The Impact of Product, Market, and Relationship Characteristics on Interorganizational System Integration in Manufacturer–Supplier Dyads

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Abstract: Firms are increasingly using collaborative systems to enhance supply-chain visibility. A key emphasis of these interorganizational systems (IOS) is to improve the coordination between buyers and suppliers through electronic integration. While

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such IOS integration is purportedly good, because it tightens linkages in the supply chain, it is not clear whether it is the best configuration under all conditions. A review of literature on adoption and use of electronic data interchange (EDI) systems (a type of IOS) shows that this issue has been examined from multiple theoretic perspectives. Researchers have examined how contingencies related to technology, organization, and environment shape EDI use. Limited attention has been directed toward understanding how conditions under which transactions are conducted impact the use of IOS. We argue that transactional characteristics are important antecedents to IOS integration and propose that demand uncertainty, complexity, market fragmentation, and market volatility capture key characteristics. These factors coupled with an open information-sharing environment are hypothesized to influence IOS integration. Data collected from the electronics industry is used to examine the research model. Results show that firms tend to deploy integrated IOS when complexity of the component is high, market fragmentation is low, and an open information-sharing environment exists. Thus, from a managerial perspective, IOS integration is the appropriate configuration under conditions of high product complexity and open information-sharing environment, but it precludes the firm from participating in the open market and gaining brokerage benefits.

Key words and phrases: collaborative systems, electronic integration, interorganizational systems, supply chains, survey research.

Supply-chain management systems (SCMS) are profoundly affecting buyer–supplier relationships. These systems, offered under the rhetoric of collaborative commerce systems, seek to solve coordination problems in an environment characterized by faster cycle times and an increasing need for responsiveness to changes in demand patterns. However, evidence on the effective use of collaborative commerce systems is mixed. Reasons for this include a lack of clarity regarding the conditions in which the use of collaborative systems is appropriate and disagreements between parties regarding the sharing of proprietary information [31]. This study attempts to shed light on these reasons by examining the context in which collaborative systems are used.

Past research on this phenomenon has examined the adoption and use of electronic data interchange (EDI), a specific type of interorganizational system (IOS). Boyette et al. [4] and Chwelos et al. [10] provide extensive reviews of literature on this topic. These reviews show a predominant focus on innovation diffusion theory and contingency theory (contextual factors) to examine the decision to adopt and use EDI. However, it is important to note that contemporary collaborative systems incorporate functionalities such as sharing of applications and databases that traditional EDI systems typically did not provide. Also, organizations deploy IOS to conduct transactions. Limited empirical investigation has focused on examining how transactional characteristics influence the choice regarding IOS deployment.

A transaction is defined as an exchange of products and services between technologically separate entities [46]. Past research that focuses on examining the transactional context brings forward contingencies such as nature of the component to be procured, nature of the demand for the component, characteristics of the sourcing market for the component, and nature of the transactional relationship [8, 19, 27, 36]. We argue that these factors pertaining to the dyadic transactional context are likely to influence the choice of coordination mechanisms that the firm makes. We also argue that IOS usage is a coordination mechanism that represents one such choice. Prior research has not explicitly examined how the transactional context shapes IOS deployment. Thus, a systematic analysis of this relationship is required. With this motivation, it is the intent of this study to examine conditions in which IOS integration, a specific configuration of collaborative systems, is appropriate. By opening up the transactional context in the study of IOS integration, the results of the study will contribute to the emerging theories that examine this phenomenon. These results will also provide insights to managers on the set of conditions within which IOS integration may be the appropriate configuration.

Literature Review

Governance structures describe how control and coordination is conducted across entities. They embody different mechanisms for information sharing. In its most general form, IOS integration involves the depth of information sharing across firms. Therefore, it is important to examine the concept of integration in light of the theories of interfirm governance. The logic of our arguments proceeds as follows:

- There are a variety of coordination mechanisms that offer varying levels of coordination capability. Efficient governance is based on an alignment between coordination needs and coordination mechanisms.
- IOS provides the technology-based infrastructure for information sharing and can be viewed as a control and coordination mechanism chosen by the organization. Its usage is a choice that can be influenced by factors that determine coordination needs.
- For IOS, the transactional context that captures factors that determine coordination needs is the least studied antecedent to IOS use and needs to be understood better.
- Therefore, the transactional context and IOS integration are the appropriate focus of this study.

Theories on governance structure distinguish between exchange designs and elaborate on conditions under which a certain design may be appropriate. Information processing theory (IPT) proposes that uncertainty is the main source of coordination needs, which needs to be matched with information processing capability through instituting appropriate coordination mechanisms [14]. IPT is based on the efficiency imperative, wherein matching needs with appropriate mechanisms results in efficiency gains. Bensaou and Venkatraman [3] suggest that the environment, relationship, and task are main sources of uncertainty and consequently determine the coordination needs. Standard operating procedures suffice when uncertainty is low; however, more coordination-intensive configuration is required in conditions of high uncertainty.

Transaction cost theory (TCT) proposes that hierarchical governance is appropriate under conditions of high levels of asset specificity, uncertainty, and transaction frequency [46]. Earlier work in this area elaborates on the make versus buy decision. However, recent work highlights the existence of hybrid forms such as bilateral governance, relationalism, alliances, and collaboration [36]. Heide [19] suggests that dependence is a critical factor that can promote or restrict development of relational structures. In case of unilateral dependence, the investment made by the trading parties in the relationship is asymmetric and thus can lead to a hostage situation due to the probability of opportunistic behavior. In a bilateral dependence, both trading parties allocate resources to the relationship, establishing mutual commitment, which puts a damper on opportunistic ambitions and can promote bilateral governance. Overall, TCT argues that exchange conditions have varying levels of costs associated with establishing and maintaining a relationship. Firms that are able to match the governance structure with the exchange context perform better. However, these structures are implemented through coordination mechanisms. Based on TCT, the choice of the appropriate coordination mechanisms when adopted and used will result in cost efficiency.

Resource dependence theory (RDT) proposes the selection of governance structure as a strategic response to uncertainty and dependence. Few firms have the adequacy to internally control all the resources required for effective functioning. Sourcing inputs from the market makes the firm dependent on others for critical resources and increases the likelihood of unpredictable events favoring the institution of bilateral relationships [19]. However, the argument to pursue bilateral governance is built on effectiveness grounds. Proponents of social contracting theory argue that exchange activity is embedded in a social context. Repeated interaction between firms creates relational capital that influences exchange design choice. Thus, the nature of the relationship plays an important role in shaping the coordination mechanisms that are deployed in managing the relationship.

Therefore, cumulatively, literature on interfirm governance recognizes that firms should employ coordination mechanisms that can effectively solve governance problems emerging from various contingencies such as the transactional environment and relational orientation between the transacting parties [36]. It is interesting to note that the different theoretical perspectives show commonality in the exogenous variables that influence governance choice. Transactional and relationship context is proposed as the main source of coordination needs, which have to be matched with appropriate coordination mechanisms for efficient and effective governance.

