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The Role of Knowledge Management in the Relationship between IT Capability and Interorganizational Performance: An Empirical Investigation

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Abstract:

Knowledge management capability (KMC) represents an important link between IT and individual firm performance. We investigate this link in an interorganizational (IO) context—an increasingly important and yet substantially underresearched area. Based on reviewing and integrating the literature, we develop and test a comprehensive empirical conceptualization of KMC that includes knowledge creation, transfer, retention, and application. We collected survey data from supply management professionals at one partner firm (either customer or supplier) in an IO relationship. We tested our research hypotheses using structural equation modeling. We found that partner firms' KMC was positively associated with IO performance. We also found that IO information technology (IOIT) infrastructure capabilities facilitated KMC through the strength of IO relational capability. Partner interdependence was positively associated with IO relational capability and with KMC. Taking a knowledge management (KM) perspective, our research shows that IT requires relational capability and KMC to bring performance gains to IO partnerships. These insights have theoretical importance for understanding IT-enabled knowledge management in IO settings and practical significance for firms to effectively use their IOIT infrastructure.

Keywords: IT Capability, Knowledge Management Capability, Relational Capability, Interorganizational Performance, Knowledge Management Processes.

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1 Introduction

Single firms no longer solely contain the knowledge and information needed to deliver value to the end customers (Hult, Ketchen, & Slater, 2004). Firms that develop competency in managing knowledge resources across their supply chains achieve higher economic benefits (Dyer & Nobeoka, 2000; Van de Ven, 2005). In an interorganizational (IO) setting, each firm usually has competence in specialized knowledge domains and may share its knowledge with partners selectively based on its own competitive strategies (Gosain, Malhotra, & El Sawy, 2004). One can ascribe a major challenge in managing IO knowledge to the competing, and often conflicting, goals of firms in the partnership. Also, firms that form knowledge-based networks can be heterogeneous in terms of size, industry, and organizational structures and cultures. In addition, the networks themselves can be heterogeneous (Kogut 2000). Information and communication technologies have long played significant roles in enabling better interfirm relationships (Saraf, Langdon, & Gosain, 2007; Vaccaro, Parente, & Veloso, 2010). Institutional theory posits that firms adopt IOIT and, subsequently, assimilate the systems into their business routines to facilitate IO information exchange and knowledge management (Sodero, Rabinovich, & Sinha, 2013). By enabling digital access and knowledge sharing between partners, such interorganizational information technologies (IOIT) improve performance of interfirm relationships (Malhotra, Gosain, & El Sawy, 2007; Saraf et al. 2007). This view concurs with other research (based on resource-based view and dynamic capabilities perspective) (e.g., Sambamurthy, Bharadwaj, & Grover, 2003; Chae, Koh, & Prybutok, 2014) that questions the direct impact that information technologies (IT) have on performance and postulates that intermediate organizational capabilities mediate the relationship between IT and performance.

Prior literature has examined the impact that knowledge management has on performance and other IS literature has studied the impact that IT has on KM. However, we did not find studies that have integrated IT, KM, and performance into a single model. IS researchers have long posited that we could explain the relationship between IT and performance by investigating overlooked key mediating variables, such as IO learning (Iyengar, Sweeney, & Montealegre, 2015). We need an integrated model to address this gap in IS literature. Further, most studies in the literature have focused on single firms, and we lack understanding about how IT, KM, and performance relate to one another in IO partnerships. Note that the term “knowledge management” (KM) in our paper refers to partnering firms’ managing “business knowledge”, which includes collecting, organizing, synthesizing, and using business data, information, and insights. Finally, we also lack understanding about the role of partner interdependence, a critical factor in IO relationships (Hsu & Chang, 2014).

In our paper, we address the above research gaps and improve our understanding about the chain of relationships from IOIT to the partnership’s performance. Specifically, we address the following research questions (RQ):

RQ1: In an interorganizational setting, how do IT and knowledge management capabilities impact performance?

RQ2: In an interorganizational setting, what is impact does partner interdependence have on interorganizational IT, KM, and performance?

Our study contributes to the KM literature by extending the knowledge-based view to an IO setting. We empirically demonstrate that IOIT creates value for the partnership through improving IO relationships, which, in turn, strengthens IO KM. A stronger IO KM is associated with higher operational and strategic performance in the partnership. Prior research has identified the need to better understand the missing links between use of IT and firm or interfirm performance as a critical research gap. We show that IO relational capability and IO KM constitute important missing links that can explain the impact that IT has on performance. Further, while prior studies have investigated KM elements (e.g., knowledge sharing or learning), we use a more comprehensive empirical KM construct that includes creating, transferring, retaining, and applying knowledge. The significance of the relationship between KM capability and performance highlights knowledge’s theoretical and practical importance in IO settings. We also found that, with high interdependence between IO partners, the partner firms can achieve greater KM benefits by investing more in their relational capabilities, such as building trust and long-term orientation and fostering collaborative partnerships.

Our paper proceeds as follows. In Section 2, we review the related literature on KM and IT-enabled IO processes and, in particular, on the relational-view of IO systems. In Section 3, we present our research model and describe the constructs and the relationships between them. In Section 4, we discuss the data we collected and how we analyzed our model. In Section 5, we discuss our findings. Finally, in Section 6, we conclude the paper.

2 Theoretical Background and Research Hypotheses

We used literature from several research streams to ground our research: the knowledge-based view, relational view, and IO information systems. The knowledge-based view considers knowledge as an important strategic resource that helps firms to compete effectively (Alavi & Leidner, 2001; Tanriverdi, 2005). In interfirm alliances, the knowledge resources for competing as a partnership comes from the partner firms and knowledge access from the partners serves as a strong motivation for forming the alliance (Grant & Baden-Fuller, 2004). Researchers have identified key KM capabilities as knowledge creation (Alavi & Leidner, 2001; Cui, Griffith, & Tamer, 2005; Gold, Malhotra, & Segars, 2001; Lee & Choi, 2003; Nonaka, 1994; Sabherwal & Becerra-Fernandez, 2003; Sabherwal & Sabherwal, 2005), knowledge transfer (Alavi & Leidner, 2001; Tanriverdi, 2005), knowledge storage (Alavi & Leidner, 2001; Argote, McEvily, & Reagans, 2003), knowledge application (Cui et al., 2005; Gold et al., 2001; Tanriverdi, 2005), knowledge conversion (Cui et al., 2005; Gold et al., 2001), knowledge integration (Grant, 1996; Tanriverdi, 2005), and knowledge protection (Gold et al., 2001). Some studies have used the terms organizational learning (OL) and KM interchangeably when referring to these capabilities (Iyengar et al., 2015; Ryu, Kim, Chaudhury, & Rao, 2005). We adopt the way in which King (2009) conceptualizes OL and KM since it acknowledges this overlapping meaning of OL and KM and views learning and the resulting improvements in decision making and performance as KM's goals. In this paper, we focus on the impact that these KM capabilities (KMC) have on inter-organizational performance.

Argote et al. (2003) suggest that KM research should study organizations' knowledge activities as three outcomes: outcomes of knowledge creation, knowledge transfer, and knowledge retention. Alavi and Leidner's (2001) framework for organizational KM suggests four socially enacted and interconnected knowledge processes: knowledge creation, knowledge storage/retrieval, knowledge transfer, and knowledge application. Tanriverdi (2005) confirmed the importance of these four processes in developing cross-unit synergies in multi-unit firms. In an IO context, Grant and Baden-Fuller (2004) argue that the desire to access partner knowledge rather than to acquire the knowledge outright primarily motivates knowledge-based alliances. We believe that the KM processes (i.e., creation, transfer, retention, and application) apply to IO partnerships and, therefore, conceptualize KMC in terms of these processes.

Information systems facilitate KM in single-firm and multi-firm contexts. The literature proposes that KM systems (supported by information systems) facilitate organizational learning by enabling firms to store and disseminate knowledge (Iyengar et al., 2015). Nonaka and Konno (1998) proposed the concept of "Ba", which refers to the environment and context that promotes knowledge conversion. "Cyber Ba" refers to using IT to promote knowledge creation. Cyber Ba is most critical when multiple groups in an organization and/or multiple organizations in an alliance combine explicit knowledge to create new knowledge (Feurst & Soderling, 2017). Tippins and Sohi (2003) propose three ways in which IT enables organizational learning: 1) by accelerating the speed at which firms acquire and disseminate information or knowledge, 2) by allowing individuals to share how they interpret information and knowledge, and 3) by serving as a mechanism for storing and retrieving knowledge. Iyengar et al. (2015) show that IT use impacts financial performance by improving knowledge transfer effectiveness and absorptive capacity, which refers to the ability to recognize, assimilate, and apply knowledge. They further suggest that one can use their IT-based learning and performance framework in a supply-chain context to examine how collaborative IT use between supply-chain partners can lead to knowledge sharing and supply chain agility and, thus, impact relationship performance. Using IT for managing interfirm knowledge can create a knowledge base for individuals and groups of different organizations to store and share important knowledge and facilitate knowledge transfer between the partner firms (Alvarez, Marin, & Fonfria, 2009; Tanriverdi, 2006; Vaccaro et al. 2010). IT support helps firms in the upstream and downstream parts of supply chains share knowledge (Shih, Hsu, Zhu, & Balasubramanian, 2012). KM systems, such as knowledge portals, constitute valuable tools that support knowledge storage and retrieval, knowledge transfer, and knowledge integration (Loebbecke & Crowston, 2012; Park, Stylianou, & Subramaniam, & Niu, 2015). Thus, the literature has found significant evidence that IT facilitates KM in IO settings.

