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Modular Interconnected Processes, Fluid Partnering, and Innovation Speed: A Loosely Coupled Systems Perspective on B2B Service Supply Chain Management

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ABSTRACT

In this paper, we examine whether and how loosely coupled systems in service supply chains influence the speed of innovation in service organizations. Drawing upon the nomological network of loosely coupled systems, we propose a way for supply chains in the business to business (B2B) market context to be conceptualized as loosely coupled systems and explain how the dialectical elements of modularity at the interface of standard process and content interfaces (SPCI) and structured data connectivity (SDC) enable the sharing of high-quality information through fluid partnership in service supply chains to improve innovation speed. Results that are based on a sample of service firms indicate that SPCI and SDC are positively associated with modular interconnected processes, and they, in turn, positively influence the ability to reconfigure supply chain partners (fluid partnership). Fluid partnership enhances information quality, which in turn, influences innovation speed. Implications are discussed for B2B service supply chain efforts in improving innovation speed.

Keywords: Fluid partnering, innovation speed, loose coupling, modular interconnected processes, structured data connectivity, structural equation modeling

1. Introduction

Loose coupling is one of the earliest and longstanding perspectives on organizational adaptation (Thompson 1967, Weick 1976). By maintaining loose coupling in organizational structures and processes, organizations adapt rapidly by innovating across products, processes, suppliers and customers, and services in response to changes in the external environment. In B2B market contexts, loose coupling in organizational design is critical because adaptation often results from the joint effort of internal and external actors (individuals, groups, departments or disciplines, organizational partners, etc.). Loose coupling allows decomposition of service structures and activities with B2B market stakeholders into distinct activities that are carried out by specialized supply chain actors whose efforts are then coordinated or "coupled" to fulfill a specific purpose (Baldwin & Clark, 2001).

Blending the notion of loose coupling in the supply chain context with innovation speed literature, we propose a theoretical framework to explain how loose coupling in supply chain influences innovation speed through standard process and content interfaces (SPCI), structured data connectivity (SDC), and fluid partnering. Biemans and Griffin (2018) highlighted the need for understanding B2B service innovation, especially with the service industry, which generate a majority of GDP and employing a majority of the workforce (Ostrom et al., 2010). In this paper, we move from an introspective within-firm view of service innovation to the nature of information and activity of organizations at the intersection of firm and supply chain members to develop a deeper understanding of how service firms, in cooperation with B2B supply chain collaborators, can enhance innovation speed. A range of factors has been proposed in explaining service innovation success, including customer-supplier involvement (Carbonell, Rodríguez-Escudero, & Pujari, 2009; Siahtiri, 2017) and service ecosystems (Vargo, Wieland, & Akaka, 2015). Service innovation literature remains underdeveloped (Droege, Hildebrand, & Forcada, 2009; Salunke, Weerawardena, & McColl-Kennedy, 2011), and there is a need to develop a coherent understanding of service innovation (Biemans & Griffin, 2018). Biemans and Griggine (2018) state that "B2B services-focused firms are overall less sophisticated in their innovation practices … they manage less explicitly for innovation, have lower innovation expectations, favor incremental innovation and, when they do initiate more innovative or radical projects, they spend less time taking them to market" (p. 112). Innovation speed is a pivotal element to competitive advantage in such firms undertaking more incremental innovation by taking less time to introduce such products to market. However, innovation speed in a B2B supply chain of service firms remains less understood. We build on the benefits of loose coupling in supply chains to propose a nomological network—SPCI, SDC, and fluid partnering—to explain how autonomous, modular, decoupled actors in a B2B supply chain whose efforts are coupled by standard content (similar to SDC), process, and electronic interfaces (similar to SPCI), adapt and innovate in response to changes in the external environment through fluid partnering.

The proposed framework makes the following contributions. First, although past studies provide us with a sense regarding factors that motivate supply chain adaptation in manufacturing organizations, they do not explain practices and events within service organizations that increasingly relying on B2B marketing relationships to develop innovative services. For instance, although we may know that economic competitiveness or environmental turbulence may pressure and push organizations into a frenzy of innovative activity, we do not know enough about the structure and partnering elements of how supply chain partners help translate these pressures into improving the innovation speed in a service firm context. Without loose coupling, supply chain actors that specialize in a given activity will be without appropriate means through which to coordinate the efforts of various actors such that they work toward the overall objective of improving innovation speed.

Second, Weick's loose coupling argument is particularly attractive as it has both theoretical and practice-based support. For instance, studies have found that loosely coupled systems are more responsive partly because they are able to better sense changes in the environment (Brusoni & Prencipe, 2001). We extend much of the previous research by performing a dialectical test of the loose coupling argument as was originally intended by Weick and pave the way for further understanding of how organizations may be conceptualized as loosely coupled systems.

Third, we frame the antecedents of innovation speed in a novel way by using the loose coupling perspective in B2B service contexts. Prior research, while using RBV (Eisenhardt & Martin, 2000; O'Reilly & Tushman, 2008) or transaction cost economics (Kogut & Zander 1996; Szulanski, 1996) has not theorized the outcome of innovation speed capability using the loose coupling perspective (Wong & Ngai, 2019), particularly in a B2B service supply chain context. In a review of 55 academic publications in supply chain innovations between 1999 and 2016, Wong and Ngai (2019: p. 9) "found that five major theoretical perspectives have been used in previous research, namely, resource-based view (21%), transaction cost economics (16%), relational theory (12%), knowledge-based theory (6%), and organizational theory (6%)." While the RBV takes the view that innovation is an outcome of resources under control, the transaction cost economics perspective proposes that reducing transaction costs by having long-term relationships improves innovation outcomes (Conner & Prahalad 1996). The loose coupling perspective used in our study, distinct from the broadly used theoretical frameworks found in Wong and Ngai (2019), takes a very different view of innovation by theorizing that the speed of innovation is primarily dependent on the inherent flexibility in the design of a firm operating system and its relationship with its supply chain partners (Schilling & Steensma 2001).

In the following sections, we briefly explain the proposed framework of modular interconnected processes (i.e., distinctiveness), as well as standardized process and content interfaces/standard data connectivity, which improves integration and responsiveness to changes in the environment. We conclude by discussing some of the theoretical as well as practical implications and provide suggestions for further research.

2. Theory and hypotheses

Service innovation in the B2B context has received limited attention over time; however, in recent years, there has been an increasing interest in service innovation in the B2B context (Kohtamaki & Rajala, 2016). Innovation in the service context is rooted in value-in-use, as in value associated with user experience. While value is created by customers and suppliers (Vargo & Lusch, 2008), the B2B supply chain cooperation is essential to pooling knowledge of customers held in the supply chain. The B2B supply chain structure allows for the necessary coproduction, cocreation, codesign and codevelopment of service innovation at a faster pace (cf. Kohtamaki & Rajala, 2016). Building on the logic by Payne, Storbacka, and Frow (2008), we posit that B2B supply chain members are central to codesigning, codeveloping, and cobranding service design. The B2B cooperation in service innovation is essential to collate, synthesize, and leverage economic, social, and cognitive experiences that customer's desire. While the value of service innovation is widely accepted, how B2B supply chain collaborators enhance service innovation speed remains unexplored.

