AN XML ADOPTION FRAMEWORK FOR ELECTRONIC BUSINESS

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ABSTRACT

One of the recent phenomena information systems (IS) practitioners are currently facing in their continuous process of adopting new technology is the utilization of Extensible Markup Language (XML). In this paper we propose an XML adoption framework, a corresponding adoption space model, and a probit model of technology diffusion to examine the decision of adopting XML-based applications in the context of electronic business. First, an XML adoption framework is proposed. The framework helps companies examine their current status in the electronic business environment from the perspective of three electronic business domains, namely enterprise intranets, value-chain extranets, and the global Internet. This framework also provides guidelines for companies seeking to understand the potential benefits of adopting XML technology, and then further suggests the appropriate path and proper applications. Second, we propose an XML adoption space model. Considering its current status of IT applications, a company can utilize this model to measure the efforts/costs that will be incurred by developing XML-enabled IT applications. Third, we use a probit model of technology diffusion to explore the feasibility of a company's adoption of XML technology. This probit model considers a company's specific characteristics and evaluates benefits and efforts/costs of its XML adoption decision.

Keywords: E-Business, Decision Model, Framework, XML

1. Introduction

One of the recent phenomena information systems (IS) practitioners are currently facing in their continuous process of adopting new technology is the utilization of Extensible Markup Language (XML). A search in a major business library index database (ABI/Informs) identified more than 1200 articles published in the past three years that are dedicated to the discussion of XML, including its specifications, usage, providers, designers, and users. However, among the many articles identified, less than one percent appeared in academic journals. While some scholarly related exceptions exist (e.g., Glushko et al.'s [1999] XML agent-based e-commerce framework and Lu et al.'s XML/EDI study [2001]), none have addressed the specific issue of XML adoption from a business IT perspective.[1] Therefore, it is our intention to add to the body of business information systems research by proposing an XML adoption framework, a corresponding adoption space model, and an associated probit model of technology diffusion. The settings of electronic business considered for a company include contexts within the corporation, in conjunction with its partners, and in the entire electronic world through the company's Internet web presence. With our proposed framework and adoption model, businesses will better understand the benefits of adopting XML and derive a more robust understanding of how much effort it will take to adopt XML before trying to realize the gains from XML in various aspects of their electronic businesses.

The contribution of this paper is three-fold. First, a new XML adoption framework is proposed. The framework helps companies examine their current status in the electronic business environment from the perspective of three electronic business domains, namely enterprise intranets, value-chain extranets, and the global Internet. The

[1] The authors recognize that there has been a great deal of research in the Computer Science discipline around various aspects of XML.

framework also provides guidelines for companies to understand the potential benefits of adopting XML technology and then suggests the appropriate path and proper applications. Second, we propose an XML adoption space model. Considering its current status of IT applications, a company can utilize this model to measure the efforts/costs that will be incurred by developing its XML-enabled IT applications. Third, we use a probit model of technology diffusion to explore the feasibility of a company's adoption of XML technology. This probit model considers a company's specific characteristics and evaluates benefits and efforts/costs of its potential XML adoption. This probit model is used to help a company to make a final adoption decision.

Theoretical Background

To understand the business adoption of XML, this research is conducted based on the prior findings of three related theories in microeconomics, social science, and information systems. From a microeconomic perspective, one of the fundamental goals of a business is to decrease its transaction costs in order to maximize profits. The theory of transaction costs has been well developed in microeconomics and has been termed Coasian Economics, due to the contributions of Ronald Coase [1937]. Coase argued that organizations exist because the cost of managing economic exchanges between firms can be greater than that of managing them within firms. Also related to the transaction costs theory and of particular relevance to XML adoption is Williamson's work [1975; 1985] on markets and hierarchies. By the same token, Williamson contends that if the market (external firm) can deliver the economic exchanges in a more cost-effective way (e.g., a grocery chain that outsources its IT functions) compared to the firm that has to perform the same functions internally under the control of its own hierarchy, then the market would be preferred. These decisions (external vs. internal or market vs. hierarchy) are largely driven by transaction costs. XML adoption is expected to significantly reduce transaction costs in various electronic business contexts, including those of enterprise intranet, value-chain extranet, and global Internet.

While some research exists on transaction costs from an information systems perspective [e.g., Malone et al., 1987; Zaheer & Venkatraman, 1994; Stapleton et al., 2001], to our knowledge, only Stapleton et al. [2001] examines transaction costs of IT in an e-commerce environment. It is our observation that no work has yet discussed the benefits of adopting XML in an e-commerce environment and its relation to transaction costs.

The promise of reduced transaction costs brought about by XML adoption is one of the potential enticements for businesses to make the adoption; however, before adopting any new technology, management should consider the expense at which this adoption will happen. Two other related theories, innovation diffusion and technology acceptance, provide insights into the complications and rewards of adopting new technology.

In his book, *Diffusion of Innovations*, Rogers [1962] lays the foundation for a theory of innovation diffusion. Rogers defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" [1995, p.5]. Much research within the IS field has utilized this theory to investigate the diffusion of information technology innovation [e.g., Brancheau & Wetherbe, 1990; Attewell, 1992; Fichman, 1992; Taylor & Todd, 1995; Kline & Sorra, 1996; Parthasarath & Bhattacherjee, 1998]. Many of these studies have empirically analyzed different situations in which a new technology has been introduced and the varying degrees of its success, often measured by its overall diffusion. XML adoption faces similar diffusion issues. Standardizing on a markup language like XML for conducting electronic business transactions can be considered an innovation when compared with traditional ways of conducting business. As businesses move toward an electronic, or paperless, environment, this innovation has to be diffused. Along with other challenges arising from this innovation, resistance in the form of maintaining outdated ways of conducting business can be an obstacle for businesses to stay competitive in the 21st century.

Closely related to the theory of innovation diffusion, Davis's [1989] technology acceptance model (TAM) has also been rather influential in IS literature [e.g., Davis et al., 1989; Taylor & Todd, 1995; Karahanna et al., 1999]. The fundamental assumption of the TAM model argues that there is a combination of perceived usefulness and perceived ease-of-use that leads to an attitude toward use. The attitude toward use will lead to a behavioral intention to use, which in turn affects the actual system use. With the general acceptance of TAM in IS discipline, a growing number of recent studies have begun to utilize TAM when examining information systems in the context of the Internet and electronic commerce [e.g., Jiang et al., 2000; Lederer et al., 2000; Lin & Lu, 2000]. While this current study does not attempt to test TAM in an experimental environment, the acceptance aspect of XML technology is fundamentally related to our proposed adoption framework and space model.

The rest of the paper is organized as follows. Section 2 provides a discussion on the electronic business environment and lays out our proposed XML adoption framework for integrating XML into electronic business solutions. Section 3 presents our XML adoption space model in detail for measuring the efforts/costs of a company that wants to adopt XML-based technology. Section 4 discusses the probit decision model for assisting companies in making a final adoption decision. The paper then concludes with a closing discussion that includes limitations and avenues for future research.

