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Research Report: Empirical Test of an EDI Adoption Model

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This paper is the first test of a parsimonious model that posits three factors as determinants of the adoption of electronic data interchange (EDI): *readiness*, *perceived benefits*, and *external pressure*. To construct the model, we identified and organized the factors that were found to be influential in prior EDI research. By testing all these factors together in one model, we are able to investigate their relative contributions to EDI adoption decisions. Senior purchasing managers, chosen for their experience with EDI and proximity to the EDI adoption decision, were surveyed and their responses analyzed using structural equation modeling. All three determinants were found to be significant predictors of intent to adopt EDI, with external pressure and readiness being considerably more important than perceived benefits. We show that the constructs in this model can be categorized into three levels: *technological*, *organizational*, and *interorganizational*. We hypothesize that these categories of influence will also be determinants of the adoption of other emerging forms of interorganizational systems (IOS).[1]
(*Electronic Data Interchange*; *Electronic Commerce*; *Interorganizational Systems*; *Adoption of IT*; *Empirical Research*; *Partial Least Squares*)

1. Introduction

According to the *Economist* (February 26, 2000), it is estimated that business-to-business (B2B) transactions will be more than 80% of the expected $3 trillion electronic commerce (EC) market by 2003. As B2B EC gains prominence, electronic data interchange (EDI) will remain an important enabling technology. To illustrate, the market for EDI software, products, and consulting services is predicted to grow from $800 million in 1997 to $2 billion annually in 2001 (Densmore 1998). Given the ongoing importance of EDI, the objective of this study is to test a parsimonious predictive model that posits three factors as determinants of the adoption of electronic data interchange (EDI): *readiness*, *perceived benefits*, and *external pressure*. To construct the model, we identified and organized the factors that were found to be influential in prior EDI research. By testing all these factors together in one model, we are able to investigate their relative contributions to EDI adoption decisions. We believe that this model can be generalized to other interorganizational information technology (IT) innovations.

Although 95% of Fortune 1000 firms have implemented EDI, only 2% of the remaining 6 million businesses in the U.S. have done so (Densmore 1998). Though the largest firms have aggressively encouraged EDI adoption, they have, on average, been able to motivate only 20% of their partners to adopt. The remainder, often comprised of small- and medium-sized enterprises (SMEs), have resisted adopting EDI for reasons that are not fully understood (Bouchard 1993, Hart and Saunders 1997). Given the ongoing importance of EDI, it is important to understand how to

[1]A previous version of this paper was presented as a work-in-progress paper at ICIS 1997.

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improve EDI adoption rates by developing and testing a parsimonious model that includes the key success factors identified in earlier work. Such work can also serve as the theoretical and empirical basis for research on other forms of interorganizational systems (IOS), such as business-to-business electronic commerce exchanges.

The rest of the paper is presented as follows. Section 1.1 reviews prior research on EDI. Section 2 describes the theoretical framework used in this paper. The research methodology is described in §3, followed by the results in §4. The paper concludes in §5.

1.1. Prior Research on EDI

EDI promises many benefits, ranging from modest (reduced communication and administration costs and improved accuracy) to transformative (enabling business process reengineering or supporting industry value chain integration initiatives such as just-in-time inventory, continuous replenishment, and quick response retailing). Because of these potential benefits, EDI has been extensively studied using several theoretical perspectives.

A fundamental approach for the study of the adoption of new technologies is the diffusion of innovations (DOI) (Tornatzky and Klein 1982, Rogers 1995), which has been, either explicitly or implicitly, a foundation for much of EDI research (e.g., O'Callaghan et al. 1992, Premkumar et al. 1994, Teo et al. 1995). The focus of DOI research is on the "perceived characteristics of the innovation" that either encourage (e.g., relative advantage) or inhibit (e.g., complexity) adoption. For example, O'Callaghan et al. (1992) examined independent property and casualty insurance agents and found that *relative advantage* was a predictor of *intent to adopt*, as well as a differentiator between adopters and nonadopters. Likewise, in a survey of EDI adopters, Premkumar et al. (1994) found that relative advantage and *compatibility* are predictors of the extent of *"adaptation"*—the degree of EDI usage in its first application (operationalized as either purchase orders or invoices). Teo et al. (1995) used innovation diffusion theory to predict intent to adopt financial EDI in Singapore. Their findings show that *complexity* is a strong inhibitor of intent to adopt, as is their measure of the perceived *risks* of adopting.

Because the DOI-based research is focused on the perceived characteristics of the particular technology, we label this perspective "technological." While the technological perspective afforded by DOI undoubtedly explains a portion of the EDI adoption decision, it is primarily based on individual-level adoption decisions. However, EDI adoption is almost always an organizational-level decision executed in an interorganizational context; therefore, there are clearly aspects of the EDI adoption decision that are not captured by looking solely at (perceptions of) the technology of EDI. Thus, much of the research on EDI has taken an "organizational" approach, focusing on organizational characteristics as well as the inherent attributes of EDI technology. Although there is obvious overlap between the technological and the organizational perspectives, in light of the fact that perceived attributes of the technology are considered relative to the adopting organization, these two approaches are conceptually distinct in that they focus on different units of analysis: technologies versus organizations.

Organizational adoption of a technological innovation can be positioned within a much larger body of innovation research conducted by economists, technologists, and sociologists (see Gopalakrishnan and Damanpour 1997 for a comprehensive literature review). Within the sociologists group, the process view of innovation (or adoption of innovations) treats all innovations as equivalent units of analysis, and thus does not differentiate among different innovations with different attributes. Conversely, IS research can largely be classified into the variance sociologists group, and has focused on the innovation level of analysis and the development of "middle-range" theories of innovation (Gopalakrishnan and Damanpour 1997). Such theories focus on the attributes of the innovation and propose relationships between these attributes and the antecedents and consequences of adoption, acknowledging that some attributes of a particular technology will vary across organizations (such as compatibility).

Grover (1993), taking a comprehensive "bottom-up" approach, empirically identified five factors that statistically discriminated between firms that have and have not adopted EDI: (i) *proactive technological organization*,

(ii) *internal push*, (iii) *market assessment*, (iv) *competitive need*, and (v) *impediments*. Reich and Benbasat (1990) examined the adoption of customer-oriented strategic systems, finding that adoption was related to customer awareness of need and support. Rogers (1995) examines the factors leading to *organizational innovativeness*, which include, among others, *organizational slack* and *size*. (Because this model focuses on the overall innovativeness of an organization—i.e., the process approach to innovation—rather than the adoption of a particular technology, it does not provide a testable model of EDI adoption.) The size and slack factors are one possible explanation for the greater rate of EDI adoption among very large (e.g., Fortune 1000) firms, as *organization size* has consistently been recognized as a driver of organizational innovation (see Damanpour 1992, for a meta-analysis).

Because adoption of EDI requires coordination between at least two organizations, the relationship between the organization and its prospective trading partner(s) becomes salient. In the best-case scenario, both firms agree that adoption is in their best interest. EDI is an example of a technology with positive externalities or network effects; thus, the actions of one firm will depend on (its perception of) the collective actions of other firms (i.e., are there enough firms adopting this technology to make our adoption worthwhile?). Collective actions and technology have been studied within a number of disciplines; Bouchard (1993) labels this collected work "critical mass theory." However, the positive benefits of having a critical mass of firms adopting the same technology is only one aspect of interorganizational relationships and EDI adoption. Another significant factor is enacted power, such as when one organization "encourages" or coerces its trading partners to adopt EDI. In the context of EDI adoption, we characterize factors relating to the actions of other organizations as belonging to the "interorganizational" level.

