INTERORGANIZATIONAL SYSTEMS AS AN UNCERTAINTY REDUCTION STRATEGY: A RESOURCE DEPENDENCE PERSPECTIVE

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Abstract
This paper explores the environment alteration property of interorganizational systems. Propositions about the relationships between environmental characteristics and IOS use are derived from the Resource Dependence theory.

Acknowledgments
The author gratefully acknowledges the assistance of Izak Benbasat, Albert Dexter and Nancy Langton, all of the Faculty of Commerce and Business Administration at the University of British Columbia, for their many helpful suggestions.

Note
This paper was presented at the 22nd Annual Conference of Administrative Sciences Association of Canada in Halifax, NS in June 1994.
Introduction

Due to their increasing use, interorganizational systems (IOS) have received a lot of attention lately from MIS researchers. However, most of the IOS research has focused on economic, mainly efficiency, motives for the adoption of IOS. A major portion of this literature, especially on electronic data interchange (EDI), has neglected the impact of IOS on interfirm relationships and the systems’ potential to alter the organizational environment of IOS participants. Recognizing this indifference, this paper adopts a perspective which focuses primarily on the organizational environment alteration property of IOS to answer several critical questions regarding the development of such systems.

The view which is adopted here is based on the Resource Dependence theory (RDT) which has been used in the Organizational Behaviour area to study several forms of strategies which seek to modify interorganizational relationships (such as mergers, the development of associations and cartels and the establishment of social norms) (Pfeffer and Salancik, 1978). Alteration and formalization of interfirm relationships, the theory asserts, are sometimes necessary to ensure the success and survival of an organization. This conjecture represents the core of the theory and is the foundation of the explanations offered in this paper about the emergence and use of IOS. Specifically, this paper employs RDT arguments to explain how environmental factors influence the development and utilization patterns of different types of IOS in an industry.

Interorganizational Systems

Interorganizational systems are automated information systems used by two or more separate organizations and consist of computer and communications infrastructures that allow their users to share in the execution of an application (Barret and Konsynski 1982; Cash, 1985). In general, the term 'IOS' is used to describe a distinctive pool of information systems (IS) which cross organizational boundaries and can take two forms: electronic markets and electronic hierarchies (Malone, Yates and Benjamin, 1987). Furthermore, depending on the business relationship between the IOS participants, IOS can be classified into another two major types: competitive telecommunication-based information systems (TBIS) and cooperative telecommunication-based information systems (Swatman and Swatman, 1992). Competitive TBIS, henceforth called competitive IOS (CIOS), refer to systems that link rival organizations within an industry; Electronic funds transfer (EFT) systems are an example of CIOS. Cooperative TBIS, henceforth called symbiotic IOS (SIOS), refer to systems which are developed to support the relationships between firms within different industries or at different channel positions; the most well known and widely implemented form of SIOS is EDI. EDI refers to IOS systems which facilitate the automated, computer-to-computer exchange of structured business data between a company and its trading partners according to an ex-ante agreement on data coding, formatting and other procedures.

Motives for the Adoption of IOS

In an attempt to better understand the diffusion process of IOS, several researchers have investigated the incentives for their development. Past research on IOS adoption has identified
the perceived positive impact of such systems on (1) organizational efficiency and (2) effectiveness as the most important IOS adoption facilitator (Bergeron and Raymond, 1992; Grover, 1993; O’Callaghan, Kaufmann and Konsynski, 1992; Reich and Benbasat, 1990; Swatman and Swatman, 1992).

The majority of the conceptual research literature on IOS has emphasized the efficiency increase effects of the technology (Cash, 1985; Clemons and Kleindorfer, 1992; Gurbaxani and Whang, 1991; Malone et al., 1987; Mukhopadhyay, 1993). This stream of research has adopted a view which assumes that the "incentives for the development of an [IOS] are economic" (Barrett and Konsynski, 1982, p. 94) and the primary objectives for IOS use are to reduce transaction costs and increase productivity to improve efficiency. Similarly, most of the past empirical research has followed this efficiency-focus approach and has attempted to primarily measure the economic impact of IOS (for example, see Bergeron and Raymond, 1992 and Pfeiffer (1992)). In general, these research studies have attempted to show that IOS use can reduce coordinations costs, asset specificity, and complexity of product description and, therefore, facilitate a shift towards markets (Malone et al. (1987), Clemons and Kleindorfer (1992)). The premise for these hypotheses is provided by the Market and Hierarchies perspective (Williamson, 1975). The Market and Hierarchies theory asserts that organizations have a single objective (i.e., maximizing efficiency) and all organizational action, such as the development of IOS, seeks to achieve this objective.

