000). Our discussion and review of prior work suggests that supply chain integration requires partners to: (1) share information at operational, tactical, and strategic levels (Simchi-Levi D. et al. 2000, Ho et al. 2002) and (2) adaptively optimize the staging and flow of physical goods
(Lee et al. 2000). Such integration of information and physical flows provide firms with distinctive capabilities that
distinguish them from their competitors and should result in superior firm performance. Accordingly, we propose that:

\[ H_4: \text{Supply chain integration of a focal firm, which is composed of information flow integration and physical} \]
\[ \text{flow integration, has a positive association with firm performance relative to its competitors.} \]

1.5 Firm Performance

Aggregate performance of the firm relative to competition is examined in terms of three critical aspects:
operational excellence, revenue growth, and customer relationships (Slywotzky et al. 2000, Rai et al. 2006).
Operations excellence is defined as a focal firm’s productivity and operational responsiveness to its customers,
relative to its competition. Firms need to execute their operational processes to balance responsiveness and
efficiency in order to generate profits and perform better than their competitors (Simchi-Levi D. et al. 2000). To
maintain relative market position and sustain profitability, revenue growth is considered to be another important facet
of firm performance. Revenue growth is considered in terms of revenues from existing products in new markets and
from new products (Zahra and George 2002).

As the cost of acquiring new customers continues to increase, firms need to focus on developing a stronger
bond with their customers. Customer relationships focus on the bond and loyalty between a focal firm and its
customers, and its knowledge of customer-related preferences as compared to its competitors. Thus, market-
focused performance (Malhotra et al. 2005) includes customer relationships (Groves and Valsamakis 1998) and
revenue growth (Kalwani and Naravandas 1995, Moorman 1995) in addition to excellence in operations. Although
the main focus here is on supply chain integration as a capability of the firm’s supply chain, we include aggregate firm
performance in our research model for nomological completeness as well as an additional validation check that
ascertains the causal logic underlying the research framework.

4. Research Methodology and Field Study

1.6 Instrument Development

A survey instrument to collect data was developed using guidelines and practices suggested in IS literature
(Straub 1989). As pre-existing validated measures were not available for many of the constructs used in the study,
multi-item measures were developed for those constructs by anchoring them in prior research, industry reports on digitally enabled supply chain initiatives, and discussions with several members in the practice community who are involved with the management of IT-enabled supply chain improvement initiatives. A list of measurement items was generated and evaluated to ensure face validity and for minimal overlap between constructs (Cronbach and Meehl 1955, Straub 1989).

A systematic process was used to validate the survey instrument. First, items were evaluated by each of the researchers independently and subsequently in joint meetings where each construct and its items were discussed until there was unanimous agreement on the construct scope and content. Next, experts in the field evaluated successive iterations of the survey instrument. Initially, two well-established researchers who had significant experience in survey research and had relevant domain expertise evaluated the draft instrument. After making appropriate changes, the first phase of the pilot test was conducted with nine faculty members who had teaching/research interest in SCM and IS. After incorporating their feedback, the next stage of the pilot test was conducted with ten supply chain and logistics managers in the greater Philadelphia region. Telephone and e-mail discussions were conducted with respondents to obtain clarifications and ensure that adjustments made to the instrument addressed their concerns. The process resulted in refinements such as modifying or deleting items and clarifying instructions. In all 21 different experts were involved in various phases of the instrument development.

Respondents were asked to anchor their responses with reference to the organization’s primary product(s) or product line(s), where primary product(s) or product line(s) were defined as those that account for a significant proportion of revenues (usually 15% to 20%, or greater). All items, except those associated with relative firm performance used a seven-item Likert-type scale where respondents were asked to state their agreement with a given statement on a scale that ranged from “strongly agree” to “strongly disagree” with its midpoint anchored as “neither agree nor disagree”.

Measures for firm performance, operational excellence, revenue growth, and customer relationships, were subjective assessments by respondents. A semantic comparison scale where respondents were asked to rate the performance of their organization in comparison to their competitors as “much better than average,” “better than average,” “same as competitors-average,” “slightly less than average” or “much less than average” was used. The
use of subjective assessments is common in organizational research, based on the premise that senior managers have access to information to form a reasonable assessment of organizational performance (Dess 1987, Powell 1992, Tallon and Kraemer 2007). Use of subjective measures is preferred when objective measures may not offer the level of specificity desired and differences in accounting conventions and practices can confound the comparison of publicly reported financial measures (Powell and Dent-Micallef 1997, Tallon and Kraemer 2007). Some performance measures, such as timeliness and knowledge about customers, do not have equivalent accounting-based performance measures rendering subjective measures as suitable alternative to objective measures (Wall et al. 2004). However, in order to examine the validity of the subjective measures of performance, we analyze the data for the presence of common-method bias.