The relational view extends the resource-based view and studies the source of strategic advantage in an interfirm relationship. The relational view suggests that the competitive advantages of a pair or network of firms stem from the idiosyncratic interfirm linkages. These linkages fall into four categories: relation-specific assets, interfirm knowledge sharing routines, complementary resources and effective governance mechanism (i.e., establishing goodwill and trust between partners) (Dyer & Singh, 1998). The relational view concurs with information systems (IS) researchers' arguments that a pair of firms represents an important unit of analysis and, therefore, that it deserves more attention (Straub & Watson, 2001). Studies using the relational view suggest that operational and strategic gains in the value chain can occur when trading partners willingly make relation-specific investments and combine resources in unique ways (Im & Rai, 2014; Patnayakuni, Rai, & Seth, 2006; Rai et al. 2012; Rai & Tang, 2010; Subramani 2004).

In summary, the IS and KM literatures have examined the impact that IT has on KM and that KM has on performance. However, few studies have included IT, KM, and performance together in a single model. Further, most studies in the literature have focused on a single firm, and we lack understanding about how IT, KM and performance relate to one another in IO partnerships. Our paper addresses this important research gap by modeling the impacts of both IO IT infrastructure and IT-enabled relational capabilities on IO KM. With increasing pressure on organizations to maximize the value from their partnerships using technology, a systematic understanding about the relationships among IT, KM, and performance has practical and theoretical significance.

We present our research model in Figure 1. In Sections 2.1 to 2.7, we discuss the model constructs and the relationships among them and present our hypotheses. We begin by discussing IO KMC, a key concept in our model.

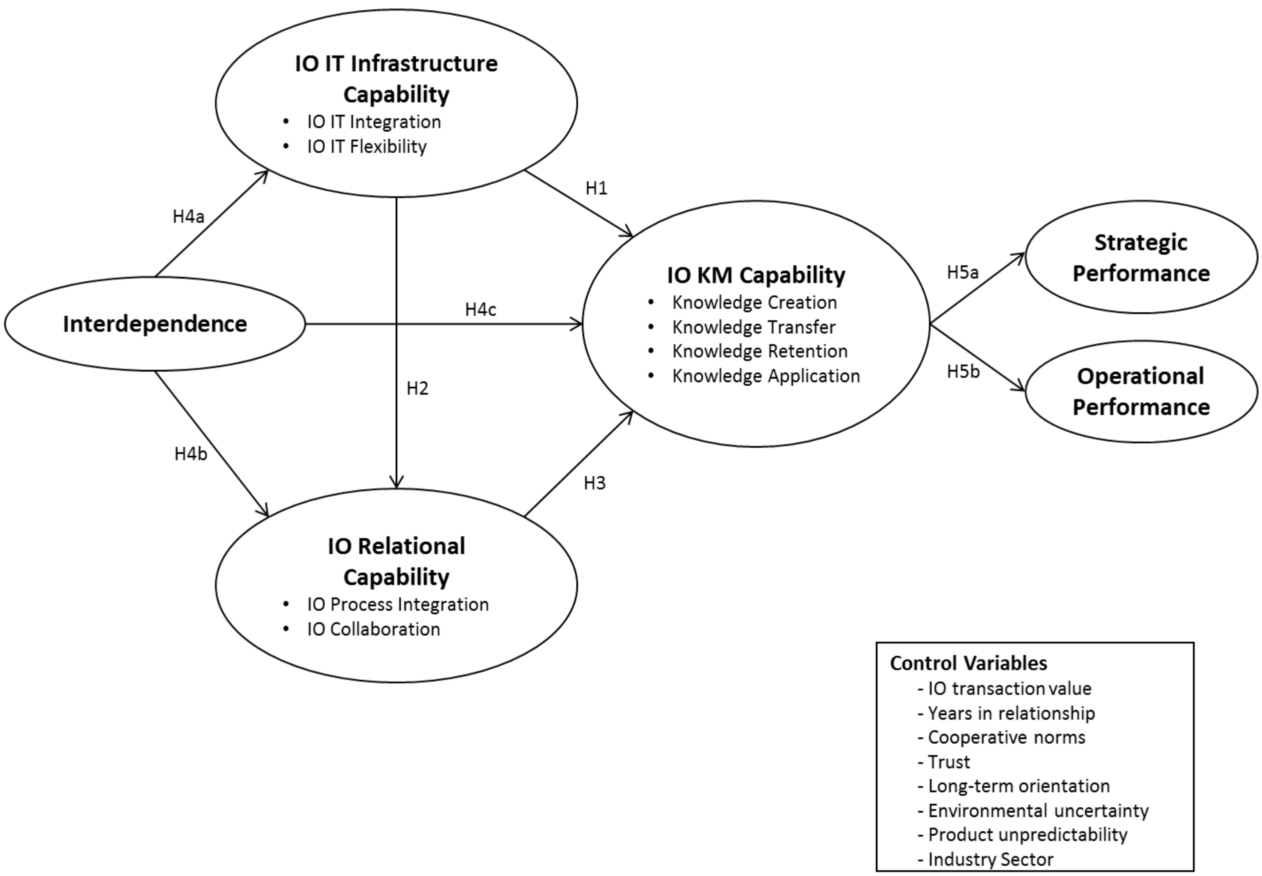

Figure 1. Research Model

2.1 Interorganizational Knowledge Management Capability

Knowledge management capability (KMC) refers to a firm's ability to create, share, retain, and apply related knowledge across its business units (Alavi & Leidner, 2001; Tanriverdi, 2005). In an IO context, KMC refers to the ability of the firms in the relationship to collectively create, share, retain, and apply their joint knowledge to their products, markets, and processes. Unlike learning in a single firm, IO learning leads to knowledge that firms in a specific partnership context develop and that benefits and resides in the partnership (Dyer & Nobeoka, 2000). Individual member firms may use the knowledge stored at the partnership level to improve their internal processes, but the KM happens primarily due to the partner firms' cooperative participation rather than firm dictates. As a result, IO learning brings many issues to the fore, such as partner firm incentives for contributions, free-rider problems, and effective mechanisms for distributing the resulting benefits between the participating firms (Dyer & Nobeoka, 2000).

To understand the impacts and antecedents of IO KMC, we use the process-perspective of KM that Alavi and Leidner (2001) developed. The process perspective of KM has its foundations in the sociology of knowledge and the view of organizations as "social collectives" in managing knowledge. The process view has four sets of socially enacted "knowledge processes": creating or constructing knowledge, transferring knowledge, retaining or storing knowledge, and applying knowledge (Pentland, 1995). The literature has discussed these four processes extensively from the perspective of a single firm. These processes also pertain to an IO KM context but involve considerably more challenge due to the conflicting goals and objectives of the firms in the IO relationship. Further, note that IO KM processes represent an interconnected and intertwined set of activities. IT provides the systems to link the sources of knowledge and enable firms to easily transfer and share the knowledge (Alavi & Leidner, 2001). In addition, the IO KMC emphasizes the partnering firms' *collective* capability and not just a single firm's ability to engage in KM processes.

Knowledge creation involves developing new content or replacing existing content in the organization's knowledge domain (Pentland, 1995). An organization creates knowledge through socialization, externalization, internalization, and combination (Nonaka, 1994). Socialization occurs via social interactions and sharing among employees in the interfirm relationship. Individuals can also create new knowledge by drawing insights from the interfirm sources (internalization) and coding the new knowledge into an explicit form (externalization). The combination mode creates new knowledge by merging, categorizing, reclassifying, and synthesizing information and knowledge currently located at the different partner firms. *Knowledge transfer* (or *sharing*) occurs when partnering firms share insights and know-how about the IO environment in which they operate, which allows them to realize and use each other's resources and capabilities. Effective transfer of information and knowledge between partners in a dyad elevates managers' cognitive processing abilities from the limitations of bounded rationality into expert rationality (Uzzi, 1997). Alavi and Leidner (2001) use the term "knowledge storage" to describe the *knowledge-retention* process, which constitutes an important aspect of KM. In interfirm relationships that lack the proper mechanisms to organize and retain the knowledge, partnering firms may lose valuable lessons about processes and markets or find them too costly to locate. Knowledge stored in both human minds and technology artifacts can also allow partnering firms to draw inferences from current business operations. Knowledge application (or leveraging) represents an important process to convert knowledge into a source of competitive advantage. Firms should convert the knowledge they create or share in interfirm relationships into directives, routines, and task teams (Grant, 1996). Grant (1996) discusses the importance of organizational structure and incentives in enabling knowledge application. Similarly, in the IO context, knowledge application would also involve evaluating the IO relationships and modifying the underlying structures and incentives (e.g., adding a grants program for joint product patents).

IO KMC refers to the joint capability of the firms in a partnership to effectively create, share, retain, and apply the collective knowledge as it relates to their joint products, customers, and processes. To manage and enhance IO KM, firms can use several human-intensive coordination mechanisms, such as liaison groups and interfirm task forces. However, these mechanisms have limitations in their information-processing and -coordination capabilities and can attract considerable costs to maintain (Tanriverdi, 2005). The information processing theory of the firm views IT's primary role as a superior coordination mechanism, which research on IO systems supports (Rai, Patnayakuni, & Seth, 2006, Saraf et al., 2007).

2.2 Interorganizational IT Infrastructure and Knowledge Management Capability

The IOS literature has identified IOIT infrastructure and IT-enabled IO relationship management as two IT-driven core capabilities that impact the IO KM (Davison, Ou, & Martinsons, 2013; Mao, Liu, Zhand, & Deng, 2016; Rai et al., 2006; Saraf et al., 2007; Zahra & George, 2002). In this section, we focus on IOIT infrastructure capabilities. Integration and flexibility constitute two dimensions of an IOIT system (Rai et al., 2006; Saraf et al., 2007). IOIT integration indicates the extent to which partnering firms' information systems consistently and in real time transfer valuable business information across firm boundaries (Rai et al., 2006). Table 1 summarizes the constructs of IOIT infrastructure capabilities that research has studied and how those constructs map to the dimensions of IOIT infrastructure capability that we propose in this study.