2. XML Adoption Framework for Electronic Business

Over 100 different industries have adopted XML-based IT technology in their business operations, including airline, financial (FinXML, FpML), insurance, news (NewsML), accounting (XBRL), banking, telecommunications, healthcare, and automotive. Many of the identified industries adopting XML are those with relatively large IT departments. However, some other industries such as food, retail, fuel, publishing, transportation, hotel management, and public utilities are also turning to XML to fulfill their business needs. For example, the National Retail Federation's standards body -- Association for Retail Technology Standards (ARTS) -- has already released its data dictionary of XML "tags" to help facilitate business exchanges between its participating vendors [Chain Store Age, 2000].

People are not only talking about XML but also talking to XML. Owners of new General Motors vehicles equipped with the OnStar wireless systems can now get the latest information on stock quotes, weather, etc. through XML-tagged data that is translated to Voice XML [Sliwa, 2000]. Another example of telecommunications involvement includes Cisco adding an XML-based IP telephony offering to its product line for its customers [Hooper, 2001]. Evidence has shown that companies of different sizes operating in a variety of electronic business capacities and domains in various industries have started to adopt XML-based IT applications. Therefore, it is our intention to propose a general XML adoption framework and corresponding adoption space model to help companies make better adoption decisions.

In general, organizations that are involved in electronic business manage activities within three electronic domains. These domains include the enterprise intranet, the value chain extranet, and the global Internet (see Figure 1). Each domain is associated with a type (or a combination of types) of electronic activities that pose their own unique set of challenges. However, typically there are some inclusive relationships among these domains. For example, a business that operates in the value chain extranet domain usually also operates in the enterprise intranet domain. That is, a business that is involved in business-to-business (B2B) commerce and related electronic commerce applications is also likely to be involved in enterprise information management systems (intranets, ERPs) and in related business electronic commerce applications. Furthermore, we conjecture that a business that operates in the global Internet environment typically also operates in the value chain extranet and enterprise intranet environments.

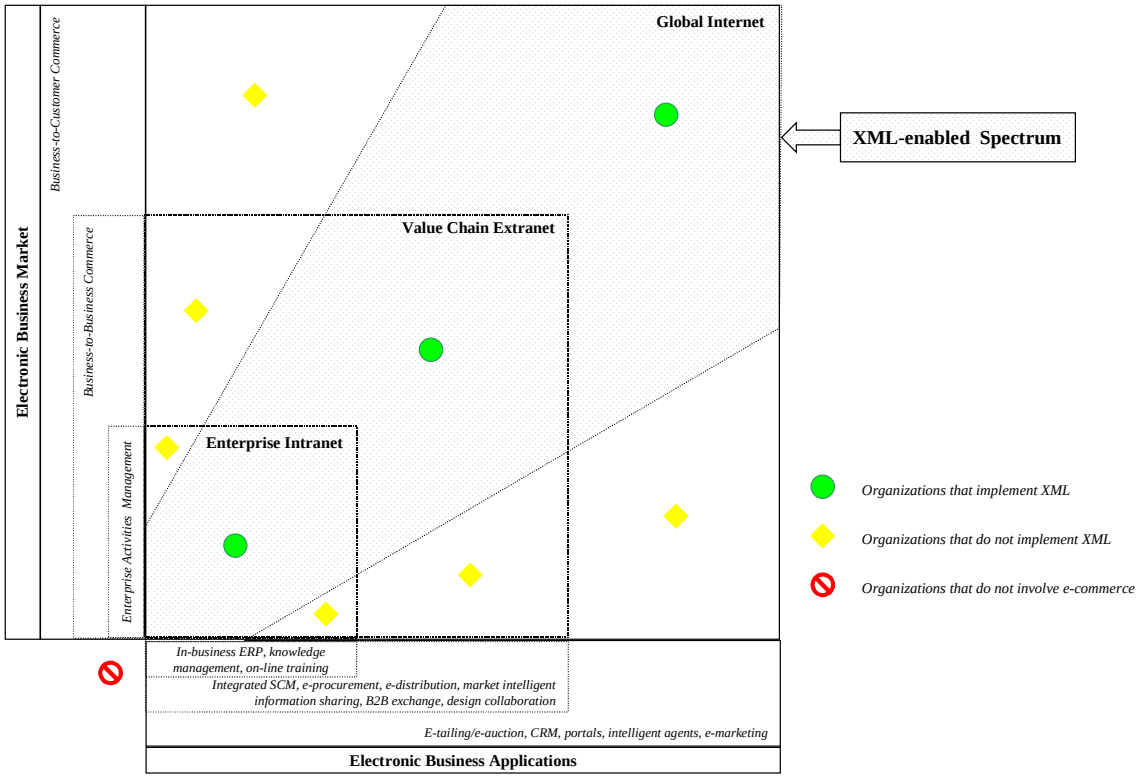

Figure 1. The electronic business environment

Enterprise Intranet

Many companies have been deploying intranets to manage internal business activities. The history of enterprise intranets stems, in part, from the vision of a "paperless office." With the pervasiveness of the computer network and the familiarity of web browser technology, many businesses have been moving documents and records, such as employee handbooks, policies and procedures, human resource benefits, and even payroll and employee stock option information, online. Additional functions employees typically enjoy with a sophisticated enterprise intranet include the ability to report absences, check for other job opportunities (within the company), or even view video clips of the last company meeting.

For electronic business, many applications are typically implemented in enterprise intranets for internal business processes and business activities management. Enterprise resource planning (ERP) systems provide solutions to integrate information and information-based business activities within and across functional areas in an enterprise. Knowledge management systems are implemented on the enterprise intranet to help capture enterprise knowledge and assist in decision-making. Additionally, on-line training through enterprise intranets empowers employees to better carry out business activities.

Value Chain Extranet

Moving beyond the walls of the corporation, another electronic domain that many companies participate in is an extranet relationship between business partners. In this domain, B2B commerce is the focus for electronic commerce applications. Electronic communication between business partners is not a new concept. Electronic data interchange (EDI) has been around since the 1970's. This technology has allowed business partners to set up proprietary, secure, and expensive data communication networks for years. More sophisticated electronic commerce applications have also been developed in modern value chain extranets for business partners. Applications such as integrated supply chain management systems (SCM), electronic procurements, and electronic distributions build strong ties and efficient communications among business partners. Contemporary applications that share market intelligence information and further facilitate collaboration among business partners have also emerged within this value chain extranet domain of electronic business.

Global Internet

The broadest domain (and the one that is most synonymous with electronic commerce) a company can participate in is the global Internet. In this domain, a company is likely to be heavily involved in business-to-consumer (B2C) commerce, applications for B2B commerce, and enterprise information management. In this domain, companies may focus more on electronic commerce applications, such as local and international electronic retailing, electronic auction, electronic marketing, web portals, intelligent agents and searching, and customer relationship management (CRM) systems. For a company to successfully operate in the global Internet domain, efficient communication and information exchange between the company and customers should be one of its most important concerns.

