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2013

Xu, Y., Boh, W. F., & Soh, C. (2014). Vertical IS standards deployment and integration: A study of antecedents and benefits. *Information & Management*, 51(2), 206-216.

<https://hdl.handle.net/10356/101949>

<https://doi.org/10.1016/j.im.2013.11.009>

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# Vertical IS Standards Deployment and Integration: A Study of Antecedents and Benefits

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Article history:

Received 27 September 2010

Received in revised form 15 February 2012

Accepted 15 November 2013

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# **Vertical IS Standards Deployment and Integration: A Study of Antecedents and Benefits**

## **ABSTRACT**

We drew on institutional and learning theories to develop a research model assessing how organizations influence standards deployment and integration by creating institutional pressures and learning opportunities. We also examined how standards deployment and integration differentially influenced operational and strategic benefits. Survey data was collected from organizations in China who have implemented RosettaNet. Overall, the study extended research on standards adoption by examining how the learning perspective complemented institutional pressures, generating an integrated view of how pressures and learning from other organizations influence standards deployment and integration as important dimensions of standards use, as well as the benefits arising from their use.

Keywords: Inter-organizational systems, Standards consortia, IT diffusion and adoption, Institutional theory, Organizational learning

## 1. Introduction

The use of inter-organizational systems (IOS) can provide significant operational and strategic benefits to organizations. However, effective deployment of IOS across a global supply chain requires a set of standards that ensure interoperability and integration of both the hardware and software of partner organizations. Hence, companies in some industries have formed consortia to develop industry-specific open IOS standards, which have been termed vertical IS (VIS) standards [11, 26]. These are similar to Electronic Data Interchange standards in several ways: they are typically implemented in IOS and facilitate the exchange of structured transaction data by defining elements such as product identification, business document layout, and business process activities. They facilitate inter-organizational business activities and specify transfer, routing and security protocols. However, VIS standards differ in that they are XML-based open standards that were developed and promoted by industry consortia, such as the RosettaNet for high-tech industry, CIDX for the chemicals industry, MISMO for the mortgage industry, and ACORD for the insurance industry.

The adoption of VIS standards is unlike the adoption of technologies used only within an organization; they cannot be adopted and used unilaterally but require the cooperation of a firm's trading partners. Thus researchers have used a sociopolitical perspective to examine how other organizations influence a firm's VIS standards adoption decisions, focusing on the balance of power among trading partners. Institutional theory argues that organizations adopt practices and innovations, regardless of their technical value [24], in order to achieve greater legitimacy and status. Based on this, studies have found that external pressures on organizations were the major factor influencing IOS adoption [24].

However, an organization's knowledge and technical capability also influences their adoption decision. In the VIS standards context, where there is an industry consortium that actively promotes knowledge sharing among trading partners and members, the consortium

community provides opportunities for all parties to build and retain cooperative relationships and a trusting climate. This encourages the use of softer influence tactics, such as learning opportunities, rather than hard-line tactics such as pressuring organizations to adopt the standards. Such tactics encourage trading partners to obtain and adopt the knowledge and capabilities that allow effective use of the technology.

We therefore extended the prior sociopolitical research on IOS adoption, by complementing the institutional view with the learning perspective. We show that providing learning opportunities for trading partners and consortia members constitutes additional, alternative paths to successfully encouraging partner organizations to implement and use VIS standards.

Furthermore, we believed that institutional pressures and learning not only influence adoption, but also *how* organizations use VIS standards. Organizations have to determine the *extent* to which they will adopt VIS standards, in terms of the number of inter-organizational business processes they will automate [2], and the extent of integration with their backend systems and internal business processes [12, 16, 20]. We therefore identify deployment and integration as two distinct dimensions that characterize VIS standards use, allowing us to examine, in an integrated manner, how institutional pressures *and* learning from other organizations influence organizational decisions to deploy more standards, and invest in systems and business integration, as well as how these two dimensions of VIS standards use influence operational and strategic benefits.

## **2. Literature Review of IOS and VIS**

IOS are telecommunication-based IS shared by two or more trading partners. Industry-specific IOS standards were collaboratively developed and adopted by all companies in one industry supply chain. Therefore, the company will not have to deal with a different set of proprietary standards in the supply chain.

***Antecedents of VIS Standards Adoption.*** O'Callaghan et al. [13] found that the adoption of EDI was related to the perceived relative advantage of the technology and the level of compatibility with existing systems. In addition, the organizational and environmental context have been found to be important aspects in determining the effectiveness of the use of the standards. The organizational context (e.g., firm size, organizational readiness, financial resources, IT sophistication, top management support, etc.) reflects the specific characteristics of an organization that constrain or facilitate the adoption of the technology. The environmental context (e.g., business partner power, competitive pressure, government pressure, trust, support from the initiator, etc.) reflects the external influence on adoption that may come from the industry, competitors, trading partners, and the government.

As IOS standards migrated toward more open Internet-based standards, there arose communities of companies that actively share knowledge and gather to collaboratively set VIS standards. This highlighted the importance of emphasizing the social context in which the firm is situated [18]. Prior research on VIS standards recognized this and has emphasized a socio-political view of VIS standards adoption; for example, based on the relational view of the firm and institutional theory, Bala and Venkatesh argued that relational depth, relationship extendability, and institutional pressure were important for the successful adoption of VIS standards in organizations. The emphasis on standards consortia prompted Markus et al. to argue that the VIS standards development and its adoption/diffusion processes are interrelated problems of collective action. Consequently, a failure in their adoption could be due to insufficient attention having been paid to the negotiation phase in standards development. Likewise, Boh et al. [3] discussed strategies that consortia can adopt in strengthening the connection between standards development and their diffusion.