Although, several research studies have been undertaken to investigate the impact of IOS use on organizational efficiency, there has been very little conceptual or empirical research which focuses on the effectiveness impact of IOS (Nidumolu, 1989; Konsynski, 1993). To more systematically investigate the relationship between IOS use and organizational effectiveness, this paper utilizes RDT to derive hypotheses about the effect of interfirm dependencies on IOS utilization patterns. According to RDT, effectiveness is defined as an external standard of "how well an organization is meeting the demands of the various groups and organizations that are concerned with its activities" (Pfeffer and Salancik, 1978, p.11). Based on the theory’s propositions, the main argument of this paper is that IOS can be viewed as strategies which can alter the relationships between trading partners by reducing environmental uncertainty and modifying organizational boundaries. In summary, this effectiveness-based approach offers a method to assess the strategic importance of IOS in the way it alters interorganizational relationships and dependencies.

**Analytic Framework**

One of the most fundamental premises of the theory is that firms pursue a wide set of objectives such as profitability (i.e., efficiency), effectiveness, power and other goals (Grandori, 1987; Pfeffer and Salancik, 1978). Organizational effectiveness is a critical goal of an organization because it cannot entirely control all of the resources necessary for the achievement of its objectives. Therefore, it must cooperate with other organizations, henceforth called external actors (e.g., customers, suppliers, financial institutions, governments, and competitors), to gain access to the needed resources. Consequently, organizations must engage in transactions of monetary or physical resources, information, and social legitimacy, with external actors
creating resource dependencies. Resource dependence is defined as follows:

Concentration of the control of discretion over resources and the importance of the resources to the organization together determine the focal organization’s dependence on any given group or organization. Dependence can then be defined as the product of the importance of a given input or output to the organization and the extent to which it is controlled by a relatively few organizations (Pfeffer and Salancik, 1978, p. 51).

The pressure on organizations to comply with external demands is especially significant when the level of dependency is high. As indicated above, high dependency levels exist when (1) the resource which is externally controlled is important for the continued success and survival of the organization, (2) the external group or organization has high discretion over the resource allocation and use, and (3) there are few alternatives (Pfeffer and Salancik, 1978). Therefore, for an organization to be effective and increase its probability of survival and success, it is necessary that it meets these, mostly incompatible, demands of the external agents in its environment. To deal with these expectations and influence from external actors, an organization can take three types of actions. The first alternative is to comply with such influence. The second response is to evade these demands. The last alternative is to alter external demands by modifying its relationships with external actors. This last option is the focus of RDT. According to the theory, organizations will take actions to reduce the risk due to the uncertainty in the interdependencies by modifying their relationships with their external environments.

Interdependencies can be altered using two strategies: (Pfeffer and Salancik, 1978):

1. Ownership-alteration strategies; these strategies include vertical integration, horizontal integration, and diversification. They involve the acquisition of the needed external resource and, thus, eliminate interdependencies.

2. Quasi-hierarchical strategies; these do not involve change in ownership, but rather the creation of quasi-hierarchical relations (such as joint ventures, interlocking boards of directors, associations, cartels, and the formation of social norms) to more formally govern interfirm relationships. The primary goal of these strategies is to reduce uncertainty in interfirm relations. Reducing environmental uncertainty is very important to organizations because stability leads to better planning, more accurate forecasting, reduced search costs, and, most importantly, continual access to the resources controlled by external agents. Reduction of environmental uncertainty is also desirable because it reduces the likelihood of high transaction costs which may be caused by the opportunistic acts of external agents (Williamson, 1975).

Given that quasi-hierarchical strategies offer less than absolute control, one could ask why firms would choose the second type of strategies and not the first. Several arguments can be used to justify the use of quasi-hierarchical strategies. Firstly, organizations will choose quasi-hierarchical strategies when they do not own the necessary capital and expertise to implement acquisition strategies. Secondly, firms will tend to choose quasi-hierarchical strategies because they are achieved more readily and are more flexible (i.e., they can be more easily renegotiated and modified). Lastly, firms in non-concentrated industries will tend to choose quasi-hierarchical strategies because as the number of firms is large, mergers and acquisitions can not significantly concentrate the industry and, therefore, quasi-hierarchical strategies which can include many organizations will be more effective (Pfeffer and Salancik, 1978).
environments, quasi-hierarchical strategies allow for more flexibility and higher incompatibility between interests (relative to the ownership-altering strategies). Therefore, they can be more effective because "the higher the number of the firms that are to be coordinated, the higher will be not only the communication and administrative costs, but also the costs of opportunistic behaviors and conflict resolution procedures" (Pfeffer and Salancik, 1978, p. 71).