1.7 Data Collection

We focus here on a focal firm’s social capital for a firm that is a member of the supply chain network for its primary product. Inferences about factors that are above the specific unit of analysis on which data is collected can be made as they provide the context for the phenomena (Capelli and Sherer 1991). In our study, utilizing the focal firm as our unit of analysis allows us to draw some inferences about the supply chain network as the supply chain serves since context for this study. Such contextualization allows us to use observations about a phenomena to inform hypothesis development, sampling, measurement, and data analysis, and report results that inform research and theory and form part of a larger whole (Rousseau and Fried 2001). Target respondents for this study were considered to be senior managers overseeing the supply chain management initiatives and/or operations of the firm. The sampling frame was drawn from a list of attendees of the Annual Meeting of Council of Supply Chain Professionals. Approximately 1800 names were randomly selected from the list a set of filters were applied to this narrowed list. We selected firms that belong to the manufacturing and retail sectors based on their SIC codes. Only one name from each organization was selected, based on the potential respondent’s title which was aligned with the profile of our target respondent. The process resulted in a list of 432 manufacturing and retail organizations.

The survey was first mailed via conventional mail; subsequently electronic communication was used to collect data. The survey was made available on a website which was known only to people on the targeted mailing list. After the first conventional mailing e-mail reminders were sent and provided respondents the option of receiving
another copy of the survey by regular mail or completing the survey online. At this stage a $10.00 gift certificate was offered as an incentive for completing the survey. After accounting for undelivered and invalid mailing addresses and incorrect e-mail addresses, the effective mailing was 360 surveys. We received a total of 110 combined responses via return mail, web and e-mail -- representing a response rate of 30.55%.

Collected data was tested for non-response bias using analysis of variance techniques. A comparison of the first and last quartiles of respondents was used to test for non-response bias, based on the premise that the last group of respondents was most likely to be similar in characteristics to non-respondents (Armstrong and Overton 1977). The two groups were compared on revenue, organization size, and other key study variables. The tests did not indicate any differences in variance across these variables. Similar comparisons were made across participants who responded by regular mail and those who completed the survey online. The analysis indicated that the two groups were statistically similar on all demographic and key study variables.

Organizations in the sample had an average revenue of 6.43 billion dollars (sd 11.23, n = 103) and an average of 19,930 employees (sd 40.54, n = 97). The median organization size was 4000 employees and the median organization revenue was 1.5 billion dollars. Forty-five percent of the respondents were from the logistics function, seventeen percent each from the supply chain and distribution functions, and thirteen percent had responsibility for IT pertaining to the supply chain. In addition, six percent specified that their direct responsibility focused on e-commerce and digitization to support the supply chain, and three percent belonged to the purchasing function. Collectively, survey respondents appear to hold positions that are well-aligned to the subject matter of our current investigation and are likely to be well-informed of their firm’s supply chain network and study variables.

1.8 Measurement Validation

We model structural, relational and cognitive social capital, as well as supply chain integration and firm performance as second order constructs. A combination of traditional psychometric techniques and second generation statistical methodologies are used to validate measures. Second generation statistical methodologies provide the ability to incorporate multiple dependent constructs, explicitly recognize error terms, and integrate theory with data. They also allow us to evaluate the measurement model along with the structural model among latent
constructs proposed in the theoretical model. We use partial least squares (PLS)\(^2\) for analyzing study data. The analytical approach is recommended for research where the emphasis is on theory development rather than confirmatory analysis (Joreskog and Wold 1982).

We analyzed the measurement properties of the first order constructs by factor analyzing items grouped under second order constructs (for example digitization, cross functional SCM application integration and relational asset specificity under structural social capital). The expected factor structure was obtained for all four second order constructs (Appendix A). We also performed an alternative analysis to assess the factor structure of first order constructs in our study. Karahanna et al. (1999) note that PLS does not directly support confirmatory factor analysis. Since PLS does not provide cross-loading information on other constructs, we used the procedure similar to the one described in Karahanna et al. (1999) and Smith et al. (1996) to evaluate the factor structure. First, a mean score for each construct’s item was computed and then each item was correlated against the mean score for each construct. For an indicator’s intended construct, this correlation represents its “loading” while its correlations with other constructs represent the “cross-loadings.” Appendix B shows each item’s correlation with its own construct and its correlation with other constructs. Each item’s correlation with its own construct should be greater than its cross-correlation with other constructs. Based on the above analysis, we observe that the indicator loadings on their respective constructs are higher than their cross-loadings on other constructs.