Framework

Companies that are currently operating in one or more of these electronic business domains may or may not be using XML in its technology solution. XML, if properly implemented, can reduce costs and provide other benefits for electronic business applications [Harvard Management Update, 2000; Kiely, 1999; Kotok, 2000; Tauber, 1999; Vidgen & Goodwin, 2000]. XML has been promoted and used by major electronic business players. It will be essential for companies that conduct electronic business to realize the benefits of adopting XML instruments into their electronic business activities. We conjecture that companies that utilize XML technologies in each of these domains are more likely to be successful than those that do not. It may appear that what propose is "*a-theoretic*," but quite the opposite is true. Our work here is best termed "*pre-theory*" in the philosophy of science sense [Hempel, 1966]. Our goal is to utilize probable propositions to demonstrate the concept and then subsequently develop a testable theory. The latter part is our ongoing research.

For this purpose, we propose a framework which supports companies that are not involved in electronic business at all (the "prohibition" dot in Figure 1) and companies that are involved in electronic business, but are not yet utilizing XML in their applications (the "diamond" dot in Figure 1). Figure 2 presents the proposed framework of adopting XML for electronic business.

Path A

For companies that (1) are not involved in electronic commerce but want to set up an intranet, or (2) have an existing intranet but want to enjoy the greater benefits of utilizing XML in their intranet; they should follow Path A. With the adoption of XML, companies can, and should, develop their own enterprise-wide XML standards. These standards will improve the exchange and dissemination of important information across functional units within the enterprise; that is, these standards will reduce transaction costs. For example, if each department uses the same

definition for part number, the integration of data between information systems becomes easier. Additionally, as new information systems go online, they should not need to repetitiously create definitions when defining their information objects. Rather, they would be able to drawn upon a common set of XML tags, thus reducing development time and ensuring a higher level of compatibility between systems.

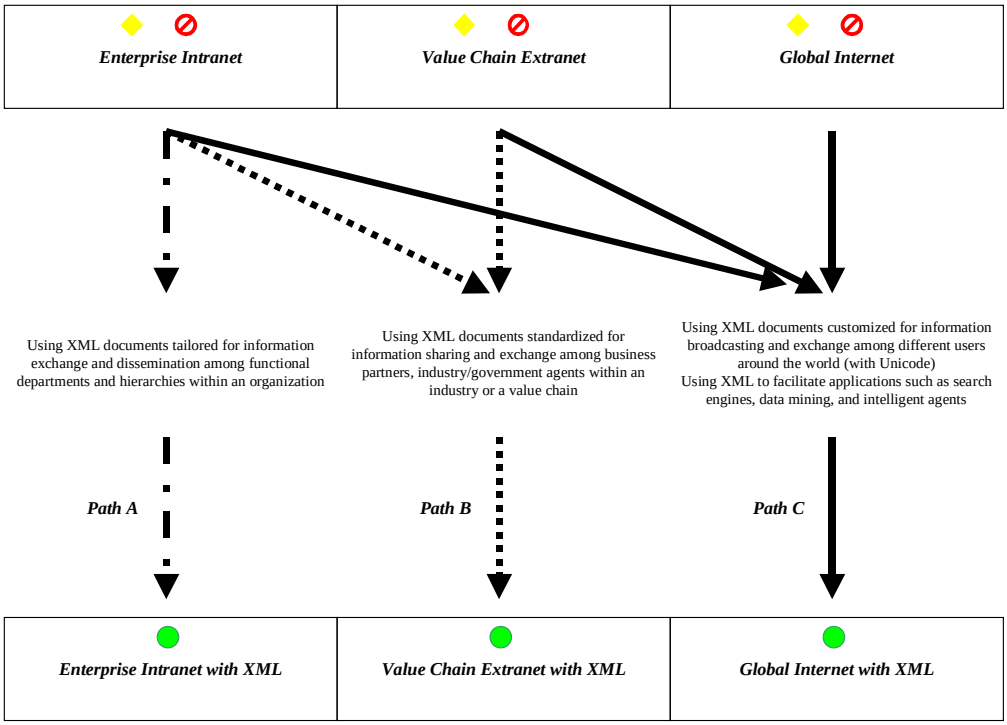

Figure 2. An XML adoption framework for electronic business

XML preserves, and, more importantly, describes information for easy processing and publishing to facilitate multiple intelligent uses. This property makes searching, indexing, and locating your information easier. In other words, when documents contain rich structural information about themselves (XML documents are self-describing), the user can contemplate formulating rather complex queries and get very precise answers. For applications in enterprise intranet, this aspect of XML allows more intelligent use of data and timely processing of data to facilitate critical decision-making within the enterprise.

XML documents are essentially databases of information. We can easily integrate data from different XML documents. For example, we can use XML processing tools to process XML documents into a collection of interlinked HTML pages. Users could also store any XML document and use any XML-aware tool to process it any way they prefer, such as performing calculations on the data. This aspect of XML certainly provides a more efficient way for information exchange and dissemination on the enterprise intranet.

Applying XML in enterprise intranet also provides cost-saving benefits. An organization only needs to produce XML documents once, but these documents can be used many times and presented in many forms (styles). Using XML also eliminates costs of producing explanatory documentation for XML documents since these documents are self-describing.

Path B

For companies that (1) are not involved in electronic commerce but want to set up an extranet and an intranet, or (2) have an existing intranet but want to expand into an extranet environment, or (3) have an existing extranet but desire the greater benefits of utilizing XML in their extranet; they should follow Path B.

Companies that are just entering the B2B electronic business environment should strongly consider adopting an XML-based approach. Much like developing new information systems within a company that has standardized XML tags, new B2B entrants should not need to repetitiously create definitions either. The real power of standardized XML tags comes at the industry level. Many industries are developing their own set of industry

specific XML tags, and this allows for easier communication within these industry groups. The direct benefit from these industry agreed upon set of standards is reduced communication (i.e., transaction) costs. Decreasing transaction costs is (or should be) one of the fundamental goals of business [Coase, 1937]. Various industries are already well on their way to establishing robust sets of XML tags. The financial industry [Zarowin & Harding, 2000] has developed FpML for standardizing foreign currency and other financial transaction exchanges. The accounting industry [Hoffman, 2000] is promoting XBRL as a common reporting language. Additionally, health, transportation, insurance, retailing and many other industries are producing their own set of XML standards for within industry communication.

The low utilization of traditional EDI is mainly attributed to the technical difficulty and high cost. With the advent of the Internet, traditional EDI implementations have severely dropped off as companies have looked for low-cost alternative ways to conduct business. XML, along with a more secured Internet is now providing these opportunities. XML/EDI will run on the Web where the Internet can be used as the conduit to replace the expensive value-added networks (VANs) for communicating EDIFACT messages. XML processing software and XML expertise, we conjecture, will be ubiquitous and thus relatively cheap compared to proprietary software and format-specific expertise required by traditional EDI. At the same time, with the use of XML, EDIFACT messages can be converted to XML and vice-versa. For those businesses that have previously invested heavily in EDI, their investments shouldn't be wasted in the future. Innovative ways have provided companies with a smooth transition to the XML-based electronic commerce model without having to totally abandon their current EDI infrastructure investments.

With high expectations of tremendous growth of electronic commerce applications, requirements of information retrieval, exchange, and dissemination increase. Inaccurate information exchange and misuse of information in electronic commerce applications can result in mishandled inventory management, failed orders, lower customer satisfaction, and loss of customers. Potential concerns about incompatibility of proprietary hardware/software, technical architectures, performance and scalability, and the complexities of collaborative computing environments need to be addressed. The benefit of adopting XML is that it can assist in resolving these issues. Users could retrieve and store XML documents directly from trading partners through the Internet and use any XML-aware tool to process it in any way they desire. XML can naturally provide easy data integration and flexible data exchange across trading partners via various systems on the value chain.