In summary, RDT hypothesizes that as an organization becomes more dependent on its environment, it will adapt by acquiring additional control over resources by utilizing one of the ownership altering strategies. However, when the organization is unable or unwilling to use any of these hierarchical strategies to alter its relationships, it will employ quasi-hierarchical strategies to strengthen the linkages with its environment and to reduce the uncertainty in its continual access to the required resources.

IOS as an Interdependence Alteration Strategy

Before I utilize RDT arguments to investigate the relationship between the environment and IOS use, it is critical to examine evidence which illustrate the environment alteration property of IOS. Although there is only one relevant empirical study (Nidumolu, 1989) which investigated the impact of IOS on the climate of seller-buyer relationships, there have been many assertions about the external environment alteration property of IOS. IOS researchers have argued that IOS are mechanisms which are used: to create a "smoother, more efficient interface to the shared environment rather than to satisfy the firm’s internal requirements" (Barrett and Konsynski, 1982, p. 93); to "address the required coordination across organizational boundaries" (Cash, 1985); to change business dynamics with partners and customers (I/S Analyzer, 1989); to exploit the benefits of the electronic communication effect to capture customers in a system biased toward a particular supplier (Malone et al., 1987); and to "redistribute buyer/supplier power" (Swatman and Swatman, 1992).

As the previous conjectures indicate, IOS can potentially alter the relationships of an IOS user with its environment (trading partners, financial institutions, governmental units such as customs, etc) in several ways. Although different types of IOS can be developed to achieve each of the above outcomes, there are some common effects which are present in all IOS. The four ways that any IOS can affect the relationships between an organization and external actors are:

1. by providing more timely information to partners. Better coordination can be achieved between IOS users because time delays in the information exchange process can be eliminated and more pertinent information can be exchanged (due to the ability of IOS to increase communication channel capacity).

2. by increasing the formalization of the relationships (Nidumolu, 1989). IOS use requires that partners (users) develop ex-ante agreements about the operation of the system (such as formatting, authentication, and acknowledgement guidelines). For example, many EDI system participants require that an EDI message acknowledging the receipt of a purchase order is sent within 24 hours, otherwise the order is considered as rejected. It is clearly evident that IOS contracts help to reduce the uncertainty in the trading relationship between the partners.
by enhancing the trust between partners. Given that IOS participants must share more information with their trading partners, their participation requires high levels of trust. The reduction of errors (due to the elimination of several re-inputting of the data and the development of extensive, automated error checking procedures in IOS systems) can reduce the potential for conflict between participants which can, in turn, enhance trust and reduce perceived uncertainty (Emmelhainz, 1988).

by increasing the stakes in the relationships between the IOS participants. IOS participants incur high financial costs for the acquisition of the hardware, software and expertise which are necessary for the adoption of an IOS. These increased economic investments make the relationship between IOS partners more significant.

In a few words, all of the above effects of IOS help to formalize and reduce the uncertainty in the relationships between the focal organization and its IOS partners.

Empirical evidence also supports the notion that there is a significant relationship between IOS use and environmental conditions (Grover and Goslar, 1993). In a recent survey study of 148 wholesalers and 90 retailers, Rogers (1990) found a significant relationship between the industry affiliation of an organization and its adoption of IOS (EDI linkages). This finding suggests that the environment of organizations influences their IOS adoption decisions. This conclusion is also supported by the pattern of emergence of EDI; "EDI has evolved within industries: first in transportation, now in food, clothing, automobiles, chemicals, and others" (I/S Analyzer, 1989, p. 5). In several other surveys on EDI adoption (Bergeron and Raymond, 1992; Pfeiffer, 1992; Saunders and Hart, 1993), researchers found that up to 70 percent of the respondents identified pressure and imposition by trading partners as one of the primary reasons for adopting EDI. This observation also illustrates that interorganizational dependencies and power are critical factors in the development of IOS.

