THE ADOPTION AND DIFFUSION OF INTERORGANIZATIONAL SYSTEM STANDARDS AND PROCESS INNOVATIONS

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ABSTRACT

Interorganizational system standards are reaching a new era in industry. When asked about interorganizational systems, invariably most people think of electronic data interchange (EDI) standards (ANSI X12). Albeit EDI still remains the preeminent type of interorganizational system, IOS solutions have been overhauled since the mid-1990s. IOS solutions are now collaboratively developed, structured around discretely defined cross-company business process standards and able to be distributed via the web. Compared with EDI technology from the past, the notions of open standards, modularity, scalability, and interorganizational business process reengineering have become embedded in modern-day IOS development. This paper is intended to examine assimilation levels of interorganizational system standards and process innovations (IOS SPI) among members of an industrial group where an IOS standards development organization (SDO) exists. A Conceptual IOS SPI Adoption and Innovation Diffusion Model is developed, defined and nine hypotheses are proposed and empirically tested based on firm-level cross-sectional surveys of 102 firms from 10 different industrial groups (encompassing 15 different SDOs). Using the organizational - technological - environmental framework (with the addition of the SDO construct), the significant determinants of IOS SPI adoption were found to be; top management support, feasibility, technology conversion, competitive pressure, SDO participation level, and SDO Architecture. Using the same framework, the significant determinants of IOS SPI deployment were found to be; feasibility, competitive pressure, SDO participation level, compatibility, shared business process attributes, SDO Architecture and SDO Governance. A rich discussion is then provided regarding findings in the areas of industrial coordination of IOS standards, consequences of IOS standards diffusion, and SDO measures of success (including governance and management practices). Numerous recommendations are provided to practitioners and researchers for future consideration in this critically important and emerging research frontier.

Keywords: Interorganizational system standards, XML, IOS diffusion model, industrial group interoperability.

INTRODUCTION

Interorganizational system standards are reaching a new era in industry. An era that could be on the verge of immense widespread diffusion. When asked about interorganizational system standards, invariably most people think of electronic data interchange (EDI) standards (ANSI X12). Albeit EDI still remains the preeminent type of interorganizational system, IOS solutions have been overhauled since the mid-1990s. IOS solutions are now collaboratively developed, structured around discretely defined cross-company business process standards and able to be distributed via the web. Compared with EDI technology from the past, the notions of open standards, modularity, scalability, and interorganizational business process reengineering have become embedded in modern-day IOS development.

This era will entail achieving integration levels of information technology with cross company business processes that have rarely been experienced. Rather than piece meals of interoperability between certain business segments (payments or inventories), this new era will encompass a broad scope of interoperability needs between organizations (collaborative engineering, concurrent research and development, supply chain management, parallel manufacturing, integrated customer relationship management and beyond.). Rather than providing only portions of information exchange needs within a business segment (goods manufactured status), this new era would encompass the full depth of tasks associated with a cross-company business process (manufacturing forecasts, receipt acknowledgement, work in progress, spoilage, actual versus forecast, etc.). Rather than ignoring small to medium sized organizations, this new era would encompass the full breadth of members from the extended industrial group (small down-stream suppliers, small up-stream distributors, industry action groups, research centers, non-profit organizations) and beyond.

The enabler of this era is the extraordinary integration of information technology standards with cross company business processes. With levels of cooperation rarely witnessed, industrial group members are jointly decomposing cross company business processes into the lowest common tasks that occur between organizations. They are agreeing on common sets of parameters that enable choreographing cross company processes that are in compliance with contractual agreements, industry practices, governmental regulations and technical requirements. If inconsistencies or inefficiencies are detected, consensus is reached and the processes are reengineered. Utilizing an industry-wide data dictionary, they are developing common sets of business terms, definitions and forms. By integrating these process standards with recent technological innovations (XML, WSDL, SOAP and other APIs) industrial groups are developing a comprehensive set of interorganizational system standards structured around discrete cross company business processes (here after referred to as interorganizational system standards and process innovations (IOS SPI)).

The benefits of this new era could be profound. The rich scope, depth and breadth of interoperability and information sharing have rarely been experienced. At the system level, the benefits to participating members would include tactical direct operational enhancements (improved response times, reduced standards negotiation efforts with new trading partners, reduced system development efforts). At the firm level, the benefits to participating members would include strategic business and operational advantages (improved compliance with contractual obligations, greater access to new customers or suppliers, technology awareness, reduced research and development expenditures). At the industrial group level, this new era could fundamentally shift the dynamics from a supply-chain versus supply-chain level of competition, to an industrial group versus an industrial group level of competition. The degree of which extends beyond most notions of pie expansion and competition to co-opetition.

Fundamentally, this work is intended to introduce the need for bridging the research gap between prior studies in IOS adoption and diffusion (based predominantly on EDI technology) versus modern-day IOS solutions. Pragmatically, this paper is intended to examine assimilation levels of interorganizational system standards and process innovations (IOS SPI) among members of an industrial group where an IOS standards development organization (SDO) exists. What practices are used to develop and deploy modern-day IOS standards through out an industrial group? What are the antecedent conditions leading towards greater adoption and diffusion of IOS standards in an industrial group? What are the consequences of deploying IOS standards? The intent of this study is to address these research questions by examining the development and deployment of modern-day IOS standards throughout an industrial group. A conceptual innovation adoption and diffusion model is developed, defined and the proposed hypotheses are empirically tested in a real work environment. The innovation under study is a grouping of related and emerging technologies referred to as interorganizational system standards and process innovations (IOS SPI). Components of this technology group include eXtensible Mark-up Language (XML), simple object access protocols (SOAP), web-services description language (WSDL) and other application programming interfaces (APIs) that have become integral in the development and deployment of cross-company business process IOS standards. The scope of this study examines the adoption and diffusion of these technologies specifically in an interorganizational system context.

The contributions from this study are substantial. First, this study will provide insights into industrial coordination, development and deployment of a new and emerging area in IOS technology standards (e.g. XML, SOAP, WSDL and other APIs). Including results from a theory-based empirical study into the significant antecedent conditions leading towards adoption and sustained diffusion of IOS technology standards. Third, this study will examine consequences on an industrial group as a result of deploying IOS standards (ordered in three tiers based on time since deployment). Fourth, this study will provide insights into SDO governance, management practices and standards architecture, including discussions regarding measures of success and the SDO value-proposition. Fifth, this study will provide recommendations to practitioners towards improving industrial coordination of IOS technology standards. Sixth, recommendations to researchers are provided for conducting future lines of inquiry into this important and emerging research frontier. This discussion will include initial thoughts and analysis regarding horizontal convergence (referred to as the 'holy-grail' of interorganizational system standards) which offers a unique niche for researchers to make significant contributions.

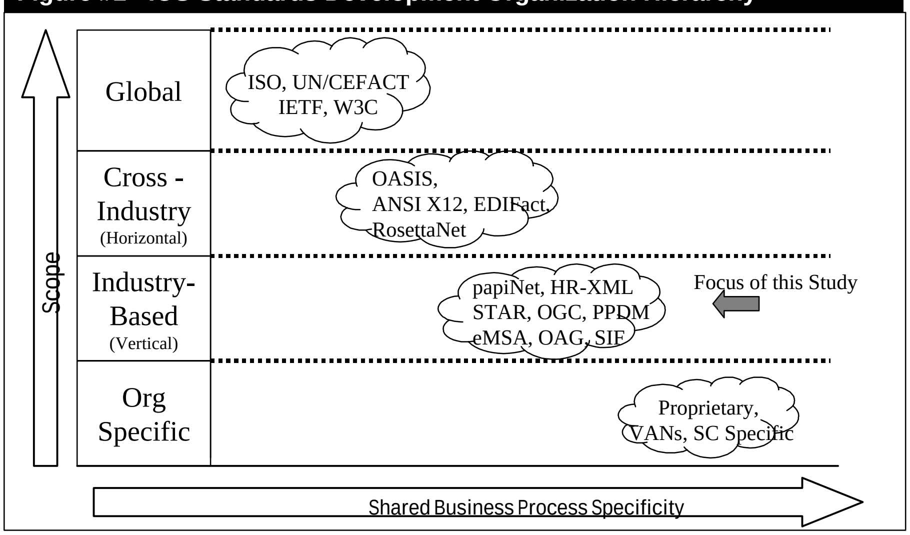
To address the research questions and accomplish the objectives, the paper is organized as follows. First a brief background is provided regarding the hierarchy of information technology standards organizations. This will identify where an *industry-based* standards development organization (SDO) fits in the information technology standards setting context. Second a comparison will be made of several industry-based SDOs including identification of the IOS SPI development process based on a synthesized review of ten SDOs participating in this study. Third, results and key findings from prior IOS diffusion studies are summarized. Fourth, a conceptual model of IOS SPI adoption and diffusion is proposed. Theoretical support and definitions are provided for the twelve measurement variables, three diffusion measures and nine hypotheses comprehended in this study. Fifth, the research setting, methodology and results of administering firm-level cross-sectional surveys to 102 firms from 10 industrial groups encompassing 15 SDOs are reported. Sixth an extended discussion ensues regarding the academic and managerial implications of the study's results, including numerous points regarding industrial coordination efforts. This paper concludes with numerous recommendations to practitioners and researchers, including future research recommendations and limitations of this study.

BACKGROUND

Information Technology Standards Hierarchy

Figure #1 provides a hierarchy of standards development organizations that influence the development of interorganizational system standards. Admittedly, one must travel far down this hierarchy to reach the type of SDO in consideration for this study. Briefly, to distinguish between the tiers of standards organizations, Internet Engineering Task Force (IETF) develops bit-orientated standards for the Internet. The World Wide Web Consortium (W3C) develops syntactic standards (that ride atop of the IETF's standards) for the World Wide Web (HTML, XML, etc.). ISO is described to have a top-down or structuralist approach with standards development (Libicki 2000). Structuralist-based SDOs develop comprehensive sets of standards in hopes of encompassing all current and future endeavors in relation to their constructs. Industry-based SDO's, on the other hand, are depicted as minimalist towards their standards development activities. Minimalist-based SDO's develop standards in small sub-sets (develop a little, test a little) and only after there's a sufficient and demonstrated need for the standard by the targeted user group(s). Development of specific semantic standards is the scope of consortia organizations that either have a horizontal (cross-industry) or vertical (single industry group) focus. ANSI X12 and OASIS are two of the most publicized horizontally focused (cross-industry) SDOs. ANSI developed X12 standards for formatting EDI business messages and OASIS is developing ebXML and UBL for the formatting of XML-based business messages. Vertical focused SDO organizations include papiNet, CIDX, PIDX, and many others and are the type of SDO under consideration in this paper. RosettaNet, which is also included in the scope of this paper, is an SDO that transcends both vertical and horizontal concentrations. Although RosettaNet focuses its' IOS standards development efforts across three high-technology industries (semi-conductor, electronics, and information technology), RosettaNet's Interoperability Framework (RNIF v2) has been adopted (or leveraged) by a host of additional industrial groups. In fact, in June 2003, OASIS and RosettaNet announced the formation of a Standards Development-to-Implementation Alliance. Finally, several organizations have developed IOS technology standards privately (e.g. within their organization) to be utilized throughout their private supply chain or their extended enterprises. These proprietary solutions typically consist of a hybrid of EDI (or EDI-like) technology standards and are outside the focus of this study.

Figure #1 - IOS Standards Development Organization Hierarchy



Industry-based, Voluntary-Consensus IOS Standards Development Organizations (SDO)

Researchers in the mid-90's were calling for the inclusion and examination of the SDO's role towards the adoption and diffusion of IOS solutions (Grover 1993; Premkumar 1995). Table #1 provides a comparison of eight of the industry-based SDO's that participated in this study. Despite variations in membership size, year incepted, and completed messages many similarities exist. Participation in the SDO is voluntary, decision making is consensus driven (typically based on voting rights associated with the type of membership), the IOS standards are made freely available to the public, and they all have a non-profit orientation. In addition, SDO members include stakeholders from the entire industrial group (producers, distributors, retailers, non-profit industry interests groups, universities and other governmental units).

Table #1 - Industry-Based Standards Development Organization (SDO) Examples

Example SDO	HR-XML	papiNet	Open GIS	PIDX
	http://www.hr-xml.org	http://www.PAPINet.org	http://www.opengis.org	http://www.pidx.org
Industrial Group	Human Resources	Paper	Geo Spatial	Petroleum & Oil
Profit Orientation / Partnerships	Non-Profit	Partnered with Idealliance. Non-profit orientation.	Non-Profit	American Petroleum Institute's (API) committee on Electronic Business. Non-profit orientation.
Membership Fee Structure	Fixed annual fees based on Charter, General, Associate or Academic membership types. Fees also vary by end-user versus technology vendors.	Annual fees based on firm revenues. Fees also vary by technology vendors and industry champions.	Fixed annual fees based on Strategic, Principle, Technical Committees, Associate or Academic and Governmental membership types.	Annual fees based on firm revenues (distinctions made for governmental and academic institutions).
Industry Participation	Voluntary	Voluntary	Voluntary	Voluntary
Development Process	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.	Consensus based on membership voting rights.
Standards Availability	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public
Members	150	47	258	27
Year	1999	1999	1994	2002*
Messages Completed	27	28	7	11
Pending (In Review)	not known	5	12	5
IOS SPI Solution Examples	Background Checking Benefits Enrollment Competencies Contact Method Education History	Credit Debit Note Goods Receipt Availability Order Confirmation Business Acknowledgment	Imagery Mark Up Language Spec Image Coordinate Transform Web Map Service Interfaces Grid Coverages Gazetteer Service Interface	FieldTicket FieldTicketResponse Invoice InvoiceResponse OrderCreate

Table #1 - Industry-Based Standards Development Organization (SDO) Examples

Example SDO	STARS	IMS	eMSA	RosettaNet
	http://www.starstandard.org/	http://www.imsglobal.org	http://www.emsa.org	http://www.rosettanet.org
Industrial Group	Automotive	Education	Marine	Semi-Conductor Mfr
Profit Orientation / Partnerships	Non-Profit	A project within the National Learning Infrastructure Initiative of EDUCAUSE	European Marine STEP Association (EMSA). Non-Profit orientation.	Merged with UCC in 2002. Non-profit orientation.
Membership Fee Structure	Fixed annual fees based on organization type (Dealerships, Mfrs, SIG) and membership status (active versus associate).	Annual fees based on firm revenues.	Annual fees based on firm employee count. Distinctions made for academics.	Fixed annual fees based on geography and voting privelages.
Industry Participation	Voluntary	Voluntary	Voluntary	Voluntary
Development Process	Consensus based on membership category voting rights.	Consensus based on membership category voting rights.	Consensus based on membership category voting rights.	Consensus based on membership category voting rights.
Standards Availability	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public	Freely Available to the Public
Members	39	64	15	500
Year	2001	1997	1994	1998
Messages Completed	15	9	6	53
Pending (In Review)	not known	3	2	52
IOS SPI Solution Examples	Parts Inventory Delivery Reporting Financial Statement General Acknowledgements Labor Operations	Learner Information Package Question & Test Interoperability IMS Vocabulary Definition Learning Design IMS Digital Repositories	Hull Structural Design Data Society type approval & product Quote machinery product data Integration & catalogue procuremer Machinery design data	Notification of Failure Distribute Design Engineering Info Distribute Product Master Request Quote Request Purchase Order

Members of an SDO management team are in a very precarious position. They are bound to upset some members all of the time, and rarely have the opportunity to exceed expectations any of the time. They are independent moderators in managing a shift from competition to co-opetition among industry-wide participants. They are the facilitators in coordinating a transformation from company versus company competition, to a supply-chain versus supply-chain competition (or, their case, an industrial group versus an industrial group). The SDO management teams are the enablers towards true pie-expansion among members of an industrial group.

