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# AN EMPIRICAL INVESTIGATION OF ELECTRONIC INTEGRATION IN A SUPPLY CHANNEL RELATIONSHIP

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## Abstract

Electronic linkage between a firm and its suppliers has opened up new avenues for information exchange between the participants. As a consequence, the very nature of the relationship between the firm and its suppliers is drastically affected necessitating a reassessment of the firm's business strategy. Our conceptual model leads us to believe that "more" is not always "better" especially in electronic integration between a firm and its suppliers. We are examining the "fit" between contextual factors and electronic integration for "optimal" performance. By understanding how a firm uses information technology for supplier relationships and how they assess the benefits of electronic linkages, we expect to verify our conceptual model. The results of this research are expected to provide both theoretical explanation and empirical validation on when tight electronic integration is appropriate and when it is not. We also expect to be able to validate the current practices in industry and offer specific recommendations regarding the information flow aspect of their supply chain logistics.

**Keywords:** Electronic integration, information flow in a supply channel relationship, interorganizational systems, IOS, IS integration, EDI

## 1. MOTIVATION

Information interchange using electronic linkages between firms has been transforming the nature of the relationships among business partners, typically moving them away from vertical integration toward external contracting of key activities (Bensaou 1997). *Electronic integration (EI) is defined as the interconnection and integration of the business processes of two or more independent organizations through information technology (IT) applications*, as an alternative to traditional vertical integration (Zaheer and Venkatraman 1994). The economic rationale for EI is that by decreasing coordination costs associated with doing business both within the firm and outside, IT will provide opportunities for cost reduction and revenue expansion. This may entail either changing the structure of markets or boundaries that separate the firms in those markets. Since these coordination processes involve communicating and processing information, it seems quite plausible to assume that IT, when used appropriately, can reduce these costs (Malone, Yates and Benjamin 1987).

EI has been studied both theoretically (e.g., Bensaou and Venkatraman 1995) and empirically (e.g., Choudhury 1997). However, prior research shares the following common limitations. First, prior research on EI has relied exclusively on rational economic perspective (e.g., transaction cost analysis). Other theories may be of value in capturing the wholeness of interorganizational relationship (Bensaou and Venkatraman 1995). Second, electronic data interchange (EDI) adoption has been the surrogate measurement for EI and that too measured on a dichotomous scale (e.g., O'Callaghan, Kaufmann and Konsynski 1992). A simple EDI link that automates merely the transmission of orders from the buyer to the seller is not an adequate measure of electronic integration (Choudhury 1997). While researchers have suggested assessment of the degree of such integration instead of presence/absence of EI between two firms (e.g., Choudhury 1997; Malone, Yates and Benjamin 1987), none has yet developed such a measure. Third, systematic, empirical investigation of theoretical propositions about EI is rather few (Bensaou 1997; Bensaou and Venkatraman 1995; Choudhury 1997).

In IS literature, the term electronic integration is often loosely used as a synonym for electronic data interchange. EI is a broader construct that encompasses (1) integration of business processes of the participating firms via electronic means and (2) the associated technological interconnectivity (Zaheer and Venkatraman 1994). Thus, in an EI environment, EDI is a subset that performs the technological function of being an efficient conduit for the information flow in the supply channel. There is a stream of research that examines the antecedents of EDI, EDI adoption behavior, impact of EDI on firm performance, etc., which is not directly relevant to our research. There are just a handful of empirical studies in the EI stream. For instance, Zaheer and Venkatraman (1994) examined the antecedents of EI in the insurance industry. The same two authors also investigated the performance effects of EI by comparing a group of insurance agents that were electronically interfaced with a group that wasn't. The groups were formed based on EI adoption behavior.

The research issues addressed in our work are: (1) measurement of EI as a multidimensional construct instead of the narrow EDI adoption behavior and (2) examination of the congruence between EI and contextual factors in the supply channel for optimal channel performance. The organizational information processing model (Galbraith 1973; Tushman and Nadler 1978) serves as the principal reference theory, with additional concepts incorporated from transaction cost economics.