IOS and Interorganizational Coordination

IOS PROVIDES THE NECESSARY INFRASTRUCTURE on which transactions are conducted. The specific IOS features and functions that firms choose to use reflect their intended level of control and coordination ability. Bensaou and Venkatraman [3] use EDI useintensity as one element of the variety of coordination mechanisms for managing transactions. Further, they propose electronic control and electronic interdependence as two governance types wherein information technology (IT) is the dominant coordination mechanism. IOS can be configured to support structures that promote purely market-based relationships to mechanisms that foster relationships more akin to bilateral governance and relationalism. The decision on IOS use is thus a result of trade-offs made between benefits emerging from electronic brokerage and electronic integration [24, 38].

Once it is recognized that IOS is an important coordination mechanism, factors that constitute the transaction context are likely to influence coordination needs and thus the appropriate use of IOS functions and features. Transactional and relational factors are highlighted by the theories on interfirm governance as antecedents to coordination mechanisms and are likely to also provide insights into the suitable configuration of IOS under these contingencies. Previous research recognizes this issue, but predominantly approaches the notion of IOS use as a technology adoption and assimilation question. We argue that the case for using IOS is integrated with the choice of deploying efficient coordination mechanisms and thus is affected by factors related to the transactional and relational context. Below, we briefly summarize the vast literature on IOS adoption and use and identify gaps that allow us to frame the current study.

Technological, Organizational, and Environmental Perspectives on IOS Adoption and Use

Researchers distinguish between adoption and use as two distinct stages in the overall implementation cycle. However, previous studies have found common factors that play a role in both stages [32, 44]. Based on this presumption, it was deemed important to examine studies that investigate not only use but also the adoption decision. Factors emanating from innovation diffusion theory, institutional theory, social exchange theory, and contingency theory [17, 34, 44] (see Table 1) have been consistently found to impact adoption and use of EDI.

The review of literature shows that the approaches used by researchers in examining IOS use can be segmented into four different streams. First, research that builds on the innovation diffusion approach predominantly focuses on the perceptions regarding attributes of the technology such as complexity, compatibility, and relative advantage in examining diffusion [34]. A second stream expands on this idea by including factors such as top management support, organizational slack, organizational readiness to accept new technology, and IT capability resident in the firm to be important determinants [10]. Studies that fall in the third stream approach the issue from an industry perspective, arguing that environmental and technological uncertainty, industry pressure, competitive pressures, and institutional factors play a significant role [3, 15, 34, 44]. Finally, relational approaches offer another perspective, wherein researchers emphasize the importance of the nature of the relationship between firms and its likely impact on IOS use [17, 41].

Table 1. Literature Review

Cite	Dependent variable	Structure of the relationship	Transaction characteristics	Market and industry-related factors	Technology factors	Organizational factors
Grover [15]	IOS adoption			• Market assessment • Competitive need		• Proactive technology organization • Internal push • Impediments
Zaheer and Venkatraman [47]	Electronic integration	• Trust			• Business process asset specificity	
Premkumar et al. [34]	EDI adoption, adaptation, internal diffusion, and external diffusion				• Relative advantage • Compatibility • Costs	
Premkumar and Ramamurthy [32]	EDI diffusion	• Exercised power		• Competitive pressure		• Top management support
Iacovou et al. [22]	EDI adoption			• External pressure	• Perceived benefits	• Organizational readiness
Hart and Saunders [17]	EDI use	• Power • Trust				
Choudhury [8]	IOS dyads and monopolies		• Demand uncertainty	• Market variability		
Choudhury et al. [9]	Use of electronic marketplace		• Complexity			

Chwelos et al. [10]	Intent to adopt	• Enacted trading partner power • Dependence on trading partner		• Competitive pressure and industry pressure	• Perceived benefits	• Financial resources • IT sophistication • Organizational readiness
Chau and Hui [6]	EDI adoption	• Business partner's influence		• Perceived support from vendor	• Perceived direct benefits	• Prior experience with EDI • Perceived costs
Teo et al. [44]	Financial EDI (FEDI) adoption			• Mimetic • Coercive • Normative		
Hausman and Stock [18]	EDI adoption and EDI implementation	• Social influence • Trust • Dependence • Participative decision making • Open communication				
Kaefer and Bendoly [23]	EDI adoption				• Technological compatibility (with trading partners)	• Operational capacity
Sanchez and Perez [39]	EDI adoption	• Supplier dependence • Mutual understanding		• External pressure	• Operational benefits • Technical difficulties	• Organizational difficulties • Cooperation • Cost difficulties

(continues)

Table 1. Continued

Cite	Dependent variable	Structure of the relationship	Transaction characteristics	Market and industry-related factors	Technology factors	Organizational factors
	EDI use	• Supplier dependence			• Strategic benefits * Cooperation	• Organizational difficulties • Experience in use of EDI • Cooperation
Premkumar et al. [33]	Support for the procurement life cycle	• Trust • Firm investment • Supplier investment	• Complexity • Demand uncertainty • Technological uncertainty • Supply uncertainty • Product criticality			
Son et al. [41]	EDI use	• Exercised power • Reciprocal investment • Trust • Asset specificity • Partnership uncertainty				
Kim et al. [26]	Information transfer for coordination Information transfer for monitoring	• Channel interdependence	• Volume uncertainty • Technological uncertainty • Complexity in use • Complexity in evaluation			

All approaches contribute significantly to our knowledge of IOS use. However, these approaches consider IOS use as technology-centric, enterprise-wide, or supply-base–wide decision, whereas IOS are used for transacting "products" from specific "suppliers." Thus, "transaction" should be used as the unit of analysis. As proposed earlier, different coordination mechanisms may be appropriate for different types of transactions. IOS as a coordination mechanism should be influenced by the modalities of the transaction, as alignment between the two is required for effective governance. Unfortunately, relatively less attention has been given to how the attributes of the transactions that are conducted through electronic channels shape IOS use. Choudhury argues that "a firm's choice of IOISs [interorganizational information systems] depends on the fit between the distinctive nature of the transaction cost benefits provided by a particular IOIS and the benefits most valuable to the firm given the characteristics of the transaction to be supported by IOIS" [8, p. 5]. He proposes demand uncertainty and market variability as two factors that capture the nature of the transaction and subsequently influence the type of IOS a firm may deploy. Electronic monopolies or electronic dyads are proposed as appropriate configurations when demand uncertainty is high and market variability is low. Further, complexity of the component and nature of the relationship between trading parties have also been highlighted as important factors that can influence the configuration of IOS [17, 26, 27, 33].

The relative scarcity of research under the column "transaction characteristics" in Table 1 motivates the need for this study. It is our contention that by jointly examining the influence of transactional and relational context of transactions on IOS use, we can substantially contribute toward the findings of earlier studies. IOS use needs to be examined at the transactional level, which highlights the characteristics of the component being purchased, the nature of the relationship with the supplier providing the component, and the condition of the market that is capable of supplying the component as important contextual contingencies. Below, we elaborate on our conceptualization of IOS use (called IOS integration) as it pertains to improving the information sharing across firms.