IOS SPI Development Process

The notion of understanding, documenting and (if necessary) reengineering the underlying business process prior to applying technology is commonly accepted in academia and industry (Laudon 2003; Hammer 1990). This effort involves more than simply providing common business semantics in data exchanges. In fact, in all stages of the Systems Development Life Cycle (SDLC) reference the underlying business process (Hoffer 2002). In industry, if technology is deployed without first addressing the underlying business process needs it is referred to as Naked Technology. Forrester estimates that the deployment of Naked Technology resulted in technology overspending of $65 billion in the United States from 1998 to 2000 (Forrester 2002). This practice of understanding the business process first, prior to deploying the technology, is all the more important when confronted with cross-company business processes (here after also referred to as shared business processes). In fact, Hammer predicted that "streamlining cross-company processes is the next great frontier for reducing costs, enhancing quality, and speeding operations. It’s where this decade’s productivity wars will be fought" (Hammer 2002). Each organization participating in an IOS must agree on a host of common business terms, definitions, and forms. They need to choreograph and synchronize the flow and timing of information associated with the shared business process to insure its compliance with contractual agreements, industry practices, governmental regulations and technical requirements. This results in a host of standards associated with the shared business process that the interorganizational system is intended to automate.

Figure #2 depicts the major steps in the development of industry-based IOS standards (based on a synthesized understanding from 10 of the industrial groups participating in this study). The IOS standards development process works as follows: (1) Choreograph business data flows and modularize these flows into shared business processes that need to occur between partners in the industrial group. (2) Reach consensus and prioritize which shared business processes will be documented, standardized and the associated timing. (3) Standardize and document the common business fields, terms and definitions, including the development of document type definitions (DTD), XML messages and ISO compliance checks. A discrete (modularized) shared business process that has completed step three is commonly referred to in industry as a message. Upon completion of the initial version of a message, they proceed through development with (4) Testing & Reviews, (5) Deployments and (6) Certifications and Compliance.

An illustration of this can be briefly explained in the chemical industry. CIDX is a non-profit IOS SDO for the chemical industry. In late 2000, CIDX members voted to ratify new by-laws thereby broadening and transforming the association into a neutral standards body focused on improving the ease, speed and cost of transacting business electronically between chemical companies and their trading partners. As of August 2003, CIDX had 75 member firms and had developed IOS standards for 52 messages ranging from Order Create, Qualification Requests, and Quality Testing Report. The 52 messages are grouped into 8 broader functional categories (Customer, Catalog and RFQ, Purchase Order, Logistics, Financials, Forecasting, Exchange Interactions, and Product Information). The SDO provides a strict hierarchy of guidelines to following when formalizing their IOS standards. Each of the messages has a DTD (document type definitions) with a hierarchy of messaging guidelines, structure guidelines, and data element guidelines that must be adhered to. Each DTD provides compliance with ISO related guidelines (ISO 8601 is a format for structuring date and time elements, ISO 639-1 is the two-character language code and ISO 639-2/T is the three-character code, not to be confused with ISO 639-2/B). In addition, IOS standards developers provide a corresponding set of sample XML messages for each of the 52 DTDs. Although the messages are modularized around discrete shared business processes, a single data dictionary is used through-out CIDX to insure consistent use and interpretation of business terms, data types, data lengths, definitions, synonyms and so on through-out their current (and forthcoming) messages. CIDX is non-profit, membership is voluntary, the standards development process is consensus-driven, the IOS standards are platform independent, vendor neutral and are based on open standards (made freely available to the public).

Figure #2 provides further description and illustrations of IOS SPI development in industrial groups. The key point of this illustration is the output of this development effort is significantly more than just common data semantics. The effort begins with a shared business process, and ends with a comprehensive set of interorganizational system standards. IOS standards that are ready for implementation by members of the industrial group whom choose to adopt them. For discussion purposes in this paper, the term IOS SPI solution refers to an instance of output from Figure #2. IOS SPI technology refers to a grouping of related innovations that provide the essential tools used during this development effort (e.g. XML, SOAP, WSDL and other APIs).

Figure #2: Interorganizational System Standards & Process Innovations (IOS SPI) Development in Industrial (Vertical) Groups

FEEDBACK & UPDATES

STEP	ACTIVITIES	ILLUSTRATIONS
Choregraph & Modularize	Choregraph and decompose key cross-company business processes into manageable units.	- CIDX choregraphed 8 broad categories of data flows for organizations in the chemical industrial group (Customer, Catalog and RFQ, Purchase Order, Logistics, Financials, Forecasting, Exchange Interactions, and Product Information). - CIDX then decomposed these broad categories into distinct interorganizational business processes. - For example Catalog & RFQ currently has 3 identifiable cross-company business processes (Customer Specific Catalog Update, Product Catalog Update, Request for Quote)
Prioritize	Assess, evaluate and reach mutual consensus as to which business processes will be completed and when.	- This is a highly consensus driven event with discussion and debate from all stakeholders from the industrial group. Strict voting rights are enforced and traditionally assigned to the type of firm membership. - It is essential for the SDO's management team to remain neutral and provide an industry-wide perspectives with technology trends in mind. Many SDO's conduct Planning Studies, Insertion Projects, and Feasibility Studies to determine pilot programs. - Low hanging fruit areas are identified based on anticipated development effort, consistency of business process flows (and terminology) through-out the industry, the business need and the likelihood of uptake by the user community. - See Table #2 for examples of higher priority cross-company business processes.
Standardize & Document	Delegate authority to speciality work groups to establish DTD, XML Messages, and maintain an industry-wide data dictionary.	- Establish working groups responsible to develop common business terms, forms, DTDs, and XML messages associated with each modularized interorganizational business process. - Establish key development milestones, timelines and insure the appropriate authority (and scope) is delegated to working groups. - Maintain a common data dictionary for the entire industrial group - Establish ongoing procedures to evaluate progress, validity checks with the appropriate ISO guidelines and periodic report outs to the extended membership and user groups.
Reviews & Test	Permit the extended user community to provide reviews and feedback regarding the draft IOS solutions.	- Firms volunteer for testing and parallel processing with the associated IOS SPI solutions. - Most SDO's offer lengthy review and testing periods (including interoperability labs, open publication of test results, and formal versioning procedures and norms).
Deploy & Implement	Develop procedures for promoting, tracking and forecasting the adoption (up-take) of IOS solutions across the user community.	- IOS SPI adoption (and sustained diffusion) is identified as one of the top priorities in every SDO. All SDOs have assigned project champions for leading adoption initiatives across the industrial group. - Extended 'support networks' are coordinated by the SDO to track key personnel with experience, lessons learned, best practices, implementation guidelines, and total number of deployments.
Compliance & Certification	Provide a process whereby conformance, certification, and interoperability can be tested and verified.	- The typical intent of these programs is to establish formal procedures concerning certifiable implementations (according to specified standards), protect the SDO's trademark name (and usage), and to document (and forecast) adoption. - Most SDO's have only recently begun to enforce their certification and compliance programs.

IOS Diffusion

If one's objective is to study the adoption and diffusion of modern-day IOS solutions, one of the closest parallels we have towards examining this phenomena in literature is the study of IOS adoption and diffusion (largely based on EDI solutions). Although the sharp contrasts between EDI versus modern-day IOS solutions have been noted (see Table #2) fundamental similarities remain. Modern-day IOS standards development entails choreographing cross-company business processes, codifying common business standards, and developing (and testing) technical messages (including interfaces and protocols). Fundamentally, these similar steps are taken in the development of EDI solutions. As described in Table #1, the differences lie in the scope, exchange frequency, breadth, diversity, transport, protocols and scope of semantics.

The coupling of EDI technology standards and business process reengineering was introduced in prior research (Clark 1996; Fiedler 1995). In addition, Massetti and Zmud's recommendations for measuring EDI adoption and diffusion across trading partners (breadth), business processes (diversity) and volume offers a superb framework for measuring the diffusion of modern day IOS solutions (Massetti 1996). Furthermore, a rich research stream of empirically based IOS adoption and diffusion models does exist.

Based on a literature survey of 21 IOS adoption and diffusion models the following are some findings from the coding and synthesizing of their findings. See Appendix A for a list of the publications included in the literature search. First, six types of IOS solutions have emerged that fit the definition of an interorganizational system, "an automated information system shared by two or more companies" (Cash and Konsynski 1985, p 134). They include (in order from most to least) EDI, EDI-like solutions (including customer-orientated interorganizational systems and proprietary-dedicated IOS), telecommunications based IOS, web-based technologies and open systems. These IOS solutions vary along lines of their business intent, technology and willingness to participate (openness) with external organizations. Second, the most common set of constructs (framework) utilized in the study of IOS diffusion is the *organizational - technological - environmental* framework. This is consistent with Rogers' four main elements in the diffusion of innovations (Rogers 1995). Third, based on coding and summing the significant determinants in prior IOS diffusion studies, the most frequently significant IOS diffusion determinants were found to be *competitive pressure, top management support, relative advantage, market uncertainty* and *power*.

TABLE #2 - EDI VERSUS IOS SPI SOLUTIONS

	Former IOS Solutions (Predominantly EDI)	Modern-Day IOS SPI Solutions
Focus	Supply-Chain (Regional)	Global
Frequency	Batch	Real-Time
Breadth (Trading Partners)	Large Businesses	All Stakeholders
Diversity (Business Processes)	10% of B2B processes	100% of B2B procesess
Transport	VAN-Enabled	Internet-Enabled
Protocols	X.12 / EDIFACT/ JE CALS	XML, SOAP, WSDL, and other APIs
Semantics	Custom Industry Dictionaries	Standard Industry Dictionaries

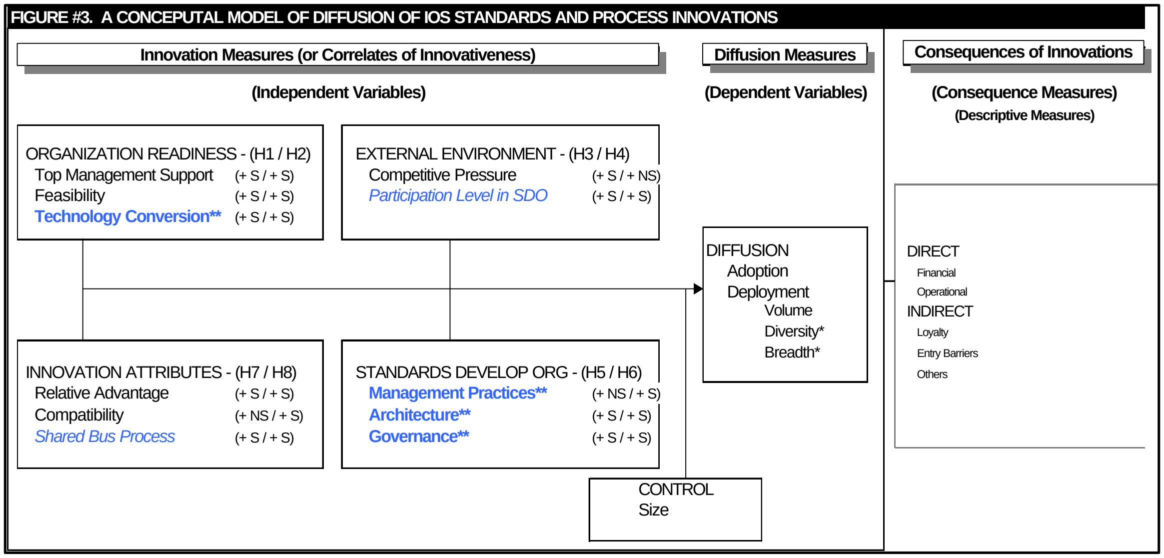
CONCEPTUAL MODEL

Conceptual IOS SPI Adoption and Diffusion Model

This study seeks to introduce a conceptual IOS SPI adoption and diffusion model, empirically compare the model in a real work environment and report the findings. Figure #3 contains the proposed conceptual IOS SPI Adoption and Diffusion model. The model is composed of three parts. Antecedent (independent) variables are on the left and include four constructs (organizational, innovation, environmental and the SDO). The theoretical support and hypothesized impact of these constructs on the diffusion variables are summarized below. The diffusion (dependent) variables are in the middle of the model and include adoption, deployment and assimilation. Adoption is a dichotomous variable and indicates whether the firm has reached a decision ('yes' or 'no') to begin utilizing the IOS SPI technology grouping. Deployment is a dichotomous variable and indicates whether a firm has actually implemented the IOS SPI technology grouping in an interorganizational system context. Assimilation is based on a modified version of the Guttman scale with seven levels of IOS SPI technology assimilation levels is used (0-unaware to 7-general deployment). This use of assimilation levels is similar in structure to Fichman and Kemerer's work with software process innovations (Fichman 1997; Fichman 1999). There are also three descriptive measures of external diffusion that measure the extent of actual implementations of an SDO's IOS SPI solutions across shared business processes with external trading partners. All three external diffusion measures are similar in scope and nature to Massetti and Zmud's recommended diffusion measures (1996). Volume refers to the total number of instances (implementations) of the IOS SPI solutions. Diversity refers to the number of different (unique) IOS SPI solutions implemented. Breadth refers to the number of different trading partners. The far right side of the model includes the consequences of innovation measures. These measures will be used to descriptively examine the effects (consequences) on an industrial group of diffusing (implementing) IOS SPI solutions. Examples of descriptive consequence measures include direct financial measures (expense components, ROI), operational measures (throughput, cycle time) and qualitative measures (trading partner loyalty, entry barriers). Consequence measures have been stratified into three ordered effects based on elapsed time since deployment.

Described below is the theoretical support for each of the four independent constructs; organizational readiness, IOS technology attributes, external environment, and the SDO. Hypotheses will also be presented that seek to predict and explain the relationship (directional and significance) between the independent and dependent variables. Detailed descriptions and definitions of all measurement variables (independent, dependent and consequence measures) are provided in the Research Setting and Methodology section.

FIGURE #3. A CONCEPTUAL MODEL OF DIFFUSION OF IOS STANDARDS AND PROCESS INNOVATIONS



Organizational Readiness

The organizational readiness construct is intended to capture firm level attributes of the organization that assess the overall readiness of the firm towards diffusing the innovations. Assessing an organization's readiness is a fundamental and necessary step prior to launching a new information systems development project (Hoffer 2002). This step is particularly relevant when an organization is considering to join an IOS standards development organization and to begin implementing IOS solutions with external trading partners. Compared with other technologies, IOS are an outward manifestation of an organization's ability to plan, commit and execute according to requirements established with external trading partners. At a minimum, this requires evaluating top management's support, financial and technical feasibility (Iacovou 1995) and the type technology that the organization will be converting from. Top management's leadership and support will be essential for successful participation in an IOS SDO. Examples of top management support include the demonstrated willingness of top management to commit resources (human and capital) to the project and the existence of a project champion who is enthusiastic about the new endeavor and is willing (and capable) to act as the organization's focal point on the project. The risk of failure with IOS solutions could have far reaching impact into supplier contracts, customer contracts and the organization's reputation in the industry. Financial feasibility could include conducting cost-benefit analysis, forecasting total cash expenditures, and estimating the indirect impact of the new technology (product costs, process re-engineering efforts, etc.). Technical feasibility could include assessing skill sets of the IS staff, identifying infrastructure enhancements necessary to accommodate the new technology, and evaluating and prioritizing which shared business processes should be automated. Although the technical feasibility should be conducted first (so as to be able to calculate the financial feasibility), all of these steps will be essential to objectively evaluating the readiness of an organization.

- H1. Organizational Readiness attributes will have a positive (and significant) relationship with IOS SPI adoption.
- H2. Organizational Readiness attributes will have a positive (and significant) relationship with IOS SPI external deployment.

Prior IOS diffusion studies have considered the readiness aspect of organizational attributes (Iacovou 1995). Several studies have considered other organizational attributes such as top management support (Premkumar 1995, 1997; Grover 1993; Chatterjee 2002) and a project champion (Premkumar 1995, 1997; Grover 1993). In addition, Grover's research into COIS considered organizational structure considerations and policy factors (Grover 1993). Also, Chatterjee's research work into e-commerce strategies considered management coordination techniques (Chatterjee 2002).