We therefore argue that this encourages the use of other influence tactics such as sharing knowledge through a variety of learning opportunities, rather than the focusing only on the

use of external pressure to adopt the VIS standards.

***Benefits of VIS Standards Adoption.*** Prior authors have examined the impacts of VIS standards. Recent literature suggests that the use of IOS could lead to benefits that include both operational efficiency from reduced inter-enterprise transaction processing times and costs [6, 12], and strategic value from knowledge creation, knowledge assimilation, and flexible supply chain relationship [5, 10]. Researchers have also begun to emphasize the relational improvement that can result from IOS implementations. For example, Subramani [22] differentiated two patterns of supply chain management systems use by suppliers (exploitation and exploration), which are associated with different relationship-specific investment in business processes and domain knowledge. These, in turn, enable suppliers to create value and retain a portion of the value created from the use of these systems in inter-firm relationships. VIS standards enable partners to gain insight into their environment, enriching each partner's perspective (enhanced bridging), and creating collective gain. Researchers have also started to examine how organizations can obtain such benefits. Wigand et al. noted that integration of companies' backend systems to the IOS is required to obtain operational benefits that can only be derived from straight-through processing.

With VIS standards defined for a broad range of business processes, organizations now also have to decide on the business processes for which VIS standards should be deployed, in addition to the extent of integration to backend systems and internal business processes. It is thus important to examine both the antecedents and benefits of the extent of deployment as well as the extent of systems and business integration.

Table 1 summarizes what has been found in terms of antecedents and benefits of VIS standards implementation.

**Table 1 Major literature on VIS standards implementation**

| Citation                | Research Context | Theory/<br>Framework/Factors   | Method     | Findings  |
|-------------------------|------------------|--|------------|---|
| Bala and Venkatesh 2007 | VIS standards    | Institutional theory,<br>Organizational inertia theory<br>Relational view of the firm, | Case study | Relational depth, relationship extendability, and normative pressure were important for dominant firms while relational specificity and influence mechanisms (coercive, mimetic, and normative pressures) were important for nondominant firms. Inertial mechanisms were important for both dominant and nondominant firms. |
| Markus et al. 2006      | VIS standards    | Collective action theory   | Case study | VIS standardization involves two linked collective action dilemmas — standards development and standards diffusion — with different characteristics. Successful VIS standards consortia must encompass heterogeneous groups of user organizations and IT vendors without fragmenting  |
| Zhao et al. 2007        | VIS standards    | Economics of standards   | Theory     | Firms' payoffs from standard adoption increase with the intrinsic value of the standard, but developers' benefits increase faster than passive adopters' benefits.  |
| Wigand et al. 2005      | VIS standards    | Industry Structure   | Case study | Lower costs and wider accessibility of XML-based standards can result in significant changes to the structure of the mortgage industry. However, the nature of industry change will depend on the specific ways in which standards are implemented by organizations in the industry   |
| Malhotra et al. 2007    | VIS standards    | Boundary-spanning mechanism  | Survey     | Collaborative information exchange between supply chain partners mediates the relationship between use of VIS standards and mutual adaptation and adaptive knowledge creation between supply chain partners.  |
| Gosain et al. 2007      | VIS standards    | Coordination theory  | Survey     | Modular design of interconnected processes and structured data connectivity are associated with higher supply chain flexibility, and deep coordination related knowledge is critical for supply chain flexibility.  |

As VIS standards are a relatively new phenomenon, we developed our research model by grounding ourselves (through interviews, industry consortia conferences, and industry publications) in the phenomenon, with RosettaNet as our research site. We then tested the research model using a survey

### 3. Research Context

RosettaNet ([www.rosettanet.org](http://www.rosettanet.org)) is a nonprofit industry consortium that aims to facilitate B2B e-commerce in high-tech industries (e.g., electronic components, semiconductor manufacturing, telecommunications). Since its founding in 1998, RosettaNet

has grown to a membership of nearly 3000 organizations and more than 25,000 Partner Connections. In 2002, RosettaNet merged with the Uniform Code Council (now GS1 US™). Today, it is organized into six industry sectors, each with its own council of key industry players. RosettaNet has one of the largest number of organizational members among all the supply chain standards consortia. Members include customers, suppliers, logistics providers, solution providers, financial institutions, industry associations, and government agencies. Its headquarters are in the United States (RosettaNet Global), and there are affiliate offices in Asia and Europe for standards diffusion.

The corner stone of the RosettaNet standard is the Partner Interface Processes (PIPs). PIPs specify the processes and associated business documents for data exchange. RosettaNet also provides implementation frameworks, which specify both the business meaning behind each data element, and technical details such as the use of certificates for message authentication. All interactions and activities are defined. Many vendors, such as BEA and Microsoft, provide support for the implementation framework of RosettaNet.

Our study builds on a three-year involvement with the RosettaNet consortium. To gain an understanding of RosettaNet, we conducted 1 to 1.5 hour face-to-face and telephone interviews with 30 key executives (seven RosettaNet regional directors, eight RosettaNet global staff and fifteen IT or business managers of companies who had implemented RosettaNet standards). We also attended several RosettaNet industry conferences where consortia members shared their knowledge of their implementations and functionality.