Recent EDI research has incorporated both interorganizational and organizational factors with somewhat mixed findings. Saunders and Clark (1992) examined the impact of *perceived benefits* and *perceived costs* (both technological factors), as well as *dependency* and *trust* (interorganizational factors) on intent to adopt EDI. They find that perceived costs reduce intent to adopt as does, somewhat surprisingly, trust. Bouchard (1993) found that DOI factors were insignificant in the EDI adoption decision, whereas the *use* or *requirement* of EDI by major business partners were the key drivers of the adoption decision. Premkumar and Ramamurthy (1995) found that the technological factor *internal need* (akin to perceived benefits) and the organizational factor *top-management support*, as well as the interorganizational factors *competitive pressure* and *exercised power*, influence whether a firm's EDI adoption decision is proactive or reactive. Iacovou et al. (1995) hypothesized a model that includes three factors as determinants of EDI adoption and impact in SMEs: *perceived benefits* (technological), *organizational readiness* (organizational), and *external pressure* (interorganizational). Proposing a high-low dichotomy for each of these factors led the authors to develop a $2 \times 2 \times 2$ classification of firms; however, this model has not been empirically tested outside the small sample of firms that led to its genesis. Premkumar et al. (1997) examined EDI adoption in the European trucking industry, finding that *firm size* and *top-management support* (organizational factors), as well as *competitive pressure* and *customer support* (interorganizational), were significant in predicting adoption of EDI. Hart and Saunders (1997) developed a theoretical framework, positing *relative power* and *trust* between trading partners as determinants of EDI adoption and usage. This framework was illustrated with the case study of an office supplies retailer. Hart and Saunders (1998) examine the impact of *customer power* and *supplier trust* on the use of EDI (transaction volume) and diversity of EDI (number of transaction sets) for the customers of two firms (an office supplies retailer and a chemical company). Their overall empirical findings are mixed, showing that: (i) increased supplier trust leads to increased diversity of EDI use; and (ii) increased customer power leads to reduced diversity of EDI use (opposite to hypothesized effect).

The factors influencing the integration of EDI within adopter firms and the subsequent impact has been studied in the motor carrier industry (Ramamurthy et al. 1999). Both technological/organizational factors (*internal support*, *EDI's benefits potential*, *EDI-compatibility*, and *resource intensity*) as well as interorganizational factors (*customer support* and *competitive pressure*) were

shown to influence EDI integration. Crook and Kumar (1998) examined EDI use in four diverse industries, using a grounded theory approach to explain types of use in different contexts, strategies for encouraging EDI, and its consequences. They derived a model that includes factors that are part of perceived benefits, external pressure, and readiness as described in the Iacovou et al. (1995) model.

EDI has also been studied using the perspective of microeconomics, and some of this work has provided direct estimates of the financial impact of adopting EDI (see, for example, Mukhopadhyay 1993, Wang and Seidmann 1995, Mukhopadhyay et al. 1995, Barua and Lee 1997). A framework of interorganizational coordination by Bensaou and Venkatraman (1996) posits that "performance" is determined by the degree of fit between the *information-processing needs* and *information-processing capabilities* of an organization. More recently, Son et al. (1999) use transaction cost theory and social cost theory to propose a model of the extent of EDI use, defined as volume and diversity of transactions, between trading partners that have already adopted EDI. Factors hypothesized to influence EDI use are *asset specificity, uncertainty, reciprocal investments, trust,* and *power.*

In summary, the adoption of EDI has been studied using several approaches and operationalizations. Currently, there are a number of overlapping, divergent models that have been shown to partially explain the EDI adoption decision by examining different factors. We show that these factors can be categorized as addressing three levels: the technological, the organizational, and the interorganizational. While each has contributed to our cumulative knowledge, and explained a part of the adoption decision, no single study has tested a model of EDI adoption that incorporates constructs that comprehensively address all three.

2. A Proposed Model of EDI Adoption

An examination of prior research on the adoption of EDI reveals that the Iacovou et al. (1995) model incorporates many of the factors previously demonstrated to be significant predictors of EDI adoption. This model draws on the three foci of EDI adoption influences identified above (technological, organizational, and interorganizational) and incorporates factors found influential in the previous literature. It was developed using case studies, and builds on a significant stream of research, including: O'Callaghan (1989), Swatman and Swatman (1991), Saunders and Clark (1992), and O'Callaghan et al. (1992).

The Iacovou et al. (1995) model, augmented to include an additional interorganizational factor, *trading partner readiness,* identified in previous studies, was adopted as the basis of the model to be tested in this study. To illustrate the commonalties of this model with others proposed before, Table 1 compares its constructs and subconstructs to those found to be statistically significant in earlier empirical work, as well as to the constructs derived in two papers mentioned above that do not conduct statistical tests (Bensaou and Venkatraman 1996, Crook and Kumar 1998).

The resulting research model used in this paper is depicted in Figure 1.

In this model, *intent to adopt EDI* is determined by three factors: *perceived benefits*, *external pressure*, and *readiness*. The constructs external pressure and readiness are both composed of subconstructs, as described in Table 2.

Perceived benefits refer to the anticipated advantages that EDI can provide the organization. Benefits are both direct and indirect in nature. Direct benefits include operational cost savings and other internal efficiencies arising from, for example, reduced paperwork, data re-entry, and error rates. Likewise, indirect benefits are opportunities that emerge from the use of EDI, such as improved customer service and the potential for process reengineering.

Hypothesis 1. *Higher perceived benefits will lead to greater intent to adopt EDI.*

External pressure encapsulates the influences arising from several sources within the competitive environment surrounding the organization: *competitive pressure,* relating to the ability of EDI to maintain or increase competitiveness within the industry; *industry pressure,* relating to the efforts of industry associations

Table 1 Comparison of the Research Model to Other Studies

Research Model	Saunders & Clark 1992	Bouchard 1993		Grover 1993					Premkumar et al., 1994			Iacovou et al., 1995			Premkumar & Ramamurthy 1995			
	Perceived Costs	Important Business Partners	Business Partner Requirement	Proactive Tech. Org.	Internal Push	Market Assessment	Competitive Need	Impediments	Compatibility	Relative Advantage	Costs	External Pressure	Organizational Readiness	Perceived Benefits	Internal Need	Top Mgt. Support	Competitive Pressure	Exercised Power
External Pressure																		
Competitive Pressure							✓					✓					✓	
Dependency on TP		✓										✓						
Enacted TP Power			✓									✓						✓
Industry Pressure												✓						
Readiness																		
Financial Resources	✓					✓		✓			✓		✓					
IT Sophistication				✓	✓								✓			✓		
TP Readiness																		
Perceived Benefits								✓	✓	✓				✓	✓			

Research Model	Bensaou & Venkatraman 1996		Premkumar et al., 1997			Hart & Saunders 1997, 1998		Crook & Kumar 1998						Ramamurthy et al., 1999					
	Environmental Uncertainty	Partnership Uncertainty	Firm Size	Competitive Pressure	Customer Support	Top Mgt. Support	Power	Trust	Organizational Context	Environmental Context	Customer-Initiated CC	Organization-Initiated CC	Reaction to Competition CC	Strategies for EDI Use	Customer Support	Competitive Pressure	Internal Support	EDI Benefits Potential	EDI Compatibility	Resource Intensity
External Pressure																				
Competitive Pressure	✓			✓			✓				✓		✓			✓				
Dependency on TP		✓					✓				✓									
Enacted TP Power		✓			✓		✓				✓			✓	✓					
Industry Pressure	✓									✓										
Readiness																				
Financial Resources			✓						✓											✓
IT Sophistication						✓			✓								✓		✓	
TP Readiness								✓		✓										
Perceived Benefits												✓						✓		

Note. Check marks indicate the intersection of the research model with previous research. Only factors found to be statistically significant in prior empirical research are included in this table.