External Environment

Intuitively, the external environment should be considered a potential significant factor in the diffusion of IOS standards. By it's very definition, Cash and Konsynski utilize an external organization in their definition of an IOS. External environment variables such as competitive pressure, partner power, and market uncertainty have evolved as determinant variables towards IOS diffusion. The majority of prior IOS diffusion studies were conducted using EDI or EDI-like technology. Thus, the overall 'pressure' to adopt IOS technology was primary from one or two dominant firms. In the current business climate (where competition has evolved into an industrial group versus an industrial group) the perceived pressure on a firm to adopt IOS standards will be felt from the entire industry. Thus when comparing the present study to prior IOS diffusion models, the notion of partner power has been dropped and competitive pressure is anticipated to be greater. In addition, expectations of market trends is also considered and its' definition is consistent with Cho's, "Expectation for market trend is the degree of expectation that the target technology will be pervasively adopted in the industry in the future" (Cho and Kim 2002, page 130). Furthermore, participation levels in an industry-based SDO are anticipated to be a significant influence (Teo 2003). Participation levels in an SDO can manifest through several means (e.g. participating in SDO development activities, becoming a member of an SDO, implementing IOS standards from the SDO).

- H3. The external environment attributes will have a positive (and significant) relationship with the IOS SPI adoption.
- H4. The external environment attributes will have a positive relationship with the external deployment of IOS SPI. Participation levels in an SDO will have significant relationship towards IOS SPI external deployment.

Standards Development Organization

The SDO construct is intended to examine attributes of the SDO and its' potential influence towards the diffusion of IOS SPI technology. Since this construct has rarely been used in prior IOS diffusion studies, a survey of critical success factors in alliance organizations was conducted to develop an SDO role continuum. For example, in Monczka's study of strategic supplier alliance organizations found the most important attributes included trust, the notion of "doing what you say you're going to do", actively encouraging bilateral communications, maintaining a joint-solving problem approach with all conflict resolutions, and formalized processes in selection and assessment procedures (Monczka 1998). In Whipple's study of 92 'paired' buying and selling organizations from the health / personal care industry found that buyers and sellers agreed on the top five factors that influence alliance success factors: trust, senior management support, ability to meet performance expectations, clear goals, and partner compatibility (Whipple 2000).

This role continuum then provides a set of criteria to evaluate the SDO with respect to its' organizational attributes and impact on the target technology's diffusion. Components of this role continuum include SDO management practices such as collaboration mechanisms, ability to meet performance expectations, problem resolution techniques, and clarity of goals and objectives. IOS architecture attributes include modularity levels and compatibility with business processes. IOS governance includes attributes related to the structure of the SDO, non-profit status, objectives of the SDO and others.

Researchers have recommended examining the role of an IOS standards alliance organization as their recommendations for future research. For example Grover, in his cross-sectional survey of 216 firms considering adoption of proprietary COIS systems, recommended an in-depth study of a group of firms utilizing an industry-based standards setting organization to enhance the understanding the 'hows' and 'whys' of the decision processes leading to the adoption decision (Grover 1993). In addition, Premkumar recommended the use of industry associations and the establishment of industry-wide standards for better electronic integration and increasing adoption by participating firms (Premkumar 1995, page 326). Premkumar also recommended the integration of process reengineering with IOS technology to fully maximize the benefits of EDI implementations (Premkumar 1995, page 327). The role of an SDO has emerged as pivotal in the development of IOS SPI. Industrial groups are viewing an SDO as a moderator in the IOS standards collaboration process, as an enabler towards generating cost savings opportunities through leveraging IOS development efforts, and as a means towards integrating 'best-in-class' IOS standards through the SDO's effort to stay abreast with the latest technology trends.

- H5. SDO attributes will have a positive relationship with IOS SPI adoption. Governance and Architecture will also have a significant relationship towards IOS SPI adoption.
- H6. SDO attributes will have a positive (and significant) relationship with IOS SPI external deployment.

Innovation Attributes

Attributes associated with the innovation itself have long been the most frequently tested and most frequently found significant determinants in innovation diffusion (Rogers 1995; Tornatzky 1982). IOS technology diffusion models are no exception to this fact, in that attributes such as relative advantage, cost and compatibility of the technology are some of the most frequently examined determinants towards IOS diffusion. This study has three components of IOS technology attributes that include compatibility, relative advantage and shared business process attributes. Compatibility assesses the compatibility of the IOS solution with the organizations IS infrastructure and work procedure needs of the firm. Relative advantage is defined as the extent to which a potential adopting organization views the innovation as offering direct financial and operational benefits over previous ways of performing the same tasks. Since the relative cost to benefits of the innovation is explicitly comprehended in this definition, the direct 'cost' of the technology is not isolated as a separate measurement variable in this study. Other aspects of the technology's cost are considered in the consequence measures portion of the model (direct financial impact of implementing the technology), as well as a perceptual-based variable in assessing the anticipated indirect impact of the IOS SDO organization (system development and standards negotiation effort).

The third component of innovation attributes is associated with the underlying business process attributes (and business requirements) shared between the partnering firms. The premise for including business process attributes is straightforward: IOS solutions are interorganizational technology standards that are fundamentally structured around the shared business processes that they are intended to automate or enhance. Thus, characteristics of the shared business process such as required response times, required exchange volumes, exchange frequency, consistent field terminology and consistent business definitions are all attributes of the underlying business process that could influence an organizations decision to implement one IOS solution versus another. That is to say, if an organization is considering an IOS solution implementation, yet the IOS solution that is presented does not comply with their business definitions and / or provide the response times required by trading partners, they would most likely elect not to implement that IOS solution. One of the potential outcomes from this research is to examine the possibility of replacing the rather generic relative advantage construct with the unique set of business-process specific attributes that drove the adoption of the IOS solution (Tornatzky 1982). The underlying shared business process attributes (and requirements) impact virtually every aspect of an interorganizational information system.

- H7. Innovation attributes will have a positive relationship with IOS SPI adoption. Relative Advantage and / or Shared Business Process attributes will also have a significant relationship towards IOS SPI adoption.
- H8. Innovation attributes will have a positive (and significant) relationship with IOS SPI external deployment.

One final proposition is that the antecedent conditions leading towards IOS SPI adoption versus IOS SPI diffusion will have a different set of significant determinants.

- H9. A different set of significant attributes will be associated with IOS SPI adoption versus IOS SPI external deployment.

RESEARCH SETTING AND METHODOLOGY

The research design is the culmination of a two-year developmental effort. It started with a detailed examination of a single implementation instance of a modern-day IOS solution between a distributor and manufacturer in the electronic components industry in the second quarter 2000. This provided insight into the technology under study, the use of interoperability standards and an understanding of the significant mutual operational and economic benefits provided to firms on each side of the IOS. The number one challenge identified by the members in the study was that of adoption. That is, how to encourage other partner firms to adopt the industry-wide standards and IOS solutions supported by their industry's SDO. These findings fueled the development of an initial conceptual IOS technology standards adoption model. A draft survey instrument was prepared and administered to eight firms (encompassing four IOS solutions) in a single industrial group. This study concluded in the first quarter 2002 and the qualitative findings provided additional insights into the constructs that influence IOS standards adoption and how the mixture of these constructs change when examining the diffusion of IOS standards (as opposed to adoption). This study also provided insight into the pivotal role of the industry's SDO and the performance metrics that should be used to assess consequences of diffusion. Add to these insights the results of a literature survey work in IOS adoption and alliance organizations, and the following research design was crafted.

TABLE #3 - SURVEY INSTRUMENT STRUCTURE AND ITEMS

CONSTRUCT	Hypothesized Impact		Prior / New	Item Count	Item Count
Measurement Variable	Adoption	Diffusion	Variable	Conceptual Model	Descriptive Analysis
DIFFUSION MEASURES					
Adoption / Assimiliation Level			Prior Research	1 item	1 item
External Diffusion:					
Volume			Prior Research		3 items
Diversity			Prior Research		3 items
Breadth			Prior Research		3 items
ORGANIZATIONAL READINESS					
Top Management Support	+ / Sig	+ / Sig	Prior Research	3 items	
Feasibility (Financial & Technical)	+ / Sig	+ / Sig	Prior Research	4 items	
Technology Conversion Type	+ / Sig	+ / Sig	New	5 items	
EXTERNAL ENVIRONMENT					
Competitive Pressure	+ / Sig	+	Prior Research	3 items	
Participation Level in an SDO	+ / Sig	+ / Sig	Derived	4 items	
SDO ORGANIZATION					
Governance	+ / Sig	+ / Sig	New	3 items	3 items
Management Practices	+	+ / Sig	New	5 items	2 items
Architecture (IOS Standards)	+ / Sig	+ / Sig	New	5 items	2 items
INNOVATION ATTRIBUTES					
Relative Advantage	+ / Sig	+ / Sig	Prior Research	2 items	
Compatibility	+	+ / Sig	Prior Research	3 items	
Shared Business Process	+ / Sig	+ / Sig	Derived	4 items	2 items
POTENTIAL CONTROL VARIABLES					
Size	-	-	Prior Research	1 item	3 items
Industry	- / +	- / +	Prior Research		2 items
CONSEQUENCES OF INNOVATIONS					
Direct					
Financial			New & Prior		7 items
Operational			New & Prior		4 items
Indirect			New & Prior		7 items
TOTALS				43 items	39 items

A cross-sectional firm level survey was conducted from May to August 2003 to empirically compare the conceptual model to a real work environment and test the hypotheses. Table #3 outlines the survey structure, item counts and hypothesized impact. The sampling frame includes firms that are members of an SDO or a user of IOS SPI technology, or who are considering the possibility of either. The organizational title associated with the individual respondent from the firm has been Director of IT Standards, Assistant Director of IT Standards, CIO or one of their direct reports (respectively). The identification of specific candidate firms to send surveys was a two-staged approach. First, a candidate list of all firms and SDO organizations that submitted IOS SPI standards to the XML.org registry were identified. The XML.org registry, which was launched in 1999 by OASIS, was utilized since its' mission is to "provide an environment and community where technologists and businesspeople alike are encouraged to unite in the adoption of interoperability standards". XML.org acts as a portal for industries to submit IOS SPI standards in order to minimize overlap and duplication of efforts. As of August 2003, this portal had registered IOS standards from 46 industries and received 16,700 page views from over 4,400 visitors per day. The second stage was to identify firms that are members (or affiliated) with an SDO. In total, 979 firms were identified that fit the sampling profile. The candidate list was then reduced to exclude organizations that were developing SPI for intra-organizational purposes only, no longer in existence, or were individuals (as opposed to a firm). A total of 579 firm level surveys were distributed.

Development of this most recent version of the survey instrument started in the first quarter of 2002 and concluded in March 2003. During this period, the instrument went through multiple reviews with IS Ph.D. students, faculty, the university's Survey Research Lab and Institutional Review Board. In addition, two sets of pre-tests were conducted. The first pre-test was conducted with eight firms from a single industrial group during the second quarter of 2002. As previously discussed, this resulted in significant changes (improvements) to the survey instrument. All responses from the first pre-test were dropped. The second pre-test was conducted with ten firms from three industrial groups during the first quarter of 2003. The second pre-test resulted in only minor changes to the survey instrument (item sequence and minor phrase changes to better enable cross-sectional understanding). Responses from the second pre-test were included.

Instrument Structure

Appendix B includes a summary of the constructs, survey items and descriptions. The survey instrument is structured in four major sections (Organizational, SDO, Industry Consequences and Demographics). The Organizational section includes items referring to the firm's use of IOS SPI technology (strictly in an interorganizational context) and comprehends all items associated with the Organizational Readiness, External Environment, and the Innovation Attribute constructs. All items in the Organizational section are perception-based measurements on a 7-point Likert scale (with the exception of technology assimilation level that was measured on a 7-point modified version of the Guttman scale). For the SDO section of the survey, respondents were asked to consider their firms predominant SDO (one in which they were participants in, or aware of for their industrial group). The SDO section of the survey includes IOS SPI solution diffusion levels for three time periods (current, mid-term and longer term), and 20 items pertaining to the SDO Organization construct and associated measurement variables (perception-based on 7-point Likert scales). Due to the proprietary nature of the survey items in the Consequences section (e.g. revenue trends, expenditure trends, trading partner loyalty trends, entry barrier assessments, and required ROI levels to justify IOS SPI technology expenditure) respondents were asked to assess consequence measures with respect to their Industrial Group (as opposed to a specific firm). A total of 18 consequence measures were assessed by respondents for three time periods (current, mid-term and longer-term) based on time since deployment of IOS SPI solutions through out their industrial group. Each time period utilized a perception-based measure on a 5-point scale (ranging from 1 - significant decrease, 3 - no change, to 5 - significant increase).

Operationalization of Variables

Assimilation Levels (dependent variables)

The diffusion (dependent) variables include adoption, deployment and assimilation. Adoption is a dichotomous variable and indicates whether the firm has reached a decision ('yes' or 'no') to begin utilizing the IOS SPI technology grouping. Deployment is a dichotomous variable and indicates whether a firm has actually implemented the IOS SPI technology grouping in an interorganizational system context. Assimilation is based on a modified version of the Guttman scale with seven levels of IOS SPI technology assimilation levels is used (0-unaware to 7-

general deployment). This use of assimilation levels is similar in structure to Fichman and Kemerer's work with software process innovations (Fichman 1997; Fichman 1999). There are also three descriptive measures of external diffusion that measure the extent of actual implementations of an SDO's IOS SPI solutions across shared business processes with external trading partners. All three external diffusion measures are similar in scope and nature to Massetti and Zmud's recommended diffusion measures (1996). Volume refers to the total number of instances (implementations) of the IOS SPI solutions. Diversity refers to the number of different (unique) IOS SPI solutions implemented. Breadth refers to the number of different trading partners.

Innovation Measures

Organizational Readiness

The organizational readiness construct considers attributes of the respondent firm. There are three measurement variables included in organizational readiness: top management support, feasibility (financial and technical readiness) and technology conversion. Consistent with Chatterjee's top management participation dimension, three activity-based items are used to assess this variable; the assignment of a champion, communication of support, and active participation in developing the vision and strategy for the new technology (2001)

Financial and technical feasibility are infrequently used measurement variables in innovation diffusion studies. Iacovou defines financial readiness as the 'financial resources available to pay for installation costs, implementation of any subsequent enhancements, and ongoing expenses during usage' (page 469). Technical readiness is referred to as 'the level of sophistication of IT usage and IT management in an organization' (page 469). The adequate financial and technical resources to develop, implement, and maintain a new technology is essential for the successful diffusion. Two survey items are used for each of these variables that request respondents to assess the firms financial and technical readiness of developing, implementing and maintaining the technology, as well as the resources to make work-flow changes to accommodate the new technology. Each item has a 7-point Likert scale ranging from strongly disagree (on the left) through strongly agree (on the right).

Technology conversion refers to the extent of older IOS solutions (e.g. EDI or EDI-like) installed in the firm, relative to extent of modern-day IOS solutions installed in the firm. Based on five categories of IOS solutions (manual-based, semi-automated, EDI or EDI-like, proprietary and Internet-based) respondents were asked to indicate the extent of their firms use of these solutions on a 5-point scale ranging from 0-for no use to 4- extensive use. For item loading purposes, the values were summed over the first four categories and the fifth category subtracted.

External Environment

Two environmental factors under consideration include competitive pressure and participation level in an SDO. Competitive pressure was found to be the most frequently tested and significant measurement variable in prior IOS diffusion studies. Competitive pressure is measured at the firm level and its use in this study is similar to that from Premkumar (1997). Competitive pressure is the respondent organizations perceived external influence from trading partners, the industry, and the firms potential for loosing their competitive advantage. Three perceptual based survey items utilizing 7-point Likert scale is used for competitive pressure. The second external environment variable, participation level in an SDO, is based on a logical combination of four types of interactions that could occur between an SDO and a firm. These interactions include the firms membership status in an SDO (dichotomous with 'member' or 'non-member'), the firms participation in the SDO's developmental efforts (dichotomous with 'yes' or 'no'), the firms user status of the SDO's IOS solutions (dichotomous with 'user' or 'non-user') and the firms projection of whether they will implement an IOS SPI in the next 12 months (on a 7-point Likert scale).