#### **4. Theoretical Framework, Hypotheses, and Research Model**

We characterize the use of VIS standards in terms of the breadth and depth of its use: (1) deployment, representing the breadth dimension, referred to the range of inter-organizational business processes that the VIS standards automated; and (2) integration, represented the depth dimension, referred to the extent to which organizations integrate VIS

standards to the back-end system and internal business processes of an organization.

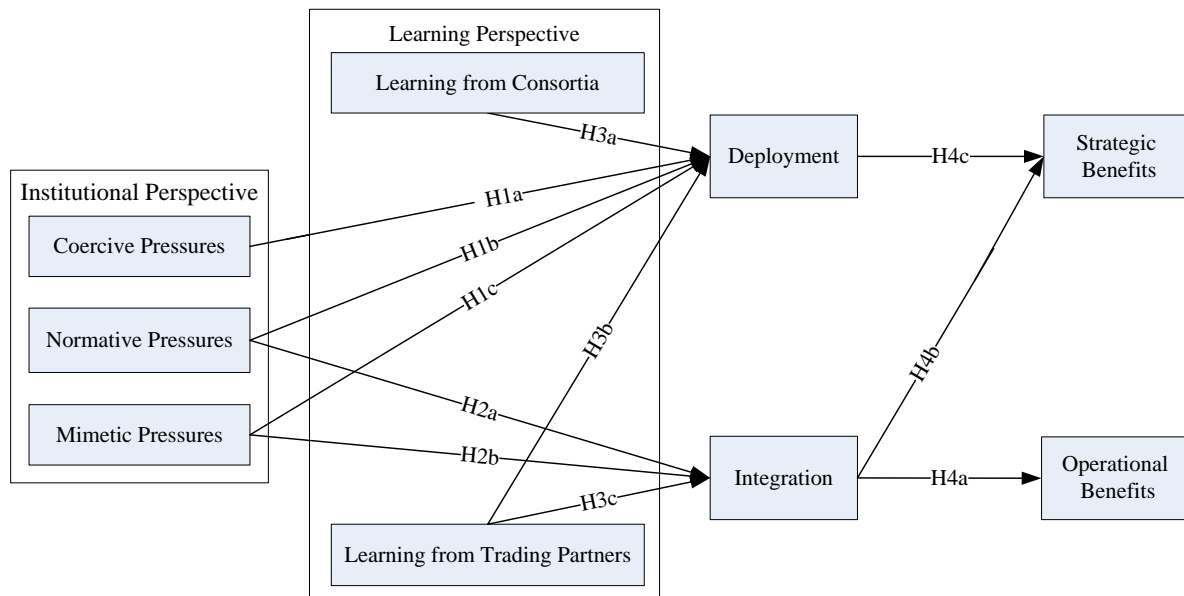
***Extent of VIS Standards Deployment.*** VIS standards have been defined for a broad range of activities between business partners. RosettaNet standards were classified into seven major clusters: order, payment, manufacturing, logistics, design, forecast, and demand creation. Such standards support transactions for a particular business process. For example, VIS standards for order management support quotation requests, quotation receipt acknowledgments, stock availability inquiries, and order status inquiries. Organizations usually initially deploy only a few transactions: automating existing methods of doing business. As organizations become more familiar with the VIS standards, they often expand their deployment of VIS standards. As one interviewee said: *“The first PIP went through the gateway of Gridnode (A solution provider), our IT team learned from them in the initial implementation. After that, we gained in-house experience of implementing RosettaNet, we saw its benefits and knew how we could replicate the use of other PIPs with suppliers or customers.* At this stage, organizations typically deploy VIS standards for more complex and collaborative business processes. Hence, VIS standards deployment is defined as the range of business processes supported by VIS standards in the value chain.

***Extent of Systems and Business Integration.*** VIS standards are typically implemented in an IOS, which may or may not be integrated to the back-end ERP system of the organization. Organizations have a choice of the extent to which they wish to invest in integrating the VIS standards-based IOS to their internal system and process. VIS standards are developed only for the interfacing interactions among trading partners, not for firm-specific internal processes. A RosettaNet country director explained: *“This is where we draw the line, companies can get service providers to provide knowledge and consultancy services for integrating internal processes”*. Hence, though VIS standards can enable seamless interconnection among business partners, organizations make their own choice of the level of

systems and business integration. *Business integration* is the extent to which business processes have been streamlined to allow seamless flow of information and events between trading partners.

The next few sections present our hypotheses, which are summarized in Figure 1.

**Figure 1. Our Research Model**



#### 4.1 Influence of Institutional Pressures on Standards Deployment

Drawing on institutional theory, studies have found organizations' IOS adoption decisions to be influenced by coercive, mimetic and normative pressures [24].