IOS Integration

Organizations use IOS applications to support transactions with trading partners. The choice regarding the usage of the attributes of information technology (IT) is dependent on the nature of the transaction [40]. IOS integration is a specific configuration of IOS use that reflects tighter linkages between trading partners enabled through IT. It thus constitutes a mechanism to support bilateral governance (relational structures), wherein both organizations invest in establishing a coordination-intensive configuration. Although the hardware and software can be put to other uses quickly, deploying an integrated IOS requires extensive commitment from trading parties in terms of aligning processes, mapping data elements, and investing in shared resources. The shared IOS infrastructure is configured to accommodate the idiosyncrasies of interfacing processes within each organization, thereby enabling seamless sharing of information and applications across the trading parties. Despite increasingly open and modular architectures, there are switching costs involved for both parties. These include setup costs in terms of understanding interfirm processes and translating that knowledge into an appropriately configured IOS. Implementing an appropriately configured IOS requires mutual commitment from the transacting parties visible in the joint allocation of resources to the configuration of IOS.

IOS integration has similarities to the notion of assimilation, which is defined as the extent to which IT becomes an integral part of the organizational processes [12]. Purvis et al. [35] highlight that the assimilation or usage stage relates to postadoption, wherein organizations often have to contend with the mutual adaptation of technology and context. Assimilation of IOSs in the context of this study can thus be equated to the notion of electronic integration. Kim and Umanath [25] propose that electronic integration captures the IT-enabled integration of business processes between organizations. Choudhury [8] proposes electronic dyads and electronic monopolies as IOS-enabled governance mechanisms that embody a high level of electronic integration. Researchers also emphasize the interpenetration of the systems and the notion of integrated databases that can provide each party with quick access to relevant information as features that connote electronic integration [5, 11, 28]. Building on this work, we define IOS integration as the extent to which the systems shared by two or more firms are integrated to facilitate access to information residing in either firm.[1]

Research Model and Hypotheses

Our approach departs from earlier research on IOS use that predominately focuses on perceptions regarding attributes of technology (such as quality, compatibility, and relative advantage), organizational factors, and environmental contingencies. We theorize that the dimensions of the transaction will shape IOS usage. In order to develop our hypotheses, we use IPT, social contracting theory, and TCT as the theoretical lens.

According to IPT, effective coordination rests on the ability to align coordination needs (emerging from uncertainty) with coordination capability. Social contracting theory brings forward the role of relationship context as an important factor that influences the choice of coordination mechanisms. TCT proposes demand uncertainty, complexity, and relationship context as important dimensions of the transaction that influence the choice of coordination mechanism. However, an additional issue brought forward by TCT is opportunism and its impact on the choice of governance. Unilateral investment can expose one transacting party to opportunistic behavior from the other party. Thus, relational governance may not be an efficient structure, when only one party is investing in the relationship. Prior research suggests that a high level of trust between trading parties can curb opportunistic behavior.[2] Further, mutual commitment, a condition when both trading parties commit resources to the relationship, can also mitigate opportunistic tendencies.[3]

We argue that IPT, social contracting theory, and TCT provide insights into the conditions in which transactions are conducted. Organizations will employ those features of IOS that best mirror the intended coordination structure that is deemed appropriate in a transactional and relationship context. We describe this context in terms of the demand uncertainty and complexity of the component involved in the exchange, market fragmentation and volatility, and the propensity to share information in the exchange.

Uncertainty and complexity contribute to the lack of ability in completely specifying all contingencies leading to adaptation problems, which require the use of mutual adjustment mechanisms for effective governance. The higher the coordination needs emerging from the unpredictability of demand and multitude of relevant transaction specifications required, the greater the importance of coordination mechanisms that enable integration. When coordination needs are lower, firms might have to look at the trade-offs between alternative coordination mechanisms, those that provide integration benefits versus those that provide brokerage benefits.

Fragmented markets consist of a large number of smaller suppliers offering diverse products. Thus, in a fragmented market, the ability to scan through the supplier market becomes critical [8]. Knowledge about prices and product offerings can enable the firms to improve their ability to bargain and get a better deal. Thus, in a fragmented market, firms will favor those features and functions of the IOS that will support electronic brokerage, rather than pursue high levels of IOS integration.

Volatile markets depict rapid change in products, prices, and suppliers entering and exiting the market. Market intelligence is critical in locating the suppliers and rationalizing price discrepancies. Thus, considering the trade-off between integration benefits versus brokerage benefits, those features of the IOS will be favored that will enable an expanded market search rather than those that promote integration. Finally, social contracting theory emphasizes the importance of interfirm relationship when transactions are viewed as embedded in a sociopolitical context as opposed to a discrete event. In our study, we capture this notion through the extent to which the relationship embodies an open information sharing environment and propose that it will promote IOS integration. The research model is presented in Figure 1, and specific hypotheses are discussed below.

Demand Uncertainty of the Component

Demand uncertainty of the component is defined as the level of confidence the buyer has in correctly estimating its demand. The unpredictability of demand creates an adaptation problem between the buyer and the supplier [19]. Adaptation can be managed either by incurring higher costs or by designing mutual adjustment processes. Galbraith [14] argues that high uncertainty increases information processing requirements that have to be matched by either expanding information processing capacity or reducing the need to process information (increase slack). For example, if demand uncertainty of the component is high, coordination requirements go up exponentially because of the possibility of excess capacity or stock outs [45]. Firms can compensate for lack of visibility by increasing buffers and safety stocks, thus incurring higher costs. On the contrary, firms can install mutual adjustment processes by expanding information processing capacity through availability of real-time information on demand, capacity, and schedules. Such information can enable firms to effectively monitor and respond to deviation from estimates [26]. Variations in demand for the component can be effectively managed through close coupling of information systems

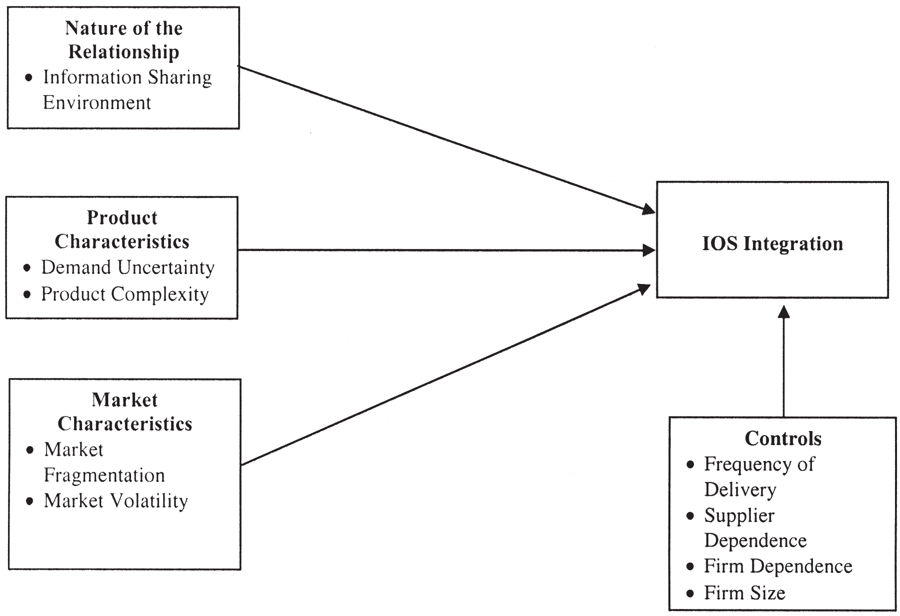

Figure 1. Research Model

(IS) that enable quick access to information [8]. Therefore, by deploying high levels of IOS integration firms can invoke the governance mechanism that facilitates access to real-time information and is an effective response to the coordination needs created by high demand uncertainty.