Technology Attributes
Three measurement variables are utilized to assess attributes of the specific technology in study: relative advantage, compatibility and attributes associated with the underlying shared business process. All items in the innovation attribute section of the survey are perceptual-based measures and that utilize a 7-point Likert scale ranging from strongly disagree (on the left) through strongly agree (on the right). The definition of relative advantage is the extent to which a potential adopting organization views the innovation as offering direct financial and operational benefits over previous ways of performing the same tasks. Relative advantage has been the most frequently tested variable in IOS diffusion models (in fact, in all innovation diffusion models (Rogers 1995) and the second most frequently found significant variable influencing diffusion of IOS technology. Examples of direct operational benefits include reduced cycle times, increased throughput capability, and increases in response times. Examples of direct financial benefits include increased inventory turnover, ROI, and enhanced payback as a direct result of implementing the standards. The compatibility variable is from three perspectives: compatibility of the innovation with the firms values and beliefs, compatibility of the innovation with the IS infrastructure and work procedure needs of the firm. Several diffusion scholars (Rogers 1995; Tornatzky 1982; Premkumar, et. al. 1994) have advocated differentiating between these types of compatibility measures. Three survey items are utilized based on definitions provided by Rogers (1995).

Shared business process attributes are characteristics associated with the underlying shared business process. Examples of these business process characteristics include transaction volume needs, timeliness of the exchange, effectiveness of the communications, accuracy and integrity needs, and collaboration levels between the participating firms. A single item with multiple characteristics is utilized on the survey instrument for this measurement variable. Due to the similarity in their meanings (and effects) the possibility of replacing (and / or combining) the relative advantage variable with the shared business process attributes will be examined. The pervasiveness of the relative advantage variable has been proven on a routine basis across multiple innovation diffusion studies. The chief complaint is the vagueness of relative advantage and its' lack of specificity towards understanding unique attributes that are driving a certain technologies adoption versus a different technology (Tornatzky 1982). Rather than setting out to prove something already known, an attempt will be made to develop a set of shared business process attributes that are 'generic' enough to span across multiple types of business processes, yet comprehensive enough to include the theoretical support for both relative advantage and shared business process attributes.

Standards Development Organization
The role of an SDO could have a profound impact on IOS diffusion. Three measurement variables are introduced in this research regarding SDO governance, SDO management practices, and attributes of the standards (architecture) from the SDO.

Management practices of the SDO seek to identify whether the organization's management is following certain activities or norms. These norms are based on critical success factors of an alliance organization as discovered by Rais (1996) and Whipple (2000). Examples of these critical alliance management practices include effective communications, a high level of trust between the alliance organization and partner firms, the ability of the alliance organization to meet performance expectations, active participation is equally encouraged from all partner organizations (no favoritism), as well as clearly stated and understood goals and objectives of the SDO. A single item with five characteristics is utilized on the survey instrument for this measurement variable. In addition, respondents are provided the opportunity to add further management practices that they anticipating to experience (or have experienced) with their participation in the consortium.

Characteristics of the SDO architecture associated include modularity levels, conduciveness to high collaboration levels, vendor neutrality of the SDO and accurate and thorough technical documentation. A single perceptual-based item with five characteristics is utilized on the survey instrument for this measurement variable.

RESULTS

The survey administration portion of this study concluded in August 2003. This section provides a summary of survey results (in entirety), including respondent demographics, results from testing the proposed hypotheses and consequence measures. The multiple logistics regression technique was chosen to test hypotheses #1 through #8. The dichotomous nature of the dependent variable(s), adoption versus non-adoption and deployment versus non-deployment, would have necessarily broken assumptions of multiple regression analysis. The benefit of logistic regression is its' flexibility and ability to accommodate dichotomous and scaled (intervals) responses. The logistic function predictor variables may be quantitative, qualitative, and may represent curvature or interaction effects (Neter 1996). Maximum likelihood estimates (MLE) was used to estimate parameters of the multiple logistic response function. Prior IOS diffusion researchers have utilized logistics regression in their innovation adoption models (Zhu, Kraemer, Xu 2002; Chau and Tam 1997). Proposition #9 will be tested based on the mix of results from hypotheses tests #1 through #8 and others qualitative findings from conducting the study.

Respondent Demographics

A cross-sectional firm level survey was conducted from May to August 2003 to empirically compare the conceptual model to a real work environment. Table #3 outlines the survey structure, item counts and hypothesized impact. The sampling frame included firms that are members of an SDO or a user of IOS SPI technology, or who are considering the possibility of either. The organizational title associated with the individual respondent from the firm has been Director of IT Standards, Assistant Director of IT Standards, CIO or a direct report to the CIO. In total, 979 firms were identified that fit the sampling profile. The candidate list was then reduced to exclude organizations that were developing SPI for intra-organizational purposes only, no longer in existence, or were individuals (as opposed to a firm). 590 surveys were distributed with a total of 102 ‘usable’ firm-level responses and 18 rejections received. An additional 34 firms indicated their willingness to respond to the survey but only provided partially completed responses (partial responses have been excluded). Multiple responses from a single firm were averaged (and considered as a single response). The overall effective response rate is 17.3%.

TABLE #4 - RESPONDENT FIRM DEMOGRAPHICS

COUNTRY OF ORIGIN		INDUSTRY		ORGANIZATION TYPE	
UNITED STATES	59	GEO-SPATIAL	17	MANUFACTURER	33
UK	12	ELECTRONIC COMP	17	GEO-SPATIAL SERVICES	11
TAWAIN	10	PETROLEUM	15	TECHNOLOGY PROVIDER	10
GERMANY	5	HUMAN RESOURCES	11	NP INDUSTRY INTEREST GROUP	9
CANADA	3	SEMI-CONDUCTOR	11	STAFFING SERVICES	8
SWITZERLAND	2	EDUCATION	8	EDUCATION	7
JAPAN	2	AUTOMOTIVE	8	ENERGY EXPLORATION	5
BELGIUM	2	PAPER	6	GOVERNMENTAL	4
NETHERLANDS	1	CHEMICAL	5	ENERGY PRODUCTION	4
AUSTRALIA	1	MARINE	3	DISTRIBUTOR	4
FRANCE	1	OTHER	1	PRINTING / PUBLISHING	4
IRELAND	1			AUTOMOTIVE RETAIL	3
SINGAPORE	1				
FINLAND	1				
DENMARK	1				
TOTAL	102	TOTAL	102	TOTAL	102

EMPLOYEE COUNT		TRADING PARTNERS		ANNUAL BUDGET (REVENUES)	
LESS THAN 25	14	LESS THAN 25	19	LESS THAN $1 million	12
25 ~ 99	11	25 ~ 49	5	$1M ~ $9 MILLION	10
100 ~ 499	13	50 ~ 74	4	$10M ~ $49 MILLION	10
500 ~ 999	9	75 ~ 99	2	$50M ~ $99 MILLION	4
1,000 ~ 4,999	13	100 ~ 149	4	$100m ~ $499 million	12
5,000 ~ 9,999	8	150 ~ 199	4	$500M ~ $999 MILLION	7
10,000 AND GREATER	34	200 ~ 250	21	$1 BILLION OR GREATER	44
		GREATER THAN 250	43	GOVERNMENT OR N/A	3
TOTAL	102	TOTAL	102	TOTAL	102

All candidate firms were provided the option to have the survey administered via (1) a paper copy through postal mail, (2) a digital copy through e-mail, or (3) a conference call interview. Of the 102 respondents, 3 chose the paper option, 67 chose the digital option and 32 chose the interview option. All survey questions were precisely the same (regardless of the option selected by the respondent) and the same individual conducted all interviews. Collectively, the firms originate from 14 different countries, represent 10 different industrial groups, and participate in 15 different SDOs. Overall, the firms could be classified into 12 different organizational types, ranging from manufacturers, distributors, energy exploration / production, printers / publishers, and a host of service orientated firms (staffing, governmental, geo-spatial, and automotive retail). See Table #4 for a summary of respondent firm demographics. Contrary to some other studies, responses from technology providers and non-profit industry interest groups were retained for analysis purposes (Chatterjee 2002). These types of organizations fit the sampling profile for this study. In addition, most of these firms are users, implementers, or (at a minimum) significant stakeholders with respect to the adoption and diffusion of IOS standards and solutions through out an industrial group.

Potential response bias was examined from three perspectives: completed surveys as percent of SDO members, non-responses as percent of surveys distributed and rejections as percent of SDO members. For larger SDO organizations (those with 75 members or more) ratios were amazingly consistent at the industrial group level and demonstrated no potential response, non-response or rejection bias. For smaller SDO organizations, ratios did significantly vary (up to a maximum of 51% of variation) with respect to three industrial groups. These variations were attributed to a low absolute count of participating members and the short time horizon since the inception of the industrial group's SDO. Overall, these results provided no significant reasons to justify further investigation into potential response, non-response or rejection bias.

Instrument Validation

Content validity was qualitatively assessed through three preliminary studies, two pre-tests, multiple reviews with IS faculty, Ph.D. students and guidance from survey development groups within the university. Content and construct validity were further qualitatively substantiated through a literature review conducted from 21 prior IOS diffusion publications, including a comprehensive coding of 101 previously used measurement variables across 6,092 samples. This resulted in the use of the organizational - innovation - environmental framework and provided a basis for deriving seven of the proposed measurement variables under examination. Consistent with Straub's recommendations, see Appendix B for a conceptual descriptions of constructs, measurement variables, survey items and item descriptions (1989). Reliability of the survey instrument's items were also quantitatively validated through calculating Cronbach alphas for each measurement variable. The alphas range from .70 to .77 and are itemized in Table #5 - Reliability of Factors. Although the Chronbach alphas are lower than Straub's (1989) .8 rule-of-thumb, they are greater than Nunnally's .6 threshold (Chau and Tam 1997). Due to the rich mix of survey items based on prior research and the introduction of new survey items pertaining to the role of the SDO, these levels are deemed appropriate for this context.

TABLE #5 - RELIABILITY OF FACTORS

		Cronbach Alpha
TopMan	3 items	0.710
Feasibility	4 items	0.734
CompPre	3 items	0.713
SDOPart	logical combination of 4 items)	0.728
RelAdv	2 items	0.714
Compab	3 items	0.700
ShareBus	4 items	0.746
ManaPra	5 items	0.724
Archit	5 items	0.722
Govern	3 items	0.713
TechConv	1 item (logical combination of 5 items)	0.769

Convergent validity and discriminant validity were also quantitatively assessed through factor analysis. Principle Components Analysis was conducted for all nine multi-item factors. Out of the 32 item loadings, all but three of the survey items loaded high (>.50 threshold) in their factors. Thus, demonstrating a good degree of convergent validity. The three exceptions are discussed and explained below

Straub defines convergent validity as "when the correlation of the same trait and varying methods is significantly different from zero and converges enough to warrant further investigation" (Straub 1989, pg. 151). Straub then distinguishes discriminant validity to be evidenced by "higher correlations of that trait and different traits using both the same and different methods" (Straub 1989, pg. 151). Discriminant validity was further quantitatively assessed using an item correlation matrix 'counting' technique outlined by Chau and Tam (1997). Generally speaking, validity is established by counting the number of higher correlations outside of an item's factor and then comparing the result with the total possible number of correlations. The general rule of thumb is discriminant validity is established if the above ratio is less than 50%. Out of the 560 total possible correlations, 220 (or 39%) experienced higher correlations outside of their own variable. Thus, these results outperform the general rule of 50% and provide partial support of discriminant validity. Further examination of this issue, as well as the Principle Component Analysis reveals the following. First, one third of the instances of these higher item correlations are associated with the Compatibility variable. Several prior IOS researchers have separated the compatibility variable between values of the firm versus the innovation (technological) compatibility. This study started under that premise until preliminary Principle Components Analysis results indicated that one of the compatibility items should be either be combined or act as a stand-alone measure. It was decided to combine the measures and avoid a single-item measure. The other two-thirds of instances of higher item correlations are associated with two of the new variables introduced in this study (SDO Management Practices and SDO Architecture). The SDO's role has become pivotal in coordinating the development and adoption of IOS SPI. Since this study is one of the first to provide framing of an SDO's role through-out an industrial group, it was decided to error on the side of too many items (as opposed to too few), to better enable research succession and progression in future studies. That is, as more studies are conducted utilizing SDO measures item phrasing, structuring, and content will evolve and improve discriminant validity. Tables #6 includes the descriptive statistics.

Table #6 - Descriptive Statistics

Variable	N	Mean	Std Dev	Min	Max
TopMan	102	5.16	1.53	1	7
Feasibility	102	5.64	0.97	2	7
CompPre	102	5.26	1.27	1	7
SDOPart	102	4.29	1.20	0	5
RelAdv	102	5.15	1.17	2	7
Compab	102	3.90	0.93	0	5
ShareBus	102	5.83	0.83	2	7
ManaPra	102	5.22	0.91	3	7
Archit	102	5.38	0.80	2	7
Govern	102	5.94	0.72	3	7
TechConv	102	1.42	0.67	-1	3
AnnSales	102	4.99	2.27	1	7

Modeling Structure

Two objectives of this study is to understand the significant antecedent conditions leading towards the adoption of IOS SPI technology and the deployment of IOS SPI solutions throughout an industrial group. Structuring the conceptual model (and analysis) in this two-staged fashion provides the ability to isolate the effects of the measurement variables on the two dependent variables (adoption versus deployment). As discussed in Survey Development, findings from preliminary work leading to this study indicate that the adoption decision (versus the deployment decision) may have a different mix of antecedent conditions. This approach is further substantiated by the notion of assimilation gaps. Assimilation gaps (large time differences between adopting a new technology versus actual deployment of the new technology across an organization) have been found to exist when a technology is susceptible to network externalities and knowledge barriers (Fichman 1999). The nature of interorganizational system standards is such that, if a firm's trading partners fail to mutually co-adopt the IOS standards, there are few benefits to be gained. Indeed, IOS SPI solutions are susceptible to increasing returns by a firm's immediate trading partners and the extended industrial group. A third reason for structuring the conceptual model in this fashion is that it enables enhanced understanding of an industrial coordination of interorganizational system standards (Johnston 2000). Using the same data and proposed independent variables, three models are constructed (altering the categorization of the dependent variable only) to measure IOS SPI diffusion from three perspectives (1) adopters versus non-adopters, (2) deployers versus non-deployers and (3) Assimilation. Two points should be noted. First, hypothesis tests were conducted regarding (1) adopters versus non-adopters and (2) deployers versus non-deployers only. Second, from a connotative perspective the use of the term 'model' seems more appropriate than the term 'scenario' for discussion purposes. Thus, the point will be re-emphasized that all three scenarios (or 'models' if you will) are based on precisely the same data set (survey responses) and proposed independent variables (the conceptual IOS SPI diffusion model). The only difference between the three models is the categorization of respondents along the technology assimilation scale (1) adopters versus non-adopters, (2) deployers versus non-deployers and (3) assimilation that entails four categories to be defined later. The following three sections provide statistical model results, hypotheses test results, and model fit assessments.

Determinants towards IOS SPI Adoption

The distinction between adopters and non-adopters of IOS SPI technology is based on responses to the 7-point technology assimilation scale (ranging from 1-Unaware, 2-Aware, 3-Interest, 4-Evaluation / Trial, 5-Commitment, 6-Limited Deployment, 7-General Deployment). Consistent with other definitions of adoption "that a decision has been reached to begin using an innovation" (Rogers 1995) responses of five, six or seven on the assimilation scale indicated that the firm adopted IOS SPI technology. No firms indicated their unawareness, rejection or discontinuance of the IOS SPI technology grouping. Non-adopters were based on responses of four, three or two. See Table #7 for respondent assimilation levels of IOS SPI technology results and definitions. Overall, there are 80 adopters, 22 non-adopters of IOS SPI technology and no firms indicating unawareness.