We draw on Weick's (1976) loose coupling theory that smaller, "loosely coupled" organizations formed of autonomous building blocks could be brought together, disconnected, rejected, or reformed with little disturbance. In clarifying their position on loose coupling further, Orton and Weick state that while the distinctiveness aspect pertains to autonomy granted to organizational actors, the responsiveness pertains to the integrating mechanism that couples these actors together in achieving a common objective. Despite the face validity and metaphorical salience, as well as robust empirical support in the broader organization literature, the loose coupling perspective has not gained much emphasis in studies on B2B service supply chain adaptation (Davis, Golicic, & Marquardt, 2008; Sampson & Spring, 2012).

We next discuss the modular interconnected processes in supply chains.

2.1. Modular interconnected processes

Modular interconnected processes refer to "the breaking up of complex processes into sub processes (activities) that are performed by different organizations independently and simultaneously with clearly specified interlinked outputs" (Gosain, Malhotra, & El Sawy, 2004; p. 16). The importance of modular interconnected processes increase as a service organization expands in its size and becomes too complex to coordinate various sub processes (or activities). In such instances, decomposed internal and external service sub processes with various B2B partners are favored over an integrated system, as smaller internal and external autonomous systems have been shown to be more responsive to innovation needs of the environment (Baldwin & Clark, 2001; Ethiraj & Levinthal, 2004; Simon, 1962).

As an illustration of modular interconnected processes, consider the B2B production and service processes of Toyota (Spear & Bowen, 1999). Toyota uses explicit and rigid specifications at the interfaces with suppliers and distributors. Similar to modular interconnected processes, the production line process of Toyota is subdivided into various sub processes. Each process is the responsibility of a specific process-owner that executes the process based on very rigid specifications. Using the example of the car seat assembly, Spear and Bowen (1999) explain how rigid, but modular, specifications are beneficial to process improvements through continuous shop floor experimentation for the best way to complete the process. Standardization of connection between processes is similar to the standardization of contents at interfaces. Standardized production processes lower confusion (such as the number of units to order, delivery time, streamlining processes, etc.) that could arise at the interfaces.

Extending this logic to supply chains, modular interconnected processes facilitate rapid innovation because partners in a value chain perform different processes independently (Ulrich & Eppinger, 1999). Figure 1 serves as a theoretical model to depict the antecedents and outcomes of loosely coupled system for service related B2B innovation speed. It is essential for distinguishing between information quality and innovation speed. Bonner (2010) draws on Maltz and Kohli (1996) to explain information quality as information that is "perceived to be accurate, relevant, consistent, and provided clear signals and important details" (page 486). Innovation speed is defined as the time transpired between "1) initial development efforts, including the conception and definition of an innovation; and 2) ultimate commercialization, which is the introduction of a new product into the marketplace. It can be viewed as one of three dimensions of innovation strategy, with the others being quality and efficiency" (Kessler & Birley, 2002: p. 2; Kessler & Chakrabarti, 1996).

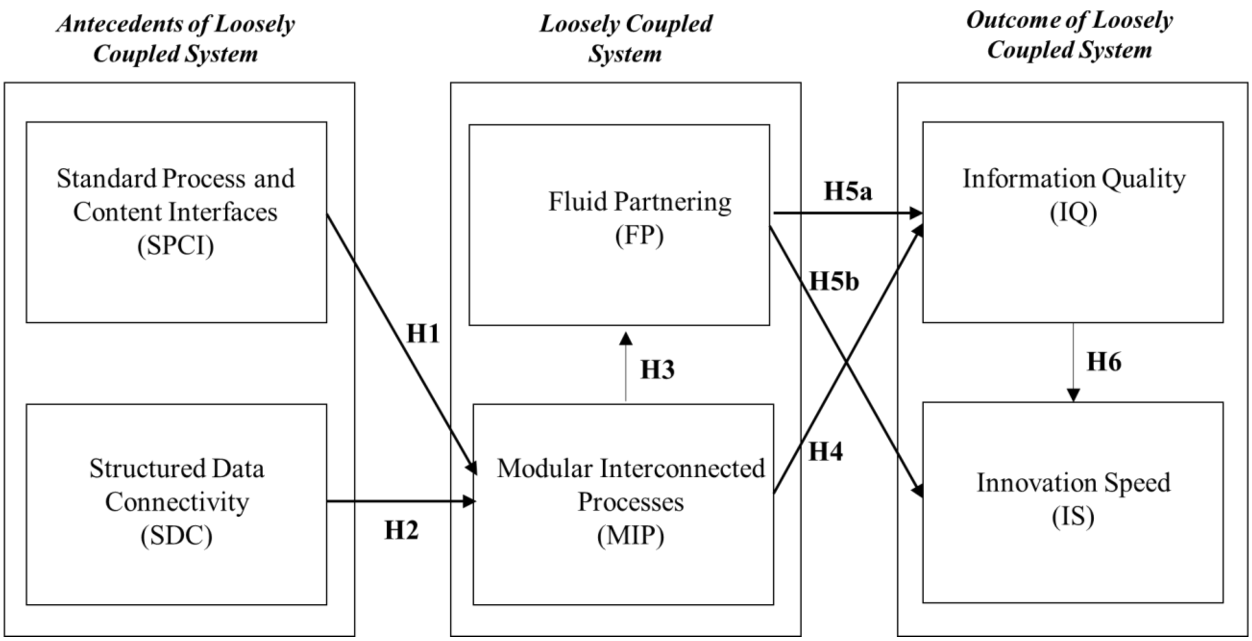


Figure 1. Theoretical model

2.2. Modular interconnected processes and standardized process and content interfaces (SPCI)

We postulate that SPCI and SDC are integrating mechanisms whose presence facilitates and encourages organizations to implement modular processes. Building on this discussion, we propose that SPCI and SDC are the coordinating mechanisms that will encourage the “move toward the middle” in loosely coupled system. That is, in the presence of SPCI/SDC, organizations are likely to move away from tightly integrated hierarchies at one end of the governance spectrum toward the middle where the organization serves to coordinate, couple and integrate the work produced by the modular, decoupled system of actors. The rationale is that when SPCI and SDC are high, the attributes of the transaction can be fairly well defined. It is easier to document the expectations from a module that can then be independently developed and integrated without affecting the development of other components of a system. Development of SPCI and SDC allows for information hiding; i.e., components and parts become "plug and play", and as long as the desired vector of features can be specified, the product complexity is hidden and absorbed by the manufacturer assigned to the module. Accordingly, when SPCI and SDC are well defined, they improve communication, as only pertinent information is communicated and the possibility of opportunism decreases. On the one hand, it is easier to communicate to the engine manufacturer the desired specifications for that part instead of attempting to communicate through a complex process of engine design and development. On the other hand, this also reduces the threat of opportunism. If the Pratt and Whitney engines, which power most Boeing airliners, do not generate the requisite amount of thrust, the modular nature of the engine allows Boeing to switch to alternate suppliers. The modular design arrangement is thus likely preferable to Boeing not only because the parts get developed at the point where the expertise exists (with the engine manufacturer) but also because it provides tremendous cost savings to Boeing and allows it to focus on its core business.