We would like to note that a firm can also manage demand uncertainty by increasing the number of suppliers in the consideration set. Flexibility in sourcing from multiple sources can enable the firm to effectively address fluctuations if a single supplier is not able to meet its needs. However, it is important to recognize that flexibility is dependent on component standardization. It is difficult to tap into alternative sources of supply when the component is important[4] to the firm's production process. Switching, which is still possible, will require ample start-up costs. Based on this presumption, we believe that for critical components, the firm's likely response in conditions of high uncertainty will be to use an integrated IOS. Thus, we argue:

Hypothesis 1: Demand uncertainty is positively associated with IOS integration.

Complexity of the Component

We define complexity of the component as the amount of information the buyer has to specify to the supplier for effective order processing [27]. Complexity of the component relates to detailed engineering specifications that are required to explain customized designs, subassemblies, and intricate component interfaces [1]. Buyers have to provide a large amount of information at the order specification stage. Order management requires effective handling of this information throughout the order fulfillment process. Subassembly interactions, engineering changes, and material defects that are part of the order management process add another layer of complexity. Rubin [37] argues that to the extent to which there are a large of number of pertinent possibilities, mutual adaptation processes need to be put in place to effectively respond to emergent events. Thus, complex products are likely to be traded through a coordination-intensive structure. In response to high coordination needs, deployment of an IOS that facilitates information processing and exchange is an effective response to managing complexity of the component [26, 33]. Such governance mechanisms support quick access to information and effective information storage, and can enable the firms to effectively manage any changes that may emerge in the order management process. Thus, we propose:

> *Hypothesis 2: The complexity of the component is positively associated with IOS integration.*

Market Fragmentation

Market fragmentation captures the extent to which the market, through which a particular component is being sourced, consists of a large number of smaller firms providing a diverse set of products and prices. Fragmented markets provide a good opportunity to buyers for comparison shopping [8]. An electronic market can enable the buyer to increase the search space with minimal search-related costs, consequently decreasing the potential for opportunistic bargaining. In a fragmented market, the value of the electronic brokerage effect goes up, and the decision on IOS integration depends on a trade-off between the benefits of integration (i.e., the coordination needs within the dyad) or brokerage. The extent of IOS integration reflects this choice.

Kambil et al. [24] argue that to gain the benefits of integration, firms have to forgo the benefits of participating in the open market. By deploying an integrated IOS, a firm may forgo the opportunity to foster competition among the suppliers and get better value. We argue that a fragmented market is ripe for leveraging the brokerage effect and developing an integrated IOS may not be in the best interest of the buyer. Therefore, we propose:

> *Hypothesis 3: Market fragmentation is negatively associated with IOS integration.*

Market Volatility

Market volatility captures the extent to which the prices and players change in the market from which a particular component is being sourced. Buyers are not sure which suppliers will be able to fill their demand at what prices [8]. IOS integration in such a condition will restrict the buyer to coordination within a specific dyad and forfeit the ability to locate multiple suppliers and gather market intelligence on prices. The rapid change in the supplier base for the component can also increase the probability of integrating with a supplier that may not remain in the business for long. When market volatility is high, the buyer will prefer to engage in a spot market transaction favoring the features of IOS that provide electronic brokerage benefits. So, contrary to IOS integration, Choudhury [8] argues that search features of the IOS are more valuable in high market volatility conditions. Thus, we argue:

Hypothesis 4: Market volatility is negatively associated with IOS integration.

Open Information Sharing Environment

Previous studies on TCT have found trust to promote hierarchical-type relationships and expectations regarding continuity of the relationship [47]. Trust is also an important factor that influences IOS use [17, 41]. Trusting relationships increase the potential for information sharing. However, it is the information sharing environment that determines the actual act of sharing information, wherein firms are willing to provide whatever information is required for effective coordination. Hart and Saunders [17] argue that increasing use of EDI systems augments the breadth and nature of information flows between trading partners, raising concerns regarding how this information may be used. Anecdotal evidence suggests that one of the main inhibitors of collaborative systems is the concern regarding the potential misuse of proprietary information that may become available through IOS integration [31]. As organizations implement integrated systems, the extent of information exchange increases, but it also heightens risks regarding the potential misuse of proprietary information. If trading partners are operating in an environment that is conducive to sharing information, such concerns may be alleviated. Trading relationships that are based on open information sharing mainly do so based on the presumption that it will help or facilitate synchronization of processes between trading partners. An open information sharing environment can facilitate IOS integration, which opens up channels to proprietary information on both sides. Thus, we propose:

Hypothesis 5: An open information sharing environment is positively associated with IOS integration.

In Table 2, we illustrate each construct by providing examples of components used in the electronics industry. We also provide a summary of our rationale for the five hypotheses. The last column of the table illustrates types of IS that would be relevant in each context.

Control Variables

Previous studies have found many variables that affect IOS use. The theoretical lenses that are used in this study primarily drive our selection of the required control variables. We selected supplier dependence and focal firm dependence as two factors that emerge from the nature of the relationship surrounding the transaction. These factors have been consistently examined in prior studies [10, 18, 32, 39].

Table 2. Rationale for IOS Integration

Antecedent factor	Example	Why IOS integration may or may not be appropriate	Examples of system types
Demand uncertainty	Company X uses a printed circuit board in manufacturing a network device. However, the demand for the network device is highly variable. Subsequently, the demand for integrated circuits fluctuates and thus is difficult to predict accurately.	Information sharing enabled through IOS integration can enhance demand collaboration and improve forecast accuracy. Information sharing can assist in understanding the variability in demand and, subsequently, developing accurate plans and making effective replenishment decisions.	Advanced planning systems, advanced shipment notice systems, automatic alert systems, and automatic replenishment systems.
Product complexity	Company X manufactures mobile phones and sources chip sets. As the chip set provides the chassis, its design is constrained by interaction with other components, size requirements, power requirements, and compatibility with multiple radio frequency (RF) bands. Complex design and interaction with other components requires specification of detailed information and thus contributes to the complexity of the chip set from a procurement perspective.	Accessibility of real-time component data (i.e., purchase orders, engineering drawings, subassembly interactions, material defects, etc.) enabled through integrated IOS can result in efficient order management and reduction of time spent on tracking and managing orders. Trading partners can utilize time for indulging in collaboration on strategic issues such as examining future product trends, new product development, and more intricate understanding of each other's processes.	Product data management systems, electronic procurement systems, and shared CAD/CAM systems.

(continues)

Table 2. Continued

Antecedent factor	Example	Why IOS integration may or may not be appropriate	Examples of system types
Market fragmentation	Company X uses special purpose sensors in the product it manufacturers. The sensor industry is highly fragmented with many small companies producing a variety of sensors.	Comparison shopping or reverse auctions can provide cost savings when a large number of suppliers are capable of supplying the component. Thus, a firm will likely be forgoing the potential savings if it decides to integrate with a supplier operating in a fragmented market.	Electronic markets and reverse auctions.
Market volatility	Company X manufactures capacitors that use tantalum. The supply of tantalum is uncertain, resulting in frequent fluctuation in price and number of suppliers that can fulfill the demand on a consistent basis.	Electronic markets can reduce buyers' costs of obtaining information about prices and product offerings from alternative suppliers. They can also reduce buyers' costs for soliciting information about prices and product characteristics, enhancing their ability to locate appropriate suppliers. Thus, integrating with a supplier providing a component for which the market is volatile may not be advantageous.	Electronic markets and reverse auctions.
Information sharing environment	Company X procures LCDs from a supplier for assembling notebooks. Both parties recognize the value of openly sharing information with each other. Thus, they are willing to exchange information that will help in streamlining the interaction between them.	An open information sharing environment reduces the probability of misuse of proprietary information that may be accessible through integrated systems, subsequently reducing the risk of opportunistic behavior. Trading partners may be open to implementing and using shared systems mirroring characteristics of integrated IOS in an open information sharing environment.	Opens the opportunity to use shared interorganizational system modules and databases.