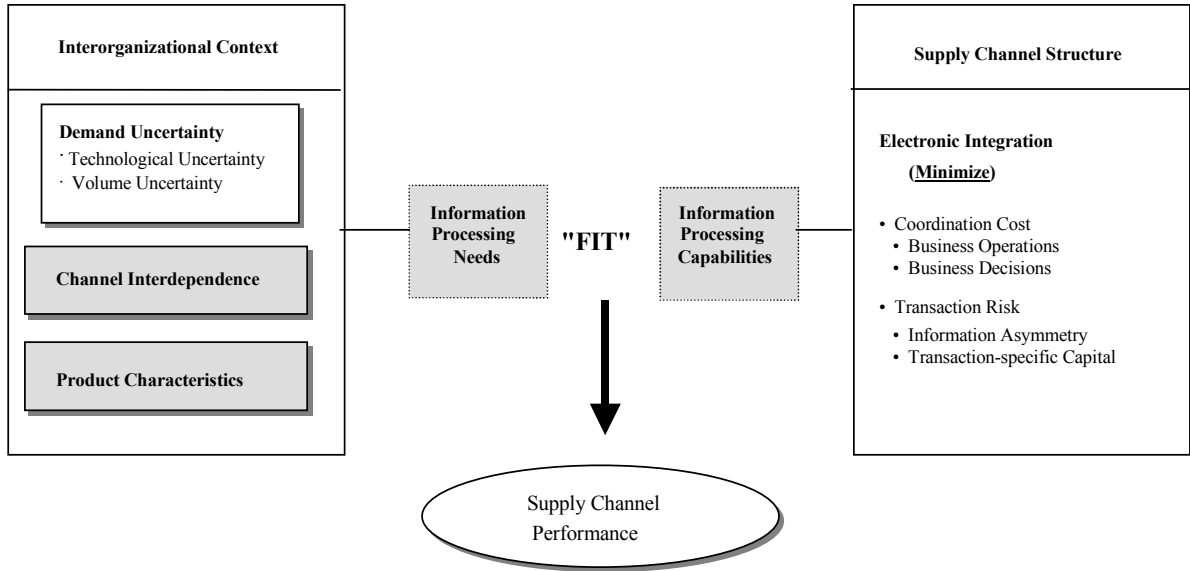
## **2. THEORY**

A conceptual model of the supply channel relationship, based on the organizational information processing theory, is developed for the interorganizational context. The research model in Figure 1 represents this extension to the organizational information processing model that Galbraith (1973) and others (Tushman and Nadler 1978) propounded. The model postulates that various forms of uncertainty in the supply channel (contextual factors) give rise to information processing needs that a channel faces; **seeking optimal channel performance**, the firms participating in the channel relationship generate appropriate information processing capabilities. The concept of "fit" connotes that insufficient information processing capabilities as well as excessive information processing capabilities lead to less than optimal performance. Since information processing needs and information processing capabilities are abstract (unmeasurable) constructs, the fit is operationalized in terms of the "congruence" between the determinants of the two constructs, namely interorganizational context factors and supply channel structural dimensions.

IT represents one of the mechanisms used by the participating dyad to provide interorganizational information processing capabilities. For instance, the use of EDI applications across multiple functions (e.g., design, purchasing, delivery) provides information processing capabilities that allow for new ways of electronic collaboration. Indeed, EDI links support the exchange of explicit and well structured operational information (e.g., quotes) and provide participants fast, accurate, and efficient exchange of data.

### **2.1 Independent Variables**

The information processing needs of the interorganizational relationship will be determined by the following contextual variables: channel interdependence, demand uncertainty, and product characteristics (see Figure 1).



**Figure 1. Information Processing View of the Supply Channel Relationship**

### 2.1.1 Demand Uncertainty

Williamson (1989) noted that one of the underlying determinants of high transaction costs is uncertainty. Especially, greater uncertainty rooted in transaction characteristics implies greater needs for information processing within the interorganizational relationship (Bensaou and Venkatraman 1995). Walker and Weber (1984) identified two forms of uncertainty of demand: technological uncertainty and volume uncertainty. A product is subject to high technological uncertainty if its specifications change frequently and/or the probability of future improvements is high. A product with low technological uncertainty has a relatively stable specification and the probability of future changes is low. Volume uncertainty of demand is defined as assessment of fluctuations in the demand for a product and the confidence placed in estimates of the demand (Walker and Weber 1984). The impact of this uncertainty on inventory and transaction costs is greater for products with higher absolute volume levels. The information processing capabilities to meet the information processing needs generated by high uncertainty of demand can be provided by tight EI between the participating firms. Hence the congruence hypothesis:

- Hypothesis 1: Electronic integration will covary with the uncertainty of demand concerning the products exchanged between the buyer and the supplier.
- H1a: The higher/lower the technological uncertainty of the channel transaction, the higher/lower will be the electronic integration between the participants.
  - H1b: The higher/lower the uncertainty of transaction volume through the supply channel, the higher/lower will be the electronic integration between the participants.

### 2.1.2 Channel Interdependence

In the continuum of task interdependence, Thompson (1967) identifies three anchor points: pooled interdependence, sequential interdependence, and reciprocal interdependence. We extend this concept to the interorganizational context. In pooled dependency, a mutual dependence in the relationship eventuates because the participants pool their resources. With sequential dependency, units work in series where the output from one unit becomes the input to another unit. In reciprocal dependency, units feed their work back and forth among themselves; in effect, each receives input from and provides output to the other, often interactively. All three forms of interdependence are likely to occur to varying degrees in the supply channel, thus contributing to information processing needs. The information processing capabilities to meet the information processing needs generated by

high channel interdependence can be provided by tight EI between the participating firms. Thus, it is postulated that channel interdependence and EI will covary.

Hypothesis 2: The higher/lower the channel interdependence between the buyer and the supplier, the higher/lower will be the electronic integration between the participants.