Figure 1 **Iacovou et al., (1995) Model as Tested**

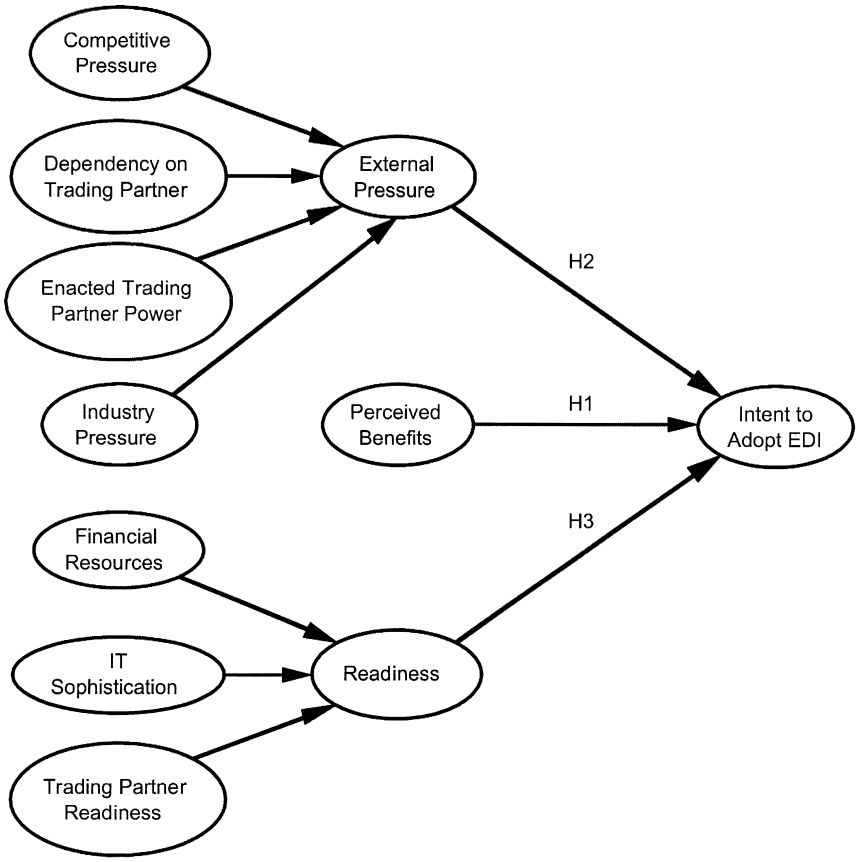


Table 2 **Sources of Measurement Constructs**

Construct	Type	Sub-constructs	Type	Source	Items
Intent to Adopt	Reflective			Developed for this study	3
External Pressure	Formative	Competitive Pressure	Reflective	Iacovou et al. 1995	3
		Dependency on Trading Partner	Reflective	Developed for this study	3
		Enacted Trading Partner Power	Reflective	Developed for this study	2
		Industry Pressure	Reflective	Iacovou et al. 1995	2
Readiness	Formative	Financial Resources	Reflective	Iacovou et al. 1995	3
		IT Sophistication	Reflective	Paré and Raymond 1991	8
		Trading Partner Readiness	Reflective	Ferguson 1992	8
Perceived Benefits	Reflective			Saunders and Hart 1993; supplemented	17

or lobby groups to promulgate EDI standards and encourage adoption; and two measures of trading partner influence (Provan 1980). *Dependency on trading partner* captures the potential power of a trading partner to "encourage" EDI adoption. *Enacted trading partner power* measures the strength of the influence strategy (e.g., rewards and threats) used to exercise that potential power.

HYPOTHESIS 2. *Higher external pressure will lead to greater intent to adopt EDI.*

Organizational readiness, as used in prior research (Swatman and Swatman 1991 and 1992, Iacovou et al. 1995), measures whether a firm has sufficient *IT sophistication* and *financial resources* to undertake the adoption of EDI. IT sophistication (Paré and Raymond 1991) captures not only the level of technological expertise within the organization, but also assesses the level of management understanding of and support for using IT to achieve organizational objectives. Financial resources express an organization's capital available for IT investments.

In the context of interorganizational systems, however, readiness is not solely an organization-level construct. At minimum, adoption of an IOS requires readiness on the part of two trading partners. Thus, we have augmented the readiness construct with a subconstruct labeled *trading partner readiness* to consider a firm that may be motivated to adopt EDI (i.e., having high perceived benefits) and be ready to adopt (i.e., having available financial resources and IT know-how) but is unable to adopt due to unready trading partners (Bergeron 1994). The trading partner readiness items (Ferguson 1992) gauge the willingness and ability of potential partners to adopt EDI. Thus, the readiness construct used in this paper is composed of three subconstructs: *financial resources* and *IT sophistication* (internal constructs encapsulating organizational readiness), and *trading partner readiness* (external).

HYPOTHESIS 3. *Higher readiness will lead to greater intent to adopt EDI.*

In this research model, perceived benefits encapsulate the technological aspects of EDI. Readiness captures both organizational factors as well as interorganizational, in the form of trading partner readiness. Finally, the external pressure construct is composed of interorganizational factors.

3. Research Method

3.1. Survey Method

The Iacovou et al. (1995) model was based on seven case studies. While the interpretive, case-based approach is ideal for hypothesis generation, theory development usually progresses to empirical testing, and hence we chose the survey approach to test the revised model statistically. Given that EDI is used on both sides of the buyer-seller dyad, two sample frames were natural choices for this survey: marketing departments and purchasing departments. We chose the purchasing side of the dyad, and sampled the membership of the Purchasing Managers' Association of Canada (PMAC).

Two versions of the questionnaire were developed, one for adopters and one for nonadopters. Where available, the items for the questionnaires were drawn from previous research; otherwise, new items were created (See Table 2). Some of the previously validated measures had to be adapted to meet the constraints of this questionnaire. For example, the Information Technology Sophistication measure (Paré and Raymond 1991) demanded a matched survey of the CEO and CIO of the organization. Because we targeted purchasing managers, this requirement was not feasible and the measure had to be adapted. Where necessary, measures were updated with more current terminology or revised to adhere more closely to the general principles of item construction, e.g., avoiding double-barreled questions and providing filters for nonopinion (Schuman and Presser 1981, Sudman and Bradburn 1983, Converse and Presser 1986, Fowler 1993).

Content validity of all items, and especially new items, was carefully assessed. First, these items were examined by a colleague with expertise in measurement theory and questionnaire design. Second, the initial questionnaires were pilot tested by sending them to 20 members of PMAC in the Vancouver area. The 15 who responded were contacted for a telephone interview to solicit their opinions on the questionnaire and to identify any items they found to be confusing or ambiguous. Random probes were also used to test the respondents' understanding of the items, allowing a check of content validity. The pilot led to the decision to send and receive the questionnaires by fax because respondents preferred this method and responded more quickly than to a mailing. After analyzing the responses, a number of minor revisions were made to the questionnaires, such as clarifying terms and removing instructions that the respondents found unnecessary. Third, the revised questionnaires were faxed to another group of 20 local PMAC members for a second pilot test. Follow-up interviews with the 20

respondents did not indicate any need for substantive changes to the questionnaire.[2]

From the PMAC national mailing list of 6,550 members, a sample frame of 5,584 was constructed; for enterprises that had more than one PMAC member, the most senior member was selected. Thus, the sample frame represents a national directory of the most senior purchasing managers in Canada. Obviously, this sample frame eliminates very small firms that do not have a formalized purchasing function. A random sample of 1,772 members who had listed fax numbers were sent a one-page invitation to participate in a study of EDI and purchasing. Six hundred and forty-three members (36.3%) agreed to participate, indicating on the fax whether their organization used EDI for purchasing. Of the 643 members, due to fax modem problems, only 545 were faxed the appropriate version of the questionnaire, yielding 317 usable questionnaires. Of the responses, 58 came from organizations that use EDI in purchasing and 259 came from nonadopters. The response rate from those agreeing to participate was over 58% (317/545). As there were no substantive revisions to the questionnaire following the second pilot study, those responses were added to the pool, yielding 337 in total. Because the purpose of this paper is to test a model of the EDI adoption decision among SMEs, the responses from firms already using EDI, as well as those of firms with annual revenues in excess of C$1 billion, were dropped. It should be noted that our goal here is not to generalize our results to the PMAC population, but to understand the relationships among variables that explain the intention to adopt EDI by SMEs (Kerlinger 1986). The remaining set of 268 responses were used to test the causal model, and all statistics presented in this paper refer to this subset of firms.

Demographic information on the respondents showed that they had considerable experience in the purchasing function: on average, six and a half years of purchasing experience in a nonmanagerial role, followed by five and a half years of managerial purchasing experience. By their own assessment, 62% rated their knowledge of EDI as "average" or better, with some (32%) of the sample having had direct experience with EDI in either their current or previous organizations. Over 53% had a college or university degree, and 20% were Certified Purchasing Professionals. Thus, the respondents had considerable purchasing and managerial experience, and were well exposed to EDI.