Table 1. IOIT Infrastructure Capability that Prior IS Research has Studied

IOIT infrastructure capability	Constructs from the literature	References	Description
IOIT integration	EDI integration	Truman (2000)	Two facets of integration in EDI environment: integration between EDI and internal systems and integration among internal systems.
	EDI embeddedness	Chatfield & Yetton (2000)	Measured by joint strategic actions and EDI integration with internal systems.
	System integration	Barua, Konana, Whinston, & Yin (2004)	Information visibility throughout the chain.
	IT infrastructure integration	Rai et al. (2006)	Consistent and high velocity transfer of SC information.
	IS integration	Saraf et al. (2007)	IS applications working as a functional whole.
IOIT flexibility	IS flexibility	Saraf et al. (2007)	IS applications adapting to changes.

In a well-integrated IOIT environment, information and knowledge automatically flow between the two trading partners, and the firms have less need for personnel to decipher or translate the exchanged information and knowledge. The collaborating firms configure IO systems to exchange and process information and explicit knowledge in a timely manner between them (Dong, Fang, & Straub, 2017). These IO systems can share the collaborative knowledge across various business functions. The IO systems then free human capital from mundane operational issues and let them focus on the tacit and more valuable knowledge exchange (Malhotra et al., 2007). IT benefits IO learning by enabling firms to transfer tacit and explicit knowledge (Kane & Alavi, 2007). Further, the design and deployment processes that precede the integrated transactions enable both firms to customize the knowledge that they exchange according to their needs (Malhotra, Gosain, & El Sawy, 2005). The customized knowledge flow can eliminate information overload on the firms and enhance their absorptive capacity in assimilating new and useful knowledge. Lastly, consistent and real-time information flows channel the information and knowledge scattered in disparate information systems. Dyer and Singh (1998) point out that the difficulty in searching for knowledge hinders firms from transferring it between them. Trading partners can more easily search for the information or knowledge they need when they have well-integrated systems. Prior studies have used institutional theory and posited that firms adopt IO systems and assimilate them into their operational routines to facilitate IO partners exchange information and knowledge (Liu, Ke, Wei, Gu, & Chen, 2010; Sodero et al., 2013).

IT flexibility indicates the partner firms' ability to reconfigure their information systems to quickly adapt to the changing environment. IT embeds the knowledge that manifests in organizational routines and organizational culture. Rapidly changing market demands make it increasingly difficult for IO partners to understand the complex environment in which they operate and, thus, poses a serious threat to their ability to assimilate new knowledge that comes from external sources. A standardized and inflexible IOIT may lead partner firms to fit incoming data into pre-existing schemas and potentially missing important market signals that could reduce their capability to share important knowledge (Dong et al., 2017). When partnering firms configure their information systems to respond to new business, they will infuse new information into the relationship, which will provide fresh perspectives and increasing opportunities to create new knowledge. When the need arises, IOIT flexibility offers the necessary capability to dynamically adjust process interfaces and content structures so that it is easier for the partner firms to share a broad range of knowledge from diverse business domains (Dong et al., 2017). Flexible IOIT can ensure a continuous flow of knowledge between the partners even when disruptions due to unstable or new market conditions arise. Flexible IOIT also frees IO personnel from onerously reconfiguring existing electronic linkages so that they will have more time and resources to exchange value-added tacit knowledge related to the partnership. Deploying flexible IT in the form of standard business interfaces between supply chain partners reduces lock-in concerns. The flexibility encourages them to share rich and valuable proprietary information without worrying that their partners will use it against them (Malhotra et al., 2007). A highly adaptable IO system increases the quality of knowledge codification (Dong et al., 2017). A flexible IT infrastructure also makes it easier for an organization to update its IT so that it can apply new knowledge (Alavi & Leidner, 2001).

Accordingly, we expect to find a positive association between IOIT infrastructure capability and IO KMC. Thus, we propose the following hypothesis:

> **H1:** Interorganizational IT infrastructure capability is positively associated with interorganizational KM capability.

2.3 Interorganizational IT Infrastructure and Interorganizational Relational Capability

According to the relational view of the firm, when partner firms can combine resources in the IO relationship in unique ways, the buyer-seller relationship generates relational rents. These rents, in turn, can provide the participating firms a source of competitive advantage over those who are not willing to or cannot mobilize their interfirm resources (Dyer & Singh, 1998). According to the relational view, *relational capability* refers to partnering firms' ability to collectively mobilize, deploy, and combine complementary relation-specific resources that each firm brings to bear. The relation-specific resources that each firm contributes may include human expertise, operational processes, organizational routines, and information. IT provides the "capability to help augment firms' social capital" (Joshi, Chi, Datta, & Han, 2010). Firms can greatly increase their IO relational capabilities by using IT. Relation-specific assets, such as physical sites, processes, and human expertise, are the resources with which firms can create relational rent (Dyer & Singh, 1998). Electronic collaboration that IT supports can facilitate cross-firm socialization, which knowledge integration requires (Joshi et al., 2010). A well-integrated IOIT infrastructure allows partner firms' functional applications to transfer consistent data (Barua et al., 2004; Markus, 2000; Rai et al., 2006; Saraf et al. 2007). To integrate their IT infrastructures, partner firms need to become involved in joint planning activities, such as understanding each other's business processes, mapping data elements, and investing in shared resources (Im & Rai, 2014; Rai & Tang, 2010). These interactions form a bond between the two firms (Malhotra et al. 2007), which increases their relational embeddedness (Granovetter, 1973). Relational embeddedness indicates the degree of reciprocity and closeness among actors. A high degree of relational embeddedness displays high levels of cooperation between firms and promotes a knowledge-oriented working environment between them (Rindfleisch & Moorman, 2001; Uzzi, 1997). In our study, we focus on the two dimensions that form the relational capabilities: 1) building of relation-specific processes by IO process integration and 2) combining complementary expertise through IO collaboration (Rai et al., 2006).

IO process integration refers to the degree to which a firm designs its key IO processes to accommodate the idiosyncrasies of its partner firm's business processes (Rai et al., 2006; Saraf et al., 2007). Partners' relational focus drives IO process integration (Dyer & Singh, 1998). In an integrated environment, the decision outcomes that result from one step can directly feed into the next step so that the activities connect as a seamless whole without interruption or intervention. The integrated process capability manifests in better coordinated interfirm activities in which joint actions and quickly resolved exceptions represent the norm (Robicheaux & Coleman, 1994). The tightly integrated processes can also greatly reduce transaction costs in the partnership (Goldhar & Lei, 1991).

IO collaboration provides partnering firms an opportunity to explore and use complementary resources across firm boundaries. Some researchers use the term "collaboration" to mean working together (Scott, 2000) while others refer to specific collaborative programs such as collaborative planning, forecasting, and replenishment (CPFR). While some researchers view the term collaboration as having a neutral connotation, others suggest that a collaborative relationship should be cooperative rather than adversarial (Lamming, Johnsen, Zheng, & Harland, 2000). In our study, we view IO collaboration more broadly as the degree to which partner firms jointly carry out business activities related to them (Bensaou, 1997). Collaboration can occur at the operational decision-making level, such as in business forecasting (Shah, Goldstein, & Ward, 2002); the tactical decision-making level, such as in process engineering (Bensaou, 1997); and the strategic decision-making level, such as in product design and development (Holmqvist, 2004; Sheth & Shah 2003).

The IOIT infrastructure capabilities constitute important drivers of partner firms' relational capabilities (Im & Rai, 2014; Rai, Pavlou, Im, & Du, 2012). The IOIT integration capability can enhance the firms' ability to achieve tightly integrated business processes. Common data definitions for key data fields provide a seamless semantic platform to support the coordination between firms. Integrated applications allow one to enter the data into a system only once and to populate it in other system functions. Integrated IOIT environments allow partner firms to develop a global optimization (Rai et al., 2006). By integrating IOIT applications with their backend enterprise applications, such as ERP and CRM, partner firms can coordinate external processes with their internal ones (Rai et al., 2006). Flexible IOIT enhances partnering firms' ability to configure their information systems to adapt to the idiosyncrasies of their business partner's processes, which can increase the firms' ability to interconnect processes across the chain. Finally, the electronic connectivity that IOIT infrastructure affords allows many employees working on related functions to participate in interconnected business processes.

Prior literature suggests that electronic data interchange (Bensaou, 1997) and information systems that support monitoring, modeling, and collaborative activities between partner firms can foster IO collaboration (Rai & Tang, 2010; Scott, 2000). One challenge that a firm faces in identifying potential collaborative opportunities with its partner involves the difficulty in acquiring accurate information about it (Dyer & Singh, 1998). Better information exchange due to IT integration provides opportunities for firms to identify the resources or capabilities in their partner firms that may have the potential for collaboration. Moreover, electronically integrated documents, such as prototype designs and product specifications, can facilitate collaboration among firms (Scott 2000). Collaborative efforts require frequent changes to information and knowledge flows to respond to new business needs. In this scenario, flexible IOIT infrastructure can positively impact the collaboration between firms. Hence, we hypothesize:

> **H2:** Interorganizational IT infrastructure capability is positively associated with interorganizational relational capability.

2.4 Interorganizational Relational Capability and Interorganizational Knowledge Management Capability

IO process integration improves the visibility of business processes, which, in turn, helps employees in the partnering firms to easily understand and execute IO tasks. When the employees' tacit knowledge about the IO processes (in the form of experience and familiarity with the relationships (accumulates, employees can more easily identify problems in the processes (Hult et al., 2004). Further, this knowledge can help employees reduce transaction costs in terms of coordination efforts and ensure they do not duplicate outputs as much. In such an environment, employees no longer need to perform the routines that keep the processes moving and can shift their focus to resolving knowledge-intensive problems and uncovering new ways of doing business. With the integrated IO processes, employees in different functions have a shared understanding, which, in turn, ensures they consistently interpret the needs of the business processes. In other words, they have a common ground for interpreting the IO activities in terms of the goals, the execution of information and knowledge flows, and the expected outcomes for given decision inputs. The overarching meanings and interests provide a nurturing platform for greater knowledge transfer between the firms (Zahra & George, 2002).