In summary, it seems that there is ample evidence to support the notion that IOS can be viewed as quasi-hierarchical strategies which are used by organizations to formalize their interdependencies and reduce the uncertainty in their environments.

Organizational Environments and IOS Use

If RDT arguments are valid, one would expect a higher level of IOS use in an environment where uncertainty is high. The level of uncertainty in an environment is determined by three dimensions (Dess and Beard, 1984). These three dimensions are:

1. Munificence, which is defined as the relative level of resources in an environment and it is measured by growth at the industry level.
2. Dynamism, which is defined as the level of turbulence and instability in an environment and is measured by the variability in growth rates.
3. Complexity, which is defined as the heterogeneity of the environment and the concentration of resources in it, and is measured by the number of firms and the disparities in market share between the firms in an industry.

Since uncertainty is influenced by each of these dimensions, one would expect the levels
of these characteristics to also impact the presence and use of IOS in a given environment. A discussion of each dimension and its relationship to IOS use follows.

Munificence is an indication of the abundance of resources in an environment (or industry group). Environments such as the computer manufacturing industry tend to be fairly munificent, while in others, such as the hydraulic cement industry, resources are much more scarce (Boyd, 1990). Given that scarcity would imply greater uncertainty regarding future access to resources, one would expect a greater number of uncertainty reduction mechanisms, such as the development of IOS, to occur in less munificent environments. This observation leads to the first proposition.

\[ P_1: \text{Munificence will be negatively related to the use of IOS in an environment.} \]

Dynamism is a measure of volatility in the environment. The less stability there is in an environment, the more uncertainty the organization faces about its continuing access to resources. Thus, organizations in more volatile environments will be more apt to adopt IOS to reduce environmental uncertainty. Consequently, we should expect that:

\[ P_2: \text{Dynamism will be positively related to the use of IOS in an environment.} \]

The third dimension, complexity, consists of two components: level of concentration (i.e., the number of firms) and the discrepancy in market shares between the firms. Many researchers (e.g., Pfeffer and Salancik (1978) and Stern and Morgenroth (1968)) have argued that the relationship between complexity and uncertainty is nonmonotonic. An explanation for this pattern is presented in Pfeffer and Salancik (1978):

When there are many firms in an industry and concentration is relatively low, the actions of any firm represents only a small proportion of the total industry; thus, any firm has few consequential effects on most of the other firms. As concentration increases even more, uncertainty begins to decrease. With only a few very large firms operating, tacit coordination becomes possible, and each develops stable expectations concerning the others’ behaviour... The inverted U-shaped relationship between concentration and uncertainty, then, derives from two factors. As concentration increases, the impact of any one firm’s activities on the others increases. Similarly, as concentration increases, the ability to coordinate interfirm activity increases even in the absence of interorganizational structures or interfirm linkages. The greatest uncertainty arises when there are enough large firms to have major impact on each other but too many separate organizations to be tacitly coordinated (pp. 124-125).

Based on this nonlinear relationship between complexity and uncertainty, one would expect to observe a similar relationship between complexity and the development of IOS. Thus, we can hypothesize that:

\[ P_3: \text{Complexity will be nonlinearly related to use of IOS in an environment.} \]

**Interdependencies and IOS types**

Concerning the two major types of IOS (CIOS and SIOS), two forms of interdependencies
can be used to explain their development patterns. The two types of interdependencies are competitive and symbiotic (Pfeffer and Salancik, 1978).

Competitive dependence refers to the fact that firms within the same environment depend on the same resources for their survival and success, and is defined as "the interdependence which derives from the competitive relationship of outcomes obtained by two or more [competitors]" (Pfeffer and Salancik, 1978, p. 124). Because this form of interdependence is based on the distribution of the same resources, organizations are likely to take steps to reduce the uncertainty by better coordinating the relationships with their competitors. One such step that organizations can take is the creation of competitive IOS. EFT systems represent an example of such a system. In a few words, as the competitive dependencies in an environment increase, competitors will be more likely to pursue a coordination strategy to reduce uncertainty. Thus, we should expect that:

\[ P_4: \text{Competitive dependence will be positively related to the use of CIOS in an environment}. \]