Since adoption versus non-adoption is a dichotomous categorization, multiple logistic regression is used where a binomial distribution is assumed. Maximum likelihood estimates (MLE) was used to estimate parameters of the multiple logistic response function. The first three columns (model #1) in Table #8 summarize the significant variables in distinguishing between adopters and non-adopters of IOS SPI technology (including the variable coefficients, Wald statistics and significance levels) based on the multiple logistics function. In distinguishing between adopters versus non-adopters the following measurement variables were found to be significant: Top Management Support, Feasibility, Technology Conversion, Competitive Pressure, Participation Level in an SDO, and Architecture. Thus fully supporting hypotheses #1 (organizational readiness attributes) and hypothesis #3 (external environment attributes), and providing partial support of hypothesis #5 (with respect to the positive direction and significance of architecture). Hypothesis #5 was only partially supported with respect to the negative direction and lack of significance of Governance, and the negative direction of SDO Management Practices. Hypothesis #7 is not supported due to the lack of significance of all innovation related attributes and the negative direction of relative advantage and shared business process attributes. See Figure #4 for a summary of hypothesis test results.

TABLE #7 - RESPONDENT ASSIMILIATION LEVELS OF IOS SPI TECHNOLOGY

							ASSIMILATION LEVELS				
	Assimilation Level	Definition	Adopters	Non-Adopters	Deployers	Non-Deployers	Non-Adopters	Adopter & Non-Deployer	Limited Deployer	General Deployer	Total
1	Unaware.	The firm is not aware of the interorganizational system SPI technologies described.		0		0	0				0
2	Awareness.	Key decision makers in the firm are aware of interorganizational system SPI concepts and capabilities.		8		8	8				8
3	Interest.	The firm is preparing plans to investigate any interorganizational system SPIs for possible production use within the next 12 months.		8		8	8				8
4	Evaluation / Trial.	The firm has purchased 'trial' capabilities and is currently evaluating possible uses of the technology.		6		6	6				6
5	Commitment.	The firm has specific plans and made formal commitments to utilize the technology in production in the next 12 months (or the near future).	22			22		22			22
6	Limited Deployment.	The firm has implemented SPI technology in at least three interorganizational systems.	30		30				30		30
7	General Deployment.	Interorganizational system SPI technology is now integrated in the majority of mission critical systems and in new systems development initiatives (where applicable).	28		28					28	28
TOTALS			80	22	58	44	22	22	30	28	102

Significance findings are based on the final (fitted) model which gives goodness of fit, maximum likelihood estimate (MLE) coefficients, Wald statistics and test results for the significant effects only (including main effects and interactions). The non-significant findings are based on the initial model that gives initial goodness of fit, MLE coefficients, Wald statistics and test results for all twelve measurement variables. Overall, the model fit was improved between the initial and final model (from an AIC of 71.64 to a final AIC of 57.34). The final model is significant at the .1212 level on a χ^2 distribution. Utilizing techniques outlined by Menard (1995) the percentage of explained variation (R^2_L) is .596. Based on the IOS diffusion literature search, the averaged explained variation in prior IOS diffusion models is .31. Thus this model's explained variation is nearly double the average from prior IOS diffusion studies. The reason is likely two-fold. First, an extensive literature search and meta-analysis of IOS adoption and diffusion studies was conducted for this study. As a direct result, six of the measurement variables and their associated survey items were utilized in this study. In addition, this resulted in the use of the organizational-environmental-technological framework in the conceptual IOS adoption and diffusion model. Second, as described in the research methodology, several preliminary studies and two pre-tests were conducted prior to launching the present study.

Table #8 - Determinants of IOS SPI Adoption & Diffusion

CONSTRUCT	**MODEL #1 - Adopters**			**MODEL #2 - Deployers**			**MODEL #3 - Assimiliation (Volume - 4 Categories)**		
Measurement Variable	Coefficient	Wald Statistic	Significance	Coefficient	Wald Statistic	Significance	Coefficient	Wald Statistic	Significance
ORGANIZATIONAL READINESS									
Top Management Support	0.849	4.959	0.026	n.s.	n.s.	n.s.	0.401	5.373	0.021
Feasibility (Fin & Tech)	1.450	6.193	0.013	0.859	5.943	0.015	0.673	5.689	0.017
Technology Conversion**	2.037	5.885	0.015	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
EXTERNAL ENVIRONMENT									
Competitive Pressure	6.004	5.648	0.018	2.168	3.445	0.064	2.698	5.759	0.016
Participation Level in an SDO	7.670	6.313	0.012	3.298	5.273	0.022	3.812	7.960	0.005
INNOVATION ATTRIBUTES									
Relative Advantage (Direct)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Compatibility (Innovation)	n.s.	n.s.	n.s.	7.496	6.242	0.013	3.974	5.448	0.020
Shared Business Process	n.s.	n.s.	n.s.	3.764	3.934	0.047	2.141	3.138	0.077
STANDARDS DEVELOP ORG (SDO)									
Management Practices**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Architecture**	1.674	5.652	0.017	0.957	5.096	0.024	0.657	4.235	0.040
Governance**	n.s.	n.s.	n.s.	-1.137	5.496	0.019	-1.049	7.473	0.006
CONTROL									
Size (Annual Budget)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
+ / - Industry	n.a.*	n.a.*	n.a.*	n.a.*	n.a.*	n.a.*	n.a.*	n.a.*	n.a.*
NON-SIGNIFICANT FINDINGS (INITIAL MODEL)									
Top Management Support	n.a.	n.a.	n.a.	0.517	0.229	0.632	n.a.	n.a.	n.a.
Technology Conversion	n.a.	n.a.	n.a.	-0.423	1.716	0.190	-0.192	0.289	0.591
Relative Advantage (Direct)	-17.010	2.047	0.153	-4.181	1.716	0.190	-1.563	0.660	0.416
Compatibility (Innovation)	2.502	0.047	0.828	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Shared Business Process	-11.585	2.461	0.117	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Management Practices	-12.284	0.949	0.330	0.325	0.005	0.945	5.551	2.443	0.118
Governance	-3.816	0.307	0.579	0.325	0.502	0.479	n.a.	n.a.	n.a.
Size (Annual Budget)	0.122	0.106	0.745	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MODEL FIT									
	AIC	Goodness of Fit		AIC	Goodness of Fit		AIC	Goodness of Fit	
		Dev / DF	Chi Squr / DF		Dev / DF	Chi Squr / DF		Dev / DF	Chi Squr / DF
INITIAL MODEL	71.64	0.38*	0.91	131.76	1.15	1.24	250.28	not reported	
FINAL MODEL	57.34	0.45	1.18	117.82	1.06	1.10	240.50	not reported	
FINAL MODEL SIGNIFIGANCE		df=91	0.1212 df=91		0.3195 df=92	0.2476 df=92			
R^2 L "% OF EXPLAINED VARIATION"			0.5960			0.2987			0.2361

Determinants towards IOS SPI Deployment

The distinction between deployers versus and non-deployers of IOS SPI is based on responses to the 7-point technology assimilation scale (ranging from 1-Unaware, 2-Aware, 3-Interest, 4-Evaluation / Trial, 5-Commitment, 6-Limited Deployment, 7-General Deployment). Distinguishing between deployers versus non-deployers is advocated in situations where significant assimilation gaps are likely to exist (Fichman 1999). As indicated in Table #7, deployers were respondents indicating six or seven on the assimilation scale (e.g. the respondents had actual implementations of the target technology in their firm), and non-deployers were respondents indicating five, four, three or two. Overall, there are 58 deployers, 44 non-deployers and no firms indicating unawareness of IOS SPI technology.

Similar to the adoption analysis, since deployment versus non-deployment is treated in this study as a dichotomous categorization, multiple logistic regression is used where a binomial distribution is assumed. The middle three columns (model #2) in Table #8 summarize the significant variables in distinguishing between deployers and non-deployers of IOS SPI technology (including the variable coefficients, Wald statistics and significance levels) based on the multiple logistics function. In making this distinction, feasibility, competitive pressure, participation level in an SDO, compatibility, shared business process, architecture and governance are the significant measurement variables (antecedent conditions) towards IOS SPI deployment. These findings provide limited support of hypothesis #2 (organizational readiness attributes) with respect to the positive direction and significance of feasibility, and full support of hypothesis #4 (external environment attributes). In addition, hypothesis #6 (SDO attributes) has limited support. The SDO architecture attribute is positive and significant, however governance was significant (but in a negative direction) and management practices was not significant. There is support of hypothesis #8 with two attributes of the innovation itself (compatibility and shared business process) that are significant and positive towards IOS SPI deployment. See Figure #4 for a summary of hypothesis test results.

Figure #4 Hypotheses Results

H1	Organizational Readiness attributes will have a positive (and significant) relationship with IOS SPI adoption.	Supported
H2	Organizational Readiness attributes will have a positive (and significant) relationship with IOS SPI deployment.	Partial Support (w.r.t. Feasibility)
H3	The external environment attributes will have a positive (and significant) relationship with IOS SPI adoption.	Supported
H4	The external environment attributes will have a positive relationship with the external deployment of IOS SPI. Participation levels in an SDO will have significant relationship towards IOS SPI deployment.	Supported (and Competitive Pressure is significant)
H5	SDO attributes will have a positive relationship with IOS SPI adoption. Governance and Architecture will also have a significant relationship towards IOS SPI adoption.	Partial Support (w.r.t. Architecture)
H6	SDO attributes will have a positive (and significant) relationship with IOS SPI deployment.	Partial Support (w.r.t. Architecture). Governance was significant, but negative
H7	Innovation attributes will have a positive relationship with IOS SPI adoption. Relative Advantage and / or Shared Business Process attributes will also have a significant relationship towards IOS SPI adoption.	Not Supported
H8	Innovation attributes will have a positive (and significant) relationship with IOS SPI deployment.	Partial Support (w.r.t. Compatability and SBP).
P9	A different set of significant attributes will be associated with IOS SPI adoption and IOS SPI deployment.	Supported

The significance findings are based on the final (fitted) model which gives goodness of fit, maximum likelihood estimate (MLE) coefficients, Wald statistics and test results for the significant effects only (including main effects and interactions). The non-significant findings are based on the initial model that gives initial goodness of fit, MLE coefficients, Wald statistics and test results for all twelve measurement variables. Overall, the model fit was improved between the initial and final model (from an AIC of 131.64 to a final AIC of 117.82). The final model is significant at the .2476 level on a χ^2 distribution. Utilizing techniques outlined by Menard (1995) the percentage of explained variation (R^2_L) is .2987. Based on the IOS diffusion literature search, the averaged explained variation in prior IOS diffusion models is .31. Thus the deployment versus non-deployment results are consistent with the explanatory power from prior IOS diffusion studies. The decline in explained variation, however, from model #1 to model #2 is substantial. The reason for this difference is likely two-fold. First, compared with a firm's decision to begin utilizing IOS SPI technology (adoption), most firms are merely on the brink of wide-scale diffusion of IOS SPI solutions. Thus, a richer empirical understanding of adoption determinants are available compared with deployment determinants. Second, the adoption decision is inherently more of a 'yes' or 'no' dichotomous event. Deployment, on the other hand, is more closely related to a measure of dispersion (e.g. diffusing IOS SPI solutions across trading partner and share business processes). A future research recommendation is to model IOS SPI diffusion as a continuos measure, as opposed to a dichotomous categorization.

With respect to the final proposition #9, these results demonstrate a different set of determinants can be attributed towards IOS SPI adoption versus deployment. Overall the findings indicate Organizational Readiness attributes are more important towards adoption than deployment. Specifically these attributes would include top management support and the firm's installed base of older IOS solutions (e.g. EDI or proprietary solutions). Often times the IOS SPI technology adoption decision is tightly coupled with the overall firm-level decision to join an SDO. In effect, this hightens the adoption decision to a larger issue of 'Which standards game will the firm choose to participate?' Based on these findings, once the adoption decision is made organizational attributes become less in the actual deployment of the technology. Second, the findings also indicate that innovation attributes are not important towards adoption, but are significantly related towards deployment. As will be discussed in the next section, this is an extremely insightful finding. This result contradicts most prior IOS diffusion studies where attributes of the technology itself (such as the direct operational benefits and compatibility) are important determinants of IOS diffusion. Thus, strong support of proposition #9 is demonstrated.

Determinants towards IOS SPI Assimilation

The distinction between assimilation levels of IOS SPI is based on responses to the 7-point technology assimilation scale (ranging from 1-Unaware, 2-Aware, 3-Interest, 4-Evaluation / Trial, 5-Commitment, 6-Limited Deployment, 7-General Deployment). As depicted on Table #7 responses are grouped into four categories; (1) Non-adopters were respondents who answered two, three, or four, (2) Adopters & Non-Deployers were respondents who answered five, (3) Limited Deployers were respondents who answered six and (4) General Deployers were respondents who answered seven. Distinguishing between deployers versus non-deployers is advocated in situations where significant assimilation gaps are likely to exist (Fichman 1999). The intent of the above categorization and modeling technique is to emulate the assimilation of IOS SPI (as opposed to treating it as a dichotomous categorization of deployment versus non-deployment). This is analogous to Massetti and Zmud's recommended diffusion measure of volume, which refers to the total number of instances (implementations) of the IOS SPI solutions (1996). Overall, there are 22 non-adopters, 22 adopters but non-deployers, 30 limited deployers and 28 general deployers of IOS SPI technology.

The final three columns (model #3) in Table #8 summarize the significant variables in distinguishing between assimilation categories of IOS SPI (including the variable coefficients, Wald statistics and significance levels) based on polytomous logistic regression (Neter 1996). With one exception, all of the significant variables in distinguishing assimilation levels are the same as those with distinguishing between deployers and non-deployers. The exception is Top management support, which became significant in the assimilation model.

The significance findings are based on the final (fitted) model which gives goodness of fit, maximum likelihood estimate (MLE) coefficients, Wald statistics and test results for the significant effects only (including main effects and interactions). The non-significant findings are based on the initial model that gives initial goodness of fit, MLE coefficients, Wald statistics and test results for all twelve measurement variables. Overall, the model fit was improved between the initial and final model (from an AIC of 250.28 to a final AIC of 240.5). The final model significance was not assessed due to the polytomous logistics regression SASv8 would not provide goodness of fit results. However, since this model is based on the same data as the two prior models (where confirmatory fit results were conducted) we can assume the fit is satisfactory. Utilizing techniques outlined by Menard (1995) the percentage of explained variation (R^2_L) is .2361. Compared with the averaged explained variation in prior IOS diffusion models of .31, this model's explained variation is less.

Control Variables

The control variable size was tested in all three models from three potential perspectives (sales or annual budget, trading partner count and employee count). From all three perspectives and in all three models, the size control variable is non-significant. Firm size was found significant in six prior IOS diffusion studies (primarily based on EDI or EDI-like technology) and non-significant in five. Traditionally, a firm's size has been considered a potential significant factor in IOS diffusion due to EDI's relative large up-front expenses. This no longer appears to the case with modern-day IOS solutions.

Second, attempts were made to incorporate an industry control variable into all three final logistics regression models. SASv8 reported convergence failures in every attempt. Convergence difficulties have been known to occur in multiple logistics regression during numerical search procedures for finding maximum likelihood coefficient estimates (Neter 1996). With satisfactory principle components analysis results, one remedy sought was to categorize the 10 industries into four higher-order industrial groups. The convergence errors remained, however, and the industry control variable was dropped. Based on discussions with statisticians, the convergence errors were likely due to the high number of significant predictor variables in relation to the sample size. Descriptive industry-based analysis and findings will provided in the discussion section.