IO collaboration between two partnering firms allows access to complementary resources and specialized knowledge from each other. Interfirm collaboration can enhance interfirm learning by introducing new knowledge and a diversity of ideas into the relationship. Prior literature indicates that interfirm partners who engage in collaborative activities such as new product development, inventory management, and demand forecasts have a better business relationship and can create more useful knowledge (Lorenzoni & Lipparini, 1999; Scott, 2000). Nonaka's (1994) knowledge-creation theory highlights the importance of human interactions and collaboration in providing a promising arena for firms to exchange ideas and, thus, learn from each other. Maintaining synergies in the relationship becomes an important motivational factor that encourages partner firms to share knowledge with each other and to actively contribute to accumulating new knowledge. Knowledge creation and sharing are social processes, and, hence, partner firms need to develop IO relationships for IO KM (Panteli & Sockalingam, 2005). MacDuffie and Helper (1997) showed that tight collaborations between Honda and its suppliers helped IO learning and resulted in economic benefits for both. Hence, we hypothesize:

> **H3:** Interorganizational relational capability is positively associated with interorganizational KM capability.

2.5 The Effects of Interdependence on Interorganizational Capabilities

Social exchange theory helps to explain how the outcomes of actions that one firm in an IO relationship takes depend on certain aspects of the relationship, such as partner interdependence (Dwyer, Schurr, & Oh, 1987; Frazier, 1983). Partner interdependence reflects the extent to which the partnering firms rely on each other for resources and services. This interdependence is a critical determinant of partners' attitudes, such as trust, commitment, conflict, and long-term orientation, in IO relationships (Ganesan, 1994; Ibbott & O'Keefe, 2004; Hsu & Chang, 2014; Kumar, Scheer, & Steenkamp, 1995). A higher level of interdependence leads to mutual empathy; a focus on joint success; a convergence of values, attitudes, and goals; less conflict; avoidance of unnecessary costs; and superior value creation (MacDuffie & Helper 1997). When firms have low interdependence, they also have low commitment between them (Kumar et al., 1995, Palmatier, Dant, & Grewal, 2007), and the interfirm relationship tends to lack long-term orientation (Ganesan 1994). The business relationship focuses more on transactional exchanges rather than higher-order collaborative partnership building, such as creating long-term IOIT infrastructure, relational, and KM capabilities. In such transactional relationships, IOIT primarily facilitates day-to-day business transactions.

Interdependence also has a positive effect on performance, and improved capabilities that result from relationship-specific investments and cooperation mediate this effect (Scheer, Miao, & Palmatier, 2015). In our study, we focus not on the investments themselves but in the resulting capabilities, which two separate constructs capture: IT infrastructure capability and relational capability. Greater interdependence promotes higher relationship-specific investments, which strengthens these capabilities. The quality of information and knowledge exchange also mediates the relationship between interdependence and performance (MacDuffie & Helper, 1997). In our study, information exchange is one of the four aspects of the KMC construct.

Therefore, we can expect high interdependence between IO partners to result in a higher focus and investment on their IOIT infrastructure, relational, and KM capabilities. Hence, we hypothesize:

H4a: Partner interdependence is positively associated with interorganizational IT infrastructure capability.

H4b: Partner interdependence is positively associated with interorganizational relational capability.

H4c: Partner interdependence is positively associated with interorganizational KM capability.

2.6 Knowledge Management Capability and Performance Impacts

Researchers have recognized knowledge management capability as a key factor in improving organizational operational and financial performance (Lee & Choi, 2003; Tanriverdi, 2005; Teo & Bhattacherjee, 2014), contributing to firm innovation (Joshi et al., 2010), and achieving firm-level competitive advantage (Cheung, Myers, & Mentzer, 2010; Grant, 1996; Kogut & Zander, 1992; Mao et al., 2016; Teece, Pisano, & Shuen, 1997; Tippins & Sohi, 2003). Both firm-level and IO competitive success requires the ability to continually learn, adapt, and upgrade knowledge capabilities (Ibrahim, Ribbers, & Bettonvi, 2012; Teece et al., 1997). Kim, Mukhopadhyay, and Kraut (2016) found that using KM systems substantially positively impacts managers' performance and that the impact increases with rich sources of knowledge and in environments that require a greater volume of knowledge (perhaps as in IO settings). In an IO setting, new knowledge about the shared processes enables firms to adopt new ways to coordinate and to improve operational efficiency and customer satisfaction. New product knowledge created in the collaborative effort improves the overall product innovation rates in both partner firms and shrinks time to market. Understanding the market and customer preferences in new ways helps the firms adjust their resources to meet market demand more efficiently and effectively. Although competitive success requires organizational learning, we do not fully understand the relationship in the IO context (Dyer & Singh, 1998; Powell, Koput, & Smith-Doerr, 1996). Further, despite considerable theoretical discussions, little research has investigated the impact that IO KM has on partnership performance (Dyer & Nobeoka, 2000).

By sharing technical know-how, interfirm partners improve each other's production technologies and increase their productivity (e.g., as in Toyota's network as Dyer and Nobeoka (2000) show). Further, interfirm partners need to share such know-how to fulfill their common goals and sustain a competitive advantage (Panteli & Sockalingam, 2005; also see Barney & Hansen, 1994). For example, a manufacturer can transfer knowledge about market forecasting to its supplier, and the supplier can improve its own capability to devise production plans that reduce backorders, which benefits both firms in the partnership. Finally, by transferring process knowledge between them, partner firms create an effective feedback loop that allows them to constantly refine their internal and IO processes to accommodate each other's needs and remove bottlenecks. Partners in dyads with highly detailed and accurate information transfer may gain a competitive edge by elevating their cognitive capacities and information-processing abilities (Uzzi, 1997). Saraf et al. (2007) found that a business unit's knowledge sharing with its distribution channel partners greatly improves the business unit's performance. Similarly, Dyer and Nobeoka (2000) found that the ability to transfer knowledge on Toyota's supply network significantly differentiated Toyota from its competitors on operational efficiency and innovation. The new insights obtained due to the knowledge-sharing in a dyad allow the partner firms to benefit strategically. For example, business volume between a supplier and a customer can increase if the supplier offers discounted orders in a certain stage of the product lifecycle based on the suppliers' familiarity with previous transactions with the partnering firm. Consequently, past knowledge about the products, processes, and market environments serve as buffers to allow the IO relationship to weather market turbulence more effectively.

In an IO context, several studies have recognized the implications of the ability of a network of firms to manage knowledge on the network's performance (Dyer & Nobeoka, 2000; El Sawy, Malhotra, Gosain, & Young, 1999; Lorenzoni & Lipparini, 1999). These studies have shown that KMC impacts both the short-term efficiency and long-term strategic gain of such partnerships. Ghobakhloo and Hong (2015) found that firms obtain such performance gains across a given supply network when they use technical and human resources (modeled here as IOIT infrastructure and relational capabilities) to achieve collaborative KM. In order to understand the differential impact that KMC has on short-term and long-term performance, we study the impact that it has on not only the IO relationship's operational but also strategic performance (Subramani, 2004). Operational performance, or first-order outcome, refers to improvements in the efficiency of the partnership's day-to-day activities (e.g., order fulfillment time, percentage of products that meet specifications, operating costs, etc.) (Pavlou & El Sawy, 2006). Strategic performance refers to the partnering firms' long-term competitiveness in their market. Thus, we hypothesize:

> **H5a:** Interorganizational knowledge management capability is positively associated with the strategic performance of the partnership.

> **H5b:** Interorganizational knowledge management capability is positively associated with the operational performance of the partnership.

In our model, H1, H2, and H3 imply that IO relational capability mediates the relationship between IOIT infrastructure capability and IO KMC. Hence, we performed a mediation test to verify IO relational capability's mediating role. In addition, prior research in IOS shows that firms that enable digital access and knowledge sharing with their partners improve their performance (Malhotra et al., 2007; Saraf et al., 2007). Other IS researchers have posited that one could explain the relationship between IT and performance by investigating overlooked key mediating variables (Iyengar et al., 2015; Tippins & Sohi, 2003l Mao et al., 2016). Hence, our model in which the IO KMC mediates the relationship between IT and performance concurs with prior literature. To test IO KMC's mediating role, we added direct links to performance from IOIT infrastructure capability, from IO relational capability, and from interdependence. Table 2 presents a list of the key hypotheses we tested in our study (excluding the mediation relationships).

Table 2. Summary of Hypotheses

Hypothesis	
H1	Interorganizational IT infrastructure capability is positively associated with interorganizational KM capability.
H2	Interorganizational IT infrastructure capability is positively associated with interorganizational relational capability.
H3	Interorganizational relational capability is positively associated with interorganizational KM capability.
H4a	Partner interdependence is positively associated with interorganizational IT infrastructure capability.
H4b	Partner interdependence is positively associated with interorganizational relational capability.
H4c	Partner interdependence is positively associated with interorganizational KM capability.
H5a	Interorganizational knowledge management capability is positively associated with the strategic performance of the partnership.
H5b	Interorganizational knowledge management capability is positively associated with the operational performance of the partnership.

2.7 Control Variables

The literature has shown several variables to impact IO performance, and, thus, we control for them in our study. We discuss them in turn below.

2.7.1 Interorganizational Transaction Value

The volume of transactions between firms likely influences the performance of buyer-seller relationships (Sheth & Shah, 2003). The greater the relative transaction volume between two firms, the better positioned they are compared to smaller partnerships to achieve performance gains because they can leverage synergies more efficiently by taking advantage of economies of scale.

2.7.2 Years in Relationship

Researchers have considered relationship time an important indicator of the evolution of partnership focus (Malhotra et al., 2007). Early-stage partnerships usually feature discrete and arm-length transactions. As time passes, the IO relationship may be able to achieve higher performance due to their better aligning IO functions with their mutual goals.