Path C

For companies that (1) are not involved in electronic commerce and want to operate in Internet, extranet, and intranet environments, or (2) have an existing intranet and want to expand directly to the global Internet, or (3) have an existing extranet and want to expand to global Internet, or (4) currently operate on the Internet but want to improve their electronic commerce in global Internet presence by utilizing XML; they should follow Path C.

XML technologies can add value to electronic commerce in the global Internet domain. Companies that follow Path C can create XML documents for information broadcasting among different users around the world. Companies may also enjoy the benefits of XML solutions in facilitating applications such as search engines (e.g., bestbookbuys.com and cnet.com), data mining, and intelligent agents for better electronic commerce.

Today's information economy has been transformed into a network economy [Shapiro & Varian, 1999]. Clusters of electronic commerce will begin to form what will essentially lock out nonconforming players. Either businesses will have the skills and the capital to participate in the new economy, or they will not be able to survive. The biggest winners in the information economy are companies that have launched technologies that have been propelled forward by positive feedback [Shapiro & Varian, 1999]. XML has been promoted and used by major electronic commerce players. It is our belief that it will be essential for companies that conduct electronic business to realize the benefits of adopting XML instruments in their electronic business activities and follow the framework that we propose in order to succeed in the new economy.

3. XML Adoption Space

With an understanding of the paths and potential advantages of implementing XML-enabled applications for electronic business, it is important for a company to analyze and measure costs and benefits of adopting XML technology. In this section, we propose an XML adoption space model to measure the efforts/costs that a company would incur in order to establish their XML-enabled IT applications with consideration of their current status of IT applications (see Figure 3). The result of this model then provides input for further cost/benefit analysis to final XML adoption decision.

The adoption space is a three-dimensional Cartesian coordinate system with the origin labeled as O. The *x*-axis represents the degree of sophistication of intranet applications. The *y*-axis represents the degree of sophistication of extranet applications. The *z*-axis represents the degree of sophistication of Internet applications.

The term "degree of sophistication" used here refers to how an organization applies different technology components, structural factors, and human factors for its intranet/extranet/Internet applications [e.g., Gomond & Picavet, 1999; IEEE Computer Society, 1999; Rockley, 1998; Wollschlaeger, 1998]. For example, we can consider what specific hardware and software a company's current applications use, how many departments or partners that a company's current applications include, how many functions or features that a company's current applications provide, and what is the current skill set of users. More specifically, technology components can include servers and clients, bandwidth and connectivity, security (firewall), and processing software. Structural factors can include the content of data exchanged (e.g., plain text, audio, video), scalability, compatibility, and compliance to standards. Human factors may include users' skill set, training mechanism for users, and ease of use. Simple measurement scales such as yes/no (1/0) or high/medium/low (1/2/3) can be easily measured on different factors in order to derive an aggregate "level of sophistication" of a company's applications. This aggregate "level of sophistication" is a continuous variable since it is either an average or a weighted-average value of measurements of all factors. A more advanced study measuring the "degree of sophistication" based on a measurement scale of important factors should be conducted as necessary. For example, a carefully designed survey study could serve this purpose and the finding may be generally applied to electronic businesses.

The far end of the space is the XML destination where all three types of applications are XML-enabled[2]. The distance between the company's current IT status and XML-enabled IT applications status represents the degree of efforts/costs that a company will encounter in applying XML to their IT applications. The shorter the distance is, the less efforts/costs a company will incur.

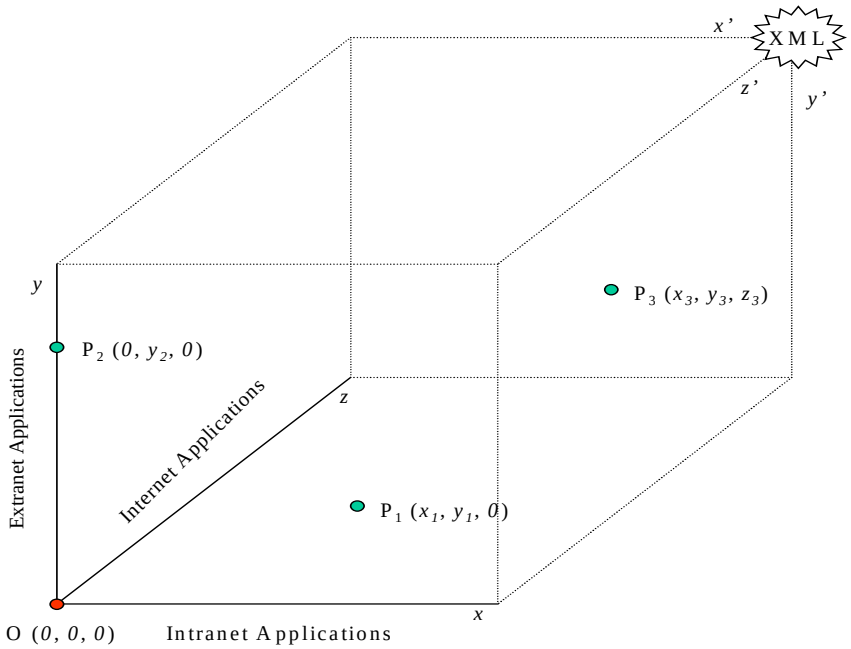

Figure 3. The XML adoption space

The position of the current IT status of a company in the adoption space can be determined in several possible ways[3]. The higher the "level of sophistication" a company's current IT applications are, the further a company's IT applications position will be away from O (origin) in the space. This also implies that the higher "level of sophistication" a company's current IT applications are, the nearer a company's IT application position will be to the XML destination in the space. Using a specific measurement, we can position a company's current IT status in the space. For example, from Figure 3, P_1 (x_1, y_1, 0) represents a company that currently has some degree of intranet applications and some degree of extranet applications but no Internet applications. P_2 (0, y_2, 0) represents a company that currently has some degree of extranet applications only (but without any intranet or Internet

[2] For demonstration purpose, we do not intend to measure how detailed a company's IT applications are in its XML-enabling functions.

[3] Ongoing research will focus on this aspect and attempt to find the most appropriate method.

applications). In Figure 3, since P_2 is fairly far away from O, it indicates that this company has a relatively sophisticated set of extranet applications. P_3 (x_3, y_3, z_3) represents a company that currently has some degree of all three types of IT applications.

For demonstration purposes, we use the scale (0, 10) to measure the "level of sophistication" in our adoption space for all three different types of applications (intranet, extranet, and Internet). For example, if a company meets almost all "high sophistication" requirements for intranet applications, we can assign a scale number close to 10 for this company's intranet applications. By the same token, we can assign scale numbers for this company's extranet and Internet applications as well. While this (0 - 10) scale may seem arbitrary, it does not affect our adoption space measurement. The distance we measure in the adoption space is a "normalized" and "relative" measurement of efforts/costs. Subsequently, we can multiply this distance measurement by a dollar amount in order to "monetize" it.