Latent constructs may be modeled as either reflective or formative in structural models (Chin 1998). Misspecification of constructs as formative, which by default tend to be specified as reflective, has been found to be common in both marketing research (Jarvis et al. 2003) and IS research (Petter et al. 2007). Jarvis et al. (2003) suggest that the decision to model a construct as formative or reflective should be based on four major criteria: (1) direction of causality from construct to its measures, (2) interchangeability of measures, (3) co-variation among measurement items, and (4) a nomological net of construct measures. For instance, in the case of construct specified as formative, measures are considered to ‘form’ as opposed to ‘reflect’ constructs, are not necessarily interchangeable, need not co-vary, and can be drawn from different nomological networks. The opposite conditions would apply in the case of constructs modeled as reflective. Using these criteria, all second order constructs are

\(^2\) The analysis was done using PLS Graph 3.0 from Soft Modeling Inc.
modeled as formative and all first order constructs, except long-term orientation, are specified as formative constructs. Although adequate measurement properties in terms of internal consistency, discriminant validity, and convergent validity have been shown for all first order constructs, measures for formative constructs are not necessarily required to satisfy such criteria (Jarvis et al. 2003).

A suggested criterion for assessing discriminant validity of constructs modeled as reflective is that the variance shared by a construct with its measures should be greater than the variance shared with other constructs in the model. The average variance extracted from the measurement items can be used to assess the variance shared between a construct and its measurement items (Fornell and Larcker 1981). The square root of the average variance extracted (AVE), which is interpreted in the same way as correlation, is compared to the correlation of the constructs with other constructs in the research model. A construct is considered to be distinct from other constructs if the square root of the AVE is greater that its correlation with other latent constructs (Barclay et al. 1995). Even though we are using formative measures, we conducted this analysis to evaluate if the associated indicators for a construct were more strongly associated with indicators of other constructs or not. Appendix C outlines the results of this analysis by providing evidence of discriminant validity and also gives descriptive data for the constructs.

Linear composite scores for each of the first order constructs were computed as described above, except for long-term orientation, which was modeled as reflective. Factor scores or multivariate means can be used to compute linear composite scores. Using summated mean values of items offers the advantage of being replicable across samples. It is the recommended approach when new measures are developed and transferability is desired (Hair et al. 1998). Rozeboom (1979) also notes that linear composite scores based on different weighting schemes are highly correlated when the items are internally consistent, which is true in our case. The linear composite scores based on a multivariate mean were used as indicators for the second order constructs in the structural model.

1.9 Assessing Common Method Bias

The study utilizes the key informant approach for data collection where perceptual responses from a single respondent are obtained for both dependent and independent variables in the study. This raises concerns that such data which is (1) largely based on perceptions of the respondents rather than actual states of various phenomena and (2) the use of a single respondent for both exogenous and endogenous constructs makes the analysis
susceptible to common method bias. To assess the susceptibility of our data to such bias, we evaluated the data using different techniques.

We subjected the data to Harmon’s single-factor test (Podsakoff and Organ 1986). All items used in the study were subjected to an exploratory factor analysis. The factor analysis produced 12 factors, each with an eigenvalue of 1.0 or greater. The first factor explained 23.4% of the variance in all the items. A similar analysis was conducted with only multivariate means of all second order constructs used in the study. The second factor analysis produced three factors where the first factor explained 35.3% of the variance in aggregated measures. In both analyses, a single factor did not explain most of the variance in the study data, which suggests that the data set may not be subject to common method bias.

Another approach to assess the vulnerability of study data to common method bias is to compare responses to objective data available from alternate sources. The survey asked respondents to report their organization’s revenues as part of demographic data. The data was then matched with revenue data from COMPUSTAT which was available for 57 organizations in our sample. Data for the rest of the sample were not available as they were not publicly traded firms, or because of incomplete data in the response. The correlation between the two sets of revenue figures was .92 (p = 0.00), which is evidence that respondents were well informed and knowledgeable about their firm’s performance.

Finally, different paths in the research models had different levels of significance, which further reduced concerns about common method bias. Collectively, the three different approaches for evaluating the potential susceptibility to common method bias -- the Harmon one factor test, correlation with independently reported data, and different levels of path significance -- suggest that common method bias is not a significant problem in the data set.