The median organization had 325 employees, carried out operations at seven locations, and had revenues of C$48 million annually. Approximately 89% of our sample had revenues under C$250 million, and all had revenues of less than C$1 billion, two definitions of SME. The respondent firms represented a broad cross section of industries, broken down by sector as: manufacturing (35.4%), services (27.2%), government agencies and crown corporations (10.1%), and primary resources (12.3%).

3.2. Statistical Analyses

Throughout the paper, individual items have been standardized unless noted otherwise. The statistical analysis technique applied is partial least squares (PLS), as implemented in PLS Graph version 2.91.03.04. PLS is a form of causal modeling that, like LISREL, works by "simultaneously assessing the reliability and validity of the measures of theoretical constructs and estimating the relationships among these constructs." PLS is better suited when the focus is on theory development, whereas LISREL is preferred for confirmatory testing of the fit of a theoretical model to observed data, thus requiring stronger theory than PLS (Barclay et al. 1995).

The progress in theory development mentioned above makes PLS more appropriate than LISREL as an analysis technique in this case for two reasons. First, this survey is the first large-scale test of a model based on Iacovou et al. (1995). As such, the research model is not based on "strong theory." Second, some of the constructs in the model are formative (see below) and cannot be adequately modeled using covariance structure analysis due to the assumptions it imposes; PLS, being components based, can incorporate both formative and reflective indicators (Chin 1998). Bollen (1984) provides an excellent discussion of the relationships between indicators for reflective (or "effect") constructs and formative (or "cause") constructs.

All of the subconstructs in the model, as well as two of the constructs (perceived benefits and intent to

[2]The items are included as Appendix 1 to this article.

adopt EDI), are operationalized directly using reflective constructs. The remaining two constructs, readiness and external pressure, are modeled using formative constructs. (Also see Table 2.) Because the distinction between formative and reflective constructs is not always clear-cut, the modeling in this paper reflects the best judgment of the authors. However, we tested two other versions of the model—with all constructs formative and with all constructs reflective—and the results were qualitatively the same: No paths gained or lost statistical significance, and no significant paths changed in sign. Thus, the reader may be confident that the results are not an artifact of the authors' modeling decisions.

Reflective indicators are used when a construct is deemed to exist before it is measured, and each item "reflects" this unmeasured latent variable. Because each item reflects the same latent variable, the construct is unidimensional, and therefore the items should be correlated, making measures of internal consistency appropriate.

To determine item-construct loadings, a factor analysis was conducted in PLS using the items and the reflective constructs (see leftmost column in Table 3), with no relationships specified between the constructs. The resulting loadings were used for computing the internal consistency statistics discussed below, as well as for constructing a single, overall measure of each of the subconstructs. It is these factor scores that are used as indicators in the formative constructs of readiness and external pressure.[3]

Table 3 provides an analysis of the measurement model. In Table 3, the diagonal elements represent the square root of average variance extracted (AVE), providing a measure of the variance shared between a construct and its indicators. A rule for assessing discriminant validity requires that the square root of AVE be larger than the correlations between constructs, i.e., the off-diagonal elements in Table 3 (Barclay et al. 1995). All constructs meet this requirement. Likewise, the values for internal consistency are all above the suggested minimum of 0.70 (Fornell and Larcker 1981). Thus, all reflective constructs and subconstructs in the adoption model display adequate internal consistency and discriminant validity.

In contrast to reflective ones, formative constructs reverse the direction of causality in that the indicators form or cause the latent variable. Thus, the latent variable is a summative index of the items. This reversion of causality requires a significant difference in the interpretation of the measurement model; in particular, internal consistency and unidimensionality cannot be used to judge the quality of the measurement model.[4] Thus, for formative indicators, one examines item weights, which can be interpreted as a beta coefficient in a standard regression and will normally have smaller absolute values than item loadings. The weights and *t*-statistics for the formative constructs are presented with the results of the model in §4 below.

4. Results

The results of the PLS analysis of the adoption model are presented in Figure 2. For this analysis, the sample is composed of the 268 responses from firms with annual revenues less than $1 billion that have *not adopted* EDI, with the dependent variable being *intent to adopt EDI*. Statistical significance was assessed using a bootstrap procedure, with 200 resamples. Because PLS does not generate an overall goodness-of-fit index, one primarily assesses validity by examining R^2 and the structural paths, as one would with a regression model.

The findings support the primary hypotheses (Hypothesis 1–3) of the model (Figure 2). Perceived benefits, external pressure, and readiness are all positively related to the intent to adopt EDI, with significance at the $p < 0.001$ level. Approximately 32% of the variance in intent to adopt is accounted for by these three independent constructs in the model ($R^2 = 0.318$). The standardized path coefficients range from 0.11 to 0.37, with two of the three paths exceeding the suggested minimum standard of significance at 0.20 (Chin 1998). Thus, the fit of the overall model is good.

Because the model was run using standardized construct values, the beta values can be interpreted directly. Thus, a one standard deviation increase in external pressure results in, ceteris paribus, a 0.37

[3]The results of the confirmatory factor analysis are included as Appendix 2 to this article.

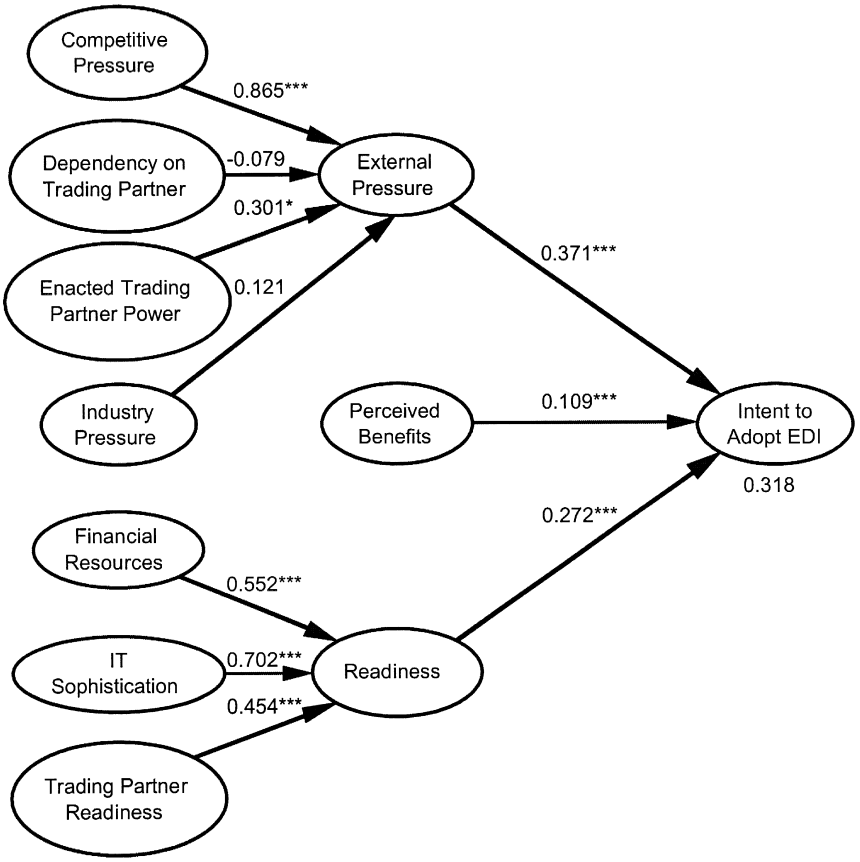
[4]Bollen (1984), Cohen et al. (1990), Chin and Gopal (1995), Mathieson et al. (1996), and Chin (1998) provide discussions of formative versus reflective constructs and their differing standards for validity.