After positioning a company's current status in the adoption space, we can then mathematically calculate the efforts/costs that a company will incur to adopt XML-enabled applications. Under the assumption that the XML destination is at (*10*, *10*, *10*) in the adoption space, we can look at the following three scenarios.

Scenario 1

A company is at P_1 (x_1, y_1, *0*) in the space (see Figure 4), which implies that this company currently has some degree of intranet applications and some degree of extranet applications but no Internet applications. When this company wants to adopt all three types of XML-enabled applications, the efforts/costs can be measured as the distance between (x_1, y_1, *0*) and (*10*, *10*, *10*) in the space (denoted by d_1). That is, $d_1 = \sqrt{(10-x_1)^2 + (10-y_1)^2 + 10^2}$. If the company P_1 (x_1, y_1, *0*) only wants to adopt XML-enabled intranet and extranet applications, the efforts/costs will be the distance between (x_1, y_1, *10*) and (*10*, *10*, *10*) in the space (denoted by d_1'), which can be measured as $d_1' = \sqrt{(10-x_1)^2 + (10-y_1)^2}$. In other words, since company P_1 does not intend to adopt XML-enabled Internet applications, we will project P_1 to the plane of x' and y' where P_1' (x_1', y_1', z_1') is the equivalent of (x_1, y_1, *10*). The same rationale is used if we project the XML destination to the corner of plane x and y, (*10*, *10*, *0*), and measure the distance between (x_1, y_1, *0*) and (*10*, *10*, *0*).

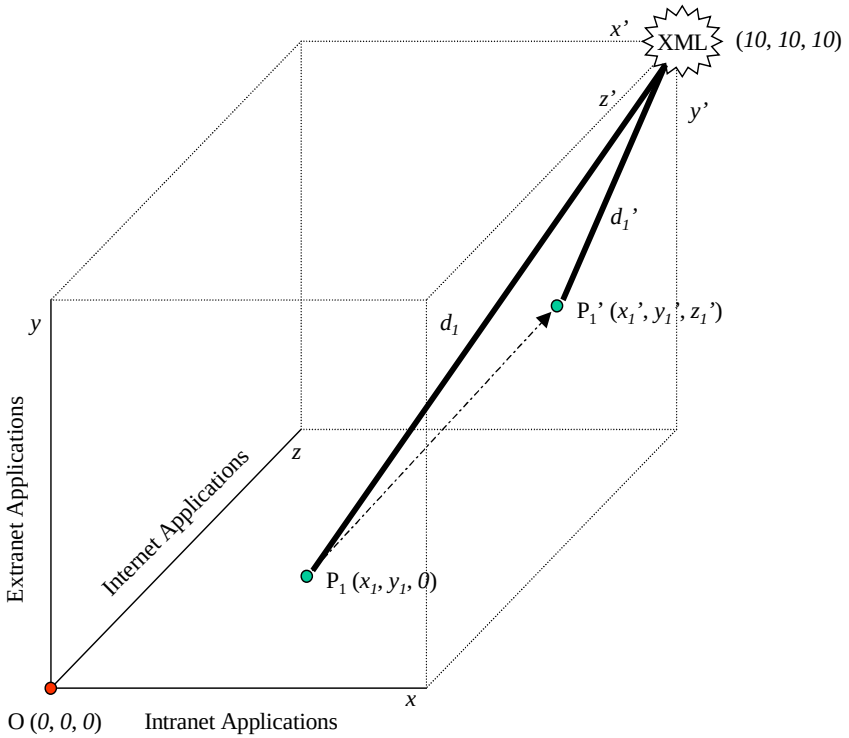

Figure 4. The XML adoption space and P_1

Scenario 2

A company is at P_2 (0, y_2, 0) in the space (see Figure 5), which implies that this company currently has some degree of extranet applications only (but without any intranet or Internet applications). When this company wants to adopt all three types of XML-enabled applications, the efforts/costs will be the distance between (0, y_2, 0) and (10, 10, 10) in the space (denoted by d_2). That is, $d_2 = \sqrt{10^2 + (10 - y_2)^2 + 10^2}$. If the company P_2 (0, y_2, 0) only wants to adopt XML-enabled extranet applications, the efforts/costs will be the distance between (10, y_2, 10) and (10, 10, 10) in the space (denoted by d_2'), which can be measured as $d_2' = 10 - y_2$. In other words, since company P_2 does not intend to adopt XML-enabled intranet or Internet applications, we project P_2 to the axis y' where P_2' (x_2', y_2', z_2') is the equivalent of (10, y_2, 10). The same rationale is used if we project the XML destination to the end of axis y, (0, 10, 0), and measure the distance between (0, y_2, 0) and (0, 10, 0).

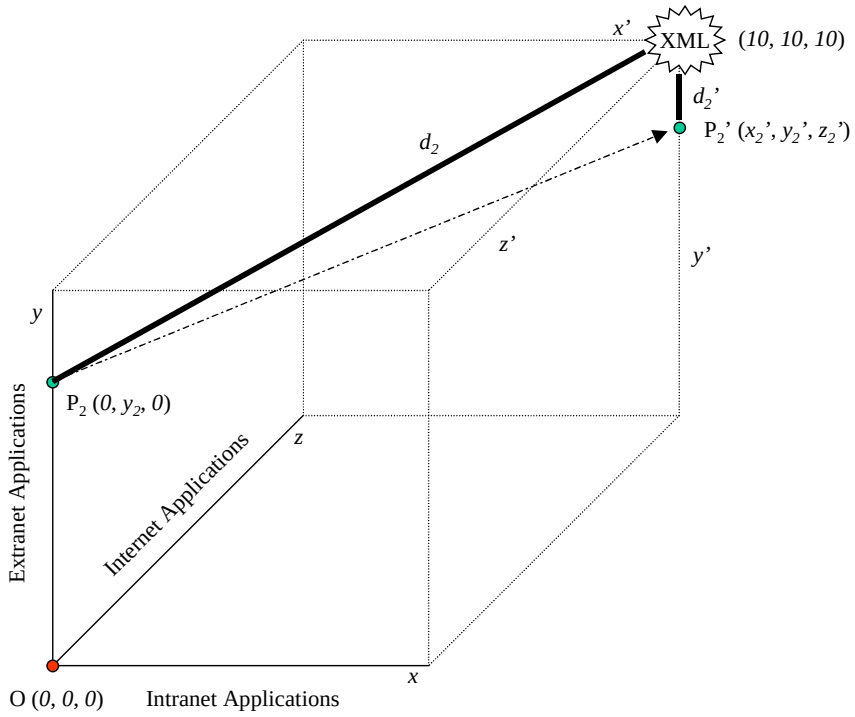

Figure 5. The XML adoption space and P_2

Scenario 3

A company is at P_3 (x_3, y_3, z_3) in the space (see Figure 6), which implies that this company currently has some degree of all three types of IT applications. When this company wants to adopt all three types of XML-enabled applications, the efforts/costs will be the distance between (x_3, y_3, z_3) and (10, 10, 10) in the space (denoted by d_3), which can be measured as $d_3 = \sqrt{(10 - x_3)^2 + (10 - y_3)^2 + (10 - z_3)^2}$. If the company P_3 (x_3, y_3, z_3) only wants to adopt XML-enabled Internet applications (but not XML-enabled intranet and extranet applications)[4], the efforts/costs will be the distance between (10, 10, z_3) and (10, 10, 10) in the space (denoted by d_3'), and can be measured as $d_3' = 10 - z_3$. In other words, since company P_3 does not intend to adopt XML-enabled intranet or extranet applications, we will project P_3 to the axis z' where P_3' (10, 10, z_3') is the equivalent of (10, 10, z_3).