Dependence relates to the extent to which one firm is dependent on another for resources and services. Hart and Saunders [17] argue that a supplier is dependent on the customer if the customer is responsible for a large portion of its sales volume and ultimate profitability. In this case, the customer can influence the supplier's decision making. On the contrary, the customer may be dependent on the supplier if the supplier provides unique products or has invested in specialized assets that other potential suppliers do not possess. In the first case, the supplier has an incentive to integrate systems as a way to managing its dependence on the buyer. However, in the second case, the buyer may be more motivated toward pursuing integration to manage its dependence on the supplier. We believe that in both cases, the firms will move toward managing dependence by establishing integrated IOS.

Frequency of delivery is proposed by work based on TCT as a factor that influences the use of governance mechanisms [36]. An integrated system is appropriate for components that have a high frequency of delivery [46]. It provides the appropriate infrastructure for effectively managing exchange of high-volume components. So, frequency of delivery represents an important aspect of the transaction that can significantly influence IOS integration. Finally, firm size is included in the model as another control variable. We expect that larger firms might have greater resources, capabilities, and inclination to deploy integrated IOS.

Methodology

A survey was conducted to collect data and examine the research hypotheses. Senior purchase managers were selected as the key respondents. Their firsthand experience in using IOS, purchasing components, and managing supplier relationships qualifies them as knowledgeable about the issues the research intends to address. The managers were asked to respond to the instrument in the context of an ongoing relationship through which a *component* that is important to their production process was being sourced. This was done to provide the respondents with a reference point for responding to the questions in the survey. It also enabled configuring the questions with respect to the unit of analysis, which, in this case, was the dyadic exchange relationship between a buyer and its supplier through which a particular component was being traded.

To limit industry effects, data were restricted to the dyadic exchange relationships of electronic equipment manufacturers and their suppliers. The sample frame consisted of a list of 5,000 electronic equipment manufacturers provided by a professional information service affiliated with a number of prestigious magazines. From this sample frame, 1,000 firms were randomly selected. An initial solicitation for participation in the study was mailed to these firms. There were 730 surveys administered to firms that agreed to participate in the study. A total of 203 responses were received after two rounds of solicitation. Out of these 203 respondents, 156 companies provided information on relationships (long term as opposed to a one-time purchase). Subsequently, the sample size was reduced to 142 due to missing values, giving a response rate of around 19 percent.

Table 3. Profile of the Respondents

Respondent profile	Percentage
Director of purchasing	8.3
Purchasing manager, buyer, procurement manager	57.1
Top management (with purchasing responsibility but not directly related to purchasing)	2.0
Other management	30.9
Missing	2.6

Nonresponse bias was examined in two ways. First, comparison between respondents and a randomly selected set of nonrespondents revealed no significant difference based on sales volume and number of employees. Second, comparison between early and late respondents with regard to the study variables also revealed no difference. The profile of the firms and respondents is given in Tables 3 and 4. The majority (65 percent) of respondents were directly involved in purchasing at the director/managerial level, while the rest were managers involved in the purchase process. Purchased components were sourced from different industries (see Table 5). However, electronic components such as semiconductors, integrated circuits, relays, and transformers constituted a relatively larger percentage of the purchased components (59 percent).

Information collected on electronic linkages revealed that 21 percent of the respondents were using a proprietary EDI system or industry platform-based EDI system, 60 percent of the firms were using a combination of EDI and Web-based systems, while the remaining 19 percent were using a Web-based system. In terms of initiation and involvement in configuring and implementing the IOS system, 80 percent of respondents initiated the IOS linkage, while the rest either involved a third party (7 percent) or were initiated by the supplier (13 percent). While the distribution of the respondents was skewed toward smaller firms, 70 percent of the respondents stated that they were actively involved in the implementation of the electronic linkages.

Measurement

Construct measurement for open information sharing environment, firm dependence, supplier dependence, and IOS integration was conducted through previously validated scales [2, 16, 17, 20]. Measures for market fragmentation, market volatility, and demand uncertainty were developed based on the work by Choudhury [8]. He proposes that market fragmentation captures the extent to which a large number of firms constitute the component market. This concept is opposite to the notion of market concentration wherein only a few large firms are capable of supplying a particular component. Market volatility captures the rate of change in suppliers and prices in the component market. Demand uncertainty reflects unpredictability in the timing and volume of demand for the component. Complexity of the component was assessed using guidelines suggested by Hobday [21] and Malone et al. [27]. The items for all the constructs are shown in Appendix Table A1.

Table 4. Profile of the Firms Based on Number of Employees

Company profile (employees)	Percentage
1–250	57.8
251–500	9.4
501–1,000	6.1
1,001–2000	6.8
>2001	17.9
Missing	1.9

Table 5. Industry Profile of the Component

Industries	Percentage
Instruments, equipment	5.8
Electrical goods (relays, transformers, etc.)	20.5
Mechanical devices (lifts, valves, etc.)	2.6
Electronic goods (semiconductors)	38.5
Materials and metals	7.7
Plastics, chemicals, and so on	3.2
Related to computers, software, motherboards, peripherals	12.2
Others	4.5
Missing	5.1

Construct validity was examined by first using exploratory factor analysis and later by partial least squares (PLS). The results for exploratory factor analysis are shown in Table 6. Table 7 provides the descriptives for each variable and Table 8 shows reliability and intervariable correlations. The results of factor analysis with varimax rotation provide evidence for both convergent and discriminant validity. The item loadings on core constructs are above the acceptable guidelines, providing evidence of convergent validity. Minimal evidence of cross-loading shows support for discriminant validity. The reliability (alpha) for the constructs is also within the suggested limits [30].

The loadings and composite reliability based on the results of PLS analysis show that scales depict good convergent validity (Table 9). Fornell and Larcker [13] suggest that discriminant validity is established when average variance extracted (AVE) for an individual construct is greater than the squared multiple correlation of that construct with other constructs. Table 8 (diagonal elements show AVE computed based on the PLS analysis) shows that this condition is met in all cases [7, 42]. Thus, based on the analysis, the constructs depict good psychometric properties.