1.10 Results

The research model was analyzed using PLS, which provides coefficients for the paths among latent constructs as well as the variance explained in endogenous constructs. Where constructs are specified with formative measures, PLS calculates weights for each measure, and loadings for measures modeled as reflective constructs. As PLS does not directly provide significance tests and confidence interval estimates of path coefficients
in the research model, a bootstrapping technique was used. Bootstrap analysis was done with 500 sub-samples and path coefficients were re-estimated using each of these samples. The vector of parameter estimates was used to compute parameter means, standard errors, significance of path coefficients, indicator loadings, and indicator weights. This approach is consistent with recommended practices for estimating significance of path coefficients and indicator loadings (Löhmoeller 1984) and has been used in prior IS studies (Howell and Higgins 1990, Chin and Gopal 1995, Compeau and Higgins 1995, Rai et al. 2006).

Results of the analysis for the structural model shown in Figure 3 indicate support for the proposed research model. One indicator of the predictive power of path models is to examine the explained variance in endogenous variables or R^2 values (Barclay et al. 1995, Chin and Gopal 1995). The results indicate that the model explained 19.5% of the variance in firm performance and 52.6% in supply chain integration. The path coefficients from structural, relational and cognitive facets of social capital to supply chain integration were .24, .21 and .45 respectively; all of which are significant at p<.005 level and above. The path from supply chain integration to firm performance is also significant with a coefficient .45.

For constructs with formative measures, there are no minimum threshold values for weights but rather they are interpreted like beta coefficients in a standard regression model. Like regression coefficients, statistical significance of weights can be used to determine the relative importance of indicators in forming a latent construct. All first order constructs except customer relationship as an indicator of firm performance had significant weights on their respective second order latent constructs. Overall, we find strong support for the proposed research model.

1.11 Mediation Analysis

The primary phenomenon of interest in our research is the impact of social capital on supply chain capabilities, but implicit in our model is the proposition that the impact of social capital on firm performance is mediated by supply chain capabilities. We further examine if this effect of social capital on firm performance is fully mediated by supply chain capabilities or if some dimensions of social capital also have a direct impact on firm performance. This analysis is conducted using two complementary procedures (Hoyle and Kenny 1999, Subramani 2004), where we assess the additional variance explained by incorporating direct effects in our model and the
significance of mediation effects.

First, we compare nested models, where the fully mediated model as proposed is nested within one that proposes additional direct effects. Three alternative partially mediated models are compared to the fully mediated model where each of these nested models has one additional path from one of the social capital dimensions to firm performance. Thus, the fully mediated model is nested within each of the partially mediated models and can be compared statistically using PLS results (Chin et al. 2003, Subramani 2004). The $R^2$ for firm performance in the partially mediated models when direct effects from structural, relational and cognitive social capital are incorporated into the research model was 20.4%, 22.7% and 21.4% respectively (see Table 1). The fully mediated model in comparison, explained 19.5% of the variance in firm performance. In order to assess the additional variance explained by the partially mediated models, we examine incremental changes in $R^2$. The procedure is similar to the one used to test competing models in stepwise linear regression. The $f^2$ statistic, which is based on the difference in $R^2$ between two models is first computed and then used to compute a pseudo F statistic. Based on this procedure, the $f^2$ for each of the partially mediated models was .006, .032, and .018 with a pseudo F (1,105) statistic of .65, 3.33 and 1.97 respectively, and all of which are statistically insignificant. These results indicate that the additional variance explained by introducing direct paths from any of the social capital dimensions to firm performance does not significantly add to the variance explained in firm performance.

<Insert Table 1 about here>

A second, complementary mediation analysis examines the path coefficients and standard error of the direct path between the independent and mediating variables and the path between mediating and dependent variables. The magnitude of the mediation is computed as the product of path coefficients of individual paths and results in values of .110, .097, and .207 for the corresponding mediated paths from structural, relational and cognitive capital to firm performance (see Table 2). The standard error of the mediated path is computed based on the standardized path coefficients and standard error of the direct paths among the independent, mediating and dependent variables.

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3 The formula for computing $f^2$ is $(R^2_{partial~mediation} - R^2_{full~mediation})/(1 - R^2_{partial~mediation})$. The pseudo F statistic is computed using the formula $f^2 = (n-k-1)$, with 1, (n-k) degrees of freedom where n is the sample size and k is the number of constructs in the model.