Consequences of Diffusion

The far right side of Figure #3 - A Conceptual Model of the Adoption & Diffusion of IOS Standards and Process Innovations examines consequences of IOS SPI diffusion. This study examines the direct and indirect impact of adopting and deploying IOS standards. Overall, these results provide initial insights into the potential consequences on an industrial group as a result of deploying IOS standards. The effects are cumulative in nature and are tiered into 1st, 2nd, and 3rd ordered effects based on time since deployment. Respondents provided insights into 18 different anticipated industry consequences for the short-term (immediate), medium-term (next 1 to 2 years) and longer-term (next 3 to 4 years). Due to the proprietary nature of the survey items in the Consequences section, respondents were asked to assess consequences with respect to their industrial group (as opposed to a specific firm). 16 of the measures utilized a perception-based measure on a 5-point scale (ranging from 1 - significant decrease, 2 decrease, 3 - no change, 4 - increase and 5 - significant increase) for each time period. Two additional consequence measures (anticipated longevity of IOS standards and required annual return on investment (ROI) required to justify IOS SPI related expenditures) utilized 7-point scaled responses including the option of an Other category for specific responses. Table #9 - Industrial Group Consequence Trends of IOS SPI Diffusion (all respondents) provides a summary of the consequence measures. The response values in table #9 have been normalized (to a 0 scale), averaged and are cumulative over the three time periods. Thus, anything above 0 reflects a mean cumulative anticipated consequence increase, anything below 0 reflects a mean cumulative consequence decrease.

Overall the consequence trends on an industrial group are extremely favorable with respect to the adoption and diffusion of these innovations. As a starting base line, respondents indicated that a 14% annual ROI would be necessary to justify expenditures on IOS SPI technology and anticipate the longevity of IOS SPI standards to be at least 36 months (or greater). The majority of trends have fallen where one would hope they would fall (for proponents of diffusing IOS standards). The direct financial (e.g. ROI, firm profitability, payback) consequences and direct operational (improved response times and throughput capability) consequences of diffusing IOS standards are both positive and are anticipated to grow during the three time periods (with the operational benefits increasing at a significantly greater rate). The key source of these positive trends stem from reductions in IOS standards negotiation efforts with trading partners in time periods two and three (despite anticipated increases in employee training and infrastructure capital expenditures in all three time periods). It's interesting to note that no significant difference exist in the anticipated direct financial consequences of diffusing IOS standards across new trading partner versus implementing new IOS standards across the same trading partners. Thus it is anticipated that the learning curve associated with bringing on new trading partners, is very similar to that of diffusing new standards across the same trading partners. This has not been the experience of EDI diffusion and may lend insight into the potential reasons for the significant IOS standards grow projections.

Also indicated in Table #9 are numerous indirect benefits enabled from diffusing IOS technology standards. For example, improved loyalty with trading partners (including compliance improvements with trading partner mandates), enhanced revenue opportunities (or the attraction of new customers), lead-time improvements, and modest product / service cost reductions.

Table #9 - Industrial Group Consequence Trends of IOS SPI Diffusion

EXPECTED LONGEVITY OF IOS SPI STANDARDS * 35.7 months
REQUIRED ROI TO JUSTIFY IOS SPI EXPENDITURES * 14.2% per annum

	All Respondents (n=102)		
	Short Term	Mid Term	Long Term
	Immediate	1 ~ 2 Yrs	3 ~ 4 Yrs
Maximum Cumulative Absolute Value-->	+/-2	+/-4	+/-6
CONSEQUENCE MEASURES**			
DIRECT MEASURES			
Direct Operational Benefits***	+ 0.5	+ 1.4	+ 2.5
Direct Financial Benefits***	+ 0.1	+ 0.8	+ 1.9
With new trading partners (same standards)	+ 0.5	+ 1.4	+ 2.5
With new standards (same trading partners)	+ 0.4	+ 1.3	+ 2.3
With new trading partners and new standards	+ 0.5	+ 1.3	+ 2.3
Employee training expenditures	+ 0.7	+ 0.9	+ 0.5
Standards negotiation time & expenditures	+ 0.0	- 0.3	- 0.7
IOS Development time & expenditures	+ 0.5	+ 0.4	+ 0.1
IOS Implementation time & expenditures	+ 0.3	+ 0.1	- 0.5
INDIRECT MEASURES			
Trading Partner Loyalty	+ 0.5	+ 1.2	+ 1.9
Compliance w/ trading partner mandates	+ 0.6	+ 1.3	+ 2.0
Entry Barriers in Industry	+ 0.2	+ 0.2	+ 0.1
Revenue (or the attraction of new customers)	+ 0.4	+ 1.3	+ 2.2
Infrastructure Capital Expenditures	+ 0.7	+ 1.0	+ 1.0
Manufacturing Lead Times	+ 0.0	- 0.2	- 0.6
Cost of providing the firm's services / products	+ 0.1	- 0.2	- 0.8

NOTES:
* Weighted average based on scale responses (incl. specific responses in "Other" category)

IOS Diffusion Levels (S-curve)

Respondents in the study currently report having 4,732 IOS SPI solutions implemented (volume), consisting of 286 distinct message types (diversity), across 904 different trading partners (breadth). Respondents are hopeful of experiencing substantial growth in diffusion levels over the mid-term and longer-term time periods. For example, they are projecting a 53% increase in diversity, a 216% increase in breadth, and an overall volume increase of 240% of deployed IOS SPI solutions over the next 12 months (alone). In the following 12 months, respondents are projecting an additional increase of 36% in diversity, a 118% in breadth, and an overall volume increase of an additional 175%. Thus, in the next two years, respondents are expecting the volume of implemented IOS SPI solutions to reach a staggering 44,158 consisting of 595 message types (diversity) and 6,217 trading partners (breadth). If these projections are representative of what is occurring throughout industries (overall) we are on the verge of reaching a much steeper segment of the IOS SPI deployment (S-curve). That is, if we simply assume an average start date of early to mid-1999 for the majority of SDO IOS SPI development initiatives (which based on Table # 6 and the fact that the W3C did not formally approve XML until February 1998) this is a fair assumption. It has taken approximately 3 to 3.5 years to reach 4,732 implemented solutions. In the next two years (alone), this expected to increase to 44,158 implemented solutions (representing a 833% increase in volume). Even if these projections are off by 50%, IOS standards are on the verge of significant widespread diffusion from all three perspectives (volume, diversity and breadth). It's interesting to note that faster growth is expected across trading partners (breath) than with new message types (diversity).

	Current Installed	% Increases Next 12 Months	% Increases Following 12 Months	Projected Next 24 Months
Volume (count)	4,732	240%	175%	44,158
Diversity (message types)	286	53%	36%	595
Breadth (trading partners)	904	216%	118%	6,217

DISCUSSION

The discussion will begin with a brief framing and scope of the background (emerging key issues) confronting firms (and industrial groups) regarding modern day IOS SPI solutions. This will include discussions regarding IOS SPI deployment levels over the next 12 and 24 months (as projected by survey respondents), standards convergence challenges and the most critical unmet needs of firms participating in an SDO. The discussion will then turn to the specific results discovered in this study pertaining to IOS SPI adoption, deployment and assimilation. Proper perspective of these findings will be integrated into the discussion in light of the emerging issues. The section will then conclude with a discussion concerning industrial coordination of IOS SPI solutions, including profiles of firm-level assimilation and other industry analysis findings. Qualitative insights from respondents are included (where appropriate) and numerous recommendations to practitioners and researchers are provided throughout.

Background

One of the aims of this study is to develop a prescriptive set of influential measures that could assist practitioners and researchers alike in reaching this new era of interorganizational information sharing. Three critical issues confronting firms (and industrial groups) with respect to IOS SPI have emerged from this study: managing diffusion levels, horizontal convergence and resolving a voluminous pile of unmet needs of firms participating in an SDO. Briefly highlighting these issues at the outset of discussion will provide proper context and framing for the ensuing analysis and recommendations pertaining to IOS SPI diffusion and industrial coordination.

First, respondents to the survey reported as having 4,732 currently implemented IOS SPI solutions (volume). They are projecting this level to reach 44,158 implemented IOS SPI solutions (representing a 833% increase in volume) at the end of the next two years. In fact, many respondents indicated they have already begun incorporating the potential operational and financial benefits into their business plans and financial forecasts, respectively, despite the fact they do not know with whom or how they will reach these deployment levels. As one respondent indicated, "The economy is in recession, budgets are being slashed, and were looking for potential upside. We have to move on faith that we'll find <trading partners> folks willing to anti up." The second area of emerging issues is horizontal convergence of IOS standards. The core issue of convergence is how to leverage the work of industry-based SDO's (a.k.a. the verticals) into horizontal (cross-industry) sets of IOS standards. The key problem is the ability to find funding sources to support the cross-industry effort. Everyone understands the potential benefits, but technology providers are unwilling bear the cost due to the 'open-source' non-profit nature of the standards, larger organizations are slow to adopt due to their EDI installed base, leaving much of the burden on small to medium sized organizations. However, even these organizations are reluctant to fund horizontal convergence since the benefits of these cross-industry level of projects will only tangentially accrue to their operations. The third area of emerging issues is a voluminous pile of unmet needs of firms participating in an SDO. Based on an open-ended survey question regarding 'What services should be offered by your industry's SDO, but currently are not', the following are the top four responses. First, adoption and sustained diffusion assistance. That is, the SDO should provide additional services associated with convincing trading partners to adopt IOS SPI. Second, horizontal convergence assistance. That is, the SDO should insure the standards that are being developed will not ultimately have to be replaced, if a new set of IOS SPI standards emerge on a horizontal basis. Third, additional services associated with compliance and conformance testing. Fourth, the SDO should find ways to minimize the amount of standards versioning.

IOS SPI Adoption

In distinguishing between adopters versus non-adopters top management support, feasibility, technology conversion, competitive pressure, participation level in an SDO, and architecture were found to be significant determinants. The first noteworthy item is the lack of any attributes associated with the innovation itself (relative advantage, compatibility, shared business process attributes). For innovation diffusion scholars, this is a significant finding. Attributes such as relative advantage and compatibility have consistently been found to be two of the most significant determinants of adoption in prior research (Rogers 1995; Tornatzky 1982). An interpretation of this finding is as follows. The direct operational and financial benefits (e.g. cost reductions, enhanced response times) enabled by IOS SPI are not significant factors in distinguishing between adopters versus non-adopters. This finding contradicts the literature search in this study where relative advantage was the third most frequently significant variable towards IOS diffusion. This finding is not with out precedence as prior IOS diffusion studies did find a lack of significance of relative advantage (Premkumar 1997, 1994; Chau 1997; Grover 1993). Thus, in certain situations, other things must become more important in making the distinction between adopters and non-adopters. Since this study examined the use of IOS SPI technology strictly in an interorganizational system context, there are plenty of other things to consider. Such as those associated with the willingness of other organizations to adopt IOS standards (competitive pressure and participation levels in an SDO) and the role of the industry's SDO (architecture and governance). Perhaps the intrinsic benefits of IOS SPI technology innovations are mutually understood, that other things take precedence.

Second, attributes associated with Organizational Readiness (top management support, feasibility and technology conversion) were significantly related towards distinguishing between adopters versus non-adopters. Top Management Support is the second most consistently found significant variable in the literature search of IOS diffusion studies. The development of interorganizational system standards is a direct outward manifestation of the firm and their willingness to participate throughout an industrial group. This was evident by the typical level of respondents to the survey (CIOs, Director of Standards, or their immediate direct reports). Often times the IOS SPI technology adoption decision is tightly coupled with the overall firm-level decision to join an SDO. In effect, this hightens the adoption decision to a larger issue of 'Which standards game will the firm choose to participate?'. The significance of Feasibility is an extremely interesting find. Feasibility refers to the firms' technical sophistication to develop and make work flow changes to use IOS SPI technology, and their financial resources to purchase and maintain the technology. It is similar to the notion of readiness (Chwelos 2001; Iacovou 1995). The start-up costs associated with implementing an initial IOS SPI solution was around $100,000 in 2001 (Behrman 2002). The incremental cost thereafter was considered minimal and could be incurred on a piece-meal basis (e.g. an additional server or software license purchase as volumes necessitated). Firms now estimate this initial start-up cost to be less than $50,000 (and dropping). In fact, an emerging group of firms no longer associate these start-up costs with IOS SPI solutions with trading partners (per se), they are now simply considered initial investments associated with having an electronic transactional capability and presence via the public Internet and the web (a.k.a. "IT infrastructure upgrades"). The overwhelming feedback regarding feasibility from survey respondents is in respect to making work flow changes to accommodate the technology. Interorganizational system standards cut to the heart of firms' underlying shared business processes. To reap the potential benefits of modern-day IOS solutions they must comply with their industrial group's choreographed cross-company business processes and common semantics. This compliance has a cascading ripple effect throughout their backend applications and internal business processes. Technology conversion refers to the firm's installed based of older IOS solutions (e.g. EDI, semi-automated, proprietary solutions) compared to modern-day IOS SPI solutions. The interpretation of this finding is, the greater the installed based of older IOS solutions (compared with modern-day IOS solutions), greater the likelihood of IOS SPI adoption. This is the first known use of this type of variable in IOS diffusion studies.

Third, attributes associated with the external environment are significantly related towards distinguishing between adopters versus non-adopters. The external environment construct includes competitive pressure (from three respects - trading partners, the industry, and the expectations of market trends) and the firms participation level in an industry-based SDO. Although the significance of SDO participation level variable may appear to be a self-fulfilling finding (in light of this overall study), the aim of this brief discussion is to prove that it is not. In fact, this finding is consistent with findings from recent researchers (Teo 2003) and consistent with recommendations from other researchers (Reekers 1994; Grover 1994; Cavaye 1996). SDO participation levels can manifest in several ways. Some firms participate in the industrial groups' standards development process, but then fail to internally deploy the IOS standards. Some firms implement the IOS standards, but then fail to become a formal member of the SDO. Some firms choose to adopt IOS standards within the next 12 months, but then fail to participate in the SDO's standards development process. The significance of the SDO Participation Level finding is that in distinguishing between adopters versus non-adopters, the greater the levels of SDO participation (from all four respects enumerated above), the greater the levels of IOS SPI adoption. This is a clear recommendation to SDOs, to improve adoption of levels of IOS SPI technology, engage member firms involved with a rich diversity of participation alternatives (e.g. standards development efforts, membership, testing / evaluation, etc.). In fact, most respondent firms provided insights into services that their industrial groups' SDO is not currently providing, but should be. For example, respondents from the Electronics industry are seeking case studies (or white papers) regarding the business process reengineering associated with IOS SPI implementations (rather than just the technical-based case studies). Respondents in the geo-spatial industry are seeking permanent walk-in hosting labs, to allow potential IOS SPI users to 'kick the tires' at any time. Respondent firms from multiple industries are seeking improved compliance and conformance testing procedures to insure they (and their partners) are on the right track. The second highest point of feedback for additional SDO services is for SDO's to develop specific plans to for shifting their vertically focused standards to more horizontally based efforts (across multiple industrial groups). The point with these illustrations is not to further burden an SDO. Rather, a preeminent role of an SDO's management team is to manage, delegate and synchronize various standards development activities throughout the industrial group. Thus, the SDO management team should acknowledge these untapped needs, and delegate them members of the industrial group's community. The greater the number of participation touch-points, the greater the likelihood of IOS SPI adoption.

The competitive pressure variable in the external environment was also found to be significant in distinguishing between adopters and non-adopters. As evident by the fact that 75% of respondent firms are at limited deployment of IOS SPI technology assimilation (or lower), there is much hesitancy occurring in industry. Many firms are in wait-n-see mode, stuck in the "analysis paralysis" state. The competitive landscape is becoming extremely complex and the front lines of the battles are beginning to form. Technology vendors have just recently started offering price discounts to firms that implement utilizing the industries "predominant" SDO's IOS standards. SDO's must remain vendor-neutral and develop open-standards that are platform independent. Larger corporations (those that use to dominate an industrial group's technology standards) must weigh the sunk-cost of their EDI investments in proprietary IOS solutions, versus the greater diversity and larger breadth of access to trading partners across the entire industrial group that IOS SPI solutions enable. Small to medium sized organizations are perhaps in the best position. They are no longer confronted with expensive EDI investments and they have a much larger (and richer) quality of access to the entire industrial group. They can not afford, however, the time nor cost of reconfiguring back-end applications if the standards they elect to implement do not ultimately have the largest up-take.