Table 3 Attributes of Constructs when Modeled as Reflective

	Fornell	IA	CP	DTP	ETPP	FR	IP	ITS	PB	TPR
Intent to Adopt	**0.899**	**0.865**								
Competitive Pressure	**0.755**	0.457	**0.716**							
Dependency on Trading Partner	**0.725**	0.143	0.308	**0.706**						
Enacted Trading Partner Power	**0.827**	0.189	0.136	0.472	**0.840**					
Financial Resources	**0.772**	0.292	0.145	0.057	−0.027	**0.748**				
Industry Pressure	**0.810**	0.341	0.632	0.209	0.181	0.116	**0.826**			
IT Sophistication	**0.857**	0.308	0.269	0.036	0.029	0.124	0.177	**0.662**		
Perceived Benefits	**0.937**	0.274	0.277	0.057	0.027	0.024	0.187	0.467	**0.683**	
Trading Partner Readiness	**0.824**	0.258	0.194	0.125	0.064	0.122	0.170	−0.071	−0.117	**0.613**

Note. Diagonal elements are the square root of average variance extracted (AVE), which, for discriminant validity, should be larger than interconstruct correlations (off-diagonal elements).

Figure 2 Results of the Model of EDI Adoption



*denotes significance at the $p < 0.05$ level
***denotes significance at the $p < 0.001$ level

standard deviation increase in intent to adopt EDI; the values for readiness and perceived benefits are 0.27 and 0.11, respectively. Overall, these results provide strong support that the augmented model predicts intent to adopt EDI, with external pressure and readiness emerging as the most important factors in terms of impact on intent to adopt.

Recent research has suggested that interaction effects may be more prevalent in IS research than empirical findings have been able to demonstrate, likely due to measurement error (Chin et al. 1996). In this model, we tested whether the relationships between perceived benefits, external pressure, and intention to adopt were moderated by the enabling construct of readiness. The interaction terms were constructed using the two-stage technique described by Chin et al. (1996) but were found to be insignificant. Thus, we do not include further discussion of interaction effects. We next examine the factors that were most influential in each of the three constructs influencing intent to adopt EDI.

Perceived Benefits. The item loadings and *t*-statistics for the reflective constructs are presented in Table 4. Perceived benefits, the only reflective independent construct, displays strongly positive loadings and high levels of statistical significance for all items. Because all of the loadings are of approximately the same magnitude, it is not possible to make determinations about the relative importance of the individual benefits (items) in determining the overall level of perceived benefits.

External Pressure. Because PLS estimates the measurement model and the relationships between constructs simultaneously, the item weights of formative constructs display the importance of their impact on intent to adopt EDI. These weights can be interpreted similarly to estimated beta coefficients from a multiple regression analysis. The subconstruct weights and *t*-statistics for the formative constructs are presented in Table 5.

Two of the four subconstructs of external pressure, competitive advantage (0.86) and enacted trading partner pressure (0.30), are positive and significantly contribute to the intent to adopt EDI.

Readiness. All three subconstructs of readiness are positive and significantly contribute to the intent to adopt EDI. The weights on the subconstructs reveal their relative importance in determining readiness: IT-sophistication (0.70), financial resources (0.55), and trading partner readiness (0.45).

Table 4 Reflective Constructs: Loadings and *t*-statistics

Item	Loading	*t*-stat	Item	Loading	*t*-stat
Intent to Adopt			**Perceived Benefits- cont**		
IA1	0.816***	33.178	PB8	0.536***	8.719
IA2	0.864***	48.392	PB9	0.707***	15.420
IA3	0.911***	81.224	PB10	0.630***	10.502
Perceived Benefits			PB11	0.627***	10.926
PB1	0.684***	12.634	PB12	0.718***	16.765
PB2	0.636***	11.970	PB13	0.787***	19.674
PB3	0.728***	13.434	PB14	0.680***	14.381
PB4	0.761***	17.791	PB15	0.763***	26.247
PB5	0.652***	11.094	PB16	0.620***	11.787
PB6	0.649***	11.593	PB17	0.639***	12.592
PB7	0.744***	14.356			

***indicates that the item is significant at the $p < 0.001$ level.

5. Concluding Comments

5.1. Limitations

This research has several limitations: First, this research tests a theory within the context of SME firms in Canada that have not yet adopted EDI. The focus is

Table 5 Formative Constructs: Weights and *t*-statistics

Sub-construct	Weight	*t*-stat	Sub-construct	Weight	*t*-stat
External Pressure			**Readiness**		
Competitive Pressure	0.865***	7.327	Financial Resources	0.552***	4.342
Dependency on TP	−0.079	−0.587	IT Sophistication	0.702***	6.065
Enacted TP Power	0.301*	1.903	TP Readiness	0.454***	3.134
Industry Pressure	0.121	0.833			

*indicates that the sub-construct is significant at the $p < 0.05$ level.

***indicates that the sub-construct is significant at the $p < 0.001$ level.

on the relationships between variables and generalizing to theory, not to any specific population (Kerlinger 1986). While our sample does not affect our testing of the causal model in this paper, generalizing to other contexts should be done with caution. Clearly, purchasing professionals will have a different perspective on EDI than, say, marketing managers. However, the finding that external pressure is significant, even in the purchasing context, highlights the importance of this construct. Likewise, our sample frame eliminates the smallest organizations that do not have a purchasing manager. Given the similarity between Canada and the United States in terms of both business environment and rates of IT diffusion, we do not suspect substantive differences in applying this model to the U.S. setting.

Second, the survey methods chosen for this research required the use of sole respondents within the organization; this approach forced the adaptation of some measures, such as IT sophistication and financial resources. Given the goals of this research and the number of constructs included in the questionnaires, we could not operationalize each individual construct in as much depth as in prior research that was more narrowly focussed, for example, on the validation of a single construct. We have included our items and the results of the factor analysis, so that other researchers can judge the content and construct validity of these measures and continue to refine and improve them.

5.2. Discussion of the Findings

This paper has tested a model, partly based on Iacovou et al. (1995), of the factors influencing the adoption of EDI. These findings are the first quantitative, positivist test of this hypothesized model, originally developed in an interpretive fashion based on a limited number of case studies. It is also a test of a model that is a parsimonious representation of the factors that were found to be influential in a number of disparate studies of EDI adoption. A survey of Canadian purchasing managers found that *intent to adopt EDI* was influenced by *perceived benefits*, *external pressure*, and *readiness*, providing strong support for the model.

Overall, we found support for examining the adoption of interorganizational systems using factors addressing three levels. At the level of the perceptions of technology, the *perceived benefits* captured the anticipated benefits of EDI adoption. At the level of the organization, *IT sophistication* and *financial resources* affected the firm's ability to adopt EDI. At the interorganizational level, *competitive pressure*, *enacted trading partner power*, and *trading partner readiness* influenced adoption intentions. Overall, these three classes of constructs accounted for more than 30% of the variance in intent to adopt. These results support the findings of previous research differentiating adopters from nonadopters, particularly Grover (1993) and Premkumar et al. (1997). Thus, future research on interorganizational technologies should clearly address these three theoretical perspectives.

The model in this paper is thus consistent with prior empirical work predicting EDI adoption, and makes novel contributions at three levels. At the conceptual level, the refined model of EDI adoption presented here incorporates the factors, identified separately in previous studies, as influencing adoption into a consistent and parsimonious predictive model. Second, the original Iacovou et al. (1995) model has been supplemented to include the interorganizational construct of trading partner readiness, the lack of which is an impediment to adopt; impediments to adoption have been earlier identified but seldom studied. Third, because this paper is the first empirical test of the Iacovou et al. (1995) model, it completes the cycle of generating theory and testing theory.

The approach of structural equation modeling has allowed examination of the individual subconstructs within the constructs, providing insight as to which aspects of these constructs are particularly salient in the context of the purchasing function. Combining the subconstruct weights with the construct path coefficients indicates that *competitive pressure* is the single most important factor contributing to intent to adopt EDI, followed by *IT sophistication*, *financial resources*, *trading partner readiness*, *enacted trading partner power*, and *perceived benefits*, respectively. These results are somewhat surprising, in that they indicate that the most important determinants of EDI adoption are competitive necessity and the availability of the enablers that compose the readiness construct, rather than imposition by trading partners, which has emerged as the most salient factor in earlier work (e.g., Bouchard 1993, Premkumar and Ramamurthy 1995).

We hypothesize that the difference in findings is due to two factors. First, previous research in many cases did not include enablers, and thus was overestimating the impact of other factors. Second, our sample looks at the adoption decision from the buyer's perspective, which is likely subject to less imposition by trading partners than the sellers that composed the samples of previous work.