4 An approximation for the standard error of the mediated path is computed using the formula $\sqrt{p_1^2s_1^2 + p_2^2s_2^2 + s_1^2s_2^2}$ where $p_1$ is the path coefficient of the path from iv $\rightarrow$ m and $p_2$ is the path coefficient from m $\rightarrow$ dv and $s_1$, $s_2$ are the corresponding standard deviations (Hoyle and Kenny 1999).
The significance of mediation is assessed using the z-statistic which are 2.64, 2.42 and 3.33 respectively for the mediated paths from structural, relational, and cognitive capital to firm performance -- all of which are significant at .05 level. The nested model analysis and the statistical significance of the magnitude of mediation provide additional support for the proposed research model and the mediation by supply chain integration on firm performance.

5. Discussion

Research on digitally-enabled supply chains has suggested that supply chain focused IT platform capabilities of a focal firm can be considered as lower order capabilities that support the creation of higher order supply chain capabilities (Rai et al. 2006). Similarly the nature of relationships between a firm and its supply chain partners plays a role in developing supply chain capabilities such as information flow integration (Patnayakuni et al. 2006). We integrate the different perspectives by positioning IT platform and relational capabilities as social capital that enables firms to leverage partner resources for supply chain capabilities. Investments in IT platform and relationships with supply chain partners have the key attributes of social capital in that they are mutually beneficial, allow partners unique access to resources and are appropriable. The empirical analysis and results support the thesis that such capabilities viewed as social capital provide the firm access to assets and resources to integrate supply chains, and that supply chain integration impacts firm performance.

We consider the structural, relational, and cognitive facets of social capital (Nahapiet and Ghoshal 1998) to examine a firm’s ability to develop supply chain capabilities. Traditionally, research based on social capital has placed considerable primacy on relational aspects over and above structural and cognitive aspects. In the context of supply chains, we argue that the nature of a firm’s IT platform with its supply chain partner, represents structural social capital and provides the firm with the opportunity and ability to access, leverage, and appropriate partner resources. We propose and find empirical support that digitization, cross functional SCM application systems integration, and relational asset specificity can be considered to represent structural social capital. Each of the three constructs had significant weights on the structural dimension of social capital. Thus, by investing and building a platform that enables a focal firm to execute supply chain processes digitally with its partners, it has access to information that it can use and appropriate to improve firm-partner flows of resources. Similarly, the integration of
applications and relationship-specific assets create structural capital in the firm-partner relationship that can provide the platform to improve and integrate supply chain processes. These capabilities allow a focal firm to execute processes and coordinate activities in a manner that is likely to result in efficient allocation of resources and, provide the firm and supply chain network partners with an advantage when competing in the marketplace.

Relational social capital describes the nature of relationships among network members and is developed over a period of time based on prior interactions (Nahapiet and Ghoshal 1998). In contrast to structural, this form of social capital has a behavioral connotation in terms of the impact it has on how members relate to each other. Attributes such as trust, trustworthiness, obligations, expectations and norms are considered to be reflective of relational social capital. Long-term orientation that permeates a firm’s relationship with its partner provides firms with capital that they can draw upon to manage their supply chains. The expectation of continuity coupled with a perspective that does not seek short-term expediency provides firms with advantages in governance, reduced uncertainty, and a platform for access to other resources such as information, market intelligence, and new product opportunities.

Nahapiet and Ghoshal (1998) contend that the cognitive dimension of social capital has perhaps received the least attention in research. This dimension refers to resources that enable shared representation and interpretation to create a system of meaning (Cicourel 1973). They are resident in shared codes and narratives. We propose that data consistency and relational interaction routines form cognitive social capital. Shared data definitions provide the platform to coordinate and execute supply chain processes in a seamless and integrated fashion. This is a necessary precursor to share information electronically, provide visibility across the supply chain, coordinate operational processes, and pursue broader collaboration. Similarly relational interaction routines form the basis for shared interpretation and understanding of supply chain activities. The shared knowledge resources recurrently created, exchanged, and integrated based on interaction routines represent the cognitive social capital available to the focal-firm.

Our research integrates alternate research streams using the social capital framework to provide an integrative approach for examining network resources at a more fundamental level. The three facets of social capital can be used to organize and examine key supply chain capabilities to provide a rationale for investing in firm-partner
IT and relational platforms. By going beyond the traditional emphasis on firm-partner relationships as precursor to improved supply chain performance we highlight the importance structural and cognitive aspects of supply chain networks. This provides a more comprehensive view of how we can model network resources that influence the development of supply chain capabilities.