2.7.3 Cooperative Norms

Cooperative norms between interacting partners likely affect an IO partnership's performance. Cooperative norms reflect expectations that two exchanging parties have about working together to achieve mutual and individual goals jointly (Malhotra et al., 2007). Cooperative norms provide an amiable environment for partner firms to form collective capabilities for transferring, renewing, retaining, and using knowledge and, thus, positively affect the partnership's performance.

2.7.4 Trust

Trust implies a firm's willingness to rely on its business partner in whom it has confidence (Ganesan, 1994). When firms have such trust, they can mitigate or avoid opportunistic behaviors in business relationships, which allows for future exchanges and increased risk-taking in the relationship. Hence, trust can have a positive effect on IO performance (Selnes & Sallis, 2003). Although some evidence shows that "trust and reciprocity norms (indicating a high level of social capital)" may drive whether firms share information (Malhotra et al., 2005, p. 175), we do not focus on trust in our model and, hence, include it as a control variable.

2.7.5 Long-term Orientation

Research has shown long-term orientation in partner relationships to positively impact their investments in relationship specific assets and their willingness to exchange information and knowledge with partners (Patnayakuni et al., 2006). We expect that IO relationships with long-term goals lead to better partnership performance and, hence, control for long-term orientation in our study.

2.7.6 Environmental Uncertainty

IO partnerships occur within an external environment, and the uncertainty inherent in the environment can affect relationship norms (Noordewier, John, & Nevin, 1990), relationship learning (Selnes & Sallis, 2003), relationship value (Cheung et al., 2010), and relationship performance (Palmatier et al., 2007). One should understand the environment external to an interfirm relationship as the output environment of the dyad that comprises the end users of the partnership's outputs (Achrol & Stern, 1988). Because the market's behavior and the choices that end users make ultimately drive the interfirm exchange relationship, the output environment constitutes the backdrop against which this relationship operates. The firms in a relationship cannot control environmental uncertainty and find it difficult to anticipate (Selnes & Sallis 2003). Research has shown that environmental uncertainty affects relationship performance and value (e.g., Cheung et al., 2010; Krishnan & Martin, 2006), and, thus, we use it as a control variable for IO performance.

2.7.7 Product Unpredictability

The characteristics of the products/services exchanged in the IO relationship can affect performance. Complex product designs and constantly changing product specifications can contribute to the unpredictability of the products and have a negative impact on partnership performance (Rai et al., 2006). Hence, we control for product unpredictability in our study.

2.7.8 Industry Sector

The characteristics of the industry sector can also affect performance (Sengupta, Heiser, & Cook, 2006). Service type supply chains distinctly differ from manufacturing ones, and they employ different practices (Ellram, Tate, & Billington, 2004). According to Sengupta et al. (2006, p. 4), "effective supply chain strategies in one sector may not be appropriate in the other sector". To account for the differential impact of the industry sector on performance, we control for industry sector. For this study, we employed the classification method that Ellram et al. (2004) used, which itself builds on the methods of the U.S. Bureau of Economic Analysis.

3 Research Method

To test the research model, we employed the survey method. We use a dyad between a supplier firm and a customer firm as our unit of analysis. We measured the constructs at the dyad level using a single informant method to collect data from one partner firm in the IO relationship. Many previous studies that focus on the impact that IT strategies or information systems have on IO performance have adopted this single-informant approach to collect data (e.g., Cao & Zhang, 2011; Malhotra et al., 2005; Narasimhan & Jayaram, 1998; Scheer et al., 2015; Tan, Kannan, Handfield, & Ghosh, 1999). The sampling frame of the survey included supply chain management professionals who have direct responsibility for and knowledge about the IO functions in their firms.

We operationalized the variables in the study using multi-item reflective and formative measures. Appendix A presents the constructs we studied, the construct types, abbreviated items in each scale, and the origin of the items. We used existing measures whenever possible and new measures when existing scale items did not exist. To ensure content and face validity of the measures, we carefully reviewed the past literature and developed a list of possible items for each construct.

We asked informants to think of a product line/service that they were most familiar with in their relationships with partnering firms. Based on the role of the informant's firm in the identified interfirm relationship (i.e., customer or supplier), we directed the informant to one of two surveys: one developed for the customer's perspective and the other for the supplier's perspective. We conducted two pilot tests in order to evaluate the clarity of instructions, appropriateness of terminology, item wording, response format, and questionnaire scales. The pilot test participants included supply chain professionals and MIS PhD and MBA students at the University of North Carolina at Charlotte. We conducted follow-up interviews and email discussions and made adjustments to the questionnaire based on the feedback.

We first collected data from a list of 2,480 members of the Association for Operation Management (APICS). For privacy reasons, APICS did not disclose the selected members' email address. However, APICS agreed to send an email on our behalf to the 2,480 members to invite them to participate. Of the 83 responses we received, we discarded seven due to missing information, which resulted in 76 usable responses. Specifically, we received 46 responses from customers and 30 from suppliers. Next, we contacted the board of directors and officers of 145 affiliates of the Institute of Supply Management (ISM) via email to ask them to participate in the survey. In addition, we asked them to forward the hyperlink of the survey to other ISM members who might be interested in the research subject. Finally, we contacted the executive officers of each affiliate via email and telephone to ask for their support in distributing the survey to the members of their affiliates. We received 97 responses from the ISM population in total. Of those 97 responses, we discarded nine due to missing information, which resulted in 88 usable responses (80 from customers and eight from suppliers).

We compared the APICS sample and the ISM sample with respect to various IO characteristics, such as the annual dollar transaction value between the partner firms, the industry, location, and partner size. Analysis of variance (ANOVA) results showed that the data collected from the APICS and ISM did not differ significantly on those characteristics. Therefore, we did not consider sample bias an issue in the data and combined the two samples for further analysis.

One can measure nonresponse bias by comparing data collected from early and late survey respondents (Armstrong & Overton, 1977). As the ISM sample responded to the survey chronologically later than the APICS sample, we used these two samples to compare for differences in the partnership characteristics and the respondents' characteristics. We did not find statistically significant differences between the two samples. We also compared the supplier and buyer samples with respect to various IO characteristics, such as the annual dollar transaction value between the partner firms, the industry, location, and partner size. The ANOVA results did not show significant differences between the responses from the two sides regarding those characteristics. Hence, we combined the sample and ended up with a total of 164 responses (126 from customers and 38 from suppliers). Tables 3 and 4 show the respondent characteristics in our sample.

Table 3. Responses by Industry

Industry	Number of responses	% of total responses
Agriculture, forestry and fisheries	2	1%
Mining	0	0%
Construction	5	3%
Utility services	8	5%
Manufacturing	71	43%
Transportation and warehousing	3	2%
Wholesale trade	14	9%
Retail trade	13	8%
Finance, insurance and real estate	8	5%
Government	4	2%
Computer systems / Data processing	5	3%
Healthcare	11	7%
Education	6	4%
Other	14	9%

Table 4. Frequencies of Relationship Time and Respondents' Years of SCM Experience

Characteristics	Categories	% in the sample
Time of the IO relationship	1) Less than 1 year 2) 1 – 5 years 3) 6 – 10 years 4) 11 – 15 years 5) 16 – 20 years 6) 21 years or more	0.9 19.8 31.1 17.9 11.3 18.9
Respondent's years of supply chain experience	1) Less than 1 year 2) 1 – 4 years 3) 5 – 8 years 4) 9 – 12 years 5) 13 – 16 years 6) 17 – 20 years 7) 21 – 24 years 8) 25 years or more	2.9 7.6 16.2 16.2 10.5 9.5 18.1 19.0

At the survey design stage, we took steps to reduce the potential for common method variance. However, since we collected the data via a single method (survey), we used Harman's one-factor test and partial correlation procedures (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) to check for potential threats of common method variance (CMV). We found that CMV did not constitute a big concern in this study.

4 Data Analysis and Results

4.1 Measurement Model

While most of the constructs in our model were reflective, three constructs (operational performance, IO collaboration, and product unpredictability) were formative. The operational performance construct was a composite measure of improvements in the time, cost, and quality of the outputs expected from the relationship that each represented a different aspect of IO operations. Productivity improvements in terms of operating costs need not co-vary with timeliness of fulfillment, and one could argue that, in order to improve timeliness, the IO partners may incur more operating costs (Petter, Straub, & Rai, 2007). We treated the IO collaboration construct as formative since prior literature has indicated that IO collaborations involve jointly developing products/services, jointly managing the operations, and jointly developing competitive strategies (Bensaou & Venkatraman 1995; Rai et al., 2006; Malhotra et al., 2005). Being better in one dimension of the collaboration (e.g., developing products/services) does not necessarily imply being better in the other two dimensions, and we needed to capture all the three dimensions of IO collaboration. For the product unpredictability construct, the literature has indicated two critical dimensions: complexity of the product/service and stability of the specifications (Subramani & Venkatraman, 2003). For the above reasons, we considered operational performance, IO collaboration, and product unpredictability as formative constructs in our study. The IO relational capability construct had two dimensions: IO process integration and IO collaboration. Since IO process integration was a reflective construct and IO collaboration was a formative construct, we treated the combined IO relational construct as a formative construct (Petter et al., 2007).

We measured the partnership interdependence construct by asking the respondents five questions about the importance of the focal firm to the business partner with regard to switching costs and relationship value (Scheer et al., 2015). For each of the above questions, we asked a matching question with a focus on the importance of the business partner to the focal firm. We averaged the responses to each pair of matching questions to give five items for the partnership interdependence construct.