The strength of the weights on *readiness* and its three subconstructs *(IT sophistication, financial resources, trading partner readiness)* indicates that while the benefits of the technology (perceived benefits) or external pressure may motivate the adoption of EDI, there are a number of necessary conditions that contribute to the ability to adopt EDI. Thus, even motivated firms must have technical ability, available resources, and willing trading partners before EDI adoption is possible.

For *external pressure,* two subconstructs emerged as significant: *competitive pressure* and *enacted trading partner power.* The large weight on the competitive pressure construct (0.86) illustrates that it is key in determining the overall level of external pressure to adopt EDI in the purchasing context. The weight on enacted trading partner power (0.30), while smaller, is still significant. The purchasing context in which the survey was conducted makes for a strong test of the significance of influence from trading partners. All other things being equal, one would expect the buyer to hold the balance of power in the buyer-seller dyad, as a buyer could exert considerable pressure on a seller to adopt EDI (as a number of larger firms have done, e.g., Wal-Mart and General Motors). Thus, it would not be surprising to find trading partner power significant in the context of the seller side of the dyad. However, the fact that enacted trading partner power is statistically significant, even on the buyer side, is a strong confirmation of the importance of this subconstruct.

One circumstance in which a seller has significant power over buyers is that of a monopolist. However, examination of the model reveals that the *dependency* subconstruct was not a significant contributor to external pressure, indicating that organizations were not being held hostage by sole suppliers. In contrast to Hart and Saunders (1998) dependency was not modeled as a determinant or antecedent of enacted power. Instead, a moderating relationship between dependency and enacted trading partner power (as dependency is a necessary but not significant condition for the use of enacted power) was tested using the two-stage procedure suggested by Chin et al. (1996) but found to be nonsignificant. Thus, we do not find dependency to be a significant determinant of external pressure, either directly or through moderation of enacted trading partner power.

Similarly, the *industry pressure* subconstruct was insignificant in affecting external pressure. Thus, industry associations were not influential in motivating organizations to adopt EDI, at least in comparison to pressure from trading partners and competitive pressure. Interestingly, Teo et al. (2000), based on a sample collected in Singapore for the adoption of Financial EDI, found industry pressure to be more significant. One possible explanation for this difference is that while Singapore has one central institutional authority that is highly influential, Canada is governed using a decentralized federal/provincial/municipality model, similar to the U.S. federal/state/county system, and thus does not have a strong central authority influencing technology decisions. Singapore-based managers may tend to make organizational choices that are only endorsed and consistent with views espoused by government, government-related, and/or collective associations. Furthermore, industry pressure may act more strongly when the focus is on a specific application, such as financial EDI, rather than the more dispersed range of applications sampled from in this study.

Future research can proceed in several directions. We believe that the core of this model has general applicability to other forms of IOS, particularly business-to-business electronic commerce. While this extension may require reoperationalization of some of the constructs, we hypothesize that the relationships predicted by our model will continue to hold. Second, while we have empirically validated the model in the context of the buyer side of the buyer-seller dyad, we have not examined the adoption of EDI from the seller's side. From the seller's side, the interorganizational relationships and power differentials may be more salient, as it is likely that a large customer could coerce a seller into adopting EDI. Given that the results from the buyers' side are statistically significant, we expect an even stronger relationship on the seller side.

In relationships in which both buyer and sellers enjoy approximately equal bargaining power, we expect that relationship factors, such as trust, would emerge as important (Hart and Saunders 1997, 1998). Third, the impact portion of the Iacovou et al (1995). model may be tested using adopters to test whether the factors influencing adoption also influence the outcome of adoption, in terms of the level of integration of the EDI system and its organizational impact (Premkumar et al. 1994, Premkumar and Ramamurthy 1995, Bergeron and Raymond 1997, Ramamurthy et al. 1999).

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Appendix 1. Measurement Items

Items with a ⋆ are reverse-scaled. Information in brackets describes the coding of the items used for analysis.

Competitive Pressure

CP1. Approximately what percent of the organizations in your industry use EDI for purchasing? [square root coded]

_____ % ☐ Don't Know

CP2. In your industry, is the adoption of EDI helpful in allowing an organization to remain competitive?

Not at all Helpful			Somewhat Helpful			Extremely Helpful	Don't Know
1	2	3	4	5	6	7	X

CP3. Please rate the pressure to adopt EDI placed on your organization **by your competitors**.

No Pressure at all			Some Pressure			Extreme Pressure	Don't Know
1	2	3	4	5	6	7	X

Dependency on Trading Partner

DTP1. At the time that your organization was being encouraged to adopt EDI, approximately what percentage of purchases (dollar value) were from this firm?

_____ % of dollar purchases ☐ Don't Know

DTP2. Approximately how many firms supply the same product(s) as this firm? [square root coded] ⋆

_____ other firms ☐ Don't Know

DTP3. Please rate the importance of this supplier to your organization at the time your organization was being encouraged to adopt EDI.

Not at all Important			Moderately Important			Extremely Important	Don't Know
1	2	3	4	5	6	7	X

Enacted Trading Partner Power

ETPP1. Please rate the amount of influence this supplier had in your organization's decision whether or not to adopt EDI.

No Influence			Moderate Influence			Strong Influence	Don't Know
1	2	3	4	5	6	7	X

ETPP2. Please attempt to classify the strength of the encouragement or pressure put on your organization by this supplier. (Check as many as apply.)

- ☐ **No encouragement or pressure**: The trading partner did not attempt to encourage EDI adoption
- ☐ **Information Exchange**: The trading partner provided information regarding EDI
- ☐ **Recommendation**: The trading partner recommended that your organization adopt EDI
- ☐ **Request**: The trading partner asked that your organization adopt EDI
- ☐ **Promise**: The trading partner made promises regarding benefits to be received from your organization's adopting EDI (promises could include discounts, faster orders, etc.)
- ☐ **Threat**: The trading partner made threats regarding detriments that would result if your organization did not adopt EDI (threats could include discontinuing the relationship, hints that non-EDI customers would receive poor service, etc.)
- ☐ Other
  ↳ (please specify) _____

Industry Pressure

IP1. Please rate the pressure placed on your organization to adopt EDI **by industry sources** (such as trade associations).

No Pressure at all			Some Pressure			Extreme Pressure	Don't Know
1	2	3	4	5	6	7	X

IP2. How many times per year do you receive information regarding EDI from sources **outside** your organization (such as industry associations, professional associations, or trade newsletters)? [square root coded]

_____ Times per year ☐ Don't Know

IT Sophistication

ITS1. Please rate the attitude of your top management toward the deployment of information technology in your organization.

Very Negative			Neutral			Very Positive	Don't Know
1	2	3	4	5	6	7	X

ITS2 8. Information technology can be used for a number of objectives. To what extent is information technology important for the fulfillment of the following objectives in your organization?

	Not at all Important			Moderately Important			Extremely Important	Don't Know
Personnel Reduction	1	2	3	4	5	6	7	X
Operational Costs Reduction	1	2	3	4	5	6	7	X
Productivity Improvements	1	2	3	4	5	6	7	X
Improved Access to Information	1	2	3	4	5	6	7	X
Improved Quality of Decision Making	1	2	3	4	5	6	7	X
Improved Competitiveness	1	2	3	4	5	6	7	X
Improved Service to Customers	1	2	3	4	5	6	7	X

Financial Resources

FR1. In the context of your organization's overall Information Systems budget, how significant would the financial cost of developing and implementing an EDI system be? ⋆

Not at all Significant			Moderately Significant			Extremely Significant	Don't Know
1	2	3	4	5	6	7	X

FR2. Approximately how many people are employed in your organization? [log-scaled]

_____ People ☐ Don't Know

FR3. What was the (approximate) total revenue of your organization last year? (For nonprofit organizations, indicate total operating budget.) [log-scaled]

_____ Dollars ☐ Don't Know

Trading Partner Readiness

TPR1– 8. Please rate the importance of each of the following issues in terms of your organization's decision **whether or not to adopt EDI.** That is, to what extent would each of these factors inhibit the adoption of EDI at your organization? ⋆

	Not at all Important			Moderately Important			Extremely Important	Don't Know
Trading Partner Reluctance to Change	1	2	3	4	5	6	7	X
Lack of Trust in Trading Partner(s)	1	2	3	4	5	6	7	X
Training or Educating Trading Partner(s)	1	2	3	4	5	6	7	X
Non-Automated/ Non-Sophisticated Trading Partner(s)	1	2	3	4	5	6	7	X
Poor Reputation of Trading Partner(s)	1	2	3	4	5	6	7	X
Lack of Adequate Accounting or Legal Controls	1	2	3	4	5	6	7	X
Inadequate Trading Volume to Justify EDI	1	2	3	4	5	6	7	X
Difficulty in Achieving "Critical Mass" of Trading Partners	1	2	3	4	5	6	7	X

Intent to Adopt EDI

IA1. At what stage of EDI system development is your organization currently engaged?