1.12 Limitations and Future Research Directions

The study provides useful insights into supply chain integration and social capital as a resource that can be leveraged to enhance supply chain capabilities. The framework based on social capital theory and the attendant view of network as a resource points toward opportunities that have the potential for further investigation. The study is exploratory in nature and an effort to combine different streams of research and suggest new theoretical directions. There are numerous limitations to this effort. First, owing to the inherent complexities of analyzing networks as a whole, the unit of analysis of this study was a focal firm and not a supply chain network. However, by recognizing the supply chain network as the context in which the study has been conducted does allow us to interpret and extend our results to the supply chain (Capelli and Sherer 1991). Second, we examine aggregate supply chain capabilities and relational characteristics across the primary products for a focal firm. A primary drawback of this approach is that it results in aggregation across supply chains for products. Although a limitation, it allows us to focus on broader organization-level social capital and integration. Third, we focus on manufacturing and retail organizations and collected data from members of the Council of Supply Chain Professionals. Future studies should examine the constructs and relationships in other industrial sectors and from a broader representation of firms in the manufacturing and retail sectors. Fourth, in this study we have restricted our scope to selected IT and relational constructs. Variables such as structure of specific supply chains, number of tiers in the chain, types of supply chain applications, and types of business processes integrated, which have not been examined, should help us develop a better understanding of supply chain capabilities and collaborative behaviors in different contexts. For such an investigation, the unit of analysis will need to be a supply network and not a focal firm (Straub et al. 2004). Methodologically, the collection of perceptual data from a single source in respondent firms leaves the results susceptible to common method bias. Although we discuss the issues and the analysis to suggest that this should not be a concern for the present study, use of tangible and objective measures in future studies would be desirable.
There are undoubtedly numerous opportunities for further research in this area, especially in view of the current interest and an insufficient number of empirical investigations in this domain. We have explored a subset of potentially relevant constructs that have been theoretically positioned in a way that can provide insight and opportunities for further theoretical development. There are opportunities to look at other modes of building each of the facets of social capital as well as the potential to explore interrelationships among them. The use of a longitudinal approach to investigate supply chain practices would complement the insights drawn from variance-based research investigations, as done in the current study.

References

24-32.
Hult, G. T., D. J. Ketchen and S. F. Slater. 2004. Information processing, knowledge development, and strategic supply chain


Figure 1: Research Framework

Social Capital
- Structural
- Relational
- Cognitive

→ Supply Chain Integration Capabilities

→ Firm Performance

Figure 2: Research Model

Structural Dimension
- Digitization
- Application Integration
- Relational Asset Specificity

Relational Dimension
- Long Term Orientation

Cognitive Dimension
- Data Consistency
- Relational Interaction Routines

Supply Chain Integration
- Physical Flow Integration
- Information Flow Integration

Firm Performance
- Operational Excellence
- Revenue Growth
- Customer Relationships

Figure 3: Results of PLS Analysis

Structural Social Capital
- Digitization
- Relational Asset Specificity
- Cross-Functional Application Integration

Relational Social Capital
- LTO1
- LTO2
- LTO3

Cognitive Social Capital
- Data Consistency
- Relational Interaction Routines

Supply Chain Integration
- Information Flow Integration
- Physical Flow Integration

Organizational Performance
- R² = .526
- R² = .195

Customer Relationships
- H₁
- H₂
- H₃

Operational Excellence
- Revenue Growth
- M4

*** p < .001
** p < .005
* p < .05
### Table 1: Tests of Mediation – Nested Model Analysis

<table>
<thead>
<tr>
<th>Direct Path</th>
<th>Graphical Model</th>
<th>(R^2)</th>
<th>(f^2)</th>
<th>(\text{Psuedo } F)</th>
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<tbody>
<tr>
<td></td>
<td>Full Model</td>
<td>Nested Model</td>
<td>Value</td>
<td>(1, 105)</td>
</tr>
<tr>
<td>SSC-FP</td>
<td>(.14^*, t=.89)</td>
<td>(.204)</td>
<td>(.195)</td>
<td>(.006)</td>
</tr>
<tr>
<td>RSC-FP</td>
<td>(.22^*, t=1.41)</td>
<td>(.227)</td>
<td>(.195)</td>
<td>(.032)</td>
</tr>
<tr>
<td>CSC-FP</td>
<td>(.22^*, t=1.41)</td>
<td>(.214)</td>
<td>(.195)</td>
<td>(.018)</td>
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### Table 2: Tests of Mediation – Mediated Path Analysis

<table>
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<th>Graphical Model</th>
<th>Mediated Path Coefficient</th>
<th>Z Statistic</th>
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<td>(.110)</td>
<td>(2.64^*)</td>
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<tr>
<td>RSC-SCI-FP</td>
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<td>(.096)</td>
<td>(2.42^*)</td>
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<tr>
<td>CSC-SCI-FP</td>
<td></td>
<td>(.207)</td>
<td>(3.44^*)</td>
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### Appendix A: Measurement Properties of Constructs