The logic for the above arguments, rooted in transaction cost economics, focuses on the risk of opportunism and minimizes the possibility of one party in a transaction taking advantage of another through actions such as misappropriating information or withholding of effort. The knowledge-based view of the firm suggests that firms organize to minimize knowledge-based transaction costs. Carlile (2002, 2004) has enriched this perspective by defining three distinct types of knowledge (the syntactic, the semantic, and the pragmatic) that can make communication difficult between organizations. Because of frequent, intense episodes of interaction as well as the existence of common vocabulary and routines (Almeida, Song, & Grant, 2002), the transfer and communication of knowledge are often considered to be easier within organizations as opposed to between them. Thus, overall the position taken within the literature is that because of the existence of opportunism, knowledge transfer is easier within organizational boundaries. Based on these theoretical arguments we suggest that:

Hypothesis 1: Standard process and content interfaces are positively associated with modular interconnected processes.

2.3. Structured data connectivity and modular interconnected processes

Structured data connectivity (SDC) refers to the exchange of electronic data and content with another enterprise in a specific format (Gosain et al., 2004). Similar to standardized process and content interfaces, the prime importance of data connectivity lies in its ability to act as a coordinating mechanism for autonomous modules (Zuiderwijk & Janssen, 2013). Structured data connectivity allows value chain partners to communicate easily and effectively in real time using an electronic format to provide guidelines to codify and exchange data in an electronic format so that it could be shared with suppliers in real time. Partners, then, can decipher the coded data more seamlessly, with less ambiguity, improving their responsiveness (Gosain et al., 2004). Some of the structured forms of data are online databases, organization-specific software, etc. Value chain partners also benefit from SDC through increased responsiveness, as they can track the flow of goods across various stages of a value chain (Rosenzweig & Roth, 2007) and align goals and objectives of various sub processes (Chung, Rainer, & Lewis, 2003).

Malhotra, Gosain, and El Sawy (2007) claim that XML-based standards such as Rosetta Net Partner Interface Processes (PIPs) enable organizations to deploy adaptable process linkages with their supply chain partners. The use of structured data connectivity essentially reflects an agreement on common specifications for information exchange formats and processing tasks at the interfaces between partners (p. 265).

Hypothesis 2: Structured data connectivity is positively associated with modular *interconnected processes*

2.4. Modular interconnected processes and fluid partnering

Fluid partnering refers to modularity in the relationship between organizations where managers have the flexibility to replace ineffective/inefficient partners with those that possess the capability to meet the changing demand in the business environment (Duysters & De Man, 2003; Gosain et al., 2004). During the selection of a partner, fluid partnering ensures that a firm can find a new partner, that can comply with the design and output standards, without much investment. Moreover, the need to reconfigure supply chain partners may also arise because of the changes in the dynamics of a business environment. The competitive pressure (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005; Gilbert, 2006) and changing customers' tastes (Erdil, Erdil, & Keskin, 2004; Jaworski & Kholi, 1993) can force a business to innovate a component(s) of a product. If an existing partner does not have the capability to supply a new component, then the replacement of that partner becomes inevitable. The ability to switch partners seamlessly is critical for business organizations to preserve a competitive edge (Stevenson & Spring, 2007).

In the interparty transactions, when parties are locked into a relationship because of asset specific investments, changing partners become increasingly difficult (Lonsdale, 2001; Williamson, 1985). To overcome the limitations of a rigid long-term relationship, Tang and Rai (2014) suggested the maintenance of a balanced approach to achieving competitive performance. In the balanced approach, partners are more competent in aligning their actions and more able to replace partners in a relationship when required.

Modularity in a process implies an ability of the process to disconnect easily from older processes as well as connect easily with new processes and implies lower relation-specific investment in processes, allowing firms to dissolve an existing relationship easily. Moreover, modularity implies that the current process can connect to a new process without customizing the existing process to cater to the new relationship. In addition, modular interconnected processes architecture allows the independent management of the constituent sub processes by each partner without hampering the activities of other partners. This is also in line with one of the advantages of a loosely coupled system, which is the localization of trouble (Orton & Weick, 1990). As Spear and Bowen (1999) stated, the presence of modular interconnected processes where a process is decomposed into sub processes and each process is assigned to a specific process-owner in a production line, ensures the smooth flow of product and services on a production path. The presence of a standardized production path enables managers to identify whether there are nonvalue adding partners and eliminate them. Therefore:

Hypothesis 3: Modular interconnected processes is positively associated with fluid partnering

2.5. Modular interconnected processes and information quality

The presence of a better quality of information in the collaborative relationships involving information sharing, problem solving, and joint decision making has a positive influence on supply chain performance (Wiengarten, Humphreys, Cao, Fynes, & McKittrick, 2010). Modularity enhances information quality through two mechanisms – improved environmental sensing and local adaptation in how work is done in an organization.

Modular interconnected processes relate to two aspects of how work is done. First, there is a clear demarcation of activities and output responsibilities between partners. Second, there is independent and simultaneous execution of activities for the creation of outputs by value chain partners. Each of these elements has a positive effect on the quality of information available, as they allow supply chain partners to generate new and unique knowledge based on their unique B2B environmental context. Continuous experimentation with very clearly specified activities and goals allows supply chain partners to make an unambiguous analysis about the best way to conduct the process. This new knowledge then can be shared with the supply chain partners for application in their own particular situations.

Great diversity of process related knowledge shared across value chain partners increases the probability that the knowledge being generated is value adding and complete. Knowledge generated through the modular process, which reflects a loosely coupled system, is analogous to highly novel knowledge obtained through weak ties (Granovetter, 1977). The parallel processing is similar to concurrent engineering that reduces product development time. Parallel processing of information allows information to be available in a timely manner. The highly specified, controlled experimentation-like setting makes the knowledge generated relevant, not just for an individual value chain partner but also the overall value chain, given the activities of the value chain partners are so inextricably linked.

Another advantage of a loosely coupled system that reinforces the distinctiveness aspect of such a system is its ability for local adaptation. For example, a supplier adapting to its local environmental contingency can avoid having to go through an entire system change, which increases the success of adaptation and survivability (Sanchez & Mahoney, 1996). Local adaptation helps overcome learning inertia that prevents innovation from occurring (Liao, Fei, & Liu, 2008). Local adaptation also enables each module to have a fewer number of decision-makers, hence less bureaucracy and less risk of conflict of interests (Carlile, 2004), increased creativity (Hirst, Van Knippenberg, Chen & Sacramento, 2011; Thompson, 1965), and a free flow of information. Based on the discussion, we hypothesize that:

Hypothesis 4: Modular interconnected processes is positively associated with information quality.