Results

PLS WAS USED TO TEST THE HYPOTHESES (PLS Graph was used as the tool to conduct the analysis). The incremental variance explained by the predictor variables over

Table 6. Factor Analysis

	Product complexity	Demand uncertainty	Information sharing environment	Market fragmentation	Supplier dependence	Market volatility
Complex1	0.91	0.03	0.10	0.14	–0.04	0.00
Complex2	0.90	0.05	0.10	0.10	–0.01	0.09
Complex3	0.70	0.20	0.05	–0.01	0.24	–0.05
Complex4	0.80	0.04	0.18	0.22	0.15	0.02
Complex5	0.85	–0.04	0.16	0.12	0.01	0.19
UnCer1	0.14	0.87	0.04	-0.03	-0.02	0.04
UnCer2	0.05	0.91	0.03	0.00	-0.05	0.08
UnCer3	0.00	0.90	–0.09	-0.04	0.01	0.02
MarFra1	0.28	–0.09	0.04	0.76	0.07	–0.13
MarFra2	0.05	0.10	–0.01	0.70	–0.05	–0.24
MarFra3	–0.01	–0.06	–0.08	0.76	–0.11	–0.21
MarFra4	0.26	–0.06	0.06	0.65	0.06	0.24
MarVol1	0.16	0.15	–0.05	–0.09	0.13	0.81
MarVol2	–0.01	0.00	–0.11	0.29	0.17	0.74
SuppDep1	0.08	–0.02	0.15	0.01	0.92	0.02
SuppDep2	0.12	–0.05	0.09	–0.05	0.93	–0.03
InfoShar1	–0.04	–0.02	0.85	–0.05	0.04	0.04
InfoShar2	0.12	0.12	0.67	–0.16	0.16	0.10
InfoShar3	0.30	–0.02	0.70	0.07	–0.00	–0.07
InfoShar4	0.13	–0.08	0.80	0.10	0.09	0.00
Variance explained	19.15	12.48	12.17	11.57	9.47	7.31

Note: Total variance explained = 72 percent.

Table 7. Descriptive Statistics

Variables	Mean	Standard deviation
Information sharing environment	5.71	1.01
Firm dependence	7.81	7.27
Supplier dependence	3.32	1.55
Demand uncertainty	3.93	1.41
Product complexity	4.12	1.41
Market volatility	4.25	0.82
Market fragmentation	4.26	1.29
Frequency of delivery (control)	15.02	82.17
IOS integration	1.91	1.49

the control variables was significant ($p < 0.01$) (Table 10). Individual hypothesis were examined by assessing the significance of the path loadings in the model. The bootstrapping procedure with a random sample of 100 from the original data set was used to assess the significance of the path loadings in the model. The results for the research model are shown in Figure 2 and Table 10.

Surprisingly, H1 was not supported, showing lack of support for the positive relationship between demand uncertainty and IOS integration. However, the results indicate that procurement of highly complex components is positively related to IOS integration, providing support for H2. The result for the negative relationship between market fragmentation and IOS integration is also significant, supporting H3. The relationship between market volatility and IOS integration was statistically insignificant and H4 was not supported. Results show support for H5, depicting that an open information sharing environment does positively relate to IOS integration. Therefore, three of the five hypotheses were supported. Among the control variables, firm size was the only factor that was positively related to IOS integration.

Discussion

Integration through IOS systems has generally been proposed as a desirable state in the context of buyer–supplier relationships. This study builds on previous research by specifically examining how the transactional and relationship context shape the use of IOS (integration) in a dyadic context. We found that firms tend to deploy integrated IOS when complexity of the component is high, market fragmentation is low, and an open information sharing environment exists. These results provide useful guidelines on conditions in which IOS integration, a specific configuration of IOS, may be appropriate.

The results indicate that integrated IOS are prevalent in the sourcing of components that are complex. Procurement of complex components requires that the buyer share rich information such as technical specifications and engineering drawings with the supplier. Complexity of the component affects the ordering process in two ways. First, at the order specification stage, if the component is of high complexity, order

Table 8. Correlation Table

	Reliability	Information sharing environment	Firm dependence	Supplier dependence	Demand uncertainty	Product complexity	Market volatility	Market fragmentation	Frequency of delivery	Firm size	IOS integration
Information sharing environment	0.74	0.77									
Firm dependence	N/A: one item measure	0.00 (0.967)	N/A								
Supplier dependence	0.80*	0.21 (0.010)	0.22 (0.007)	0.95							
Demand uncertainty	0.90	–0.03 (0.709)	–0.03 (0.764)	–0.07 (0.365)	0.89						
Product complexity	0.88	0.31 (0.000)	0.31 (0.000)	0.17 (0.036)	0.28 (0.001)	0.84					
Market volatility	0.38*	–0.02 (0.814)	0.16 (0.045)	0.17 (0.033)	0.10 (0.253)	0.18 (0.028)	0.78				
Market fragmentation	0.73	0.00 (0.964)	0.38 (0.000)	0.01 (0.929)	–0.06 (0.430)	0.28 (0.001)	0.17 (0.038)	0.73			
Frequency of delivery	N/A: one item measure	–0.06 (0.448)	–0.03 (0.748)	–0.07 (0.410)	0.12 (0.138)	0.09 (0.290)	–0.02 (0.824)	–0.01 (0.902)	N/A		
Firm size	N/A: one item measure	–0.09 (0.253)	0.27 (0.001)	0.11 (0.167)	0.15 (0.067)	0.13 (0.124)	0.10 (0.245)	0.13 (0.123)	–0.01 (0.60)	N/A	
IOS integration	0.82	0.28 (0.000)	0.13 (0.098)	0.23 (0.004)	0.15 (0.070)	0.29 (0.000)	0.05 (0.540)	–0.06 (0.464)	–0.04 (0.599)	0.19 (0.02)	0.87

Notes: * = interitem correlation. *p*-values are shown in parentheses. Square roots of average variance extracted are shown on the diagonal. N/A = not applicable.

Table 9. Loadings and Composite Reliability Based on PLS Analysis

Constructs/items	Loadings	Composite reliability
Product complexity		0.87
Complex1	0.90	
Complex2	0.89	
Complex3	0.69	
Complex4	0.91	
Complex5	0.89	
Demand uncertainty		0.92
UnCer1	0.92	
UnCer2	0.90	
UnCer3	0.86	
Market fragmentation		0.80
MarFra1	0.73	
MarFra2	0.71	
MarFra3	0.94	
MarFra4	0.40	
Market volatility		0.75
MarVol1	0.57	
MarVol2	0.94	
Information sharing		0.86
InfoShar1	0.81	
InfoShar2	0.73	
InfoShar3	0.76	
InfoShar4	0.79	
IOS integration		0.90
IOSInt1	0.89	
IOSInt2	0.88	
IOSInt3	0.83	
Supplier dependence		0.95
SuppDep1	0.95	
SuppDep2	0.95	

entry becomes a cumbersome process, as more attributes of the product have to be assessed. Subsequently, in the order management stage, engineering changes and defect reporting require revisions that can consume immense resources. IOS that depict close coupling through sharing of application and databases can streamline both order specification and order management. Based on our reasoning and results, we conclude that deploying integrated IOS for procurement of complex products is the appropriate approach.

It is surprising that IOS integration does not show a relationship with demand uncertainty, a factor capturing the rate of change in component demand. Demand uncertainty poses an adaptation problem, wherein a buyer and supplier need to respond to the changing market demand. Researchers argue that under these conditions, flexibility is an important consideration [36]. Integrated IOS can provide the information required in managing the adaptation problem, but this information may be of less value if

Table 10. Results for PLS Analysis (the Dependent Variable Is IOS Integration)

Variables	Model I Standardized coefficients	Model II Standardized coefficients
Firm size	0.17*	0.18*
Supplier dependence	0.21*	0.13
Firm dependence	0.02	0.04
Frequency of delivery	–0.03	–0.08
Uncertainty		0.12
Complexity		0.17*
Market volatility		0.14
Market fragmentation		–0.22*
Information sharing environment		0.21**
R-square	0.082	0.22
F-value to test for change in *R*-square		14.15**

* $p < 0.05$; ** $p < 0.01$.