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>Factor Structure and Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Digitization (DIG)</strong></td>
<td></td>
</tr>
<tr>
<td>DIG1</td>
<td>Number of product parts and materials procured through online trading exchanges and electronic catalogs.</td>
</tr>
<tr>
<td>DIG2</td>
<td>Proportion of INBOUND supply chain activities managed online (e.g. procurement, warehousing, payments).</td>
</tr>
<tr>
<td>DIG3</td>
<td>Proportion of INTRA-ORGANIZATION supply chain activities managed online (e.g. manufacturing, material requirement planning, product planning).</td>
</tr>
<tr>
<td>DIG4</td>
<td>Proportion of OUTBOUND supply chain activities managed online (e.g. orders received, billing, distribution, tracking).</td>
</tr>
<tr>
<td>DIG5</td>
<td>CUSTOMER SERVICE activities conducted online (e.g. answering questions, complaints, live chat).</td>
</tr>
<tr>
<td><strong>Cross Functional SCM Application Systems Integration (CAI)</strong></td>
<td></td>
</tr>
<tr>
<td>The following applications communicate in real-time:</td>
<td></td>
</tr>
<tr>
<td>CAI1</td>
<td>Supply chain planning applications (e.g., demand planning, transportation planning, manufacturing planning).</td>
</tr>
<tr>
<td>CAI2</td>
<td>Supply chain transaction applications (e.g., order management, procurement, manufacturing and distribution).</td>
</tr>
<tr>
<td>CAI3</td>
<td>Supply chain applications with internal applications of our organization (such as enterprise resource planning).</td>
</tr>
<tr>
<td>CAI4</td>
<td>Customer relationship applications with internal applications of our organization</td>
</tr>
<tr>
<td><strong>Relational Asset Specificity (RAS)</strong></td>
<td></td>
</tr>
<tr>
<td>RAS1</td>
<td>Partner tools and machinery are customized to our needs.</td>
</tr>
<tr>
<td>RAS2</td>
<td>Partners have dedicated significant investment and capacity to our relationship.</td>
</tr>
<tr>
<td>RAS3</td>
<td>Partner knowledge of our procedures, culture and technological know-how is difficult to replace.</td>
</tr>
<tr>
<td><strong>Average Variance Extracted</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>54.7%</td>
</tr>
<tr>
<td><strong>Cronbach’s Alpha/Composite Reliability</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.80/.83</td>
</tr>
<tr>
<td><strong>Relational Social Capital</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Long Term Orientation (LTO)</strong></td>
<td></td>
</tr>
<tr>
<td>LTO1</td>
<td>We have long-term relationships with our strategic partners.</td>
</tr>
<tr>
<td>LTO2</td>
<td>In key partner relationships, trust and goodwill will have the same,</td>
</tr>
<tr>
<td>Appendix A: Measurement Properties of Constructs</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td></td>
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</table>

### Measurement Items

<table>
<thead>
<tr>
<th>Factor Structure and Loadings</th>
</tr>
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<tbody>
<tr>
<td>or greater significance than formal contracts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LTO3</th>
<th>Both sides in the relationship do not make any demands that can hurt the relationship.</th>
<th>.745</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Average Variance Extracted</th>
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<table>
<thead>
<tr>
<th>Cronbach’s Alpha/Composite Reliability</th>
<th>.70/.76</th>
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### Cognitive Social Capital

<table>
<thead>
<tr>
<th>Data Consistency</th>
<th>Relational Interaction Routines</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Consistency (DC)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DC1</td>
<td>Automatic data capture systems are used (e.g., bar code) across the supply chain.</td>
</tr>
<tr>
<td>DC2</td>
<td>Definitions of key data elements (e.g., customer, order, part number) are common across the supply chain.</td>
</tr>
<tr>
<td>DC3</td>
<td>Same data (e.g., order status) stored in different databases across the supply chain is consistent.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relational Interaction Routines (RIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RIR1</td>
<td>We have created formal and informal arrangements for information exchange with our partners.</td>
</tr>
<tr>
<td>RIR2</td>
<td>Partners are involved in quality and improvement initiatives.</td>
</tr>
<tr>
<td>RIR3</td>
<td>We share best practices with our partners.</td>
</tr>
<tr>
<td>RIR4</td>
<td>We learn about new technologies and markets from our partners.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Variance Extracted</th>
<th>62.6%</th>
<th>71.6%</th>
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<thead>
<tr>
<th>Cronbach’s Alpha/Composite Reliability</th>
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<th>.88/.88</th>
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### Supply Chain Integration