**Coercive Pressures** arise from regulations, rules, or the influence of a powerful manager. Coercive pressures from trading partners have been found to influence organizations' IOS adoption decisions. In the case of VIS standards, major players in the industry (e.g. major buyers such as Intel and Sony for RosettaNet, major lenders in the Mortgage industry such as Countrywide Home Loans and Wells Fargo) are often the main advocates of VIS standards. They have the resources and power to align the standards consortium's objectives with their interests, and they would thus be the ones who exert coercive pressures on their trading partners to adopt the VIS standards [3]. Our interviewees indicated that organizations decided to adopt RosettaNet standards because they were told to

do so by their customers. One interviewee said that the message from their customers was “*If you don’t implement the standards, you don’t get our orders*”. We thus hypothesized:

**H1a:** Coercive pressures are positively related to VIS standards deployment.

**Normative Pressures** stem from shared norms and values among members of a network, and they influence standards deployment in several ways. First, deployment of technology by other members of a community sends a strong message that they should also deploy the technology [8, 23]. Second, as an organization builds relationships with other organizations, they establish values norms, and beliefs about actions needed to contribute to the development of the community [21]. Organizations thus feel pressures to deploy VIS standards, to help their community become fully interoperable throughout their supply chain. We thus hypothesized:

**H1b:** Normative pressures are positively related to VIS standards deployment.

**Mimetic Pressures** arise from uncertainty about appropriate behavior that causes modeling after similar organizations such as key competitors. When organizations observe that other organizations are deploying VIS standards, they feel compelled to mimic other organizations, to “avoid being perceived as technologically less advanced and as less suitable trading partners than their competitors” [24]. As noted by an interviewee: “*If your competitors have the capability to use RosettaNet standards and you don’t, then you must make it available to your customers.*” We thus hypothesized:

**H1c:** Mimetic pressures are positively related to VIS standards deployment.

## **4.2 Influence of Institutional Pressures on Standards Integration**

The decision to integrate the VIS standards-based IOS to internal back-end systems and streamline business processes requires significantly greater commitment of resources than the decision to simply deploy a VIS standards-based IOS. Integration requires the support of senior management, and the availability of appropriate resources and expertise.

Hence, we argue that a firm must view VIS standards as valuable and be committed to the integration of VIS standards, in order to achieve integration.

The decision to invest in systems and business integration requires an understanding of the benefits of using the standards and willingness to commit resources for the effort. Therefore, managers who succumb to coercive pressures to deploy VIS standards are not necessarily expected to expend effort for systems and business integration.

***Normative Pressures.*** Standards consortia provide opportunities for firms to establish multiple inter-firm linkages and create a network where information is shared about how VIS standards are used and how benefits are derived. Through activities such as informal discussions, formal presentations that share success stories, and participation in technical working groups and committees, members are reminded of the benefits of systems and business integration. Thus, we hypothesized:

***H2a:*** Normative pressures are positively related to VIS standards integration.

***Mimetic Pressures*** occur in two ways: (1) technology adoption among competitors and (2) the perceived success of such competitors. When organizations observe that successful competitors gain benefits from using VIS standards through investing in systems and business integration, the inherent uncertainty in using VIS standards cause firms to mimic the actions of their successful peers. Mimicking success may reduce search and experimentation costs, or avoid the risks of first-movers. Firms typically practice benchmarking of business benefits from IT use against those derived by their peer organizations [9]. Hence, we hypothesized:

***H2b:*** Mimetic pressures are positively related to VIS standards integration.

#### **4.3 Influence of Learning from Trading Partners and Consortia Members**

As organizations learn more about the standards and the associated benefits [1], they understand the potential impacts and challenges of adopting and implementing the technology.

By learning from other members of the standards consortium, organizations become cognizant of the costs and benefits of using the standards, and the challenges of implementing the technology. It is therefore important to examine what role learning plays in influencing organizations' adoption decisions.

***Learning from Standards Consortium Members.*** The consortia provide opportunities for firms to establish multiple inter-firm linkages and create a knowledge sharing network, offering access to specialized knowledge. Standards consortia involve diverse industries that span the entire value chain. RosettaNet has offices in ten countries in Asia and Europe. Such global reach presents organizations with access to knowledge from a wide variety of international sources.

What members of the consortium provide to other members is information that the firm is prepared to reveal in the public domain [25]. Learning from standards consortium members provides an efficient way to help organizations understand the VIS standards, and what they achieve, thus diminishing the uncertainties they face [17]. We therefore hypothesized:

***H3a:*** Learning from other members of the standards consortium is positively related to VIS standards deployment.

***Learning from Trading Partners.*** While learning from other members of the standards consortia provides opportunities for organizations to access a diverse array of knowledge resources, we expect such learning opportunities to have limited impact on helping an organization to improve its readiness and capabilities for business and systems integration. Prior literature shows that weak ties and strong ties are beneficial for knowledge sharing in different ways. Weak ties are helpful for the diffusion of ideas [19] and the search for publicly available information [25]. Strong ties are characterized by high level of trust, which results in greater willingness by parties to divulge private, idiosyncratic information about a firm [25].

Studies have also shown that strong ties are associated with the expenditure of effort to ensure that a knowledge seeker understands and can put into use newly acquired knowledge [7]. We propose that learning from other members of standards consortia is akin to learning from an organization's weak ties, whereas learning from one's trading partners is similar to learning from an organization's strong ties.

The task of integrating the back-end systems to the IOS, and changing internal business processes is a complex endeavor. Given the complexity of knowledge required, we proposed that only close and frequent interactions with trusted partners would achieve good integration capabilities. Trading partners with whom organizations are implementing VIS standards represent strong tie relationships, as there are significant amounts of relationship-specific investments made toward sustaining the relationship.