Another initial assumption for our XML adoption space is that equal efforts/costs will be measured for a company if the company tries to adopt XML-enabled intranet applications from existing intranet applications, adopt XML-enabled extranet applications from existing extranet applications, or adopt XML-enabled Internet applications from existing Internet applications. When evidences suggest that different efforts/costs should be applied to different types of adoption, we can modify our calculations by assigning distinctive weights to distance measurements of

[4] The existing intranet and extranet applications of this company are kept as non-XML applications or are not upgraded.

different axes. For example, if the company located at P_3 (x_3, y_3, z_3) in the adoption space wants to adopt all three types of XML-enabled applications, the efforts/costs will be the distance between (x_3, y_3, z_3) and (*10*, *10*, *10*) in the space with assigned weights. That is, $d_3 = \sqrt{w_x(10-x_3)^2 + w_y(10-y_3)^2 + w_z(10-z_3)^2}$ where w_x, w_y, and w_z are the corresponding weights to measure the transformation effort of different applications for each e-business domain.

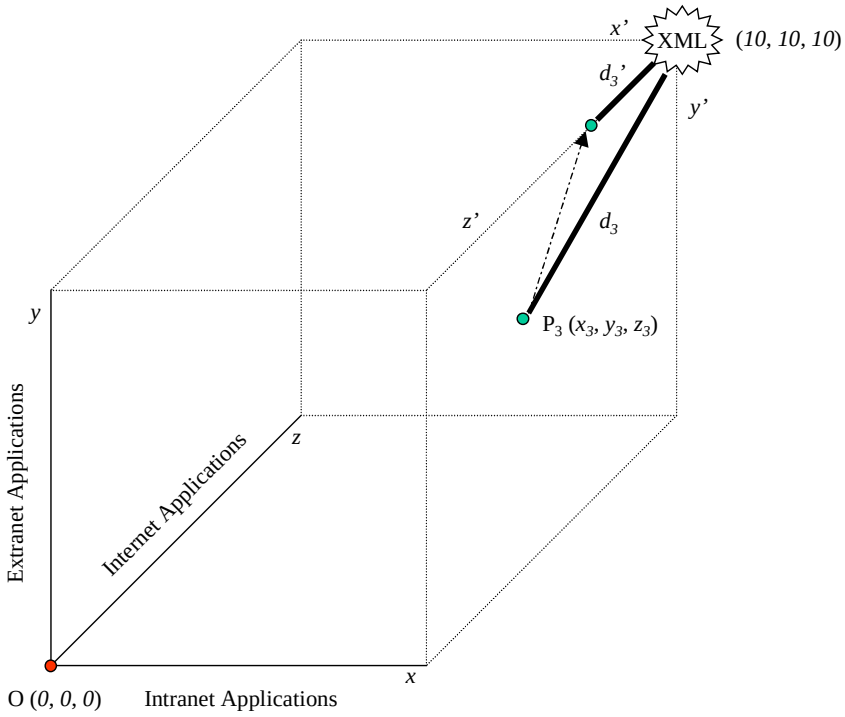

Figure 6. The XML adoption space and P_3

4. Adoption Decision Model

We have discussed the various paths and the potential benefits of adopting XML technology in business. We have also proposed an XML adoption space to measure the efforts/costs that a company will incur in order to establish their XML-enabled IT applications with consideration of their current status of IT applications. The final decision of feasibility and timing of a firm to adopt XML technology has to be made based on a cost/benefit analysis. That is, we must compare the potential benefit of adopting XML technology and efforts/costs to examine whether it is feasible for a company, and if so, at what time to establish their XML-enabled IT applications. Here, we use a probit model, which is widely utilized in technology diffusion literature, to analyze a company's individual decision.

In the literature of technology diffusion, two most commonly used categories of models to explain adoption of new technology are *epidemic* models and *probit* models. The former type of model (epidemic model) attempts to examine the phenomenon that lack of information available about what the new technology is, how to use it, and what it does, drives the delay of adoption of new technology [e.g., Bass, 1969; Rogers, 1995; Skiadas, 1985; Teng et al., 2002]. The latter type of model (probit model) follows the idea that specific entities (individuals or organizations) with specific characteristics will adopt a new technology at differing times [e.g., Aboelmaged, 2000; David, 1969; Davies, 1979]. Epidemic models consider the whole population under investigation as a whole and abstract from differences in the goals, capabilities, or actions of individual members. Under our framework, we are more interested in explaining how individuals make their decision on technology adoption based on their unique characteristics; therefore, a probit model is the natural choice. However, by applying a probit model, we do presume that sufficient relevant information of new technology is available to potential users.

When applying a probit model, identifying interesting and relevant characteristics of an entity is important. Some common characteristics (e.g., organization size) are used by researchers in this type of study [e.g., Ash, 1997; Gopalakrishnan & Damanpour, 2000; Gourlay & Pentecost, 2002; Lai & Guynes, 1997]. We assume that each

company has a distinct value of a specific characteristic at time t (x_{it} denotes the value of the specific characteristic for company i at time t). This specific characteristic affects the profit, π_{it}, of adopting XML technology for company i at time t. We assume that the relationship between the company's characteristic and profit of adopting XML technology is in some functional form as $\pi_{it} = f(x_{it})$. When π_{it} exceeds some threshold level, π^*, at time t, the company is considered to be at the right position and time to adopt XML technology. That is, the π^* (profit) is large enough to cover and exceed corresponding efforts/costs. Through the reverse of function $f(\cdot)$, we can derive the corresponding x_t^* which make π_{it} reach the π^* threshold. In other words, we can find the x_t^* threshold that a company's characteristic x_{it} should exceed in order to gain enough profit from adopting XML technology.

In summary, with the assumptions that (1) function $f(x_{it})$ is continuous and strictly increasing and (2) $\pi_{it} = f(x_{it})$ represents a one-to-one mapping between π_{it} and x_{it}, we present the following formulations:

$\pi^* = f(x_t^*)$ and then $x_t^* = f^{-1}(\pi^*)$

if $x_{it} > x_t^*$ company i is in a favorable position to adopt XML technology at time t

if $x_{it} < x_t^*$ company i is in an unfavorable position to adopt XML technology at time t

To demonstrate and help clarify the concept, we offer Figure 7 to visualize this adoption decision model with the following example. Assuming x_{it} is distributed across the population in some functional form as $g(x_t)$. For demonstration purposes, we arbitrarily pick $g(x_t)$ as a normal distribution function in Figure 7. In real-world scenario, one should carefully examine and find out the true distribution form of x_{it}. That is, $g(x_t)$ could be a uniform, lognormal, Poisson, or normal distribution function. The line of adoption (L_a) is a vertical line (drawn from the threshold value x_t^*) that divides the population of companies. Companies that fall to the right of L_a are the companies that are in a favorable position to adopt XML-enabled applications at time t. That is, these companies will generate enough profits to cover efforts/costs incurred by adopting XML. Companies that fall to the left of L_a are the companies that are in an unfavorable position to adopt XML-enabled applications at time t. Since the line of adoption (L_a) is a vertical line that is drawn from the threshold value x_t^*, L_a will move to the left when x_t^* becomes smaller and L_a will move to the right when x_t^* becomes larger.