2.6. Fluid partnering, information quality, and innovation speed

Schwab and Miner (2011) argue that partnering flexibility, a term used by Gosain et al. (2004) to refer to fluid partnering, could have important implications for a firm in at least two stages of project implementation – first, during the execution of a project, and second after the completion of a project. The replacement of a partner upon project completion is a normal phenomenon and occurs frequently. The existing partners may be replaced with newer ones that have the skill sets to conduct tasks outlined in a new project. In the case of film making, for example, a director uses different combinations of actors in subsequent movies, depending upon the plot of a movie. The replacement of a partner when a project is underway is a rare phenomenon but occurs, nevertheless, if a partner in the relationship is unable to contribute as expected. Given the changing demands of customers in a dynamic business environment, the alteration of a component of a product or service could also be inevitable, and at times desired. This could result in the search for a new partner with a skill to fulfill the new demand. Of course, the replacement of partners could have a negative impact on the efficiency of project completion. However, Schwab and Miner (2011) argue that if the replacement of partners occurs frequently, then the costs involved in the replacement of a partner declines and the organization becomes more effective and efficient at replacing partners. The idea resembles the learning curve in partner selection (Li & Rowley, 2002).

With the advent of a new partner and the harnessing of the existing relationship, a focal firm learns new knowledge from its partners (Cattani, Ferriani, Frederiksen, & Täube, 2011). Over time, by the virtue of it being in various relationships, the repertoire of a focal firm's information is enhanced. If the existing partner lacks the necessary skills, the focus firm searches for a new partner. The new partner contributes to the knowledge and skills of the focal firm that further is accumulated in the focal firm's knowledge repository, thus enhancing the range of the knowledge repertoire. The increase in depth and breadth of knowledge over time, through interaction with various partners, might also improve the ability of an organization to locate and disseminate relevant information. The ease of information integration, however, depends on whether the partners are using the same standards and complementary information (Zhao and Xia, 2014).

As discussed in Breidbach, Reefke, and Wood (2015), service supply chains are characterized by their demarcation from traditional goods and services, that is, unique characteristics of services. Simultaneous consumption and production, real-time or quasi-real-time interaction, intangibility, perishability, and labor intensity differentiate goods, and oriented supply chains form product oriented supply chains (Ellram, Tate, & Billington, 2004). Service supply chains rely on flow of information (Akkermans & Vos, 2003) and are constrained by the availability of skilled labor (Zeithmal, Parsuraman, & Berry, 1985). These elements of a service supply chain pose governance challenges in terms of stability in the nature, volume and flow of information exchanges. The variability and customizability in services may limit investments in coordination and relational governance mechanisms, as such mechanisms are difficult to devise, implement and manage. Relational mechanisms in the service context are complex, require commitment, are costly to implement and take longer to develop (Alvarez, Pilbeam, & Wilding, 2010); therefore, reliance on arms-length contracts may be necessary, with such contracts possibly providing a basis for openness and trust (Selviaridis & Spring, 2010). However, this may limit the long-term development of trust and social norms, particularly salient in service supply chains. Quick and frequent changes of partners might have a negative effect and may limit the ability of partners to learn and develop a relationship, as learning is also a path-dependent process facilitated by the encoding of experiential lessons and inferences based on continued interactions (Levitt & March, 1988). Such short-term relationships lead to a lower accumulation of know-how related to a particular relationship, which could hamper innovation. Another downside may be a lower level of trust among supply chain partners, making it difficult to exchange information, as past experiences and learning could influence the willingness and ability of a focal firm to trust its partners (Huang and Wilkinson, 2013). Such short-term relationships might provide a disincentive to these partners to make significant specialized investment in such a relationship, leading to a detrimental effect on a firm's innovative capability.

As seen from the previous discussion, fluid partnering can have a positive as well as a negative relationship with innovation. Our contention is that in the service context, where the asset specific investments are smaller and innovations are generally incremental in nature, the positive effects of fluid partnering outweigh the negative effects. Reviewing the research on asset specific investments in the service industry, specifically 149 buyer–supplier relationships in the German construction industry, Ebers and Semrau (2015) found that power balance lowers investments in transaction specific investments. Similarly, De Vita, Tekaya, & Wang (2010) find that in the UK service industry, buyer related specific investments lowered relationship satisfaction; however, higher specific investment from suppliers improved relationship satisfaction. Additionally, Handley and Benton (2012) found that shirking also influenced relationship specific investments. Due to the generally intangible and perishable nature of services, lower relationship specific assets may create more holdup, and fluid partnering may further facilitate focus on more arms-length exchanges. Service innovation in recent research is innovation in provider, client, technical, and user characteristics on the dimensions of degree of change, type of change, degree of newness, and novel means of provision (Snyder, Witell, Gustafsson, Fombelle, & Kristensson, 2016). Related to the incremental nature of service innovations, in a review of 1,046 academic articles, Snyder et al. (2016) found that "inward and views service innovation as something (only) new to the firm" (p. 2041). Due to the benefits of fluid partnering in lowering relationship-specific investment and the ability to leverage incremental innovation in partner relationships, we hypothesize:

Hypothesis 5a: Fluid partnering is positively associated with information quality.

Hypothesis 5b: Fluid partnering is positively associated with innovation speed.

2.7. Information quality and innovation

Information quality has four aspects – it should be relevant, valuable, timely, and complete (Gosain et al., 2004). Relevant information is useful information. Irrelevant information is a burden to B2B relationships. Cognitive limitation of individuals or even organizations hinders them from grasping excessive information. When inundated with information, organizational actors could find it difficult to interpret, comprehend, and benefit from the excessive information (Bawden, Holtham, & Courtney, 1999; Cohen & Levinthal, 1990). Irrelevant information could be noise and increase the rate of error (Edmunds & Morris, 2000). It is only when a firm and its partners have a complementary knowledge base that they can absorb new information and learn from it (Lane & Lubatkin, 1998). The exchange of relevant and concise information could reduce the information overload (Butcher, 1995) and distraction (Klapp, 1986), and protect organizational actors from processing unnecessary information (March & Simon, 1958). Another element of information quality is the exchange of information in a timely manner. Because product/service lifecycles are shortening (Bakker, Wang, Huisman, & den Hollander, 2014; Chien, Chen, & Peng, 2010; van Iwaarden & van der Wiele, 2012), firms need to rely on the real-time information to address pressing issues in business environments.

For new product development, organizations should balance the act of independent idea generation and the synthesis of such ideas against collective action with their B2B partners. An organic B2B structure emphasizes decentralization. Members in such a structure can generate a vast quantity and better quality of new information, as the crux of a problem is attended to by an expert in that area (Zahay & Peltier, 2008). Moreover, an organic B2B relationship organization also promotes the free flow of information among organizational members. A substantial amount of scattered and high quality information has to be synthesized for collective actions to expedite new product development. A mechanistic B2B organization is not apt for the synthesis of information (Sheremata, 2000). Information quality emphasizes not only the generation of relevant, complete, and valuable information but also the synthesis of such information through timely exchange among supply chain partners. Based on the above discussion, we propose the following hypothesis:

Hypothesis 6: Information quality is positively associated with innovation speed.