Interactions with close trading partners often include formal and informal, face-to-face meetings and in-depth conversations. Through such repeated interactions, firm representatives develop ties that increase the level of trust, fine-grained information exchange, and joint problem-solving efforts. This enables organizations to learn about not only the benefits of deploying VIS standards, but also how they can increase systems and business integration. An interviewee stated that *"During the implementation, we formed a project team to work through project implementation issues. It helped us to get the system implemented and integrated smoothly. If the customer had just given us the requirements and not helped us with the details, I think the process would have been a lot more difficult for us."* We thus hypothesized:

**H3b:** Learning from trading partners is positively related to VIS standards deployment

**H3c:** Learning from trading partners is positively related to VIS standards integration.

#### **4.4 Benefits of VIS Standards Deployment and Integration**

Prior research identified two types of benefits from IOS use: operational benefits and strategic benefits. Operational benefits include lower transaction and production costs from

quicker response time, inventory cost saving, greater data accuracy, and reduced clerical work. In contrast, strategic benefits arise from opportunities for closer collaboration and cooperation with trading partners due to tighter linkages arising from IOS implementation. These opportunities include the development of new products and services, better relationship management, and new forms of inter-organizational collaboration.

Operational benefits from VIS standards use can only be realized by companies that modify their internal business processes and invest in systems and business integration. Hence,

***H4a:*** A higher extent of VIS standards integration is associated with greater operational benefits from implementing VIS standards.

Organizations can also gain strategic benefits from greater VIS standards integration. Establishing systems and business integration requires organizations to work closely with their trading partners [4, 14]. The organizations develop a detailed understanding of their trading partner's practices, which provide them with the knowledge and expertise to solve unstructured and difficult problems that may arise. We therefore hypothesized:

***H4b:*** A higher extent of VIS standards integration is associated with greater strategic benefits from implementing VIS standards.

Companies who are willing to invest in a large array of standards signal their commitment to their customers and reap the strategic benefits of the investment through better customer ties and relationships. The extension of VIS standards to a wider range of business processes enable organizations to create an all-encompassing, relationally complex partnership with their trading partners which generates long-term strategic benefits. An interviewee noted that his company gave more business to suppliers who used RosettaNet standards. Hence, we hypothesized that:

***H4c:*** A higher extent of VIS standards deployment is associated with greater strategic benefits from implementing VIS standards.

## 5. Research Methodology

To test our hypotheses, we conducted a survey of organizations that have adopted RosettaNet PIPs. Based on insights from our interviews and prior literature, we generated a survey and reviewed the questionnaire with some RosettaNet executives and users to examine the face validity of the items. The questionnaire was then translated into Chinese using a forward-backward translation method by independent translators, after which, the translated English questionnaire was compared to the original version to detect and correct any discrepancies.

We then distributed the survey through two channels. First, the China Association for Standardization (consisting of organizations and individuals engaged in voluntary standardization on a nation-wide basis) helped us to identify key RosettaNet champions in each enterprise, and we emailed our survey to them in August 2011. Second, hard copy questionnaires were given to participants in two RosettaNet related conferences in China in September 2011 (The International Conference on E-Business System and Education Technology” and “The China Conference of the Application and Standards of The Internet of Things”). These conferences were attended by organizations who were interested in or already implementing supply chain standards. In order to identify RosettaNet users, the first author sat at the registration counter and asked each participant whether his/her company used RosettaNet standards. A hard copy questionnaire was given to participants, along with a pre-stamped return envelope and a small gift.

All respondents were asked to obtain the relevant information for each section of the survey from the manager most likely to provide accurate responses. We randomly called 20 organizations to double check on the process and found that it was adopted for all the organizations we called. The completed surveys were returned to us either by email or by prepaid mail. Of the 518 questionnaires distributed, we obtained 194 responses; 186

questionnaires were usable for data analysis (an effective response rate of 36%).

We emailed or called 30 random non-respondents to obtain information about their industry, revenue, and number of employees. We assessed non-response bias by comparing these attributes for the responding companies' and this random sample of non-respondents and we found no significant differences ( $p > 0.05$ ).

## 5.1 Operationalization of Constructs

We identified the appropriate measures for the constructs by using scales previously validated in the literature, with some adaptations to the VIS standards context. The definition of the constructs and the source of the items are shown in Table 2 (Measures are shown in Appendix A). As prior studies on IOS and VIS standards have not measured learning from other organizations, measures for these constructs were not readily available. In order to generate measures for this construct, we coded the transcripts of the preliminary interviews to identify the strategies adopted by RosettaNet to encourage the adoption of the standards, and the inter-organizational routines in which supplier organizations and customers engaged. We then compared the items derived from the interviews to the list of strategies and routines obtained by a comprehensive search of the literature in marketing, strategy, and technology adoption. RosettaNet directors were then consulted about the comprehensiveness of the items identified through this process.

**Table 2. Construct Definitions and Operationalizations**

| Research construct       | Definition  | Origin of item scales                       | Cronbach Alpha |
|--------------------------|---|---|----------------|
| Strategic benefits       | The outcomes that result when firms take advantage of opportunities arising from relationships with their trading partners, including the development of new products and services, a richer understanding of the partner, and the ability to sense and respond to changes in the relationship. | Subramani [22], Zhu and Kraemer [28]        | 0.894          |
| Operational benefits     | The benefits arising from efficiency improvements, such as reduction in cycle time, inventory cost and operating costs, as well as increases in productivity and information accuracy.  | Subramani [22], Zhu and Kraemer [28]        | 0.931          |
| VIS standards deployment | The range of business processes supported by VIS standards in the value chain.  | Conceptualization based on field interviews | N.A.           |

