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ADOPTION OF XML SPECIFICATIONS: AN EXPLORATORY STUDY OF INDUSTRY PRACTICES

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Abstract

Despite intense coverage of the rapid growth of XML technologies, little is known about the forces shaping their adoption by organizations. This paper provides insight into these processes via unstructured interviews with four global organizations. Despite the small number of study participants, some interesting cross-industry patterns worthy of further study emerge. Among them are indications that a lack of recognized industry standards slows market adoption of XML technologies, and that organizations are building internal expertise in anticipation of future standards-based work. Balance of power in customer/supplier relationships also emerges as a significant factor. Of the three types of standards-setting efforts acknowledged in the literature (free market forces, industry alliances, and government intervention), only the first two can be represented in this study. There have not been any significant efforts by governments to declare standard XML specifications. Thus, the organizations interviewed for this study represent only free market efforts and initiatives by industry alliances. Further study is recommended in order to ascertain the presence of these effects and their extent across industries.

Keywords: XML, power, standards, adoption of innovations

Introduction

The rise of the eXtensible Markup Language (XML) and supporting technologies has been well documented in industry (Lim and Wen 2002, CIO.com 2002). However, apart from the headlines generated by the popularity of these technologies, little is known about the forces shaping XML adoption by real organizations, or the impact of standardization efforts in the area (Kauffman and Walden 2001). This paper provides some insight into XML adoption processes, the forces shaping them, and the potential impact of formal XML applications standardization. The information presented in this article was collected via informal, unstructured interviews with global organizations currently using or planning for the deployment of these technologies. In all cases, the names of the participating organizations have been changed to protect their confidentiality.

The companies participating in this effort are major players in the financial services, pharmaceutical, and avionics industries. During this effort, seventeen organizations with global presences were contacted for an interview. This study presents results from four of the interviews completed so far. The small number of participating organizations and the exploratory nature of the interviews makes a strict quantitative methodology impractical at this stage. However, the nature of the information gathered during the interviews is similar enough for a few cross-industry patterns to emerge. Naturally, more extensive empirical work is needed in order to confirm any of the observed phenomena.

The data collected so far indicate that a lack of recognized industry standards slows market adoption of XML technologies. Also, the relative balance of power in customer/supplier relationships in any given industry appears to be a significant factor in the adoption of XML data exchange specifications. We have also learned that, while waiting for accredited industry-wide standards to emerge, organizations are developing in-house expertise by deploying XML applications specifically tailored to their needs. These events have combined to slow the deployment and adoption of consistent XML applications in any given industry and to greatly reduce the impact of XML technologies in the electronic business landscape.

The eXtensible Markup Language (XML)

XML is a set of World Wide Web Consortium syntax recommendations that facilitate the seamless, cross-platform exchange of data via the development of formal industry-wide applications (Glushko et al. 1999). Unlike the HyperText Markup Language (HTML), XML goes beyond merely defining data format on a browser window. XML utilizes user-defined tag sets to provide transaction-specific meaning to data and the ability to customize data display format. This capability provides data with uniform meaning for buyers and sellers in any specific transaction for which a formal XML application is created. For example, consider HTML code written to display information in two similar formats:

Table 1. HTML Code Samples

<table border=1> <th>*Quantity*</th> <th>*Description*</th> <th>*Price*</th> <tr> <td>1</td> <td>Love in the Time of Cholera (November 1994) Gabriel Garcia Marquez</td> <td>USD 45</td> </table>	<table border=1> <th>*Qty*</th> <th>*Title/Author*</th> <th>*Cost*</th> <tr> <td>One</td> <td>Love in the Time of Cholera (ISBN 0140119906) Garcia Marquez, Gabriel</td> <td>US$45.00</td> </table>

Figure 1 illustrates the displays on an end-user's browser window that result from the HTML code samples presented above. As can be readily observed, both code samples describe the same product, but human intervention is necessary to reach that conclusion due to the different tags employed.