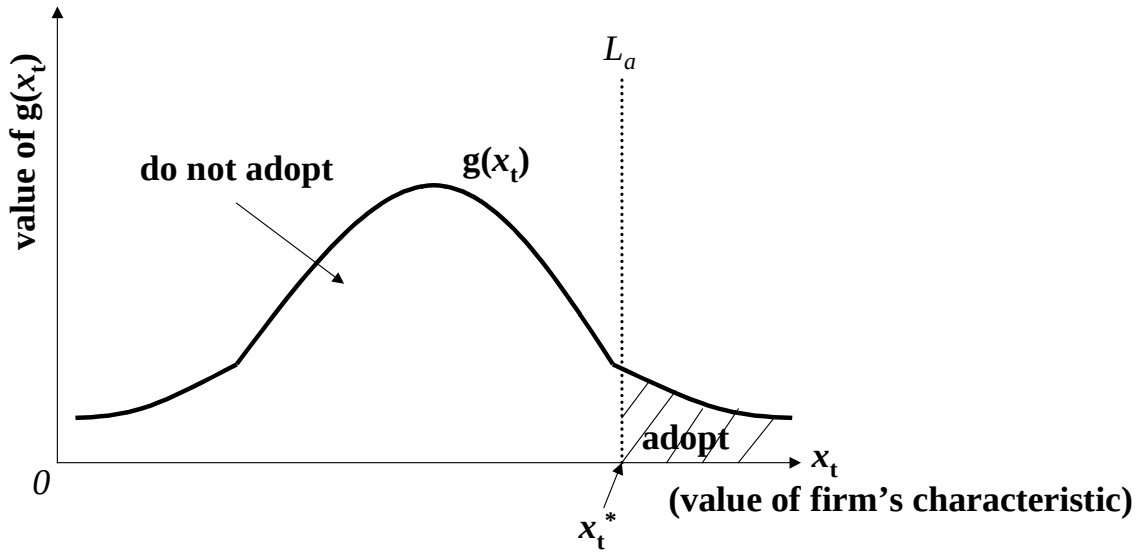

Figure 7: Simple adoption decision model with normal distribution of g(x)

When x_t^* changes, a different line of adoption will be drawn and different proportions of "do not adopt" and "adopt" will be formed. For example, as time advances, it is likely that the line of adoption (L_a) should move toward the left and more companies will be in a favorable position to adopt XML technology. That is, as XML technology matures and network externality effect happens (the threshold value x_t^* becomes smaller), more companies will be in a favorable position to establish XML-enabled IT applications.

There are other possible factors that will affect the position of the line of adoption (L_a) and subsequently affect the proportion of companies that may be in good position to adopt XML technology. Changes in business environment can move L_a. For example, new government regulations that stimulate XML technology diffusion could potentially move L_a to the left. Decreases in costs or easier efforts to implement XML-enabled IT applications could also shift L_a to the left. From the firm level, a company may go through some changes (e.g., business process

reengineering, technology adoption, organization structure, business merger, etc.) and these changes may affect the value of a company's specific characteristic, x_{it}, and subsequently affect its position (favorable or unfavorable) in adopting XML technology.

5. Conclusions

The study of electronic business is drawing a lot of attention from both academics and industry. Each group is trying to make sense of how to structure electronic business solutions most effectively. It is clear by the sheer volume of transactions and their associated value that electronic business should be an important part to any business strategy. Furthermore, with the rapid pace at which business schools are adopting electronic commerce courses, we observe that this topic is important to academia as well. Business schools are tasked with preparing our future business leaders and enhancing the skill sets of existing business leaders; a clear understanding of the electronic business world is an essential part of that education.

While XML has enjoyed a lot of press in many practitioner journals, the popular press, and to a lesser extent the academic computer science journals, it has not been sufficiently examined within the business context of scholarly IS journals. The purpose of this paper is to examine XML adoption within a business context. XML will change the use of the Internet as much as HTML has. Information Systems researchers need to monitor this phenomenon and make contributions where applicable. XML has the potential to make business transactions even more efficient, and this implication alone is worthy of our attention. Whether a business is looking to build or enhance its enterprise intranet, develop or extend its value chain extranet, or construct or increase its global Internet presence, XML can play a key role in its success.

The contribution of this paper is three-fold. First, a new XML adoption framework is proposed. The framework helps companies to examine their current status in the e-business environment from the perspective of the three electronic business domains, namely enterprise intranets, value-chain extranets, and the global Internet. The framework also provides guidelines for companies who need to understand the potential benefits of adopting XML technology and then assists them in choosing the appropriate path and proper applications. Second, we have proposed an XML adoption space model. Considering the current status of its IT applications, a company can utilize this model to measure the efforts/costs that will be incurred by developing its XML-enabled IT applications. Third, we use a probit model of technology diffusion to explore the feasibility of a company's adoption of XML technology. This probit model considers a company's specific characteristics and evaluates potential benefits and efforts/costs of its eventual XML adoption. This model is used to help a company to make a final adoption decision.

This research paper is not without its limitations. The framework suggests there is a success path, one that utilizes XML throughout the electronic business solutions of a firm. Future empirical studies will be useful to test and validate this framework. Another limitation of this study is the framework is developed solely on the perceived future impact of the XML technology. While XML's future looks bright, and several businesses and industries have adopted XML, there still exists the question of whether or not it will reach critical mass and become as prevalent as HTML. It is our opinion that this will happen; however, we cannot speculate when, be it in one year, ten years, or ever.

We recognize that using empirical data and actual functional expression can add to the understanding and value of our framework. At the same time, framework-based research in the e-commerce area still provides valuable insights for interested readers (e.g., Glushko et al., 1999). In this paper, the main focus is proposing a conceptual framework and our ongoing research will conduct a qualitative case study work and follow some specific firms through their migration toward an XML-based electronic commerce solution. Additionally, gathering some quantitative empirical data would also help strengthen this framework. Models of this framework can be developed to test theories. These theories would lead to affirming and enhancing this framework, or potentially rejecting the notion that XML really provides a competitive advantage for electronic business.

In sum, this XML framework for electronic business provides a comprehensive structure for companies to succeed in electronic business at all levels, regardless of whether they are just entering a new electronic business domain or are migrating from other technologies, such as EDI, to the use of XML. XML allows companies to standardize their information, and, at a higher level, lets industries standardize their information needs. When utilized correctly, XML-based applications will decrease transaction costs, thus enhancing the firm's potential for profitability.

REFERENCES

Aboelmaged, M.G., "Researching Information Technology Adoption Process in Higher Education Institutions: A Rational for Applying Individual-Based Models," *Proceedings of the 2000 IEEE International Conference on Management of Innovation and Technology*, 384 -389, 2000.