| Research construct                | Definition  | Origin of item scales                       | Cronbach Alpha |
|-----------------------------------|---|---|----------------|
| VIS standards integration         | Second order formative construct made up of the following reflective constructs:<br>1. Systems integration: The extent to which the IOS is integrated with back-end application systems by implementing VIS standards.<br>2. Business integration: The extent to which business processes have been re-engineered to enable the seamless flow of information and events between trading partners. |   | 0.824<br>0.875 |
| Coercive pressures                | The perceived extent of formal and informal pressures from dominant trading partners  | Teo et al. [24]                             | 0.846          |
| Normative pressures               | The perceived extent to which organizations are influenced by the views of other members of the standards consortia   | Teo et al. [24]<br>Liang et al. [9]         | 0.807          |
| Mimetic pressures                 | The perceived extent to which competitors have adopted VIS standards and have benefited from using the standards. (formative measures)  | Teo et al. [24]                             | N.A.           |
| Learning from trading partners    | The extent to which organizations participate in and learn from the activities organized by the trading partners. (formative measures)  | Conceptualization based on field interviews | N.A.           |
| Learning from standards consortia | The extent to which organizations participate in and learn from the activities organized by the standards consortium. (formative measures)  | Conceptualization based on field interviews | N.A.           |
| Firm size                         | Sales revenue and no. of employees  | Zhu and Kraemer [28]                        | 0.930          |
| Experience                        | Experience in VIS standards and experience in EDI   |   | 0.882          |
| IT capability                     | Number of PCs per employee and IT professionals   |   | 0.832          |
| Connection                        | The number of trading partners that are connected with RosettaNet standards   |   | N.A.           |

All items were measured using a five-point Likert scale. Reflective indicators were used for all constructs, with the following exceptions. First, consistent with Teo et al., the mimetic pressures construct was operationalized as a formative construct. Second, adopting the approach of Tsang<sup>1</sup> and Olk and Young<sup>2</sup> who used formative indicators to assess learning in joint ventures and an organization's involvement in an R&D consortium respectively, we also defined learning from trading partners and learning from standards consortium members as formative constructs. Third, business and systems integration have been shown to form a unifying concept of organizational integration, but they capture differing aspects of integration based on our conceptualization and interviews. Hence, business integration and systems integration, which are both measured with reflective indicators, together formed a second order

<sup>1</sup> E.W.K. Tsang, Acquiring knowledge by foreign partners from international joint ventures in a transition economy: Learning-by-doing and learning myopia, *Strategic Management Journal*, 23 (2002) 835-854.

<sup>2</sup> P. Olk, C. Young, Why members stay in or leave an R&D consortium: Performance and conditions of membership as determinants of continuity, *Strategic Management Journal*, 18 (1997) 855-877

formative construct representing VIS standards integration.

Prior research has shown that organizational readiness and perceived benefits are two key factors influencing IOS adoption, in addition to institutional pressures. Hence, we included controls for an organization's IT experience and capability as a proxy for organizational readiness. We did not include perceived benefits as a control, as the construct is more applicable for non-adopters. We measured the actual perceived benefits from using VIS standards as the outcome variable. In addition to the extent of deployment and integration, we also controlled for the number of business partners connected using RosettaNet standards.

## **6. Analysis and Results**

We used PLS Graph (Version 3.0 build 1126) for data analysis since our research model contained both reflective and formative constructs.

### **6.1 Measurement Validation**

We assessed the convergent and discriminant validity of the reflective constructs through factor analysis. Principle components analysis was conducted for the reflective construct items (see Appendix B). All items loaded highly on their factors ( $> 0.5$ ). Reliability of the reflective constructs was assessed with Cronbach alphas. The standardized alphas ranged from 0.807 to 0.930 as shown in Table 2. Regarding the reliability of formative constructs, Petter et al.[15] suggested that in order to evaluate reliability, the researcher should examine multicollinearity to determine if  $VIF < 3.3$  for formative constructs. The highest VIF is 2.75 for formative constructs here. The PLS measurement validation also provides the loadings of individual items on their variables. The items loaded high ( $>0.50$ ) in their respective constructs and the t-values of the Outer Model Loadings were above 1.96.