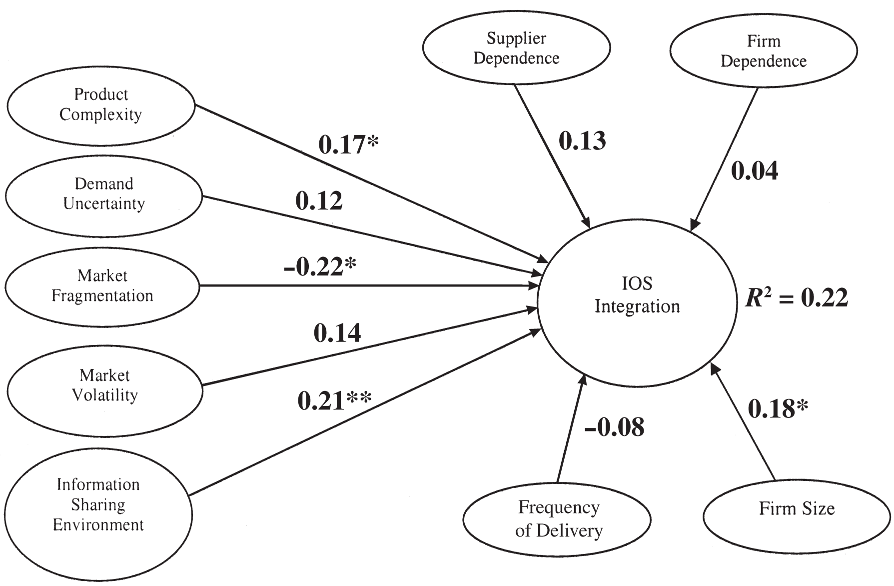

Figure 2. Results for the PLS Structural Model
* $p < 0.05$; ** $p < 0.01$.

the shop floor realities dictate the extent of permissible flexibility. For example, in a manufacturing context, altering capacity is a rather difficult proposition. Integrated systems may enable buyers and suppliers to share real-time information, which, in essence, should enable them to manage demand uncertainty. However, this may lead to situations where the buyer or the supplier may face over- or under-capacity situations, thus diminishing the value of real-time information. Another plausible reason relates to the logic that loose coupling may enable managing demand uncertainty by quickly tapping into alternative sources of supply. However, in this case, we should expect a negative relationship between demand uncertainty and IOS integration, which was not observed. Therefore, we suspect that additional contingencies may be diluting this relationship, which would benefit from further examination.

The results show that firms tend to have low IOS integration when sourcing components for which the market is fragmented. Fragmented markets are characterized by a large number of smaller firms fiercely competing for business. So, firms want to keep their options open when the market for the component from which they are sourcing is fragmented. Rather than integrating, loose coupling with multiple players may enable them to gather market intelligence and do comparison shopping. Choudhury et al. [9] observed in the aircraft parts industry that electronic market–type systems were appropriate for components for which markets were fragmented. Such systems open up the opportunity for cost savings by enabling the firm to expand the search space and survey the market more thoroughly. It can be argued that having an integrated IOS is not always the best approach to pursue. In the case of fragmented markets, having loose coupling with multiple suppliers can be more advantageous to the buyer.

We also found the relationship between market volatility and IOS integration to be nonsignificant. If the component market is volatile, there are no invariant sources of supply, and pricing is unpredictable. Under these conditions, putting resources into high levels of integration can limit a firm's comparison shopping ability [8]. However, the results do not lend support to this argument. It seems that market volatility may not, by itself, be an antecedent to integration at this stage and within this sample. Firms may still be in the process of comprehending how to configure IOS in procuring components for which markets are volatile. Further, contemporary IT might be able to absorb volatility issues independent of its configuration.

Hart and Saunders [17] emphasize that trust actually alleviates the concerns that firms may have on the potential loss and misuse of proprietary information that may be flowing through the systems. Our analysis provides support for this assertion. Despite increasing emphasis on collaborative commerce systems, major impediments remain in realizing their true potential. It is our belief that an open information sharing environment is a prerequisite for integration of systems between a buyer and a supplier. Such an environment plays a pivotal role in mitigating the concerns regarding the intrusiveness of integrated IOS. It also enables firms to realize the potential benefits of integration, as firms are willing to share information that may help in improving the efficiency and effectiveness of the linkage.

Implications for Research and Practice

We offer several implications for managers struggling to comprehend the conditions under which IOS integration makes sense. Complexity of the component and market fragmentation are fixed conditions on which managers have relatively less control.

So, here the main suggestion is to configure integrated IOS when procuring complex products and, on the contrary, focus less on integrated systems when component markets are fragmented. It is recommended that before embarking on configuring integrated IOS, managers need to craft an open information sharing environment in which both the buyer and the seller are willing to share information. One approach in this regard is to start with small projects with an explicit objective of demonstrating benefits of information sharing. Firms tend to initiate pilot projects, the positive results of which form the basis for an open information sharing environment, which then facilitates implementation of integrated IOS. This will help in mitigating the concerns regarding the intrusive nature of integrated IOS. It will also alleviate anxiety about misuse of proprietary information.

IOS integration from a systems and supply-chain perspective is usually presented as a state that firms wish to achieve. The core arguments relate to the importance of seamless information flow in order to create efficiencies within the chain. However, this study suggests some caveats to this "universal truth." First, the decision to integrate needs to be examined in the context of its potential impact on loss of brokerage effect. There are transaction types in which market-type relationships provide the best benefits. The fact that integration and bilateral governance requires a level of mutual commitment and trust presents a hurdle that needs careful consideration. So, it is important to examine the contextual conditions to assess the trade-offs between brokerage and integration in determining whether using integrated systems is indeed the appropriate approach. Today, the emergence of component-based architectures provides the organizations the flexibility to select from a variety of system features. Base ordering systems can be expanded by adding modules for forecasting, capacity planning, inventory management, and replenishment that can be shared by organizations. This provides an organization the flexibility to implement system functionalities that align with the transactional and relationship context.

Second, better information integration by itself may not be a sufficient condition for supply-chain performance. Having integrated IOS may enable the firms to increase information visibility. But visibility can only be beneficial when flexibility to rapidly adapt to changing circumstances exists. Capacity and equipment constraints generally limit the flexibility and subsequently pose boundary conditions on the benefits of visibility. Thus, the decision to expand visibility through IOS should always be evaluated in the context of the entire system's ability to respond to improved information.