Fourth, one attribute associated with the industry's SDO (architecture) was significantly related towards distinguishing between adopters versus non-adopters. The SDO's architecture includes items pertaining to the appropriateness of modularity levels (scope) of the IOS standards, the conduciveness of the standards towards interoperability between supply chain partners, the vendor neutrality of the SDO's standards, and the quality of the SDO's technical documentation. The fact that this variable is significant (with an extremely diverse mix of survey items) is a significant contribution from this study and to researchers. No known use of this variable could be found in the literature survey regarding IOS adoption.

IOS SPI Deployment & Diffusion (Volume)

The section's discussion will focus on differences between the determinants towards adoption versus deployment. As supported with proposition #9, the findings suggest a different mix of significant determinants is associated with each.

First, one organizational readiness attribute (feasibility) was significant in distinguishing between deployers and non-deployers of IOS SPI. All three organizational readiness attributes were significant towards adoption. The explanation is closely related to innovation attribute findings, where no innovation attributes were significant towards adoption, but two are significant towards deployment. This is consistent with earlier findings where the adoption decision is regarded as a higher order and more challenging decision. In light of the industry-focused nature of IOS SPI development, firms have a variety of SDOs to choose from. The selection of an SDO has a ripple effect throughout their entire organization (across shared business processes and trading partners). As firms progress from adoption to implementation, the types of decisions shift from "Whether the firm should adopt IOS SPI", towards "When do we implement the standards with trading partner X, for business process Y". Thus, the decisions become more finite and organizational attributes become less important and attributes associated with the technology become more important. It's interesting to note that an exception to this occurred in distinguishing between diffusion levels (model #3). Recall that model #3 classified respondents into four groups (non-adopters, adopters but non-deployers, light deployers and general deployers). Top management support was found to be significant in advancing a firm from one level to the next.

Second, shared business process attributes are significantly related towards deployment of IOS SPI. Modern-day IOS solutions are structured around shared business processes. SDOs coordinate work groups whose sole focus is to document consistent definitions, develop parameters and choreograph information flows, all of which are designed around cross company business processes. Some of these attributes include timeliness, data accuracy, communications effectiveness, data integrity, and collaboration levels. From a researcher's perspective, shared business process attributes have become pivotal in modern day IOS solutions and their role should be comprehended in future IOS diffusion studies. In the spirit of Tornatzky's criticisms regarding the generality of the relative advantage, initial objectives of this study was to ultimately combine relative advantage with the shared business process variable. With hopes of providing specificity towards the meaning of the direct operational and financial benefits enabled by the technology. However, based on the PCA results and the lack of significance of relative advantage, these two variables are distinct.

Third, two attributes associated with the industry's Standards Development Group (architecture and governance) are significant towards IOS SPI deployment. The SDO's architecture attribute was included in the adoption discussion. This variable includes items pertaining to modularity levels, the conduciveness of the standards towards interoperability, the vendor neutrality of the SDO's standards, and the quality of the SDO's technical documentation. Governance includes items related to the structure of the SDO such as its' non-profit status, its' scope and mission, and the perceived benefits provided to firms. No known use of the SDO architecture or governance variables was found in the literature survey. The survey items were constructed based on the preliminary work leading to this study, as well as critical success factors in the alliance literature survey. The implications of these findings to standards development organizations are numerous. First, architecture is significant towards adoption and deployment. Governance, on the other hand, is only significant towards deployment and the relationship is negative. Thus the interpretation, as counter intuitive as it may seem, reads the greater the governance, the less likelihood of deployment. Further examination into the qualitative feedback from the survey sheds light on this interpretation. Firms with the greatest IOS SPI assimilation levels are the same firms seeking the greatest number of services from an SDO. They often disagree with the SDO's mission and scope since they seek additional value-added services including development of innovative technologies or expanding the SDO's scope to operate as a creative "think-tank". Many of these General Deployer firms have ranked the perceived benefits of the SDO low, because of the firm's high expectations of the SDO.

Industrial Coordination

Categorization of Respondents (Profiles of Firm-Level Assimilation)

Based on an examination of assimilation levels, the industrial group trends analysis, and qualitative feedback from respondents a pattern is emerging with respect to firm-level IOS SPI technology assimilation. This pattern is briefly described here and in Tables #7 and #10. For purposes of this analysis, non-adopters of IOS SPI have been grouped into a single group referred to as Fence-Sitters. Indicating that these firms have IOS technology standards available to them (through their respective industry's SDO), and they have demonstrated awareness, interest or are conducting evaluations / trials regarding the technology, but currently have elected not to adopt (nor deploy them) in an interorganizational system context. This results in a categorization of respondents into four categories based on their technology assimilation level: (1) Fence-Sitters (Non-Adopters), (2) Commitment (Adopter, Non-Deployer),

(3) Light Users (Limited Deployment) and (4) Heavy Users (General Deployment). See Table #7 for assimilation levels of survey respondents. This categorization is similar to practices from prior IOS diffusion researchers (Grover 1993; Grover and Goslar 1993; Sabherwal and Vijayasarathy 1994 and others). In addition, this categorization is consistent with Fichman and Kemerer's recommendations where the likelihood for significant assimilation gaps exist (1999). The discussion within each group will include a summary of the group demographics, IOS SPI assimilation levels and key consequence measures. Based on results from the study and conceptual IOS SPI diffusion model, a prescriptive set of influential measures (managerial recommendations) that could be taken by the industrial groups SDO (or other members from the industrial group) to move a group further on the assimilation scale are also provided.

Fence-Sitters

The Fence-Sitters (non-adopters) are equally composed of small, medium and large sized organizations. The have the lowest expectation of ROI levels to justify IOS SPI expenditures, but also expect the greatest longevity of IOS SPI technology standards. They also have a relatively balanced installed based of older IOS solutions and more modern Internet-based IOS solutions. An analysis of the anticipated consequence results sheds light on the obstacles preventing fence-sitters from achieving greater assimilation levels. Fence-sitters have the lowest expectations regarding the direct financial and operational benefits of diffusing IOS standards. In addition, Fence-sitters have the lowest expectations regarding the indirect benefits from diffusing the IOS standards (lead times, product cost savings, and trading partner loyalty). If an industrial group wishes to encourage fence-sitters to get off the fence (a.k.a. adopt), these areas represent impressions that must be adjusted. Based on the adopter versus non-adopter conceptual model findings, the following are specific recommendations towards strategies to encourage adoption. Overall, the recommendation is to promote the SDO first, and the technology second.

- *Maximize the number of 'touch-points' between the Fence-sitter and the industry's SDO (e.g. participation levels in an SDO).* This study focused on several dimensions of this such as becoming a member in the SDO or participating in IOS SPI development activities. Developmental participation can be as simple as reviewing technical documentation, providing feedback on the industry-wide data dictionary (e.g. the use of business term and definitions) or simply attending the SDO's conferences and meetings. The point is not to burden the Fence-sitter, but rather to engage them in industry-wide cooperative initiative. Recall that the adoption decision has more to do with the industry-wide SDO initiative and less to do with the technology itself.

- *Promote the feasibility of adopting IOS SPI.* Fence-sitters may have a false impression that their organization lacks the financial or technical resources to begin utilizing IOS SPI. Manage these expectations and promote the benefits of SDO involvement; technology awareness, mutually shared R&D expenses, greater quality of access to potential suppliers and customers across their industry. Compared with developing these solutions 'in-house', SDOs offer an extremely valuable alternative. Recall the up-front expenses associated with IOS SPI are 50% of what they were two short years and are continuing to drop. Technology providers are beginning to offer discounts to firms engaged in an SDO and others are beginning to develop off the shelf solutions.

- *Engage support from the Fence-sitters top management*. Gathering support from lower level employees may provide a foot in the door, but it clearly will not close the deal. IOS SPI adoption has firm-level consequences with a breadth and scope that go well beyond lower level employees. The adoption decision has less to do with the innovation itself, and much more to do with the 'will the firm join the industry's IOS standards game'.

- *Adjust IOS SPI ROI and longevity expectations*. Ironically, Fence-sitters have the lowest ROI expectations of benefits enabled by the technology and also the greatest expected longevity of IOS SPI standards. Both of these impressions need to be managed and educated. The failure of many SDO's is to simply offer volumes of white-papers and case studies justifying IOS SPI implementations. Rather, they should supplement these case studies with the value that the SDO offers (e.g. mutually shared R&D expenses, greater quality of access to potential suppliers and customers in the industrial group, technology awareness). Again, when the issue is related to adoption, promote the SDO first and the IOS SPI second.

Table #10 - Profiles of Firm-Level Assimilation

	Fence-Sitters	Commitment	Light Users	Heavy Users
n=	22	22	30	28
DESCRIPTION	Demonstrated Interest in IOS SPI, but are non-adopters	Adopters, but Non-Users	Deployed IOS SPI technology in three or less IOS	Deploy IOS SPI in all major new systems development (where
FIRM SIZE	Balanced between Small, Med, Large Firms	Balanced between Small, Med, Large Firms	Large to Medium Sized Firms	Small to Medium Sized Firms
EXPECTED LONGEVITY OF IOS SPI STANDARDS *	45 or greater	27 or greater	36 or greater	33 or greater
REQUIRED ROI TO JUSTIFY IOS SPI EXPENDITURES *	8.9%	17.8%	14.2%	17.4%
EXISTING IOS SOLUTIONS INSTALLED BASE **				
Manual Solutions	Low	High	Moderate	Moderate
Semi-Automated	Low	Moderate	High	Moderate
EDI orEDI-Like	Moderate	High	High	Low
Other / Proprietary	Low	Moderate	Low	Low
Internet-Based	Moderate	Moderate	Low	High
OBSTACLES TOWARDS ADOPTION / DIFFUSION	Unaware of the industry-wide nature and benefits of the SDO Lowest expectations of Direct Operational Benefits Lowest expectations of Direct Financial Benefits	Lowest expected longevity of IOS standards Lowest expectations of indirect revenue growth / opportunities Greatest expected increases in IOS development & expenditures. Greatest expected increases in new infrastructure expenditures	Overcoming large EDI installed base The largest sized firms, Internal ripple effect of IOS standards cascades thru the organizaton. Avoidance of re-work. Reluctant to deploy new IOS standards, if uptake is not likely on a cross-industry (horizontal basis). Lack of resolutions to overcome horizontal convergence.	Very few obstacles. These small to medium sized firms are the market leaders of this technology.
PRESCRIPTIVE INFLUENTIAL MEASURES TOWARDS DIFFUSION	Promote the SDO first, and the technology second. Maximize the number of 'touch points' with the SDO. Promote the technical and financial 'feasibility' of utilzing IOS SPI Engage support from the fence-sitter's top management Adjust ROI and longevity expectations.	Promote the technology first, and the SDO second. Demonstrate the indirect benefits of deploying IOS SPI SDO outreach is crucial. Demonstrate infrastructure investments are associated w/ establishing a transactional presence via the Internet. Demonstrate the compatibility of the technology.	Demonstrate IOS SPI benefits on business process by business process basis. Emphasis the industry-wide benefits and network externalities. Engage the horizontal convergence issue. Manage the SDO governance issues (manage and meet expectations, stay focused, satisfy unmet demands).	Manage the SDO governance issues (manage and meet expectations, stay focused, satisfy unmet demands). Engage the Heavy users with outreach activities. Engage the horizontal convergence issue.

Commitment Group

The Commitment Group (Adopters but Non-Users) are equally composed of small, medium and large sized organizations. They also have a relatively balanced installed based of older IOS solutions and more modern Internet-based IOS solutions. Ironically, the commitment group has the highest ROI expectations to justify IOS SPI related expenditures, but also have the lowest longevity expectations regarding the IOS SPI technology standards. [It is noteworthy to point out that these measures are the opposite of the Fence-sitters.] This is challenging to explain since they also have the lowest expectations regarding increased revenue opportunities and the greatest anticipated expenditure increases associated with new IOS systems development, implementation and infrastructure expenditures. Based on the qualitative survey feedback, firms in the Commitment Group have experienced significant pressure from industry and trading partners to adopt. They have made the adoption decision, but just beginning to ramp-up their internal capabilities to accommodate the upcoming implementations. For the most part, they appear to be reluctant adopters, but are willing to give the innovations a chance. Firms in the commitment group do expect cost reductions through in IOS standards negotiation and product cost. Based on the deployment versus non-deployment conceptual model findings, the following are specific recommendations towards strategies to encourage deployment. Overall, the recommendation is to promote the technology first, and the SDO second. SDO outreach (and from fellow trading partners in the industrial group) is crucial throughout.

- *SDO outreach is crucial*. The Commitment group is experiencing the height of pressure (both internally and externally) with respect to their recent adoption decision. They have responded to industry pressures to 'play in their industry's standards game', but now must deliver the financial and operational benefits internally to their management. Support from their industry's SDO is crucial. This will maximize the touch-points, in addition to assisting new adopters through the pressures.

- *Promote the indirect benefits of deploying IOS SPI.* To supplement these internal pressures, the indirect benefits must be demonstrated. Indirect consequence measures include improved trading partner loyalty, enhanced revenue opportunities and greater quality of access to suppliers and potential customers.

- *Demonstrate their investments associated with becoming IOS SPI ready are broader than just their industry's SDO*. Based on qualitative feedback from the study, many high-end IOS SPI users are no longer associating the IT investments with a particular SDO or trading partner, but rather with their firms need to develop an overall on-line transactional presence over the Internet.

- *Demonstrate the compatibility of the technology.* Notions of compatibility stem from multiple perspectives, consistency with the firms future vision / needs of their IT infrastructure, values and beliefs, and workflows. In addition, the benefits associated with enhanced business process attributes such as timeliness, accuracy, data communications reliability and integrity need to be emphasized.

Light Users

The Light Users (Limited Deployment) represent the largest sized firms with the largest existing installed based of semi-automated and EDI-based IOS solutions. The Light Users may also be considered moderately coerced into IOS SPI adoption. They have the greatest expectations regarding increases in trading partner loyalty and compliance with trading partner mandates. Although these firms may not be the leaders in "pushing" IOS SPI solutions through out an industrial group, their size and bargaining power always makes them forces to contend with. They have huge sunk-cost investments in EDI and will be reluctant to sustain diffusion of IOS standards unless the benefits can be demonstrated directly to them. More importantly however, is the ripple effect of adopting new IOS standards throughout their backend applications and internal business processes. Based on survey feedback, these larger firms are willing to make the necessary work flow changes to accommodate IOS standards, but they will only do it once. Their chief concern is the ability for the vertically orientated IOS standards to gain momentum and uptake on a cross-industry (horizontal) basis. Clearly, large up-take reduces the likelihood of massive rework in the future. Although these larger organizations could hold the key towards wide-spread diffusion among an industrial group, most have currently avoided making widespread mandates. They have chosen rather, the "develop a little, implement a little" approach. Based on the diffusion conceptual model findings, and the qualitative feedback from the study, the following are specific recommendations towards strategies to encourage further diffusion.

- *Demonstrate IOS SPI benefits on process by process basis*. The large EDI installed base of Light Users is a significant hurdle to overcome. Many firms have developed techniques to utilize their existing IT infrastructure to accommodate EDI and IOS SPI. The key is to demonstrate IOS SPI on a business process by business process basis. Emphasize the improved compatibility and enhanced business process attributes (timeliness, through-put capability, and capacity).

- *Emphasize Industry-wide (scope and breadth) benefits*. Large firms will have the entire industrial group's perspective and interest as forefront. IOS SPI could enable the shift from a supply-chain versus a supply-chain perspective, to an entire industrial group versus industrial group. Highlight the network externalities and other indirect benefits. These benefits include substantial improvements indirect consequences (employee morale, trading partner loyalty). In addition to significant gains in collaboration levels, richer quality of access to small to medium sized organizations (including industry action groups, research centers, down-stream distributors and up-stream suppliers).