We validated the measures for the two types of constructs differently (Petter et al., 2007). We used confirmatory factor analysis to assess the item loadings and cross-loadings for all reflective constructs. The loadings for the items reten3 and appl2 (KM capability), strat1 and strat3 (strategic performance), and indep3 and indep4 (partner interdependence) were all below 0.5 and well below the recommended threshold of 0.7 (Nunnally & Bernstein, 1994). Hence, we decided to remove these items from the measurement. The subsequent analysis showed that all reflective items except for indep5 (Partner Interdependence) had loadings greater than 0.7 and the cross-loading differences higher than the suggested threshold of 0.10 (Gefen & Straub, 2005). The indep5 item loading was 0.5211, but we decided to keep the item since it captures the important switching cost dimension of the interdependence construct. Further, among the reflective constructs, the lowest Cronbach's alpha value was 0.77, the lowest composite reliability was 0.86, and the lowest value for square root of AVE was 0.83 (see Table 5), all above the acceptable cut-off values (Bagozzi & Yi, 1988; Fornell & Larcker, 1981). Thus, we considered the reflective constructs in our model to have adequate reliability.

We examined the convergent and discriminant validity of the reflective constructs. Convergent validity reflects the extent to which the items for each construct actually measure the same construct. If the factor loading of an item on its designated construct is 0.60 or more, one establishes convergent validity (Gefen & Straub, 2005). Discriminant validity reflects the extent to which constructs significantly differ from each other. One assesses it by examining whether the correlation between a pair of constructs is less than the squared root of AVE of each construct (Chin, 1998; Fornell & Larcker, 1981). We found that the reflective constructs in our model had adequate convergent and discriminant validity (see Table 5 and Appendix A).

For formative constructs (i.e., IO collaboration, operational performance, partner interdependence, and product unpredictability), we examined the outer model weights for statistical significance. The following items had very low weights, and, thus, we removed them from the measurement: sccol5 (supply chain collaboration), oper1 and oper4 (operational performance), and pdep4 (partner interdependence). In subsequently analyzing the model weights, we found that all formative items had significant weights except pdep3 (partner interdependence) and oper3 (operational performance). We decided to keep pdep3 to maintain content validity for the construct partner interdependence and to keep oper3 to avoid making operational performance a single-item construct. Multicollinearity among indicators is problematic for formative constructs as it can result in non-significant items. We used the variance inflation factor (VIF) to assess multicollinearity problems. We produced VIF values for all retained indicators of the formative constructs and, as Appendix A shows, the VIF values were below the recommended threshold of 3.3 (Diamantopoulos & Siguaw, 2006). Therefore, multicollinearity did not pose a problem for the formative constructs.

Table 5. Correlations and Descriptive Statistics

	ENV	INTER	ITCAP	KMCAP	LONGTERM	NORM	OPER	PERCT	RELCAP	SECTOR	STRAT	TIME	TRUST	UNPRED
ENV	**0.84**													
INTER	-0.08	**0.83**												
ITCAP	0.19	0.03	**0.85**											
KMCAP	0.14	0.32	0.62	**0.88**										
LONGTERM	0.07	0.19	0.24	0.36										
NORM	0.04	0.23	0.20	0.35	0.64									
OPER	0.09	0.19	0.39	0.52	0.24	0.31								
PERCT	0.11	-0.05	0.08	0.00	0.01	-0.02	-0.09							
RELCAP	0.23	0.22	0.77	0.75	0.33	0.31	0.43	0.09						
SECTOR	0.04	0.09	-0.10	-0.11	-0.02	-0.04	0.11	-0.03	-0.10					
STRAT	0.08	0.36	0.45	0.61	0.37	0.50	0.60	-0.13	0.52	0.05	**0.84**			
TIME	*0.05	0.13	-0.02	0.06	0.14	0.20	0.17	-0.07	-0.06	0.19	0.17			
TRUST	0.14	0.16	0.17	0.32	0.63	0.69	-0.25	0.09	0.32	0.04	0.38	0.08		
UNPRED	0.02	0.33	0.26	0.29	0.15	0.21	0.16	-0.11	0.28	0.07	0.34	0.27	0.05	
Mean	3.33	4.11	2.53	2.77	3.85	3.96	3.35	0.26	0.00	0.45	3.38	3.34	3.82	3.42
Std. dev.	0.90	0.64	1.24	1.16	0.87	0.79	0.74	0.23	1.00	0.50	0.82	1.35	0.88	0.65
Cronbach's a	0.79	0.77	0.94	0.97							0.79			
Composite reliability	0.88	0.86	0.95	0.97							0.88			

Note: columns in light grey shading contain formative constructs, columns in dark grey shading contain single-item constructs, and bolded numbers in the diagonal represent the square root of the AVE (not reported for formative and single-item constructs)

ENV: environmental uncertainty, INTER: partner interdependence, ITCAP: IOIT infrastructure capability, KMCA: IO knowledge management capability, LONGTERM: long-term orientation, NORM: cooperative norms, OPER: operational performance, PERCT: percentage of revenue accounted by partner, RELCAP: IO relational capability, SECTOR: industry sector, STRAT: strategic performance, TIME: relationship time, TRUST: trust, UNPRED: product unpredictability.

4.2 Test of Hypotheses

To test the research hypotheses, we used PLS, a component-based structural equation model. PLS represents an alternative approach to factor-based SEM (e.g., Lisrel). PLS emphasizes prediction while simultaneously relaxing the demands on data and specifications of relationships (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017). PLS works efficiently with both complex models and those with relatively smaller sample size. Further, it can test complex relationships by avoiding inadmissible solutions and factory determinacy (Hair, Ringle, & Sarstedt, 2011). Smaller sample sizes affect the performance of PLS less in the structural model, and the relative deviations compare to those from factor-based SEM for similar sample sizes. Considering the small sample size and the relatively complex relationships in our study, we determined that PLS constituted an appropriate SEM model to use. We used the SmartPLS software, which academic researchers can use free of cost. We used 500 bootstrapping samples to test the statistical significance of structural paths. To test for robustness, we also ran the structural models with 1,000 and 2,000 bootstrapping samples. The structural results (i.e., the significance of the paths and significance levels) did not change across different bootstrap sample sizes. Table 6 and Figure 2 display the results of the path analysis for the structural model and the hypotheses tests. We found support for six of the eight hypotheses. Our data did not support the direct association that we hypothesized between IOIT infrastructure capability and IO KMC (H1). The effects of IOIT infrastructure capability manifest through IO relational capability. Our data also did not support the direct association we hypothesized between partner interdependence and IOIT infrastructure capability (H4a). Partner interdependence was directly and positively associated with IO relational capability and IO KMC. We discuss the implications of the supported hypotheses in Section 5.

Among the control variables in our study, the industry sector was positively associated with operational performance, though with a statistical significance of only $p < 0.1$. The cooperative norm was positively associated with strategic performance with a statistical significance of $p < 0.05$, whereas the transaction value was positively associated with strategic performance at the $p < 0.1$ level. Since we used these variables as control variables in our study, we only report those that had statistically significant paths in our model and do not discuss their impacts or implications.

Table 6. Path Analysis Results

Dependent variable	R^2	Independent variables	Path coefficient	Standard error	T statistic	Hypothesis	Supported (yes/no)
ITCAP	0.001	INTER	0.034	0.124	0.276	H4a	No
RELCAP	0.633	INTER	0.194	0.061	3.180***	H4b	Yes
		ITCAP	0.765	0.045	17.019***	H2	Yes
KMCAP	0.593	ITCAP	0.164	0.119	1.377	H1	No
		RELCAP	0.580	0.115	5.037***	H3	Yes
		INTER	0.186	0.065	2.852***	H4c	Yes
OPER	0.347	KMCAP	0.428	0.143	2.991***	H5b	Yes
		SECTOR^{+}	0.171	0.100	1.702*	Control	
STRAT	0.521	KMCAP	0.351	0.107	3.1286***	H5a	Yes
		NORM^{++}	0.286	0.128	2.237**	Control	
		TRANVAL^{+++}	0.121	0.070	1.733*	Control	

* p < 0.1, ** p < 0. 05, *** p < 0.01
$^{+}$ SECTOR stands for industry sector, a control variable
$^{++}$ NORM stands for cooperative norm, a control variable
$^{+++}$ TRANVAL stands for interorganizational transaction value, a control variable