Quantity	Description	Price
1	Love in the Time of Cholera (November 1994) Gabriel Garcia Marquez	USD 45

Qty	Title/Author	Cost
One	Love in the Time of Cholera (ISBN 0140119906) Garcia Marquez, Gabriel	US$45.00

Figure 1. HTML Code Samples

Using XML, a standardized tag set (or *application*) may be developed to ensure consistent meaning and uniform machine-processing of this data. This application may be enforced within a single company or extended to an entire industry. Since XML is simply a set of syntax recommendations, any number of code implementations may exist. Thus, the flexibility to generate transaction-specific definitions creates uniformity problems in the adoption of industry-wide specifications. For the sample transaction presented above, one possible XML code implementation could be formally defined as:

Table 2. XML Code Sample

```
<ItemQty>1</ItemQty>
<Currency>U.S. Dollars</Currency>
<ItemDescription>
    <Title>Love in the Time of Cholera</Title>
    <ISBN>0140119906</ISBN>
    <Price>45.00</Price>
    <Author>
        <AuthorLastName>Garcia Marquez</AuthorLastName>
        <AuthorFirstName>Gabriel</AuthorFirstName>
    </Author>
</ItemDescription>
```

This XML application provides buyers and sellers with a consistent meaning for each product descriptor. Further, the HTML display generated for individual users may be customized rather easily to reflect either output shown in Figure 1, without losing the uniformity of the data meaning. The transaction can be handled without human intervention, and modifications to the XML application would only be necessary when changes to the complete product specification are made. For example, if publication date was a field that needed to be added, the following tag set could be added to the standardized application in Table 2:

```
<PublicationDate>
        <Month>November</Month>
        <Year>1994</Year>
</PublicationDate>
```

Buyer and supplier searches for matching product attributes do not need to consider multiple tags (such as "price" versus "cost") for the same product descriptor. In fact, XML has been found to reduce the costs of applications development and systems maintenance anywhere from 30%-50% (CIO.com 2002).

Multiple proposals for formal XML applications are currently sponsored by various industry-specific alliances. In some cases, these consortia act simply as repositories for multiple industries (Dogac and Cingil 2001) or for multiple applications for a single industry (see http://www.XML.org). However, as of late 2002, no official, internationally-recognized standards for XML applications exist. This potentially confusing situation highlights the complexity of XML technologies.

XML Specifications and Standardization Processes

Standards have been argued by proponents to facilitate network externalities (Katz and Shapiro 1985, 1994), lower customer uncertainty in markets (Shapiro and Varian 1999), and to promote technological progress and develop better technological solutions (Gruber and Verboven 2001). Standards are particularly important in tipping markets (Shapiro and Varian 1999), in which a particular technology establishes itself as the dominant technology on the strength of its market position (Farrell and Saloner 1988). A position of relative advantage in tipping markets results in an effect called increasing returns, in which "that which is ahead…[gets] further ahead and… that which is losing advantage…[loses] further advantage" (Arthur 1989, 1996). It has been shown that, in markets that exhibit the effects of increasing returns and network externalities, the size of a technology's installed base and availability of complementary products are key to its success as an industry or market standard (Schilling 1999).

The processes through which technical specifications become standards in various industries have been studied extensively. They are widely acknowledged to be the result of efforts led by free market forces, industry or market alliances, and official government bodies (Besen 1995, David 1995). It is also generally recognized that, while all three of these efforts are necessary to the establishment of the various standards found in IT, none of them is sufficient by itself to guarantee success (Funk and Methe 2001). Since XML technologies are a relatively recent introduction, there has not been time for all three types of standards-setting efforts to have a significant impact on XML industry adoption.

Standards-making efforts described above, i.e., those led by free market forces, industry or market alliances, and official government bodies, would result in three distinct types of XML specifications: Proprietary, Sponsored, and Public specifications, respectively. Of the three types of XML specification, however, only two currently exist. Proprietary and Sponsored specifications abound, while Public specifications have not yet been developed. We now turn our attention to the properties of each type of specification.

Public Specifications

Free market forces are responsible for making XML the *de facto* technology for developing data-exchange applications within and across industries (CIO.com 2002). This does not mean, however, that a single, universally-accepted standard for specific industries, or even individual transactions, exists. This is analogous to the formation of a transnational organization for which English is selected as the official language of business. While the syntax for the English language is known to all members, the terms used to describe the products they buy and sell will vary greatly if a standard description is not agreed upon. Human intervention is required to sort out the different product descriptors employed by the members of this fictional organization. Since the object of XML-based transactions is to enable end-to-end computing without human intervention, XML-based product descriptions used by organization members have to be identical. This example illustrates the fact that, while XML is the *de facto* technology for data-exchange application development, there is still a great need for the development of uniform product descriptions within industries.