☐ Not Currently Developing an EDI System
☐ Planning
☐ Pilot Testing

IA2. Does your organization intend to adopt EDI?

No Intent to Adopt EDI			Moderate Intent to Adopt EDI			Definite Intent to Adopt EDI	Don't Know
1	2	3	4	5	6	7	X

IA3. If your organization is developing EDI or intends to adopt EDI, how soon do you anticipate that it will have an operational EDI system? ⋆

- ☐ Less than 6 months
- ☐ 6 to 12 months
- ☐ 12 to 18 months
- ☐ 18 to 24 months
- ☐ More than 24 months
- ☐ No plans to develop EDI

Perceived Benefits

PB1–17. Please rate the importance of achieving each of the following **benefits of EDI** in terms of your organization's decision **whether or not to adopt EDI.**

	Not at all Important			Moderately Important			Extremely Important	Don't Know
Increased Productivity	1	2	3	4	5	6	7	X
Paper Reduction	1	2	3	4	5	6	7	X
Overhead Cost Reduction	1	2	3	4	5	6	7	X
Reduced Error Rates	1	2	3	4	5	6	7	X
Reduced Data Re-keying	1	2	3	4	5	6	7	X
Reduced Inventory Costs	1	2	3	4	5	6	7	X
Improved Customer Service	1	2	3	4	5	6	7	X
Reduced Need for Cash-on-Hand ("Float")	1	2	3	4	5	6	7	X
Faster Response to Orders	1	2	3	4	5	6	7	X
Reduced Stockout Costs	1	2	3	4	5	6	7	X
Higher Product Quality	1	2	3	4	5	6	7	X
Reduced Communication Cost	1	2	3	4	5	6	7	X
Improved Accuracy	1	2	3	4	5	6	7	X
Enhanced Ability to Compete	1	2	3	4	5	6	7	X
Greater Integration of Automated Systems	1	2	3	4	5	6	7	X
Improved Access to Suppliers' Price and Product Descriptions	1	2	3	4	5	6	7	X
Potential for Purchasing Process Re-engineering	1	2	3	4	5	6	7	X

Appendix 2. Construct-Item Correlations

	AI	CP	DTP	ETPP	FR	IP	ITS	PB	TPR
IA1	0.822	0.311	0.139	0.163	0.288	0.210	0.153	0.112	0.171
IA2	0.864	0.422	0.091	0.154	0.238	0.319	0.301	0.342	0.040
IA3	0.908	0.394	0.124	0.178	0.215	0.283	0.271	0.211	0.148
CP1	0.216	0.578	0.097	−0.034	0.056	0.269	0.069	0.025	0.065
CP2	0.357	0.728	0.166	0.119	0.123	0.374	0.286	0.323	0.020
CP3	0.346	0.806	0.252	0.121	0.133	0.596	0.198	0.186	0.057
DTP1	0.112	0.209	0.732	0.307	−0.077	0.124	−0.035	0.064	0.071
DTP2	0.022	−0.016	0.585	0.036	0.017	0.030	0.008	−0.026	0.043
DTP3	0.138	0.299	0.816	0.459	0.167	0.173	0.121	0.052	−0.022
ETPP1	0.185	0.177	0.449	0.845	−0.015	0.195	0.020	0.019	0.051
ETPP2	0.136	0.006	0.230	0.845	−0.033	0.074	0.072	0.046	−0.053
FR1	0.184	0.066	−0.008	0.016	0.355	−0.006	−0.044	−0.206	0.287
FR2	0.253	0.123	0.075	−0.041	0.878	0.155	0.139	0.128	−0.001
FR3	0.209	0.139	0.040	−0.021	0.884	0.130	0.117	0.046	−0.065
IP1	0.205	0.370	0.064	0.138	0.104	0.829	0.111	0.025	0.133
IP2	0.321	0.625	0.203	0.126	0.141	0.829	0.164	0.230	0.033
ITS1	0.289	0.151	−0.003	−0.043	0.140	0.090	0.545	0.249	−0.027
ITS2	0.156	0.084	0.011	0.057	0.235	0.089	0.340	0.160	−0.148
ITS3	0.206	0.223	0.091	0.101	0.154	0.181	0.754	0.379	−0.120
ITS4	0.193	0.188	0.010	0.057	0.092	0.117	0.791	0.381	−0.164
ITS5	0.234	0.156	0.071	0.047	0.042	0.096	0.663	0.260	−0.102
ITS6	0.182	0.132	−0.056	−0.009	0.037	0.071	0.802	0.328	−0.113
ITS7	0.117	0.314	0.142	0.050	0.005	0.154	0.624	0.381	−0.198
ITS8	0.187	0.184	0.017	0.034	0.059	0.100	0.712	0.414	−0.156
PB1	0.178	0.167	0.066	0.044	0.041	0.070	0.385	0.696	−0.174
PB2	0.188	0.167	0.049	−0.053	0.076	0.053	0.364	0.612	−0.180
PB3	0.112	0.162	0.009	0.049	0.086	0.085	0.388	0.731	−0.168
PB4	0.194	0.186	0.031	0.059	0.047	0.062	0.342	0.768	−0.137
PB5	0.183	0.093	−0.006	0.040	0.070	0.026	0.274	0.663	−0.139
PB6	0.161	0.213	−0.008	0.036	0.070	0.182	0.313	0.661	−0.213
PB7	0.157	0.197	−0.002	0.068	0.030	0.120	0.347	0.756	−0.157
PB8	0.108	0.174	0.055	0.049	0.039	0.151	0.268	0.558	−0.275
PB9	0.155	0.238	0.055	0.012	0.028	0.130	0.296	0.724	−0.249
PB10	0.174	0.209	0.068	0.018	−0.044	0.162	0.262	0.647	−0.226
PB11	0.047	0.160	0.052	0.046	−0.064	0.124	0.267	0.641	−0.183
PB12	0.199	0.164	0.042	−0.039	−0.034	0.120	0.328	0.729	−0.154
PB13	0.185	0.203	0.016	0.076	−0.082	0.094	0.355	0.792	−0.139
PB14	0.166	0.349	0.078	0.086	−0.036	0.209	0.345	0.693	−0.204
PB15	0.310	0.174	0.027	0.068	0.112	0.083	0.426	0.766	−0.186
PB16	0.113	0.148	0.007	−0.058	−0.032	0.170	0.277	0.623	−0.168
PB17	0.229	0.134	0.038	−0.045	0.109	0.080	0.372	0.653	−0.220
TPR1	0.068	−0.003	−0.060	−0.030	0.033	0.047	−0.084	−0.137	0.688
TPR2	0.040	−0.066	−0.020	0.039	−0.017	0.023	−0.180	−0.218	0.718
TPR3	−0.026	−0.047	−0.072	−0.164	0.046	0.007	−0.305	−0.300	0.688
TPR4	0.084	0.081	0.064	−0.047	−0.001	0.070	−0.105	−0.171	0.695
TPR5	0.102	0.052	0.034	0.034	−0.013	0.057	−0.125	−0.239	0.686
TPR6	0.081	0.048	0.072	0.130	0.002	0.089	−0.091	−0.177	0.708
TPR7	0.290	0.257	0.149	0.062	0.037	0.205	0.022	0.051	0.493
TPR8	0.132	0.096	0.078	−0.018	0.063	0.080	−0.099	−0.157	0.626

References

Barclay, D., C. Higgins, R. Thompson. 1995. The partial least squares approach to causal modeling: Personal computer adoption and use as an illustration. *Tech. Stud.* **2**(2) 285–309.