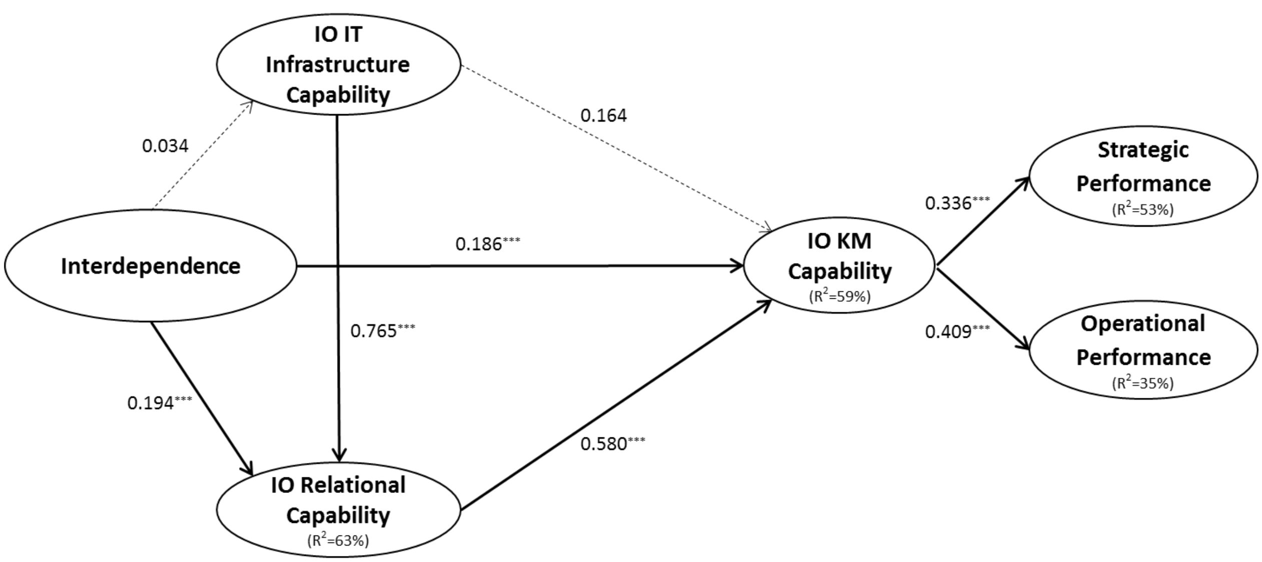

Figure 2. Structural Analysis Results

4.3 Test of Mediation

In our model, KMC was the main mediating construct between IOIT capability and the resulting performance gains (e.g., Tippins & Sohi, 2003; Mao et al., 2016). In addition, based on prior literature on IO systems, we retained the mediation role of relational capability between IT and KMC (Chae et al., 2014; Ghobakhloo & Hong, 2015; Rai et al., 2006; Saraf et al. 2007). We conducted two complementary methods to analyze mediation (Subramani, 2004). First, we ran a research model for partial mediation by incorporating a direct path from the independent variable to the outcome variable. We compared this partial mediation model with a competing model that proposed a full mediation (i.e., without the direct path). For example, in testing whether IO relational capability (RELCAP) mediated the relationship between IOIT infrastructure (ITCAP) and knowledge management capability (KMCAP), the full mediation model had a path from ITCAP to RELCAP and another path from RELCAP to KMCAP and no path from ITCAP to KMCAP. The partial mediation model added a direct path from ITCAP to KMCAP. The two models were nested and the partial mediation model had one more path than the full mediation model. We obtained the difference between the R^2 statistics of the two models to produce an f^2 statistic, and we assessed the statistical significance of the f^2 based on a pseudo F test[1]. A statistically non-significant pseudo F indicates full mediation, while a significant pseudo F indicates partial mediation. For each mediated relationship, we also computed the joint magnitude and variance of the direct paths among the independent variable, mediator variable, and outcome variable (Hoyle & Kenny, 1999; Subramani, 2004)[2]. Table 7 summarizes the mediations we tested and the results. From these results, we conclude that KMCAP fully mediated all relationships between IT capabilities and performance outcomes. The direct paths between IOIT infrastructure capability and from IO relational capability to operational and strategic performance were statistically non-significant. We also found that, while KMCAP fully mediated the relationship between partner interdependence and operational performance, it only partially mediated the relationship between partner interdependence and strategic performance.

Table 7. Mediation Analysis Results

Mediation tested	R^2 in mediated model (no direct path)	R^2 with direct path	f^2	Pseudo F (p value)	Conclusion about mediation	Mediated path magnitude (Std. error)
ITCAP→RELCAP→KMCAP	0.583	0.593	0.025	3.989 (0.048)	Partial mediation	0.544 (0.085)
INTER→RELCAP→KMCAP	0.558	0.593	0.086	13.812 (0.000)	Partial mediation	0.147 (0.097)
ITCAP→KMCAP→OPER	0.346	0.352	0.010	1.581 (0.210)	Full mediation	0.070 (0.192)
ITCAP→KMCAP→STRAT	0.523	0.533	0.020	3.218 (0.075)	Full mediation	0.058 (0.190)
RELCAP→KMCAP→OPER	0.352	0.352	0.000	0.049 (0.824)	Full mediation	0.244 (0.197)
RELCAP→KMCAP→STRAT	0.532	0.533	0.000	0.069 (0.794)	Full mediation	0.202 (0.170)
INTER→KMCAP→OPER	0.352	0.352	0.000	0.025 (0.875)	Full mediation	0.076 (0.158)
INTER→KMCAP→STRAT	0.519	0.533	0.029	4.656 (0.033)	Partial mediation	0.070 (0.128)

4.4 A Post Hoc Power Analysis

One can assess the power of PLS path models in a similar way to calculating power in linear regression (Chin & Newsted, 1999). One uses the maximum number of predictors—formative indicators or paths from exogenous latent variables—to calculate power. There were 12 exogenous variables that each connected to operational performance (OPER) and strategic performance (STRAT), which had the maximum numbers of predictors in this model. We ran a post hoc power analysis in G*Power (Faul, Erdfelder, Buchner, & Lang, 2009). We specified a medium effect size and a two-tail test with alpha 0.05. When the sample size was 164, the power of the test was 98 percent, an acceptable level of power to detect the effects that truly existed.

[1] We calculated f^2 as (R^2 partial - R^2 full)/(1- R^2 partial). We calculated the pseudo F statistic as 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.

[2] We approximated the standard error of the mediated path as sqrt ($p_1^2 * s_2^2 + p_2^2 * s_1^2 + s_1^2 * s_2^2$), where p_1 and p_2 are the path coefficients between ITCAP and RELCAP and between ITCAP and KMCAP, and s_1 and s_2 are the standard deviations of p_1 and p_2.

5 Discussion

One can consider knowledge embedded in IO relationships as a type of complementary resource that participating firms find valuable. According to the relational view, a collective capability in retaining, mobilizing, and using the knowledge resource can contribute to supply chains' sustainable growth. We postulate three types of capabilities and the relationships among them that lead to improved performance in the partnership. Given that IO partners may have different motivations and expectations about the partnership, we also investigate the impact that partner interdependence has on these capabilities and on IO performance. The empirical results demonstrate that the impact of IOIT infrastructure and relational capabilities materializes through a strengthened IO KMC, which, in turn, improves the partnership's operational and strategic performance. In addition, even though previous studies have found that partner interdependence has a direct impact on strategic performance, our results suggest that it also has a significant indirect impact through IO KMC. One could use these empirical results to extend the model to a supply chain context where the multiple players with competing incentives have to work together to create value from the partnership knowledge.

Consistent with the relational view and previous studies' results (e.g., Vaccaro et al., 2010; Iyengar et al., 2015; Mao et al., 2016), we found that the KMC was positively associated with performance. We contribute to the literature by showing that the positive impact exists in the IO context. Further, the impact extends to not only the partnership's operational performance but also to its strategic performance. Firms in a partnership require substantial expertise and significant time in order to put into place the IT infrastructures necessary to support integrated processes and collaborative activities. Furthermore, leveraging knowledge resources embedded in employee interactions can highly depend on the partnership's contexts, which makes it difficult for competitors to imitate the partnership's performance. Previous studies have investigated portions of our KMC construct, such as knowledge sharing (Panteli & Sockalingam, 2005) and the quality of information exchange (MacDuffie & Helper, 1997). With our study, we contribute to the literature in using a more comprehensive empirical conceptualization of KM that includes knowledge creation, transfer, retention, and application.

Previous literature has shown that "relationship-specific" investments and the resulting capabilities can lead to performance gains. In our model, we untangle such capabilities into two constructs: IOIT infrastructure and relational capabilities. Our results contribute to the literature by demonstrating that IOIT capability has a significant impact on the IO relational capability, which includes IO process integration and IO collaboration. In addition, consistent with the resource-based view, which questions the direct effect between IT capabilities and performance, our results indicate that first IO relational capability and then IO KMC mediate IOIT infrastructure capability's impact on performance (e.g., Chae et al., 2014). Common data definitions and tightly coupled applications that occur due to IOIT integration and flexibility provide a seamless platform to support process flows across firms. Improved information exchanges due to integrated and flexible IT infrastructure create opportunities for firms to identify resources or capabilities in their partner firms that may have potential for collaboration. Investments that partnership firms make to build IOIT infrastructure capability also signal their motivation to jointly carry out IO activities. Our results concur with prior research that shows that IO relational capabilities are important intermediate organizational capabilities through which partner firms can materialize IS resources' value (e.g., Ghobakhloo & Hong, 2015). Our study also contributes to the literature on the impact that collaborative relationships have on performance (e.g., Cao & Zhang, 2011; Mentzer, Min, & Zacharia, 2000).

Contrary to our expectation of a direct relationship between IOIT infrastructure capability and IO KMC, we found that relational capability fully mediated the impact that IT infrastructure capability had on KMC. This result is not, however, entirely unexpected as prior research has argued both in favor of a direct and an indirect link between IT and KMC (see Mao et al., 2016). Our study contributes to the literature in showing that IO relational capability represents an important step for interfirm partnerships to reap performance benefits from building KM capabilities. We can understand relational capability's mediating effect in light of the knowledge-based view (Grant, 1991), which identifies KMC as a higher-order organizational capability that draws on the knowledge across individuals, groups, and divisions. Because employees serve as conduits of KM processes, the activities or processes that mobilize employees' knowledge contribute to creating firms' KMC. Consequently, as a practical implication, our results suggest that, to materialize the benefits from using IT for managing intangible knowledge resources, partner firms have to first focus on building relationships grounded in process integration and collaboration. They should invest in IT in the areas of collaboration and information sharing rather than in just improving the efficiency of their transactional processes. Our study also contributes to the KM literature by extending the knowledge-based view to an IO setting.

Research has found interdependence to be an important aspect of IO relationships with both direct and indirect impacts on long-term orientation and performance. Contributing further to both practice and theory, we found that IO partners that depend on each other extensively can achieve greater KM benefits by investing more in their relational capabilities, such as building trust and long-term orientation and fostering collaborative partnerships. While we found that interdependence had a direct impact on strategic performance in our mediation analysis, we found no such link with operational performance, which further supports the role that interdependence for long-term relationship building.