For true public specifications to take root, they must be championed by an internationally-accepted standards-setting body, or imposed by governmental decree. There are no proposed XML specifications currently being championed by any international standards-setting body, and in the United States, government involvement has been limited to exploratory and coordination efforts by federal agencies (Kane 2002). These efforts are strictly internal, i.e., they are limited to establishing uniform XML specifications for use by government agencies, and not to the regulation of XML specifications within or across industries. Government agencies currently investigating or adopting XML include the General Services Administration (Kane 2002), the U.S. Navy, Air Force, and Army, the Department of Energy (XML.CoverPages.org), and the General Accounting Office (GAO.gov). Outside the United States, government involvement has been similarly limited (Microsoft.com 2002). The result of these initiatives, or the lack thereof, is that no open specifications currently exist for any industry, despite joint efforts between industry alliances (such as OASIS) and international standards-setting bodies (like the ISO).

Proprietary Specifications

The lack of universally-accepted transaction- or industry-specific standards has forced organizations using XML technologies to develop applications specifically suited to their needs. These idiosyncratic, proprietary XML applications cannot be adopted by other organizations without major modifications, and sometimes not at all. The investment made between two organizations in developing these applications is very specific to the nature of their relationship and cannot be easily redeployed. Classical transaction costs economic theory identifies these investments as being relationship-specific (Clemons et al. 1993) between organizations. Such relationship-specific investments in XML applications increase the risk to organizations by negating fundamental economic characteristics of software, such as replicability, transferability, and the reduction of sunk and switching costs (Clemons and Row 1992).

Sponsored Specifications

Sponsored specifications are created by alliances of organizations in a single industry, or in related industries. The aim of these alliances is to establish technologically-integrated business communities offering complementary services to their memberships, and to establish a position of dominance over their target markets (Hill 1997). Thus, applications are developed in a collaborative manner and made available, typically free of charge, to firms participating in the alliance's target industries. While the IP rights for these applications remain with the alliances themselves, they are distributed freely in order to establish the communities and dominant positions sought by the alliance (Updegrove 1994). There are nearly as many of these alliances promoting their own niche XML specification as there are industries in need of consistent specifications. Organizations such as XML.org, ebXML, XBRL, xCBL.org, cXML.org, and XML.gov maintain websites to disseminate information about their individual efforts and constituencies.

Adoption Theory and Industry Adoption Issues

This section summarizes the experience of four global organizations currently using XML technologies. All information presented in this section was collected via unstructured interviews with IT leaders at each of the organizations. The companies participating in these case studies are major players in the financial services, pharmaceutical, and aviation industries. The validity of the case study approach as an exploratory tool has been recognized by leading researchers in the MIS field (Benbasat et al. 1987, Walsham 1995), and is employed in this study to provide a starting point for hypothesis generation and further empirical study.

Adoption is studied in this effort using general concepts from adoption of innovations theory (Rogers 1983). However, extensions to the original ideas developed by Rogers (1983) are necessary to get a more complete picture of the processes at work and issues faced by the organizations in this study. Classical diffusion theory describes voluntary choices made by individual adopters to accept or reject an innovation whose expected benefits are independent of the adoption of the innovation by others (Fichman 1992). As previously discussed, XML is a complicated technology generally not subject to adoption by individuals but by organizations, and it is subject to the effects of network externalities (Katz and Shapiro, 1985, 1994). In Fichman's (1992) framework of classification of diffusion research, XML is a Type 2 technology: it presents a high knowledge barrier to potential adopters, it is subject to significant user interdependencies, and has an organizational locus of adoption. As such, the classical assumptions of diffusion theory are not sufficient for the analysis of XML adoption, and additional variables such as competitive effects (Robertson and Gatignon 1986) and power effects in the competitive environment (Emerson 1962, Cook et al. 1992, Lucas et al. 2001) must be incorporated into the present analysis.

All of the participating organizations make use of sponsored XML applications to meet some of their business needs. Some of these companies use sponsored applications to exchange data with business partners. Others use them simply to convert incoming data to internally-acceptable formats. At the same time, all of these companies are busy developing in-house XML applications either to meet internal business needs, or to develop expertise with the use of XML technologies. Given that public specifications do not yet exist, as outlined in the previous section, only organizations which have deployed Proprietary and Sponsored specifications are included in this study.