Barua, A., B. Lee. 1997. An economic analysis of the introduction of an electronic data interchange system. *Inform. Systems Res. 8*(4) 398–422.

Bensaou, M., N. Venkatraman. 1996. Interorganizational relationships and information technology: A conceptual synthesis and a research framework. *Euro. J. Inform. Systems* **5**(2) 84–91.

Bergeron, M. 1994. Measuring the business value of EDI: The case of financial EDI in Canada. Unpublished Ph. D. dissertation. University of British Columbia, Canada.

——, ——. 1997. Managing EDI for corporate advantage: A longitudinal study. *Inform. Management* **31**(6) 319–333.

Bollen, K. A. 1984. Multiple indicators: Internal consistency or no necessary relationship? *Quality and Quantity* **18** 377–385.

Bouchard, L. 1993. Decision criteria in the adoption of EDI. *Proc. 14th Internat. Conf. Inform. Systems*, Orlando, FL 365–376.

Chin, W. W. 1998. Issues and opinion on structural equation modeling. *MIS Quart.* **22**(1) VII–XVI.

——, A. Gopal. 1995. Adoption intention in GSS: Relative importance of beliefs. *Data Base Adv.* **26**(2&3) 42–63.

——, B. L. Marcolin, P. R. Newsted. 1996. A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and voice mail emotion/adoption study. *Proc. 17th Internat. Conf. Inform. Systems*, Cleveland, OH., 21–41.

Cohen, P., J. Cohen, J. Teresi, M. Marchi, C. N. Velex. 1990. Problems in the measurement of latent variables in structural equations causal models. *Appl. Psych. Measurement* **14**(2) 183–196.

Converse, J. M., S. Presser. 1986. *Survey Questions: Handcrafting the Standardized Questionnaire.* Sage Publications, Beverly Hills, CA.

Crook, C. W., R. L. Kumar. 1998. Electronic data interchange: A multi-industry investigation using grounded theory. *Inform. Management* **34** 75–89.

Damanpour, F. 1992. Organizational size and innovation. *Organ. Stud.* **13**(3) 375–402.

Densmore, B. 1998. EDI vs. the new kids. *Emmerce*. ⟨www.computerworld.com/home/emmerce.nsf//all/980406edi⟩.

Ferguson, S. 1992. The benefits and barriers to adoption of EDI. Working paper. University of British Columbia, Vancouver, BC, Canada.

Fornell, C., D. F. Larcker. 1981. Structural equation models with unobservable variables and measurement errors. *J. Marketing Res.* **18**(1) 39–50.

Fowler, F. J. 1993. *Survey Research Methods,* 2nd ed. Sage Publications, Newbury Park.

Gopalakrishnan, S., F. Damanpour. 1997. A review of innovation research in economics, sociology, and technology management. *Omega* **25**(1) 15–28.

Grover, V. 1993. An empirically derived model for the adoption of customer-based interorganizational systems. *Decision Sci.* **24**(3) 603–640.

Hart, P., C. S. Saunders. 1997. Power and trust: Critical factors in the adoption and use of electronic data interchange. *Organ. Sci.* **8**(1) 23–42.

——, ——. 1998. Emerging electronic partnerships: Antecedents and dimensions of EDI use from the supplier's perspective. *J. Management Inform. Systems* **14**(4) 87–111.

Iacovou, C. L., I. Benbasat, A. S. Dexter. 1995. Electronic data interchange and small organizations: Adoption and impact of technology. *MIS Quart.* **19**(4) 465–485.

Kerlinger, F. N. 1986. *Foundations of Behavioral Research,* 3rd ed. Holt, Reinhart and Winston, New York.

Mukhopadhyay, T. 1993. Assessing the economic impacts of electronic data interchange technology. R. Banker, R. Kauffman, eds. *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage.* Idea Group Publishing, Harrisburg, PA.

——, S. Kekre, S. Kalathur. 1995. Business value of information technology: A study of electronic data interchange. *MIS Quart.* **19**(2) 137–156.

O'Callaghan, R. 1989. Adoption and diffusion of electronic marketing channels: A study of the property and casualty insurance industry. Unpublished Ph.D. dissertation, Harvard Business School, Boston, MA.

——, P. J. Kaufmann, B. R. Konsynski. 1992. Adoption correlates and share effects of electronic data interchange systems in marketing channels. *J. Marketing* **56**(2) 45–56.

Paré, G., L. Raymond. 1991. Measurement of information technology sophistication in SMEs. *Proc. Admin. Sci. Association of Canada* 90–101.

Premkumar, G., K. Ramamurthy. 1995. The role of interorganizational and organizational factors on the decision mode for adoption of interorganizational systems. *Decision Sci.* **26**(3) 303–336.

——, K. Ramamurthy, S. Nilakanta. 1994. Implementation of electronic data interchange: An innovation diffusion perspective. *J. Management Inform. Systems* **11**(2) 157–186.

——, ——, M. R. Crum. 1997. Determinants of EDI adoption in the transportation industry. *Europ. J. Inform. Systems* **6**(2) 107–121.

Provan, K. G. 1980. Recognizing, measuring, and interpreting the potential/enacted power distinction in organizational research. *Acad. Management Rev.* **5**(4) 549–559.

——, ——, M. R. Crum. 1999. Organizational and interorganizational determinants of EDI diffusion and organizational performance: A causal model. *J. Organ. Comput.* **9**(4) 253–285.

Reich, B. H., I. Benbasat. 1990. An empirical investigation of factors influencing the success of customer-oriented strategic systems. *Inform. Systems Res.* **1**(3) 325–347.

Rogers, E. M. 1995. *Diffusion of Innovations*, 4th ed. Free Press, New York.

Saunders, C. S., S. Clark. 1992. EDI adoption and implementation: A focus on interorganizational linkages. *Inform. Resources Management J.* **5**(1) 9–19.

——, P. Hart. 1993. Electronic data interchange across organizational boundaries: Building a theory of motivation and

implementation. *The Economist*. 2000. Survey: E-commerce, shopping around the web. Working paper #7-93, Decision and Information Systems, Florida Atlantic University, Boca Raton, FL 55–56.

Schuman, H., S. Presser. 1981. *Questions and Answers in Attitude Surveys*. Academic Press, New York.

Son, J. L., S. Narasimhan, F. J. Riggins. 1999. Factors affecting the extent of electronic cooperation between firms: Economic and sociological perspectives. *Proc. the 1999 Intern. Conf. Inform. Systems*. Charlotte, N.C. 556–560.

Sudman, S., N. M. Bradburn. 1983. *Asking Questions: A Practical Guide to Questionnaire Design*. Jossey-Bass, San Francisco, CA.

Swatman, P. M. C., P. A. Swatman. 1991. Electronic data interchange: Organizational opportunity, not technical problem. *Proc. 2nd Australian Conf. Databases and Inform. Systems*. Sydney, Australia.

——, ——. 1992. EDI system integration: A definition and literature survey. *Inform. Soc.* **8**(3) 169–205.

Teo, H. H., B. C. Y. Tan, K. K. Wei. 1995. Innovation diffusion theory as a predictor of adoption intention for financial EDI. *Proc. 1995 Internat. Conf. Inform. Systems,* Amsterdam The Netherlands 155–165.

——, K. K. Wei, I. Benbasat. 2000. Predicting predisposition toward IT-based interorganizational linkages: An institutional perspective. Working paper. Department of Information Systems, National University of Singapore, Singapore.

Tornatsky, L. G., K. J. Klein. 1982. Innovation characteristics and innovation adoption-implementation: A metaanalysis of findings. *IEEE Trans. Engrg. Management* **29**(1) 28–45.

Wang, E. T. G., A. Seidmann. 1995. Electronic data interchange: Competitive externalities and strategic implementation policies. *Management Sci.* **41**(3) 401–418.

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