**Table 3. Correlations among Major Constructs**

| Construct                         | Mean<br>(SD)     | 1           | 2           | 3      | 4           | 5           | 6           | 7           | 8           | 9           | 10          | 11          | 12          | 13          |
|-----------------------------------|------------------|-------------|-------------|--------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1. Operational Benefits           | 3.63<br>(0.92)   | <b>0.83</b> |             |        |             |             |             |             |             |             |             |             |             |             |
| 2. Strategic Benefits             | 3.15<br>(0.91)   | 0.45**      | <b>0.88</b> |        |             |             |             |             |             |             |             |             |             |             |
| 3. Deployment                     | 7.37<br>(8.21)   | -0.17*      | 0.52**      | N.A.   |             |             |             |             |             |             |             |             |             |             |
| 4. Systems Integration            | 3.80<br>(0.72)   | 0.54**      | 0.53**      | 0.16   | <b>0.86</b> |             |             |             |             |             |             |             |             |             |
| 5. Business Integration           | 3.46<br>(0.78)   | 0.51**      | 0.49**      | 0.20   | 0.54**      | <b>0.83</b> |             |             |             |             |             |             |             |             |
| 6. Coercive Pressures             | 3.84<br>(0.81)   | 0.16        | 0.25*       | 0.48** | 0.07        | 0.17        | <b>0.87</b> |             |             |             |             |             |             |             |
| 7. Mimetic Pressures              | 3.15<br>(0.71)   | 0.27*       | 0.17*       | 0.42** | 0.19        | 0.21        | 0.23**      | <b>N.A.</b> |             |             |             |             |             |             |
| 8. Normative Pressures            | 2.96<br>(0.82)   | 0.17        | 0.21        | 0.20*  | 0.12        | 0.14        | 0.27        | 0.21*       | <b>0.86</b> |             |             |             |             |             |
| 9. Learning from Trading Partners | 3.04<br>(1.05)   | 0.10        | 0.41**      | 0.49** | 0.34**      | 0.48**      | 0.28*       | 0.27*       | 0.26        | <b>N.A.</b> |             |             |             |             |
| 10. Learning from Consortia       | 3.03<br>(1.52)   | 0.05*       | 0.27**      | 0.39*  | 0.28*       | 0.15*       | 0.14*       | 0.18        | 0.19        | 0.33*       | <b>N.A.</b> |             |             |             |
| 11. Size                          | 3.70<br>(1.65)   | 0.44*       | 0.23        | 0.32*  | 0.51**      | 0.37**      | 0.26        | 0.32*       | 0.21        | 0.26        | 0.15        | <b>0.93</b> |             |             |
| 12. IT capability                 | 3.23<br>(1.32)   | 0.41*       | 0.21*       | 0.35** | 0.53**      | 0.41**      | 0.18*       | 0.36**      | 0.17        | 0.22        | 0.22        | 0.47**      | <b>0.84</b> |             |
| 13. Experience                    | 6.78<br>(4.12)   | 0.31*       | 0.11        | 0.41** | 0.37**      | 0.40**      | 0.21*       | 0.31*       | 0.15        | 0.38*       | 0.37**      | 0.53**      | 0.53**      | <b>0.87</b> |
| 14. Number of Connections         | 13.31<br>(12.43) | 0.11        | 0.13        | 0.09   | 0.12        | 0.13        | 0.09        | 0.27*       | 0.18*       | 0.15        | 0.11        | 0.38**      | 0.36*       | 0.37*       |

\* p< 0.05, \*\* p< 0.01

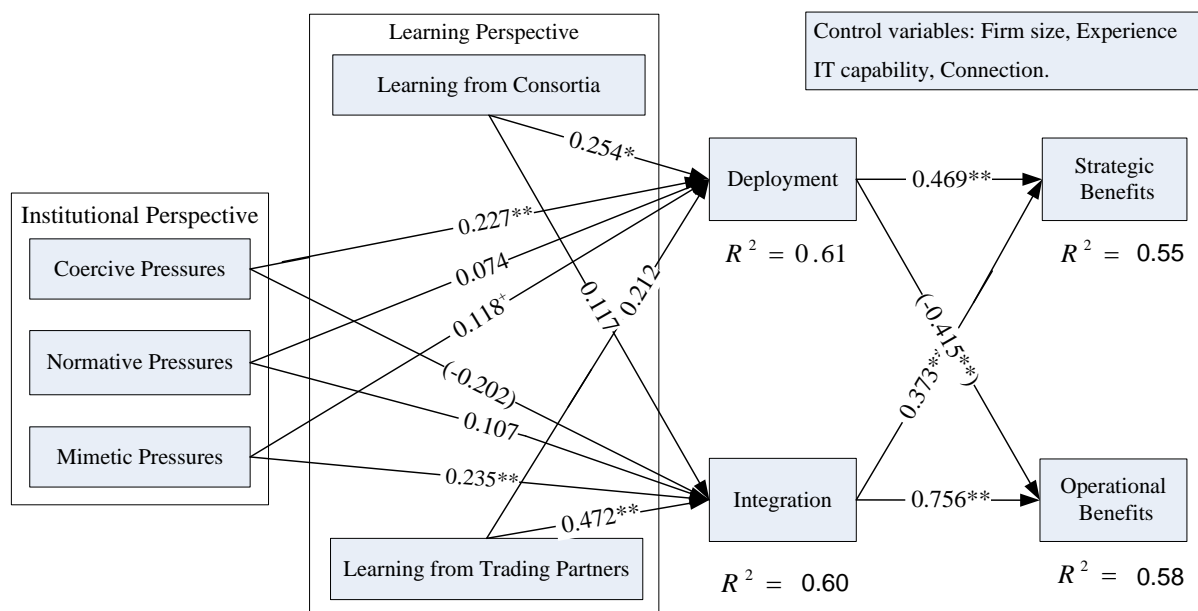
Table 3 displays the descriptive statistics and correlation analysis of the constructs used. The diagonal cells list the square root of average variance extracted for the reflective constructs, which are above 0.50, indicating that the measurements are reliable and the latent construct account for at least 50 % of the variance in the items. The values in the diagonal cells are considerably higher than all other cells in the same row, highlighting adequate discriminant validity.

**Common Method Bias Assessment.** Harman's one-factor test was conducted. Unrotated factor analysis using the eigenvalue-greater-than-one criterion revealed eleven factors, and the first explained only 35 percent of the variance in the data. We concluded that common method bias is unlikely to be of serious concern.

## 6.2 Structural Model Results

We tested a saturated model that included links from all institutional and learning factors to deployment and integration, and all links from both deployment and integration to the outcomes of strategic benefits and operational benefits. This allowed us to test whether linkages not explicitly hypothesized in our research model were insignificant. Figure 2 shows the PLS path coefficients and explained variances.