Sponsored Specifications

The Finseco Corporation, a major player in the financial services area, has adopted the Open Financial Exchange specification (OFX.net) to download and use Quicken data from publicly-available sources. OFX was developed by CheckFree, Intuit and Microsoft in 1997, and became XML-compliant in the Fall of 2001. Participating organizations use OFX as "the primary mechanism for supporting financial data exchange in their products and services" (OFX.net). As of early 2003, OFX was supported by over 1500 financial institutions. Clearly, the intent of sponsoring this XML-based specification has been to establish CheckFree, Intuit, and Microsoft as the leading providers of financial transaction services on the Internet. Company representatives indicate Finseco's use of this sponsored specification is currently limited to the download of public financial information for internal consumption, i.e., Finseco does not yet exchange structured documents via this specification with its business partners. The current lack of industry-wide standards is of great concern to the company, as is the fact that no movement towards convergence is evident. XML application development is done via a combination of internal resources and consultants, and it is being carried out to build internal expertise in preparation for future standards-based work. Previous diffusion literature has identified the role of organizational learning in reducing knowledge barriers in technology adoption strategies (Attewell 1992). As stated by diffusion researchers (Fichman and Kemerer 1999), Finseco is choosing to "create the option of… [using] the technology when the appropriate time has arrived." The company is also very interested in leveraging its large investment in EDI systems, and XML technologies are a very important option in this strategy. Lastly, Finseco IT leaders are keenly aware of the importance of installed base as a determinant of success for standards in their industry. They believe that XML specifications adopted by the company's major customers will lead to increasing returns (Arthur 1989, 1996) in the financial services industry. This effect will provide the impetus for other firms to adopt those specifications, leading to an industry-wide standard.

Interviews with Icaria, a large multinational organization in the avionics industry, and with Global Pharmaceuticals Incorporated (GPI) reveal concerns similar to those of Finseco IT leaders. There are no industry-wide standards for the submission of clinical trial and product development data to regulatory agencies. Similarly, the avionics industry lacks a recognized set of XML industry specifications. Various consortia, such as the International Conference on Harmonization (ICH.org) in pharmaceuticals and Cordiem in the aerospace industry, are leading efforts towards the creation of such standards. While the promise of these sponsored efforts is great, usable specifications are still several years away.

The power of regulatory agencies to influence the adoption of sponsored specifications cannot be ignored. Agencies such as the FDA and the FAA in the United States, are in a position to determine the dominant specification for their respective industries. Industry players need to implement virtually any sponsored specification adopted by either agency in order to remain competitive. GPI and Icaria recognize this situation and, as a result, actively participate in the development work of both consortia and government agencies. They see this participation as a way of protecting their investment in XML technologies by attempting to influence the development of industry specifications. It is widely recognized, however, that while government participation is critical in the establishment of a specification as dominant in an industry, it is not sufficient by itself. This is certainly the case in industries in which the federal government does not play a major role as regulator. Thus, participation in government efforts towards standards convergence is prized by both Icaria and GPI management.

All of the organizations participating in this study acknowledge the importance of positive network externalities (Katz and Shapiro 1985, 1994) on the acceptance of sponsored specifications. The larger the number of organizations supporting any given specification, the more attractive the specification becomes. More important, perhaps, is the influence major business partners exert over the choice of specifications these three companies adopt. IT leaders at Icaria state they will support *any* specification their major customers support. In fact, they add, Icaria will support *as many* sponsored specifications as become necessary in order to exchange vital business information with these customers. They further added that adopting XML-based specifications, even multiple ones, will be simpler and cheaper than continuing to provide development and support for the bevy of inconsistent EDI specifications they currently support.

Proprietary Specifications

GPI is one of the organizations that actively collaborates with industry standards-setting consortia while, at the same time, developing in-house applications to meet specific business needs and develop internal expertise. GPI receives large amounts of electronic customer data from various sources. A Java application was developed in-house to parse the well-defined, structured text received by the organization. This data may be transmitted to GPI systems via email, FAX, or by surface mail on CD-ROM. The Java application converts this data into XML templates developed by the company. This process is known as "reskinning" in XML parlance. The reskinning process homogenizes the differing data formats received for use by internal database, Knowledge Management, Enterprise Application Integration, and Enterprise Resource Planning systems. Once integrated into these corporate systems, the data is reskinned once again to make it available to internal customers in interface formats best suited for their individual consumption needs. The company's data acquisition, analysis, and dissemination processes are all reflected in the components of the XML application itself. This fact makes the actual code of the application highly-sensitive, competitive information, a situation that would not occur as readily with the use of sponsored or public specifications. The longer it takes for industry-standard specifications to emerge, the more difficult it will be for organizations to simply abandon their proprietary applications in favor of the standard. Proprietary XML specifications, then, become highly specific investments (Williamson 1984) by an organization, since they cannot be easily deployed to other uses in different contexts.