Symbiotic dependencies arise because organizations engage in transactions with organizations in other industries. Such dependencies are present when the output of one organization is the input of another, as in supplier-manufacturer, manufacturer-distributor and other relationships. Because of the uncertainty involved in these relationships and their critical importance, organizations attempt to either eliminate such dependencies by acquiring the resource or decrease uncertainty by formalizing the relationship. An uncertainty reduction mechanism that firms can utilize is the use of IOS to coordinate these relationships. Thus, one would expect that the development and use of SIOS (such as EDI systems between suppliers and customers) will increase as the level of transactional dependencies increase. This leads to the fifth hypothesis.

\[ P_5: \text{Symbiotic dependence will be positively related to the use of SIOS in an environment}. \]

Even though it was suggested that symbiotic dependence influences the adoption and use of SIOS, the above explanation does not address the issue of SIOS’s direction. Several firms have developed SIOS systems (such as EDI) to transact with either suppliers or buyers, but not both. Consequently, one could ask what factors determine the direction of an SIOS? RDT arguments also provide an answer to this question by studying the impact of concentration on transactional dependencies. Pfeffer and Salancik (1972) found that in relatively concentrated areas where there are a few sellers the interdependence of the organizations in the environment with their suppliers of input will be relatively more important and problematic than their interdependence with their customers. They pointed out that:

The concept of concentration means that the organization has relatively few competitors for sales. In turn, concentration presumably gives it market power, but this market power is with respect to those organizations to which it sells. Its power with respect to customers comes from the fact that these customers have few alternative sources of supply. Since an organization in a more concentrated industry has power with respect to customers, it would be expected that it would focus its attention in managing dependence on those organizations from which it buys input (p. 121).

Consequently, one would expect to observe a stronger relationship between purchase interdependence and supplier-focus IOS in highly concentrated environments. This assertion is
supported by the evidence of recent SIOS development actions of large automotive manufacturers which reside in a highly concentrated industry. Therefore, it is proposed that:

\( P_6: \) The correlation between purchase interdependence and supplier-focus SIOS will be higher in environments with high levels of concentration.

Conversely, sales interdependence should better account for patterns of IOS development in environments with lower levels of concentration. As mentioned, at very high levels of concentration the few organizations have high market power with respect to customers and, thus, the sales dependence is not problematic. Sales uncertainty is relatively higher at intermediate levels of concentration because the actions of the competitors can make a difference and the buyers have several alternatives of supply. However, at low levels of concentration where the industry approximates perfect competition, there is no strategic interaction uncertainty and "the firm becomes a passive taker of price and other competitive factors and sales dependence can not be managed through interfirm linkages" (Pfeffer and Salancik, 1978, p. 122). In short, this argument suggests that the relationship with customers will be most uncertain and problematic at intermediate levels of concentration. Therefore, it is expected that:

\( P_7: \) The correlation between sales interdependence and buyer-focus SIOS will be higher in environments with intermediate levels of concentration.

In summary, this set of conjectures is based on a new conceptualization of IOS which assumes that the primary purpose of these systems is to formalize the relationships between organizations so that the uncertainty due to interfirm dependencies is reduced.

**Conclusion**

Unquestionably, interorganizational systems have recently become a more legitimized and widely used tool for achieving increased coordination between organizations (Konsynski, 1993). Recognizing this critical role of such systems, this paper addressed three issues regarding the development of IOS. First, it was argued that IOS emerged as a way to reduce uncertainty in organizational environments. Second, it was hypothesized that different types of IOS were developed to deal with different types of interdependencies which are present in the relationships of organizations with their environments. Third, it was proposed that the focus of an IOS can be predicted by the concentration of the environment and the type of uncertainty that it creates.

The framework presented in this paper, which is based on RDT, proposes that the patterns of IOS development and use are closely related to the intentions of organizations to reduce uncertainty in their interdependencies with other firms. The adoption of this approach offers three major advantages. First, the view that IOS are uncertainty reduction strategies takes into account the fact that organizations have multiple objectives. More specifically, this approach asserts that effectiveness, which is considered to be one of the most critical objectives of every organization, can be significantly enhanced by the adoption and use of IOS. Second, the adopted approach illustrates that organizational actions are restrained by environmental demands. This critical component of organizational action has been largely neglected by the market failures approach which has been used extensively to explain the development of electronic markets and hierarchies. Third, this paper has introduced IOS in the pool of possible dependence alteration mechanisms which are available to organizations. IOS can offer all the advantages of the less-
formal, quasi-hierarchical mechanisms while being able to enhance the relationships between organizations and, thus, reduce uncertainty.
References