3. Methods

The sample was drawn from the target population of U.S. service organizations. We used a sample of service firms for assessing innovation speed in the context of B2B relationships, as there are few studies focused on B2B relationships and innovation in the service sector. A recent call for future research has noted, “We found that supply chain innovation research has heavily relied on manufacturing firm-based samples and U.S. samples, limiting the generalizability of the findings" (Wong & Ngai, 2019; p. 9). Our use of a service firm B2B sample addresses this research gap. We used the B2B panel provided by Zoomerang, a survey platform.

The target respondents were mid to high-level managers in service industries (see Table 1) to ensure that the respondents were knowledgeable about strategic issues. We used several screening items to ensure the respondents are representative of our target population. Screening questions are related to whether the respondents worked full time and whether the respondents worked in a service firm. We screened out part-time workers and those employed in a manufacturing firm. Fifteen hundred respondents were contacted, and we received 264 completed responses, resulting in a response rate of 17.6%. This response rate is in line with other B2B studies that have used Zoomerang B2B panel (e.g., Richey, Tokman, & Dalela, 2010). We used a web based survey tool with forced responses and consequently did not have missing data. The total sample size was 264. The characteristics of the sample are presented in Table 1.

Table 1
Sample characteristics

Sales		**Respondents**	
<$1 million (m)	83	Vice President/Asst. Vice President	19
$1 million - $ 10 million	79	CFO/Treasurer/Controller	13
>$10 million - $100 million	55	Director/Asst. Director/ Department Head	41
>$100 million - $ 1 billion	17	Manager/Asst. Manager	144
> 1 billion	30	Small business owner	21
Total sample	**264**	Doctor/Physician	26
		Total Sample	264

Industry		**Number of employees**	
Automotive services	6	19–20	82
Biotech	2	21–49	28
Telecommunication services	9	50–99	17
Agriculture, forestry, fishing and hunting services	3	100–149	24
Construction	18	150–499	28
Wholesale trade	13	500–999	20
Retail trade	45	1000–4999	22
Transportation and warehousing	23	5000–9999	18
Finance, banking and insurance	50	10,000–14999	2
Healthcare and social assistance	70	15,000–25,000	5
Arts, entertainment and recreation	14	>25000	18
Information services	4	**Total sample**	**264**
Total sample	**264**		

The sample is evenly distributed across different organizational sizes based on the number of employees and sales revenue. Although sample size also represents various service industries, the majority of sample companies were in healthcare (n = 70), finance, banking and insurance (n = 50), retail trade (n = 45), and transportation and warehousing (n = 23). Of 264 responses, 97 were public firms, and 167 were private firms.

3.1. Measures

The measures used in the study are established in the prior studies. To adapt the measures in the context of our study, we modified the measures judiciously. The scales that were used to measure variables are presented in Appendix A. The average variance extracted (AVE), composite reliabilities (CR), and correlation among variables are presented in Table 2. Below we provide the definition and a sample item of each variable.

Table 2
Correlation among variables, and validity and reliability of the constructs

	CR	AVE	IS	SPCI	MIP	SDC	FP	IQ
Employee	--	--	0.074^{ns}	0.063^{ns}	0.120^{ns}	0.315***	0.054^{ns}	0.109^{ns}
Sales	--	--	0.031^{ns}	0.131*	0.081^{ns}	0.165*	0.019^{ns}	0.047^{ns}
Industry	--	--	0.093^{ns}	0.140*	0.051^{ns}	0.039^{ns}	-0.029^{ns}	0.040^{ns}
IS	0.938	0.835	*0.914*	--	--	--	--	--
SPCI	0.876	0.706	-0.068^{ns}	*0.840*	--	--	--	--
MIP	0.886	0.723	0.236***	0.136*	*0.850*	--	--	--
SDC	0.783	0.546	0.031^{ns}	-0.164*	0.187*	*0.739*	--	--
FP	0.930	0.815	0.391***	0.054^{ns}	0.314***	0.074^{ns}	*0.903*	--
IQ	0.890	0.673	0.328***	0.080^{ns}	0.639***	0.183*	0.573***	*0.820*

Note. ***$p \leq 0.001$; **$p \leq 0.01$, * $p \leq 0.05$; ns = not significant.
Square roots of AVE are presented along the diagonal in italics.
CR = composite reliability; AVE = average variance extracted; MSV = maximum shared variance; ASV = average shared squared variance; IS = innovation speed; SDCI = standardization of process and content interfaces; MIP = modular interconnected processes; SDC = structured data connectivity; FP = fluid partnering; IQ = information quality.

3.1.1. Standardized process and content interfaces (SPCI)

We follow Gosain et al., (2004) to measure SPCI - three items on a 7-point Likert scale were used. SPCI refers to the agreement among partners regarding the common specification regarding the information exchange at the interfaces. These specifications relate to “format, data repository, and processing tasks” (Gosain et al., 2004; p. 14). A sample item includes, “Extent to which your business process interfaces with your supply chain partners and are similar across all partners, in terms of rules and procedures.” The AVE and CR of SPCI are 0.706 and 0.876, respectively.

3.1.2. Structured data connectivity (SDC)

Three items on a 7-point Likert scale were used to measure SDC. SDC refers to the ability to exchange structured transaction data and content with another enterprise in an electronic form (Gosain et al., 2004; p. 17). A sample item of SDC is, “What is the extent to which you can exchange data in electronic formats with your supply chain partners and other potential supply chain partners?” The AVE of SDC is 0.546 and CR is 0.783.

3.1.3. Modular interconnected processes (MIP)

MIP was measured using three items on a 7-point Likert scale. MIP refers to decomposition of a complex process into various subprocesses that are independently performed by various organizations through either overlapping phases or fully simultaneously (Gosain et al., 2004). A sample item includes, “The processes conducted in conjunction with your supply chain partners are divided into clearly understood activities to be performed by you and each of your supply chain partners.” The AVE of MIP is 0.723, and CR of MIP is 0.886.

3.1.4. Fluid partnering (FP)

FP was measured using three items on a 5-point Likert scale. Fluid partnering refers to the ability to reconfigure supply chain network (Rosenzwieg and Roth, 2007). A sample item of FP is, “You are adept at reconfiguring network of supply chain partners in very short time.” The AVE and CR of FP are 0.815 and 0.930, respectively.

3.1.5. Information quality (IQ)

We used four items on a 7-point Likert scale to measure IQ. IQ refers to the ability of supply chain partners to exchange relevant, valuable, complete information in a timely manner (Gosain et al., 2004). A sample item of IQ includes, “How would you rate the information exchanged with your supply chain partners in terms of its relevancy to your business needs?” The AVE and CR of IQ are 0.673 and 0.890, respectively.

3.1.6. *Innovation speed (IS)*

Three items were used to measure innovation speed on a 5-point Likert scale. Innovation speed refers to the ability of a business unit to develop new service, features, and technology at a higher rate compared with competitors (Nassimbeni, 2003). A sample item includes, “How does your business unit’s ability to develop new services at a high rate compare with your competitors?” The AVE of IS is 0.835, and CR is 0.938.