Worldwide Insurance, the fourth participant in the study, is one of the largest and most influential members in the financial services and insurance industry. Worldwide has developed an XML-based data exchange application capable of providing real-time commercial insurance quotes to business partners. The application has been created in-house by a Worldwide wholly-owned subsidiary. The role and strategic positioning for the subsidiary and its capabilities are the subject of much debate at the company. Worldwide IT leaders are currently exploring the ramifications of maintaining tight control over the application versus becoming an open-source service center for the industry. Though the application is not currently being used by competitors, the base XML code developed for the purpose is flexible enough to accommodate such use. This would allow Worldwide to become an industry service center if it determines that is the best approach to take.

Table 3 summarizes the specific concerns and benefits of current XML specification adoption strategies stated by each of the four companies participating in this study.

Table 3. XML Specification Adoption Concerns and Benefits

Company	Adoption Concerns	Adoption Benefits
Finseco	1. Absence of industry standards 2. Lack of standards convergence	1. Public financial data processing 2. Lowering of knowledge barriers 3. Increasing returns effect 4. EDI investment leverage
Icaria	1. Absence of industry standards 2. Power effects 3. Government regulation	1. Lowering of knowledge barriers 2. Simpler than current EDI applications 3. Industry consortia participation
GPI	1. Absence of industry standards 2. Government regulation 3. Business processes embedding 4. High asset specificity	1. Lowering of knowledge barriers 2. Industry consortia participation
Worldwide Insurance	1. Specification control versus Industry service center	1. Lowering of knowledge barriers 2. Industry consortia participation

Conclusions

Despite the small sample of organizations participating in this study, several recurring themes are easily observable. The first is that a large amount of effort is being spent by organizations in building internal expertise with XML technologies. The primary mechanism for acquiring this expertise is the development of proprietary XML applications. This investment may play a significant role in the adoption of industry standards later on, as companies attempt to protect their investments on systems that have been custom-made to handle their business processes. The combined costs of migrating from these proprietary systems may be substantial. Software development, business process changes and disruptions, and organizational retraining all contribute to these costs. Thus, organizations may be slow to embrace emerging industry specifications, delaying their adoption and the onset of positive network externalities.

Second, a lack of official industry-wide, or even transaction-specific, standards forces organizations to develop proprietary specifications to meet their particular needs. As noted before, protecting large investments in these proprietary systems, along with migration and business process change issues, may lead to slower market convergence on a single sponsored (or public) XML specification. Not surprisingly, sponsored specifications lead the way in the exchange of information between organizations. All four of the organizations interviewed for this study declare their preference for the simplification of development and support activities associated with the eventual use of standardized specifications. They view the confusing landscape of multiple sponsored specifications as promising, despite the current slow pace of adoption.

Lastly, it has become clear through the interviews that the balance of power between organizations is a factor worthy of deeper study. All of the companies mentioned in this paper cite an influential business partner's decision to adopt a particular specification as critical in their own choice of applications. Influence of trading partners has been shown to be a significant factor in the adoption of technologies similar to XML, such as EDI (Bouchard 1991). Government influence is seen as important in regulated industries, but not as the decisive factor for adoption of any particular specification. Though the United States federal government is a major customer for two of these companies, IT leaders interviewed believe that free market forces will have the most influence in the determination of the dominant XML specification for their industries.

It must be noted that all of the participating organizations in this phase of the study are large corporations with sizable IT resources and budgets. Initial conversations were also held with a medium-sized company in the data networks and telecommunications industry regarding its use of XML technologies. The initial interview offered clues that companies with fewer resources prefer a wait-and-see approach to this problem. Data from this interview was not included in the main body of findings because of its preliminary nature.

The results of this study suggest that additional empirical research would be fruitful. The interviews, while useful, do not adequately identify which variables play the most important roles in determining the success of XML specifications. For example, companies that distribute physical products may have different reasons for adopting specifications than companies that distribute information-based products. The extent to which a uniform product specification affects physical versus information-based

products may change the nature of the competitive advantage obtained by the firm when adopting such specification. The ability to differentiate products, whether physical or information-based, may also be an important factor. Suppliers of homogeneous products, such as salt, stock quotes and, increasingly, personal computers, may have different motivation to adopt uniform specifications than suppliers of products that are more easily differentiable. Perhaps more importantly, a much larger sample of both industries and products is necessary to rigorously isolate these and any other individual variables affecting adoption of XML specifications.

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