By focusing on the transactional and relational context, this study treads on different ground with respect to IOS usage studies. However, interesting research questions still remain to be explored. One issue emerging from this study is the likelihood of the differential role that uncertainty (rate of change) and complexity of the component play in determining IOS integration. IOS integration represents an information sharing structure that should be appropriate for conditions in which demand for the component is variable. But our study does not support this; rather, we found that complexity emerging from trading of technical complex components fits well with IOS integration. This issue deserves further research. A study on a more granular assessment of this differential role may expand on the conceptualization of uncertainty, complexity, and IOS integration. Uncertainty can also emerge from the environment, while complexity could be product, process, and supply-chain related. Similarly, the notion of IOS integration can be transformed to include a proactive flow of information by the systems. Current systems are being equipped with tools that trigger automatic information flows. They are configured to take a more proactive role in dissemination of information. Such an analysis can nicely build on the results of this study and can provide greater insights.

In addition, further research that investigates the relationship between market volatility and integration is warranted. If there are firms that are sacrificing brokerage effects and integrating their systems in conditions of high market volatility, it would be important to understand the vagaries of this relationship. Perhaps expanding the nomological network by including variables from social network theory would enhance our understanding. Finally, to truly generate prescriptive implications, it would be useful to build upon the conceptual structure presented here by explicitly examining the performance implications of the fit between the conditions and the IOS configurations. This will provide further credence to results and also examine what aspects of performance may be affected.

Limitations

The study suffers from some limitations, which mainly emerge from the trade-offs that we made over the course of the study. The generalizability of the study is restricted to the electronics industry and the sample is a little skewed toward smaller firms. However, industries that have similar characteristics to the focal industry may be able to benefit from these results. The respondents were asked to select an ongoing relationship and it was left to the respondent to decide which relationship they selected. Assuming that the choice of the relationship will be randomly distributed across the sample, it may have minimal effects on the results of the study. Another limitation of the study is how IOS integration is conceptualized. Subramani [43] argues for using the patterns of appropriation perspective, wherein IOS is conceptualized to reflect the intentionality of use. Although we recognize that intentionality of use is important, understanding the configuration of IT systems that can support diverse uses is also pivotal. The conceptualization that we use provides insights into the structural configuration of the IOS that may become the basis for using the system for exploitation or exploration. Further, the current operationalization of IOS integration also does not capture the functionality aspect. We provide examples of system types that may be appropriate under different contingencies. Capturing the various functionalities of the IOS in addition to the extent of integration can provide a better measurement approach in future studies. The study frames the question regarding IOS integration as dyadic in nature, but does not explicitly incorporate power issues that have been found to be important in prior literature. We include firm dependence and supplier dependence as control variables in the model to account for the influence of dyadic asymmetry in dependence, which is likely to influence IOS choice. Finally, the cross-sectional nature of the study only provides us with evidence for association among the study variables. However, the theoretical bases employed to support the hypotheses provide justification for the path model presented in the paper.

Conclusion

Many previous studies have examined the factors that impact the adoption and use of EDI systems. Most of the research in this domain treats IOS use as an adoption or assimilation question rather than one integrated with governance structures. While prior work has contributed much to the knowledge base, few empirical studies have examined what role factors related to the transactional context play in influencing IOS integration. We argue that jointly examining the nature of the relationship along with characteristics of the transaction provides a perspective that can contribute toward the knowledge that has already been accumulated.

Overall, four important insights emerge from this study. First, an open information sharing environment lays the foundation for integrated IOS. Second, integrated IOSs are appropriate when the component being purchased is complex, but may not be appropriate for purchasing components for which the market is fragmented. Third, the relationship between IOS integration and demand uncertainty may possibly be confounded by shop floor rigidities. Integrated IOS may enable free flow of information, but if adjustments cannot be made based on the information, its value diminishes. Fourth, there is a cost to integration in forgone brokerage benefits that could vary depending on the context. These findings also alert interested readers to the caveats associated with promoting IOS integration as a panacea for managing all dyadic supply-chain relationships.

Notes

1. Assimilation can also be achieved in the context of IOS that have attributes of an electronic market. However, because our focus is on enduring relationships, this notion of assimilation is not addressed.

2. While not specifically theorized, it is useful to note that the level of “trust” measured in the relationships studied was high (5.9 on a seven-point scale).

3. High asset specificity raises the risk of opportunistic behavior and consequently increases the need for coordination for effectively controlling opportunism. Firms may internalize production to manage the possibility of opportunistic behavior, but can also create mutual safeguards through fostering joint commitment to the relationship [19]. It can be argued that investing in specific IT assets that promotes integration could actually increase opportunism. However, it should be noted that specificity of the IT assets lies in how the system is configured to support the interaction between trading partners. If the relationship is terminated, both parties will lose the resources and efforts expended on configuring and optimizing the IOS. Further, the basic components of the IT assets (hardware and software) can still be easily deployed in another context subject to resources that will have to be spent in the setup of the new configuration. However, both parties will have to incur these costs. We believe that “sharing” of applications and data requires mutual commitment from both transacting parties in terms of synchronizing data items and information flows. Further, the benefits of proactively sharing information in terms of streamlined operations through bilateral planning can put a damper on opportunistic ambitions [29].

4. As described later, our focus was on components that are *important* to the production process.

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Appendix

Table 1A. Items for the Constructs

Variables	Items
Open information sharing environment [20]	• In this relationship, it is expected that any information that might help the other party will be provided (InfoShar1). • Exchange of information in this relationship takes place frequently and informally and not according to a prespecified agreement (InfoShar2). • It is expected that the parties will provide proprietary information if it can help the other party (InfoShar3). • It is expected that the parties keep each other informed about events or changes that may affect the other party (InfoShar4).
Firm dependence [2]	Suppose your company were to switch suppliers for component C and start purchasing them from another source. How much time would the switchover take? (This is the time that might be required to locate, qualify, train, make the necessary investments, conduct testing, and develop a working relationship.) It would take ______ months until satisfactory performance could be expected from the new supplier.
Supplier dependence [17]	• For supplier S, the percentage of its total revenue that involves sales of component C to our firm is very high (SuppDep1). • For supplier S, the percentage of its total profits that involves sales of component C to our firm is very high (SuppDep2).
Demand uncertainty [8]	• It is easy to predict the timing of our requirements for component C (UnCer1). • We are confident of our ability to estimate our future need for component C (UnCer2). • The volume of our future demand for component C is predictable (UnCer3).
Product complexity [21, 27]	• Component C tends to be technically complex (Complex1). • Component C requires a lot of information to fully describe (Complex2). • Component C has a large number of subcomponents to describe (Complex3). • Component C needs significant engineering effort and expertise (Complex4). • Component C tends to be relatively sophisticated (Complex5).

(continues)

Table 1A. Items for the Constructs (*continued*)

Variables	Items
Market volatility (based on [8])	• The rate at which the prices of component C change over time is very high (MarVol1). • The rate at which the suppliers of component C change over time is very high (MarVol2).
Market fragmentation (based on [8])	• On average, the number of external suppliers capable of providing component C is very high (MarFra1). • The number of substitutes for component C is very high (MarFra2). • The extent of competition among suppliers of component C is very high (MarFra3). • The degree of difficulty for a new supplier of component C to enter the market is very high (R) (MarFra4).
Frequency of delivery	On average, how may times do you order component C from supplier S? ______ per month
IOS integration [16]	Please indicate the extent of your company's computing interaction with supplier S: • Our company shares databases with supplier S (IOSInt1). • Our company shares applications with supplier S (IOSInt2). • Our company exchanges files with supplier S (IOSInt3).

Note: Perceptual items were measured by using a scale ranging from 1 to 7.