Finally, our research contributes to explaining the role that IT has in managing knowledge resources in IO relationships. First, it articulates the role that IOIT has in facilitating KM and, in turn, creating performance advantage. As many IS studies have found, we found that IT and performance had an indirect relationship with each other (Iyengar et al., 2015; Mao et al., 2016; Wade & Hulland, 2004). Taking a KM perspective, we show that relational capability and KMC represent critical mediating capabilities for IT to bring performance gains to IO partnerships. Firms may find this insight useful to effectively implement and use their IT infrastructure. The significance of the relationship between KMC and performance highlights the theoretical and practical importance of knowledge in IO settings. We believe, from our understanding of supply chain research, that extended partnership and supply chain networks may also feature significant relationships between IOIT, KM and IO performance as we found in our study. However, we need additional research to confirm and better understand such relationships.

6 Conclusion

An IO partnership involves not just flows of products or services but also flows of knowledge. Firms can access complementary knowledge resources from their IO partners. In our study, we examine IT-enabled KM in an IO setting: an increasingly important and yet substantially underresearched area in IS literature. Specifically, we focus on the technology antecedents and performance consequences of IO KM by partner firms. Taking the perspective of a dyad, we present survey research that examines the relationship between the partnership's IT capability and KMC and the KMC's impact on the partnership's performance. The results suggest that partner firms' ability to collectively manage knowledge resources positively impacts their performance. In addition, we found that IOIT infrastructure capabilities impact the partner firms' IO KMC primarily by improving their relational capability and that both the relational and KM capabilities increase in strength when partner interdependence increases in strength.

Our study has a few limitations and offers opportunities for future research. First, we used subjective measures of partnership performance. Since we surveyed anonymous respondents (which the University of North Carolina at Charlotte's institutional review board required), we could not identify respondent organizations in order to collect objective performance data. Second, we collected data from only one side of the dyadic relationship to measure constructs at the partnership level. To make sure that answers from the informants represented the partnership, we asked the informants to identify a relationship between their firms and one of their firms' suppliers or customers that they were most familiar with. Although previous research has used the same approach that we did to collect data (e.g., Cao & Zhang, 2011; Scheer et al., 2015), future research could collect data from matched-pair samples. Researchers could include the type of IOIT and the type of knowledge as variables in future studies to extend our understanding about IT-enabled KM capabilities to different business contexts. The differential effects of KMC on performance based on the relationship type (product-oriented vs. service-oriented), relationship context, and product type could serve as interesting ground for future research (Scheer et al. 2015). Further, researchers could extend our research by studying the impact that interorganizational structure and network structure have on KM when the latter involves more than two partners, such as in a supply chain relationship. Finally, future research could examine both partner dependence and interdependence and distinguish between these variables' relationship-value and switching-cost components.

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Appendix

Table A1. Psychometric Details of the Measures

Constructs (type)	Dimensions	Items	Adapted From	Type	Item loading / weight (T)†	VIF
IO knowledge management capability (reflective) (KMCAP)	IO knowledge creation capability (CREAT)	*Creat1*: promoting cross-functional dialogues and activities	New measures	Reflective	0.8614	
		Creat2: drawing expertise from the supply chain partner to develop new knowledge			0.8698	
		Creat3: stimulating discussion encompassing a variety of opinions			0.8689	
		Creat4: integrating different sources and types of knowledge in the supply chain			0.9070	
	IO knowledge transfer capability (TRANS)	*Trans1*: sharing experience with the supply chain partner	New measures	Reflective	0.8991	
		Trans2: exchanging ideas and concepts with the supply chain partner			0.9046	
	IO knowledge retention capability (RETEN)	*Reten1*: documenting expertise, ideas and experiences in the supply chain	New measures	Reflective	0.8961	
		Reten2: maintaining accuracy and currency of our understanding about the supply chain			0.8692	
		Reten3: retaining past experiences and events			*	
	IO knowledge application capability (APPL)	*Appl1*: using past feedback from the supply chain partner to improve current interactions	New measures	Reflective	0.8742	
		Appl2: matching sources of knowledge to problems and challenges			*	
		Appl3: converting new understanding about customers, technologies and supply chain processes into plans of action			0.8715	
		Appl4: evaluating the supply chain relationship and, if needed, adjusting the way the relationship is managed			0.8834	
Operational performance (OPER)		*Oper1*: the order fulfillment cycle time	Malhotra et al. (2005), Palmatier et al. (2007) Robson, Katsikeas, & Bello (2008), Selnes & Sallis (2003)	Formative	*	*
		Oper2: percentage of delivered products/services meeting specifications			0.7901 (3.025)	1.015
		Oper3: operating costs of the supply chain			0.347 (1.062)	1.203
		Oper4: accuracy in demand forecast for the product line/service			*	*

Table A1. Psychometric Details of the Measures

Strategic performance (STRAT)		*Strat1*: business volume increase over the past year		Reflective	*	
		Strat2: new products/services can be quickly introduced into the supply chain.			0.7884	
		Strat3: it is difficult for the supply chain to make adjustments to cope with changes in the business environment.			*	
		Strat4: the supply chain has allowed the [SC Partner Firm] to become more competitive in the market.			0.8747	
		Strat5: the supply chain has achieved its set goals.			0.8490	
IOIT infrastructure capability (reflective) (ITCAP)	IOIT integration (ITINT)	*Itint1*: data are entered only once to be retrieved by both firms.	Saraf et al. (2007)	Reflective	0.8249	
		Itint2: the supply chain applications in our firm and the [SC Partner Firm] communicate in real time.			0.8444	
		Itint3: most of the software applications used in the supply chain have been integrated between the firms.			0.8431	
		Itint4: software applications on multiple platforms are interoperable with each other across the supply chain.			0.8192	
	IOIT flexibility (ITFLEX)	*Itflex1*: the supply chain applications are scalable.	Saraf et al. (2007), Byrd & Turner (2000)	Reflective	0.8321	
		Itflex2: the supply chain applications are designed to accommodate changes in business requirements.			0.8428	
		Itflex3: the supply chain applications can be easily upgraded to support new functions in the supply chain.			0.8587	
		Itflex4: the manner in which the components of the supply chain applications are organized allows for rapid technological changes.			0.8983	

Table A1. Psychometric Details of the Measures

IO relational capability (formative) (RELCAP)	IO process integration (IOPROINT)	*Proint1*: supply chain procedures and routines are shared between the firms.	Rai et al. (2006), Saraf et al. (2007)	Reflective	0.8864	
		Proint2: supply chain procedures and routines are formalized consistently so that the firms can interact without misunderstanding.			0.9119	
		Proint3: the flow of material and information is optimized across the supply chain.			0.9263	
		Proint4: the supply chain procedures and routines between the firms are highly connected.			0.9079	
		Proint5: each firm's way of doing business in the supply chain is closely linked with the other firm.			0.8873	
	IO collaboration (IOCOL)	*Col1*: supply chain-wide logistics is jointly managed between our firm and the [SC Partner Firm].	Bensaou & Venkatraman (1995), Rai et al. (2006), Kulp, Lee, & Ofek (2004), Malhotra et al. (2005)	Formative	0.3516 (4.755)	1.023
		Col2: our firm and the [SC Partner Firm] work together to develop production and delivery schedules.			0.1897 (2.838)	1.778
		Col3: our firm and the [SC Partner Firm] work together to develop performance metrics.			0.1687 (2.416)	1.034
		Col4: our firm and the [SC Partner Firm] work together in arriving at demand forecasts.			0.1743 (3.124)	1.894
		Col5: our firm and the [SC Partner Firm] work together to develop new products/services for the relationship.			*	*
		Col6: our firm and the [SC Partner Firm] work together to perform competitive analysis and formulate strategies.			0.3078 (4.464)	1.958
Partner interdependence (INTER)⊕		*Indep1*: the partner firm is key to the product line/service.	Kumar, Scheer, & Steenkamp (1998), Heide & John (1988)	Reflective	0.9423	
		Indep2: the partnership relationship is very important to the achievement of performance goals.			0.9527	
		Indep3: there are potential suppliers/ customers who could replace the partner for this product line/service.			*	
		Indep4: minimal cost would be incurred to replace the partner for this product line/service.			*	
		Indep5: if the partnership relationship was discontinued, it would be difficult to make up the sales and profits.			0.5211	
Volume of transactions		Dollar transaction volume	Sheth & Shah (2003)		‡	‡
Cooperative norms (NORM)		*Norm*: our relationship with the [SC Partner Firm] can be described as cooperative.	Malhotra et al. (2007)		‡	‡

Table A1. Psychometric Details of the Measures

Long-term orientation (LONGTERM)	*Longterm*: the [SC Partner Firm] and our firm have long-term relationship goals.	Patnayakuni et al. (2006)		‡	‡
Trust (TRUST)	*Trust*: our firm considers the relationship with the [SC partner firm] as built on trust.	Ganesan (1994)		‡	‡
Environmental uncertainty (ENV)	*Env1*: customer needs and preferences change rapidly.	Selnes & Sallis (2003), Ganesan (1994)	Reflective	0.8615	
	Env2: the competitors in the market frequently make aggressive moves to capture market share.			0.8512	
	Env3: major innovations to the product/service have constantly emerged in this market in recent years.			0.8012	
Product unpredictability (UNPRED)	*Unpred1*: the product line/service is generally very complex.	Subramani & Venkatraman (2003)	Formative	0.6608 (2.4886)	1.571
	Unpred2: the specifications of the product line/service are stable.			1.1081 (8.7247)	1.731
Relationship time (TIME)	*Time*: how long has your firm had a business relationship with the [SC Partner Firm]? Less than 1 year 1-5 years 6-10 years 11-15 years 16-20 years 21 years or more	Klein & Rai (2009)		‡	‡
Industry sector (SECTOR)	*Sector*: industry category that best describes focus of the firms.	Ellram et al. (2004)		‡	‡

†: Column reports item loading for reflective constructs and weight (T value) for formative
*: Item dropped
‡: Single-item construct
⊕: Respondents answered two sets of questions regarding interdependence: one set about their firm's dependence on the partner and a parallel set about the partner's dependence on their firm. We averaged the scores from each set of matching questions to obtain the interdependence item scores that we used in the analysis.

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