- *Engage the horizontal convergence issue.* The horizontal convergence issue has already been defined to be one of the largest hurdles to overcome with IOS SPI. This issue is paramount with larger firms. The ripple effect (and re-work) of modifying back-end work procedures and systems due to modifications in IOS standards could be devastating. SDO's must demonstrate their willingness to engage this issue at the shared business process (message) level. Keep abreast of solutions developed by other industrial groups and the higher order SDOs (if applicable). If a message is significantly different from another SDO's, then halt development. Investigate the differences, apply best practices and identify the risks of proceeding with development. Compare, contrast and communicate the differences. Encourage all voting members to make informed decisions. Absent the funding and resources to institutionalize cross-industry coordination, these techniques must be incorporated to avoid re-work and encourage sustained diffusion.

- *Manage the SDO governance issues*. The light users represent the largest size firms in the industry. Most SDO governance structures (non-profit, voluntary consensus, vendor neutrality) represent the antithesis of how larger organizations are accustomed to operating their business. With equal voting rights established in most SDO by-laws, Light Users may view their traditional 'size' power to be diminished. SDO's must keep these large firms engaged. Be responsive to the unmet needs (as discussed earlier), manage expectations and deliver when commitments are made.

Heavy Users

The General Deployment (Heavy Users) is the most experienced group of Firms with IOS SPI technology. These are small to medium-sized organizations with minimal EDI installations and already operate the majority of their IOS solutions over the web. Heavy Users have the greatest expectations of the direct operational and financial benefits enabled by IOS SPI technology. Heavy users are the drivers of this technology throughout their industrial groups. Sustaining diffusion from this group of firms will most likely not be a substantial problem. They are enjoying the benefits of being the most experienced and knowledgeable with respect to this technology. Based on the diffusion conceptual model findings, and the qualitative feedback from the study, the following are specific recommendations towards strategies to encourage further diffusion.

- *Manage the SDO governance issues.* An interesting finding from this research was the negative (and significant) correlation between IOS SPI diffusion and SDO governance.

Recall, SDO governance includes items such as the SDO's mission and objectives, non-profit status, and the perceived benefits of participating in the SDO. Thus, be responsive to the unmet needs (as discussed earlier), manage expectations and deliver when commitments are made.

- *Engage Heavy End Users for with SDO Outreach.* Several prior recommendations involved reaching out to firms lower on the technology assimilation scale. Enlisting the assistance of high end firms to assist with this outreach would be an excellent approach towards maximizing firm participation levels in an SDO and further engaging the high-end user base.
- *Engage the horizontal convergence issue.* Similar to the discussion with the Light Users, SDO engagement of the horizontal convergence issue will encourage sustained diffusion with the Heavy User group.

CONCLUSIONS

The landscape for a new era in interorganizational information sharing is firmly within our grasp. Cross-industrial coordination is important, but the adoption and diffusion of interorganizational system standards and process innovations is tantamount. A conceptual IOS SPI adoption and diffusion model was defined, supported and eight hypotheses and one proposition were tested. Based on a cross-sectional survey of 102 firms from 10 industrial groups representing 15 SDOs, the hypotheses were tested and results provided. The following conclusions have been reached.

First, Interorganizational system technology has been overhauled since the mid-90's. IOS solutions are now collaboratively developed, structured around discretely defined cross-company business process standards and able to be distributed via the web. Compared with EDI technology from the past, the notions of open standards code, modularity, scalability, and interorganizational business process reengineering have become embedded in modern-day IOS development. Second, these modern day IOS solutions can be referred to as interorganizational system standards and process innovations. IOS SPI are the enablers towards reaching a new era in interorganizational information sharing; the scope, depth and breadth of which have rarely been experienced at an industrial group level. Third, the role of an industry-based standards development organization has emerged as pivotal in coordinating the development and managing the adoption and diffusion of IOS SPI. An industry-based SDO's minimalists approach towards standards development enables them to be extremely responsive to market demands. Their non-profit, voluntary-consensus, vendor neutral structure places them in a unique and challenging position with their industrial group. Fourth, the determinants of IOS SPI diffusion change from adoption to deployment. The significant determinants of IOS SPI adoption are top management support, feasibility, technology conversion, competitive pressure, SDO participation level, and SDO architecture. The significant determinants of IOS SPI deployment are feasibility, competitive pressure, SDO participation level, compatibility, shared business processes, SDO architecture and SDO governance. Only two of these variables (competitive pressure and top management support) are consistent with the synthesized findings from prior IOS diffusion studies. Fifth, IOS SPI solutions deployment across industrial groups is merely on the brink of widespread diffusion. Respondents from this study anticipate astronomical growth projections (nearly 833%) over the next 24 months. Sixth, horizontal convergence is regarded as one of the primary inhibitors of IOS SPI adoption and diffusion. The underlying issues revolve around funding and coordination. Similar to the OASIS-RosettaNet-UCC model, industry based SDO's are positioned well to brake the stalemate. Seventh, the consequences of IOS SPI diffusion are extremely favorable. Respondents indicated an annual 14% ROI with longevity estimated at 36 months (or greater). The direct financial and operational consequences are positive and anticipated to grow during the three time periods (with operational benefits increasing at a significantly greater rate). The key source of these positive trends stem from reductions in standards negotiation efforts (in outer periods) and improved trading partner loyalty, enhanced revenue opportunities, the attraction of new customers, lead-time improvements, and modest product / service cost reductions. Finally, four profiles of firm-level IOS SPI assimilation were provided (fence-sitters, commitment, light users and heavy users). This categorization enabled the development of several prescriptive influential measures that could be taken my practitioners towards encouraging IOS SPI adoption and deployment.

Academic Contributions / Future Research Considerations

This study has provided several contributions and recommendations to the research community. First, a conceptual IOS SPI adoption and diffusion model was developed, hypothesized antecedent conditions were proposed and empirically tested based on a cross-sectional survey. The significant antecedent conditions leading towards adoption and deployment of IOS SPI were identified. Second, this study introduced, defined and tested four new measurement variables associated with IOS SPI diffusion (SDO governance, architecture, SDO management practices and Technology Conversion). Three of these variables (SDO governance, architecture and Technology Conversion) resulted in significant determinants towards IOS SPI diffusion.

Several recommendations to researchers for future considerations in the critical and emerging research frontier have been made throughout the discussion. First, begin lines of inquiry and analysis regarding horizontal convergence. This area presents a unique opportunity for researchers to provide specific recommendations or possibly to act in coordination roles. At a minimum, future IOS diffusion researchers should assess the SDO's (and their member firms) perceptions towards horizontal convergence. Are specific plans in place to manage horizontal convergence? Have they driven the plans down to a business process level? Second, future IOS diffusion studies should comprehend the role of the SDO and shared business process attributes. As was concluded in the study, both of these aspects are important in modern-day IOS standards development, adoption and deployment. Third, further examine the four new measurement variables introduced in this study (SDO governance, architecture, SDO management practices and Technology Conversion). Fourth, future IOS diffusion studies should comprehend standards versioning into their research design (potentially as a technology attribute). Based on the qualitative feedback from the study, versioning is an emerging issue in IOS standards development. Frequent versioning causes re-work to early adopters and carries a cascading re-work effect throughout backend applications and business processes.

Limitations

The limitations of this study are summarized as follows. First, the sampling frame was limited to industrial groups where an SDO existed. Efforts were made to identify an industry where an SDO did not exist, but the attempts failed. The sampling profile, however, did include a rich mix of industrial groups where the SDO was recently formed (less than six months) to several years since the SDO's inception. Second, consequence measures are descriptive only and respondents assessed consequence measures at the industry-effects level (as opposed to the respondent's firm). Based on pre-test results, respondents expressed concerns of sharing firm-level consequence measures (due to confidentiality clauses in work agreements) even on a confidential basis. Third, the organizational - environmental - innovation - SDO framework of the research design. Although a significant amount of up-front rigor and content validity activities were conducted to minimize this limitation, there could be more specific (firm level and industrial group level) contextual factors influencing IOS SPI adoption and deployment.

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APPENDIX A

IOS ADOPTION AND DIFFUSION LITERATURE SURVEY PUBLICATIONS

Code#	Reference	Year of Publication	Journal	Article Title	Type of Technology
1.0	Saunders and Clark	Winter 1992	*Information Resources Management Journal*	EDI Adoption and Implementation: A Focus on Interorganizational Linkages	EDI
2.0	Grover and Goslar	Summer 1993	*JMIS*	The Initiation, Adoption and Implementation of Telecommunications Technologies in U.S. Organizations	15 Distinct Telecommunication Technologies
3.0	Varun Grover	1993	*Decision Sciences*	An Empircally Derived Model for the Adoption of Customer-based Interorganizational Systems	Proprietary IOS systems with customer interfacing connectivity (inherently supplier dominant, since suppliers are developing systems for their customer connectivity)
4.0	Zaheer and Venkatraman	May-94	*Management Science*	Determinants of Electronic Integration in the Insurance Industry: An Empirical Test	Proprietary IOS systems based on ACORD - IVANS standards (insurance industry specific standards group).
5.0	Prekumar, Ramamurthy, Nilakanta	Fall 1994	*JMIS*	Implementation of Electronic Data Interchange: An Innovation Diffusion Perspective	Interorganizational Systems (EDI)
6.0	Reekers and Smithson	1994	*European Journal of Information Systems*	EDI In Germany and the UK: strategic and operational use	EDI
7.0	Sabherwal and Vijayasarathy	1994	*European Journal of Information Systems*	An Empirical investigation of the antecedents of telecommunication-based IOS	Telecommunication-based IOS (across 11 technologies: Mobile phones, ISDN, LAN, WAN, e-Mail, Fax, VideoConferencing, PBXs, Computer to computer)
8.0	Iacovou, Benbasat, and Dexter	Dec 1995	*MIS Quarterly*	Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology	EDI in Small Business
9.0	Premkumar and Ramamurthy	1995 (26:3)	*Decision Sciences*	The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of IOS	Interorganizational Systems (EDI)
10.0	Alm Cavaye	1996	*European Journal of Information Systems*	The Implementation of Customer Oriented Inter-Organizational Systems: an investigation from the sponsor's perspective	Customer Oriented IOS (e.g. ATM Networks, POS Systems, HHD)
11.0	Massetti and Zmud	Sep 1996	*MIS Quarterly*	Measuring the Extent of EDI Usage in Complex Organizations: Strategies and Illustrative Examples	EDI Usage in Complex Organizations
12.0	Prekumar, Ramamurthy, Crum	1997	*European Journal of Information Systems*	Determinants of EDI Adoption in the transportation industry	EDI IOS in Trucking Industry
13.0	Chau and Tam	1997	*MIS Quarterly*	Factors Affecting the Adoption of Open Systems: An Exploratory Study	Open Systems
14.0	Kettinger and Grover	1997	*Decision Sciences*	The Use of Computer-Mediated Communication in an Interorganizational Context	e-mail used for interorganizational settings
15.0	Crook and Kumar	1998	*Information & Management*	Electronic Data Interchange: A multi-industry investigation using grounded theory	EDI
16.0	Hart and Saunders	1998	*JMIS*	Emerging Electronic Partnerships: Antecedents and Dimensions of EDI Use from the Supplier's Perspective	EDI
17.0	Chwelos, Benbasat, Dexter	Sep 2001	*ISR*	Research Report: Empirical Test of an EDI Adoption Model	EDI
18.0	Sanjay Gosain	Dec 2001	*DIGIT Workshop 2001*	Web Technology Diffusion - Initial Adoption, Assimiliation and Network Prominence	Web Technologies
19.0	Chatterjee, Grewal, Sambamurthy	2002	*MIS Quarterly*	Shaping Up for E-Commerce: Institutional Enablers of the Organizational Assimiliation of Web Technologies	Web Technologies (e-Commerce Activities and Strategies)
20.0	Zhu, Kraemer, Xu	Dec 2002	*23rd ICIS Conference*	A Cross-Country Study of E-Business Adoption Using the Technology-Organization-Environment Framework	e-Commerce Technologies
21.0	Teo, Wei and Benbasat	March-03	*MIS Quarterly*	Predicting Intention to Adopt Interorganizational Linkages: An Institutional Perspective	Interorganizational Linkages (IOL), more specifically FEDI (Financial EDI)

APPENDIX B

Constructs, Measurement Variables, Survey Items, Item Descriptions

Construct	Measurement Variable	MV Code	Survey Items	Item Measure Description	Scale
ORGANIZATIONAL READINESS	Top Management Support	TopMan	4(a)	- Actively participate	7-point Likert (SD~SA)
			4(b)	- Assigned project champion	7-point Likert (SD~SA)
			4(c)	- Effectively communicates support	7-point Likert (SD~SA)
	Feasibility (Financial & Technical)	Feasibility	5(a)	- Technical sophistication to implement & maintain	7-point Likert (SD~SA)
			5(b)	- Technical sophistication to make work flow changes	7-point Likert (SD~SA)
			6(a)	- Financial resources to implement & maintain	7-point Likert (SD~SA)
			6(b)	- Financial resources to make work flow changes	7-point Likert (SD~SA)
	Technology Conversion Type	TechConv	Sum of D14(a~d)	- Extent of IOS solutions use (EDI, manual proprietary)	5-point (None to Extens)
			minus D14(e)	- Extent of IOS solutions use (Internet-based)	5-point (None to Extens)
INNOVATION ATTRIBUTES	Relative Advantage	RelAdv	11	- Direct operational benefits	7-point Likert (SD~SA)
			12	- Direct financial benefits	7-point Likert (SD~SA)
	Compatibility	Compab	3	- Required work procedure changes are consistent	7-point Likert (SD~SA)
			13	- Consistent w/ future vision of IS infrastructure	7-point Likert (SD~SA)
			14	- Compatible with existing IS infrastructure	7-point Likert (SD~SA)
	Shared Business Process Needs	ShareBus	15(b)	- Enhances timeliness	7-point Likert (SD~SA)
			15(c)	- Provide reliable data communications	7-point Likert (SD~SA)
			15(e)	- Improve data integrity	7-point Likert (SD~SA)
			15(f)	- Improve collaboration levels	7-point Likert (SD~SA)
EXTERNAL ENVIRONMENT	Competitive Pressure	CompPre	7	- Meet trading partner requirements	7-point Likert (SD~SA)
			8	- Industrial group pressure	7-point Likert (SD~SA)
			9	- Firm will loose competitive edge	7-point Likert (SD~SA)
	Participation Level in an SDO	SDOPart	17 + 18 + 19	- SDO member status, user status, development status	Dichotomous 'yes' / 'no'
			+ (2 * #24)	- Committed to implement IOS SPI next 12 months	7-point Likert (SD~SA)
STANDARDS DEVELOPMENT ORGANIZATION	Management Practices	ManaPra	28	- Open & honest communications	7-point Likert (SD~SA)
			29	- SDO meets performance expectations	7-point Likert (SD~SA)
			30	- Responsibilities are appropriately delegated	7-point Likert (SD~SA)
			31	- SDO's goals are well communicated	7-point Likert (SD~SA)
			32	- SDO is neutral w.r.t. to all member firms	7-point Likert (SD~SA)
	Architecture	Archit	34	- Modularity levels are appropriate	7-point Likert (SD~SA)
			35	- Technical standards are conducive to interoperability	7-point Likert (SD~SA)
			36	- Vendor neutral technical standards	7-point Likert (SD~SA)
			37	- Require minimal changes to business processes	7-point Likert (SD~SA)
			38	- Accurate and useful standards documentation	7-point Likert (SD~SA)
	Governance	Govern	21	- SDO's mission and objectives	7-point Likert (SD~SA)
			23	- An SDO should be a non-profit entity	7-point Likert (SD~SA)
			25	- SDO benefits are well understood	7-point Likert (SD~SA)