### *2.1.3 Product Characteristics*

Characteristics of a product may be viewed in terms of its complexity. Complexity stems from the amount of information that must be exchanged between the buyer and the seller of a good or service in order to describe its attributes in sufficient detail so that buyer can make an informed choice between competing suppliers (Malone, Yates and Benjamin 1987). When the products have simple, standardized descriptions like securities, there is less needs for information exchange between the trading partners. However, highly complex product descriptions like complicated manufacturing systems require more information exchange through the supply channel. When there are high information processing needs due to complex product descriptions, tighter EI between the participating firms is expected to prevail in order to generate the necessary information processing capabilities in the supply channel.

Hypothesis 3: The more/less the complexity of the products exchanged between the supplier and the buyer, the higher/lower will be the electronic integration between the participants.

## **2.2 Supply Channel Performance**

Optimal supply channel performance will eventuate when the information processing capabilities produced by electronic integration precisely meet the information processing needs generated by the interorganizational context. Alternatively, the better the match between the information processing needs and the information processing capabilities, the better will be the channel performance. Variation in an interorganizational context generates variations in the information processing needs in the supply channel. EI adds value in a channel relationship through an increase in the efficiency of transaction processing and improvements in the coordination and communication systems (O'Callaghan, Kaufmann and Konsynski 1992). Therefore, EI, among other things, can be deployed to supply the necessary information processing capabilities to cater to the needs created by the contextual factors. Operationally, this amounts to the congruence between interorganizational context and the supply channel structure represented by EI, influencing channel performance. Thus, we hypothesize,

Hypothesis 4: The degree of congruence between interorganizational context and supply channel structure will influence supply channel performance.

H4a: As demand uncertainty increases, stronger/weaker EI will have a positive/negative impact on supply channel performance.

H4b: As channel interdependence increases, stronger/weaker EI will have a positive/negative impact on supply channel performance.

H4c: As product complexity increases, stronger/weaker EI will have a positive/negative impact on supply channel performance.

## **2.3 Control Variables**

Governance structure of the relationship (e.g., ownership ratio, continuity of the relationship) has been known to influence channel performance. This is consistent with the theoretical arguments of the transaction cost economics perspective (Williamson 1989). When the buyer, for instance, has ownership interest in the supplier, the motivation and incentives for cooperation are greater and can influence the performance of the interorganizational relationship. Continuity, defined as the expectation of repeat transactions and future interaction, acts as a direct or indirect promise of guaranteed volumes and repeat business and, for that reason, reduces the uncertainty about the intentions and behavior of the other party. Continuity reduces uncertainty about the partner, and the partner's inclination for opportunistic behavior, while enhancing willingness to make a genuine effort leading to cooperative behavior. As a result, the performance of the interorganizational relationship tends to improve.

### 3. METHOD

While the supply channel entails a dyadic environment, this research examines the phenomenon from the principal's perspective in the dyad. The data required for this study will be collected from managers/buyers responsible for the supplier relationship. Our fieldwork will proceed as follows. First, a set of field interviews will be conducted with senior managers responsible for purchasing. The purpose of the interviews is to clarify the following issues: (1) corroboration of the applicability and appropriateness of the constructs and hypotheses and (2) to ensure that we have an adequate basis to sample the relationships covering the vast array of suppliers and products. We are debating if we should restrict the study to a single industry or conduct a cross-sectional study. It appears that we will get access to firms in the U.S., Europe, and Korea.

We found the benefits dimensions identified by Iacovou, Benbasat and Dexter (1995) to be a comprehensive list and have used it as a major resource in developing the instrument to measure supply channel performance. We also operationalized demand uncertainty following the conceptualization of volume uncertainty and technological uncertainty by Walker and Weber (1984). Channel interdependence will be measured based on the three forms of task interdependence originally defined by Thompson (1967). The measurement for product characteristics is based on the two product complexity dimensions suggested by Upah (1983).

While several researchers have argued that EDI is not EI, none have developed an instrument to measure EI *per se*. A major component of this research is the development of an instrument to measure EI. Using transaction cost economics as the theoretical foundation, we conceptualized electronic integration on the basis of minimization of coordination costs and transaction risk. We then identified business operations and business decisions as the avenues for coordination cost. Similarly, we noted information asymmetry and transaction-specific capital as the dimensions of transaction risk. The measure for EI follows this conceptualization.

A structured questionnaire to measure the variables has been developed. Pretests of the instruments are under way.

### 4. EXPECTED CONTRIBUTION

Interorganizational systems (IOS) have the unusual quality of providing significant benefits to both sides of the dyad. The principal can not only deliver cost savings to its channel partners, but also enhance the service it provides while reducing its own costs of operation. When an IOS developer can reduce another channel member's transaction costs while simultaneously reducing its own, the entire channel can compete more effectively with the alternatives. The linchpin in this complex set of relationships is the extent of EI between the participating firms. The results of this research on the IOS relationship performance are expected to verify whether the expected competitive advantage of EI is realized.

As firms outsource selected activities to external agencies, EI between the participating firms becomes critical. This research is expected to provide both theoretical explanations and empirical validations on when tight electronic integration is desirable and when it is not. We will also be able to validate the current practices in industry and offer specific recommendations concerning the information flow aspect of their supply chain logistics.

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