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<thead>
<tr>
<th>Information Flow Integration</th>
<th>Physical Flow Integration</th>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information Flow Integration (IFI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IFI1</td>
<td>Production and delivery schedules are shared across the supply chain.</td>
</tr>
<tr>
<td>IFI2</td>
<td>Performance metrics are shared across the supply chain.</td>
</tr>
<tr>
<td>IFI3</td>
<td>Supply chain members collaborate in arriving at demand forecasts.</td>
</tr>
<tr>
<td>IFI4</td>
<td>Our downstream partners (e.g. distributors, wholesalers, retailers) share their actual sales data with us.</td>
</tr>
<tr>
<td>IFI5</td>
<td>Inventory data are visible at all steps across the supply chain.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Flow Integration (PFI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix A: Measurement Properties of Constructs

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>Factor Structure and Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PFI1</strong></td>
<td></td>
</tr>
<tr>
<td>PFI1: Inventory holdings are minimized across the supply chain.</td>
<td>.827</td>
</tr>
<tr>
<td>PFI2: Supply chain wide inventory is jointly managed with suppliers and logistics partners (e.g., UPS, FedEx).</td>
<td>.671</td>
</tr>
<tr>
<td>PFI3: Suppliers and logistics partners deliver products and materials just in time.</td>
<td>.733</td>
</tr>
<tr>
<td>PFI4: Distribution networks are configured to minimize total supply chain–wide inventory costs.</td>
<td>.671</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Variance Extracted</th>
<th>52.4%</th>
<th>53.0%</th>
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<tbody>
<tr>
<td>Cronbach’s Alpha/Composite Reliability</td>
<td>.81/.82</td>
<td>.69/.70</td>
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</tbody>
</table>

### Firm Performance

<table>
<thead>
<tr>
<th>Operational Excellence</th>
<th>Revenue Growth</th>
<th>Customer Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>OE1: Product delivery cycle time.</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>OE2: Timeliness of after sales service.</td>
<td>.81</td>
<td></td>
</tr>
<tr>
<td>OE3: Productivity improvements (e.g., assets, operating costs, labor costs).</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>RG1: Increasing sales of existing products.</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>RG2: Finding new revenue streams (e.g., new products, new markets).</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>CR1: Strong and continuous bond with customers.</td>
<td></td>
<td>.74</td>
</tr>
<tr>
<td>CR2: Precise knowledge of customer buying patterns.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Average Variance Extracted</th>
<th>57.1%</th>
<th>69.1%</th>
<th>70.0%</th>
</tr>
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<tbody>
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<td>Cronbach’s Alpha/Composite Reliability</td>
<td>.66/.80</td>
<td>NA/.82</td>
<td>NA/.82</td>
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</table>

**Notes**

a) Rotated factor solution based on principal component analysis with varimax rotation. All cross-loadings below .40 are suppressed.

b) Internal Consistency was calculated using Cronbach’s alpha and a measure of composite reliability proposed by Fornel and Larcker’s (1981) for assessing internal consistency of constructs in structural equation models using the formula \( \sum \frac{(\lambda_i)^2}{\lambda_i^2 + \sum Var(\varepsilon_i)} \) where \( Var(\varepsilon_i) = 1- \lambda y_i^2 \) and \( \lambda \) is the item loading and \( \varepsilon \) is the error. Cronbach’s alpha is not reported for two-item constructs.

c) Average variance extracted is calculated using the formula \( \sum \frac{\lambda_i^2}{\lambda_i^2 + \sum Var(\varepsilon_i)} \) where \( Var(\varepsilon_i) = 1- \lambda y_i^2 \) and \( \lambda \) is the item loading and \( \varepsilon \) is the error.
## Appendix B: Item-Construct Correlation

<table>
<thead>
<tr>
<th>Items</th>
<th>DIG</th>
<th>CAI</th>
<th>RAS</th>
<th>LTO</th>
<th>DC</th>
<th>RIR</th>
<th>IFI</th>
<th>PFI</th>
<th>OE</th>
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<tr>
<td>DIG1</td>
<td>.647</td>
<td>.224</td>
<td>.062</td>
<td>-.007</td>
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<td>.212</td>
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<td>.308</td>
<td>.245</td>
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<td>DIG3</td>
<td>.807</td>
<td>.318</td>
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<td>.143</td>
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<td>.201</td>
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### Appendix C: Assessment of Discriminant Validity

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