3.1.7. Evaluation of common method bias

We assessed whether there was an effect of common method bias in our study using marker variable technique as suggested by Lindell and Whitney (2001). We included a leisure variable in our study as a marker variable. We asked respondents to rate a statement on a 7-point Likert scale with anchor points ranging from strongly disagree to strongly agree. The statement stated, "I spend my leisure time mostly traveling." We choose this leisure variable as our marker variable because it is theoretically unrelated to other measures in this study. To test for common methods bias using marker variable technique, Lindell and Whitney (2001) suggested comparing the hypothesized research model that has a marker variable with the research model without a marker variable. If the result obtained from the comparison indicates that the difference between the two research models is not statistically significant, then we can conclude that the subsequent analyses are not affected by common methods bias. The result obtained from the chi-square test indicated that the hypothesized research model without a marker variable was not significantly different from the hypothesized model with the marker variable ($\chi2[df] = 9.678[6]$, $p = 0.139$). We also used a Harmon single factor test (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) to assess common method bias. The single factor accounted for only 28.82% of the variance, indicating that common method bias is not an issue for our study. Therefore, we conclude that common method bias is less likely to be a concern in the subsequent analyses.

3.2. Validity of measures.

AMOS 21 was used for testing the validity of measures and for testing the proposed hypotheses. The psychometric properties of scale were identified by evaluating the reliability and validity of constructs. Confirmatory factor analysis was conducted to examine the discriminant and convergent validity of constructs. A two-step technique was used to examine the measurement model and structural model (Anderson & Gerbing, 1988). The two-step technique ensures that the hypotheses testing is conducted after researchers assess the model fit of a measurement model, internal consistency, and convergent and discriminant validity.

3.2.1. Convergent, discriminant validity, and composite reliability

Table 2 presents the validity and reliability of the constructs used in the study. The value of average variance extracted (AVE) for all constructs are above the 0.50 threshold, providing support for convergent validity (Fornell & Larcker, 1981). Moreover, the square root of the AVE of each construct is greater than its correlation with other variables in the model (Fornell and Larcker, 1981), providing evidence of discriminant validity.

We conducted the confirmatory factor analysis (CFA) using the measurement model with freely correlated latent variables. All items measuring its latent variable were statistically significant. Table 3 presents the factor loading for all the variables. The minimum value of item loading was 0.649, indicating convergent validity.

Table 3
Factor loading and standardized regression weights

Constructs	Items	Factor loading
IS	IS_1	0.882***
	IS_2	0.945***
	IS_3	0.912***
SPCI	SPCI_1	0.881***
	SPCI_2	0.928***
	SPCI_3	0.694***
MIP	MIP_1	0.886***
	MIP_2	0.914***
	MIP_3	0.739***
SDC	SDC_1	0.776***
	SDC_2	0.718***
	SDC_3	0.723***
FP	FP_1	0.826***
	FP_2	0.941***
	FP_3	0.937***
IQ	IQ_1	0.872***
	IQ_2	0.923***
	IQ_3	0.703***
	IQ_4	0.763***

Note. ***$p \leq 0.001$; **$p \leq 0.01$, * $p \leq 0.05$; ns = not significant
IS = innovation speed; SPCI = standardization of process and content interfaces; MIP = modular interconnected processes; SDC = structured data connectivity; FP = Fluid partnering; IQ = information quality

3.2.2. Evaluation of nomological structure

We evaluated the fit indices of both the measurement model (χ^2 [df] = 317.771[137], p = 0.000; CFI = 0.949; RMSEA = 0.071) and the proposed model (χ^2 [df] = 323.103[144], p = 0.000; CFI = 0.949; RMSEA = 0.069), which were within the suggested cutoffs. The fit indices provided support for the nomological structure of the research model (Kline, 1998).

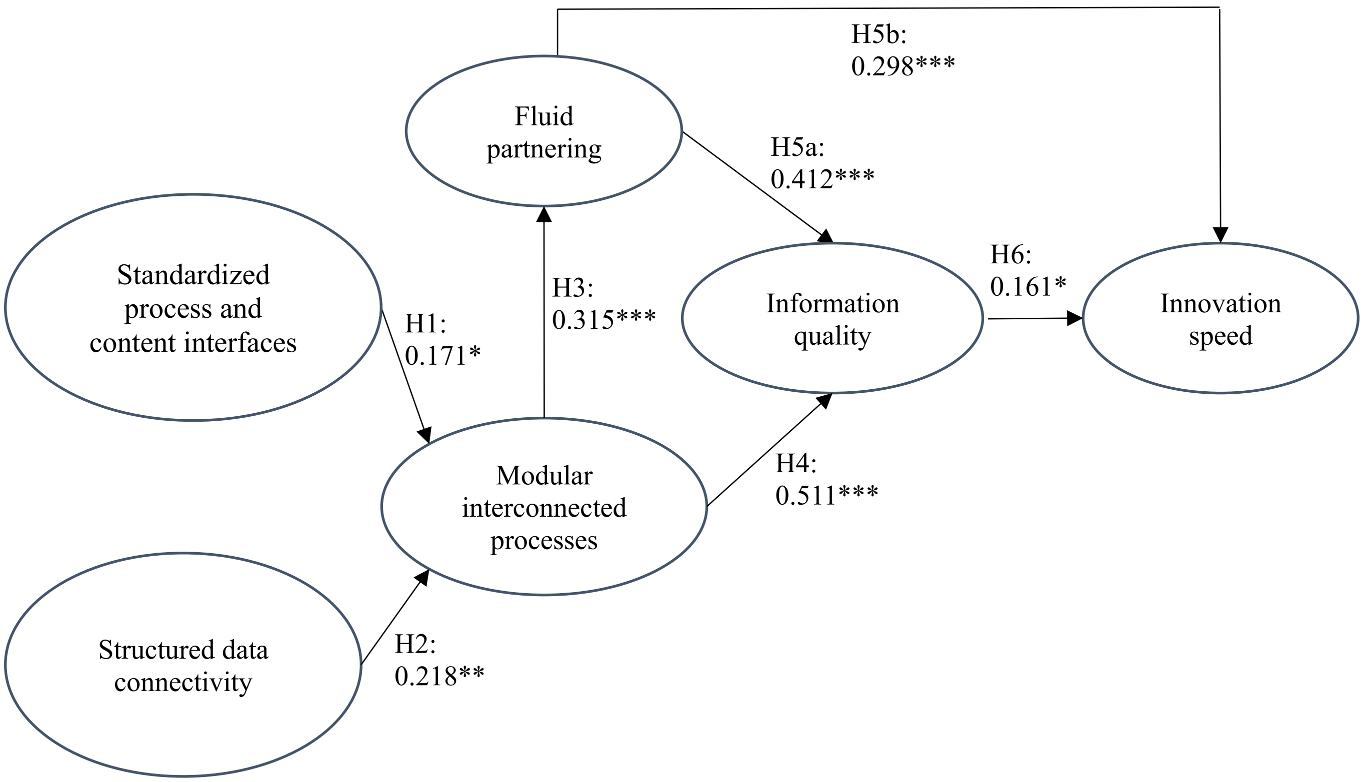
3.3. Control variables

Number of employees, sales revenue, and *industry types* were used as control. Companies having a large number of employees have greater human capital that could work in a different setting such as collaborative teams to pursue innovative activities. Similarly, companies with greater sales revenues will likely have higher profitability (assuming expenses remain constant), part of which could be used to fund research and developmental activities that support innovative pursuits. Innovation speed could be different across industries. For example, industries in a science-based sector are more innovative than those in a conventional manufacturing-based sector (Park, Yoon, & Lee, 2005).