Anonymous, "ARTS Publishes XML Retail Data Dictionary," *Chain Store Age*, Vol. 27, No. 11:108, November 2000.

Anonymous, "What the Next-Generation Web Means for Managers," *Harvard Management Update*, 1-2, November 2000.

Ash, J., "Organizational Factors that Influence Information Technology Diffusion in Academic Health Sciences Centers," *Journal of the American Medical Informatics Association*, Vol. 4, No. 2:102-111, 1997.

Attewell, P., "Technology Diffusion and Organizational Learning: The Case of Business Computing," *Organization Science*, Vol. 3, No. 1:1-19, 1992.

Bass, F. M., "A New Product Growth Model for Consumer Durables." *Management Science*. Vol. 15, No. 1:215-227, 1969.

Brancheau, J. and J. Wetherbe, "The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing," *Information Systems Research*, Vol. 1, No. 2:115-143, 1990.

Coase, R., "The Nature of the Firm," *Economica*, Vol. 4:386-405, 1937.

David, P., *A Contribution to the Theory of Diffusion*. Mimeo. Stanford University and forthcoming as Chapters 1-3 in his *Behind the Diffusion Curve*, Westview Press, Boulder, CO, 1969.

Davis, F., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly*, Vol. 13, No. 3:319-340, 1989.

Davis, F., R. Bagozzi, and P. Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models." *Management Science*, Vol. 35, No. 8:982-1003, 1989.

Davies, S. *The Diffusion of Process Innovations*. Cambridge University Press, Cambridge, MA, 1979.

Fichman, R., "Information Technology Diffusion: A Review of Empirical Research," *Proceedings of the Thirteenth International Conference on Information Systems*, Dallas, TX, 1992.

Glushko, R., J. Tenebaum, and B. Meltzer, "An XML Framework for Agent-based Electronic Commerce," *Communications of the ACM*, Vol. 42 No. 4:106-114, 1999.

Gomond, G. and M. Picavet, "Framework for Managing Intranet-based Applications," *Proceedings of the 7th International Conference on Emerging Technologies and Factory Automation*, Vol. 2:1011-1019, 1999.

Gopalakrishnan, S. and F. Damanpour, "The Impact of Organizational Context on Innovation Adoption in Commercial Banks," *IEEE Transaction on Engineering Management*, Vol. 47, No. 1:14-25, 2000.

Gourlay, A. and E. Pentecost, "The Determinants of Technology Diffusion: Evidence from the UK Financial Sector," *Manchester School*, Vol. 70, No. 2:185-203, 2002.

Hempel, C.G., *Philosophy of Natural Science*, Prentice-Hall, Englewood Cliffs, NJ, 1966.

Hoffman, C., "Run XBRL Right Now," *Journal of Accountancy*, 28-29, August 2000.

Hooper, L., "Cisco Adds XML-based IP Telephony to the Mix," *CRN*, No. 949:91-92, 2001.

IEEE Computer Society, "IEEE Recommended Practice for Internet Practices - Web Page Engineering - Intranet/Extranet Applications," *IEEE Standards 2001-1999*, 1-35, 1999.

Jiang, J.J., M.K. Hsu, G. Kline, and B. Lin, "E-Commerce User Behavior Model: An Empirical Study," *Human Systems Management*, Vol. 19, No. 4:265-276, 2000.

Karahanna, E., D. Straub, and N. Chervany, "Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs," *MIS Quarterly*, Vol. 22, No. 2:183-213, June 1999.

Kiely, D., "XML: More Than Just a Quick Fix," *Informationweek*, February 8:77-82, 1999.

Kline, K. and J. Sorra, "The Challenge of Innovation and Implementation," *Academy of Management Review*, Vol. 21, No. 4:1055-1080, 1996.

Kotok, A., "Making XML Work in Business," *XML.COM*, http://www.xml.com/pub/a/2002/01/02/bizvalue.html, O'Reilly & Associates, Inc., 2000.

Lai, V. S. and J. L. Guynes, "An Assessment of the Influence of Organizational Characteristics on Information Technology Adoption Decision: A Discriminative Approach." *IEEE Transaction on Engineering Management*, Vol. 44, No. 2:146-157, 1997.

Lederer, A.L., D.J. Maupin, M.P. Sena, and Y. Zhuang, "The Technology Acceptance Model and the World Wide Web," *Decision Support Systems*, Vol. 29, No. 3:269-282, 2000.

Lin, J.C. and H. Lu, "Towards an Understanding of the Behavioral Intention to Use a Web Site," *International Journal of Information Management*, Vol. 20, No. 3:197-208, 2000.

Lu, E.J., R.H. Tsai, and S. Chou, "An Empirical Study of XML/EDI," *Journal of Systems and Software*, Vol. 58, No. 3:271-279, September, 2001.

Malone, T., J. Yates, and R. Benjamin, "Electronic Markets and Electronic Hierarchies," *Communications of the ACM*, Vol. 30, No. 6:484-497, 1987.

Mansfield, E., "Technical Change and the Rate of Imitation," *Econometrica*, Vol. 29, No. 4:741-766, 1961.

Parthasarathy, M. and A. Bhattacherjee, "Understanding Post-Adoption Behavior in the Context of Online Services," *Information Systems Research*, Vol. 9, No. 4:362-379, 1998.

Rockley, A. "Designing an Effective Intranet/Extranet," *Proceedings of the IEEE International Professional Communication Conference*, Vol. 2:313-316, 1998.

Rogers, E., Diffusion of Innovations, Free Press, New York, NY, 1962.

Rogers, E., Diffusion of Innovations, 4th Ed. Free Press, New York, NY, 1995.

Shaprio, C. and H. Varian, *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, Boston, MA, 1999.

Skiadas, C., "Two Generalized Rational Models for Forecasting Innovation Diffusion," *Technological Forecasting and Social Change*, Vol. 27:39-61, 1985.

Sliwa, J., "OnStar Takes Voice XML for Drive," *Computerworld*, Vol. 34, No. 21:1 & 16, 2000.

Tauber, J., "XML After 1.0: You Ain't Seen Nothin' Yet," *IEEE Internet Computing*, Vol. 3:100-102, 1999.

Taylor, S. and P. Todd, "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research*, Vol. 6, No. 2:144-176, 1995.

Teng, J. T. C., V. Grover, and W. Guttler, "Information Technology Innovations: General Diffusion Patterns and Its Relationships to Innovation Characteristics," *IEEE Transaction on Engineering Management*, Vol. 49, No. 1:13-27, 2002.

Vidgen, R. and S. Goodwin, "XML: What is it Good for?" *Computing & Control Engineering Journal*, 119-124, June 2000.

Williamson, O.E., *Markets & Hierarchies*, Free Press, New York, NY, 1975.

Williamson, O.E., *The Economic Institutions of Capitalism*, Macmillan, London, 1985.

Wollschlaeger, M., "Planning, Configuration and Management of Industrial Communication Networks Using Internet Technology," *Proceedings of the Global Telecommunications Conference*, Vol. 2:1184-1189, 1998.

Zarowin, S. and W. Harding, "Finally, Business Talks the Same Language," *Journal of Accountancy*, 24-28, August 2000.