4. Results

4.1. Test of hypotheses

Figure 2 presents the estimates of the research model along with path loadings. We looked the variance inflation factors to assess multicollinearity. All the VIFs were below 1.5 indicating that multicollinearity was not an issue (Hair, Anderson, Tatham, & Black, 1995). Hypothesis 1, which stated that standardized process and content interfaces were positively associated with modular interconnected processes, was supported ($\beta = 0.171$, $p = 0.012$). Hypothesis 2 stated that structured data connectivity was positively associated with modular interconnected processes. This hypothesis was supported ($\beta = 0.218$, $p = 0.003$). The positive association between modular interconnected processes and fluid partnering, as stated in Hypothesis 3, was also supported ($\beta = 0.315$, $p = 0.000$). Hypothesis 4, which tested the positive association between modular interconnected processes and information quality, was supported ($\beta = 0.511$, $p = 0.000$). Hypothesis 5a, which stated fluid partnering was positively associated with information quality, was supported ($\beta = 0.412$, $p = 0.000$). Hypothesis 5b, which stated fluid partnering was positively associated with innovation speed was also supported ($\beta = 0.298$, $p = 0.000$). Finally, Hypothesis 6, which stated that fluid partnering was positively associated with innovation speed, was supported ($\beta = 0.161$, $p = 0.036$).



***p≤0.001; **p≤0.01; *p≤0.05; ns = not significant.

Figure 2. Research model with path loadings

We also examined whether there were any indirect effects. The results (Table 4) show that standardized process and content interfaces positively affect fluid partnering (β = 0.054, p = 0.025) and information quality (β = 0.109, p = 0.033) through modular interconnected processes. Similarly, structured data connectivity positively influences fluid partnering (β = 0.069, p = 0.012) and information quality (β = 0.140, p = 0.017) through modular interconnected processes. Additionally, modular interconnected processes have a positive influence on information quality (β = 0.130, p = 0.000) through fluid partnering. Modular interconnected processes also positively influence innovation speed (β = 0.197, p = 0.000) though fluid partnering and information quality. Finally, fluid partnering positively influences innovation speed (β = 0.066, p = 0.050) through information quality.

Table 4
Test of total indirect effect using bootstrapping

	SDC	SPCI	MIP	FP	IQ	IS
MIP	0	0	0	0	0	0
FP	0.069**	0.054*	0	0	0	0
IQ	0.140**	0.109*	0.130***	0	0	0
IS	0.043*	0.034*	0.197***	0.066*	0	0

Note. ***$p \leq 0.001$; **$p \leq 0.01$, * $p \leq 0.05$; ns = not significant
IS = innovation speed; SPCI = standardization of process and content interfaces; MIP = modular interconnected processes; SDC = structured data connectivity; FP = fluid partnering; IQ = information quality

We examined the effect of three control variables on the dependent variable - innovation speed. These control variables are number of employees, sales revenue, and industry types. We compared the hypothesized research model including the control variables with the one without the control variables. The chi-square difference between the hypothesized research model with controls and the ones without controls was not statistically significant (χ^2 [df] = 3.101[3], p=0.376), providing evidence that control variables did not have a statistically significant impact on innovation speed. Individual path coefficients of the control variables on the number of employees (β = 0.048, p = 0.534), sales revenue (β = -0.018, p = 0.814), and industry types (β = 0.094, p = 0.108) were not significantly significant.

5. Discussion and conclusion

Although service innovation has been an area of interest in B2B marketing (Kohtamaki & Rajala, 2016), there also have been increasing calls to develop increased coherence in our understanding of service innovation in a B2B marketing context (Biemans & Griffin, 2018). We attempted to answer how cocreation and coproduction of value creation can be organized among B2B service supply chain members. We discuss the theoretical implications of our findings below.

5.1. Contribution of the study

Our main contributions are as follows. First, prior literature has not theorized the combination of relationships that include the relational (Duysters & De Man, 2003) and structural aspects of B2B supply chain design (Gosain et al., 2004) for innovation speed in service contexts. We use the loose coupling perspective to provide details of the mechanisms through which loosely coupled systems improve the speed of innovation (Thompson, 1967; Weick, 1976) through the dynamics at the interface of the firm and its suppliers and distributors.

Second, our first two hypotheses explore the interplay between the two aspects (distinctiveness and responsiveness) that define loosely coupled systems. H1 explores the relationship between standard processes and content interfaces and modularity in processes. We find that SPIC is a significant predictor of MIP. Specifically, we find that the greater the extent of SPIC, the greater is the extent to which organizations (are in a position to) implement modular interconnected processes. As we noted earlier, SPIC measures the extent to which the desired task characteristics can be specified in detail. This is consistent with arguments in other areas of organization theory such as Agency and Control Systems (Eisenhardt, 1985; Ouchi 1979). Task parameters are specified, and actors in the network are evaluated based on the extent to which they meet the task requirements. Actors can act autonomously and are free to choose how to implement the objectives as long as the specifications are met. This is also consistent with Eisenhardt's agency argument that as task programmability (the extent to which tasks can be programmed or defined in terms of a process) decreases, a pseudo market-like outcome based management becomes more likely. When task programmability is low, managers may not be able to exactly specify how jobs should be done (e.g., designing a new fashion) and may prefer to instead specify the requirements and delegate control to respective individuals who specialize in that area. Hendry (2002) as well as Conner and Prahalad (1996) use a knowledge-based view to explain when markets are chosen over firms. They contend that when employees are more competent and honest, it is likely that management may prefer to grant them full autonomy in work as a way of minimizing knowledge-based transaction costs. Our finding that SPIC is positively related to modularity or decomposition and the "outsourcing" of work, thus reflects not simply the desire for parallel execution of work but also the need to overcome cognitive limitations that can hamper the progress of the organization.

Third, we also find that structured data connectivity or SDC is positively related to modular interconnected processes. We find the greater the degree to which data is codified and standards and data exchange formats are specified, the greater is the extent to which organizations (are in a position to) implement modular interconnected processes. This finding as we noted earlier is consistent with the arguments made in the information systems literature. As Malhotra et al. (2007) have argued, the establishment of structured data connectivity suggests that there is a considerable level of agreement on how coordination will be realized between supply chain partners.

Fourth, Hypothesis 3 examines the relationship between modular interconnected processes and fluid partnering. As expected, we find a positive relationship, which suggests that as processes become more modular, it becomes easier for the organization to switch partners to fulfill the overall objectives of the relationship. This argument parallels the asset specificity hypothesis in transaction cost economics that states that a high degree of asymmetric asset specific investments can make it difficult to exit and lock partners into ineffective value deprived relationships.

Fifth, with respect to H4, we find that the greater the degree of modular interconnected processes, the greater is the extent to which high quality information will be shared among the partners. Because modularity implies autonomous functioning by supply chain partners, the greater the extent of modular interconnected processes not only means more independent partners that act as "sensing mechanisms" for changes in the external environment but also more experimentation and generation of innovative ideas, as each partner attempts to adapt to its local environment and bring these ideas into the supply network. H5 explores how fluid partnering affects information quality, and here our results suggest that the greater the extent of fluid partnering, the greater is the quality of information brought and shared among supply chain partners. This is reasonable, as fluid partnering involves an organization that continuously searches for and brings competent partners into its supply chain network.

5.2. Future research directions and limitations

Further research utilizing the loose coupling perspective could extend our study in several ways. One way of extending our study is to include additional conceptions of innovation speed and organizational adaptation. For instance, studies could use life-cycle times or time-to-market, or examine the nature and quality of innovations, and draw comparisons vis-a-vis centralized organizations. There is some anecdotal evidence that loosely coupled systems tend to produce higher quality innovations, although this proposition remains to be tested. Moreover, our measure was subjective. Studies could benefit from using more objective count-based measures such as the number of innovative projects and ideas implemented within a particular time frame.

Our study also collected data from a single focal firm. This might have produced a threat of common method bias. Although we were careful in the selection of knowledgeable respondents and used the marker variable test, further studies might use multiple respondents per firm to obtain a more accurate assessment of the focal concepts in the study. One interesting avenue for further research is how partners in the network tend to perceive fluid partnering. We have assumed that fluid partnering is beneficial because it leads to better information but it is possible that the threat of being swapped out of the network may encourage partners to withhold proprietary information that could be mutually beneficial to everyone involved.

Another limitation of our model is that we do not consider the effect of market and cultural differences, which would affect the ability of supply chain partners to work with each other. Our model does not incorporate the effect of international differences that exist in a global supply chain. Future research should explore market, culture, and international contingencies that affect the need for adaptation and flexibility. Our study was conducted in the US context. It would be interesting to see whether our model holds in other more “relationship oriented” cultures such as those in Asia. It is very likely that due to cross-cultural differences, fluid partnering and modularity, which are perceived as perhaps “undesirable necessities and matter of doing business”, may be perceived quite differently as “selfish manipulative acts” on the part of the focal organizations. Thus, people may refrain from sharing information or in extreme events may “game” the system by sending false information into the network. Another future research direction is exploring the conditional effect of market and institutional environment on information quality and innovation speed.

Finally, we do not elucidate the types of innovation a service firm is conducting in the B2B context. Although we expect direct and indirect benefits of the proposed mechanisms, additional studies are necessary to understand whether the role of different types of innovations require distinct types of organizational structures. While an organic organizational structure is apt for radical idea generation, a mechanistic organizational structure favors incremental innovation (Nord & Tucker, 1987; Sheremeta, 2000). It is intuitive to assume that modular interconnected processes themselves are organic, as the decision-making authorities are separated and interaction between subunits is restrained. However, from a module’s standpoint, the identification of organizational design that is apt for the structure of a module – interactions of functional departments and decision-making authorities within a module – is something we hope will be examined in further research.

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APPENDIX A. Operationalization of constructs

Standardization of Process and Content Interfaces (SPCI; Gosain et al., 2004): 7 points Likert-scale

1. Extent to which your business process interfaces with your supply chain partners are similar across all partners, in terms of rules and procedures. (*Very similar for all partners, moderately similar across partners, extremely specific for each partner)*
2. Extent to which the business process interfaces with your supply chain partners are similar across all partners, in terms of data formats. (*Very similar for all partners, moderately similar across partners, extremely specific for each partner)*
3. Extent to which information exchanged (e.g., sales reporting, service information, service availability, inventory information, etc.) with your supply chain partners needs to be converted/translated to be interpreted by your business unit. (*Does not need to be converted/translated, needs to be converted/translated moderately, needs to be converted/translated extensively)*

Structured Data Connectivity (SDC; Gosain et al., 2004): 7-point Likert scale

Please respond to the items related to your ability to exchange transaction and content data electronically with your supply chain partners and potential supply chain partners.

1. What is the extent to which you can exchange data in electronic formats with your supply chain partners and other potential supply chain partners? (*Mostly electronic, Equally electronic and non-electronic, Mostly non-electronic)*
2. What is the extent to which you can exchange data in real time with your supply chain partners and other potential supply chain partners? (*Extensive real-time exchange, Equally Real time and batched exchanges, Mostly batched delayed exchanges)*

3. What is the extent to which data exchange with your supply chain partners is structured (rather than free format exchange such as e-mail text)? (*Data can be highly structured, Moderate support for structured data, No support for structured data)*

Modular Interconnected Processes (MIP; Gosain et al., 2004): 7-point Likert scale (*Strongly disagree, Neutral, Strongly agree*)

Please respond to items related to channel processes conducted by your company in conjunction with your supply chain partners (e.g. order fulfillment/service delivery, new service introduction, service failure handling, promotions planning, after sales support).

1. The processes conducted in conjunction with your supply chain partners are divided into clearly understood activities to be performed by you and each of your supply chain partners.
2. The output/job requirements of your supply chain partners from your business unit and your requirements from your supply chain partners are precisely specified and understood.
3. The activities performed by your company and your supply chain partners are performed simultaneously to a large extent.

Fluid Partnering (FP; Rosenzwieg and Roth, 2007): (*5-point Likert scale; strongly disagree, neutral, strongly agree*)

Please respond to items given below related to your business unit's capability in building supply chain partnerships.

1. You are adept at reconfiguring network of supply chain partners in very short time.
2. You have the ability to quickly coordinate activities across a dynamic pool of supply chain partners.
3. You have the ability to effectively maintain a shifting network of supply chain partners.

Information quality (IQ; Gosain et al., 2004): 7-point Likert scale

1. How would you rate the information exchanged with your supply chain partners in terms of its relevancy to your business needs? (*Not relevant, Moderately relevant, Very relevant)*
2. How would you rate the information exchanged with your supply chain partners in terms of its value-added to your business needs? (*Of no value, Moderately valuable, Very valuable)*
3. How would you rate the information exchanged with your supply chain partners in terms of its timeliness? (*Always late, Sometimes on time, Very timely)*
4. How would you rate the information exchanged with your supply chain partners in terms of its completeness? (*Incomplete, Moderately incomplete, Very complete)*

Innovation speed (IS): 5-point Likert scale (*Far behind the competitors, At par with the competitors, Far ahead of the competitors*)

1. How does your business unit's ability to develop new services at a high rate compare with your competitors?
2. How does your business unit's ability to develop new features in your existing services at a high rate, compare with your competitors?
3. How does your business unit's ability to develop new service delivery technology, at a high rate, compare with your competitors?