**Figure 2. Parameter Estimates for Final Structural Model**



\*\*  $p < 0.01$ ; \*  $p < 0.05$ ; +  $p < 0.1$

**Antecedents of VIS Standards Deployment and Integration.** The coercive pressures have a significant influence on deployment (path coefficient = 0.227,  $p < 0.01$ ), but not on integration (path coefficient = -0.195,  $p > 0.1$ ), thus supporting H1a. Normative pressures have an insignificant influence on deployment (path coefficient = 0.074,  $p > 0.1$ ) and integration (path coefficient = 0.107,  $p > 0.1$ ). This did not support H1b and H2a. Mimetic pressures have a marginally significant influence on deployment (path coefficient = 0.118,  $p < 0.1$ ) but a significant influence on integration (path coefficient = 0.235,  $p < 0.01$ ), showing partial support for H1c and support for H2b. The hypotheses for the learning constructs were partially supported. Learning from standards consortia had a significant influence on

deployment (H3a, path coefficient = 0.254,  $p < 0.05$ ), and learning from trading partners had a significant influence on integration (H3c, path coefficient = 0.472,  $p < 0.01$ ). Learning from trading partners, however, did not have significant influence on deployment (H3b, path coefficient = 0.212,  $p > 0.1$ ), thus not supporting H3b.

Overall, the variables accounted for 61% of the variance in the extent of standards deployment and 60% of the variance in the extent of systems and business integration.

***Benefits of VIS Standards Deployment and Integration.*** Integration positively influenced operational benefits (path coefficient = 0.756,  $p < 0.01$ ) and strategic benefits (path coefficient = 0.373,  $p < 0.01$ ), supported H4a and H4b. As hypothesized by H4c, the PLS analysis indicated that standards deployment positively influenced strategic benefits (path coefficient = 0.469,  $p < 0.01$ ). The results also indicated that standards deployment negatively influenced operational benefits (path coefficient = -0.415,  $p < 0.01$ ). The  $R^2$  values of both dependent variables (operational and strategic benefits) were greater than 0.5, which indicated that the model explained a substantial amount of variance. None of the control variables had significant influence on either dependent variables, except that firm size positively influenced operational benefits (path coefficient = 0.382,  $p < 0.01$ ).

We used AMOS to test the model, as a robustness check. For formative constructs, we used the average of all items as a single item indicator and found that the results remained the same.

***Power analysis.*** Following Liang et al. [9], we calculated power values for the PLS model. PLS estimates a structural model block by block, so we calculated power values separately. Each block consisted of a DV and its IVs. Our model had four endogenous variables (strategic benefits, operation benefits, integration, and deployment), which were the DV in each block. So we had four major blocks and four power analyses. The power values ranged from 0.89 to 0.99 (Given  $\alpha = 0.01$ ).

## 7. Discussion

We found that coercive pressures significantly influenced standards deployment, but not standards integration. This, together with our results about the benefits from deployment and integration, suggests that organizations that respond to coercive pressures without integration will not enjoy operational benefits. Normative pressures had no influence on standards deployment and mimetic pressures only marginally influenced standards deployment. In our interviews, we noticed that there was a substantial group of VIS standards adopters who adopted the standards ceremonially, and did not gain benefits from using VIS standards. The influence of normative and mimetic pressures weakens when organizations are aware that adopting the VIS standards does not automatically lead to benefits from adoption. However, mimetic pressures were shown to significantly influence integration, in line with our arguments that organizations imitate competitors' integration because organizations observe that competitors have obtained benefits from integration.

Learning from other standards consortium members is significantly associated with the extent of standards deployment while learning from trading partners was shown to be related to VIS standards integration. This highlights the need for organizations to be more cognizant of the importance of helping other organizations reduce the knowledge gap in IT assimilation. It may be more effective for the standards consortium and trading partners to help organizations learn about the benefits of VIS standards adoption, and how these can be achieved through the implementation process, rather than to use pressure tactics.

Our analyses also show that only users who integrate the VIS standards to their backend systems and who change their business processes as part of the integration effort benefit from using VIS standards. In addition, wide deployment, on its own, was negatively associated with operational benefits. Organizational investment in integration is critical for reaping operational benefits. VIS standards provide the opportunities for organizations to

invest in generating relationship specific assets, learn more about their trading partners, and signal their commitment to the relationship.

### **7.1 Implications for Research**

Our research contributes in three ways. First, we extend prior research on IOS and VIS standards adoption. The presence of a standards consortium in VIS standards context highlights the need to widen the socio-political perspective that has traditionally been used to consider the role that other organizations play in influencing an organization's decision to adopt the VIS standards. A standards consortium is an important source of institutional influence in VIS standards context, but the social influence exerted by standards consortia is not restricted to institutional pressures. We complement the institutional perspective with a learning perspective.

Second, while deployment and integration have individually received attention in prior IOS literature [2, 16, 27, 28], they have not been examined together. They represent different dimensions of VIS standards use, and each dimension emphasizes its own set of considerations and impacts. It is necessary to examine the effect of both at the same time, as they are important dimensions of organizations' VIS standards adoption decision.

Overall, our analysis shows that it is important to examine both the antecedents and outcomes of organizations' decisions to deploy VIS standards and invest in systems and business integration. Moreover, our results show that institutional pressures and inter-organizational learning influence VIS standards deployment and integration decisions in different ways, highlighting that the socio-political influence *how* VIS standards are *used*, not simply whether the standards are *adopted*. Our results show that it is important to supplement the institutional perspective with the learning perspective.

Finally, by examining the operational and strategic benefits arising from VIS standards deployment and integration, we broaden the view of why and how organizations generate

benefits from using IOS.

## **7.2 Implications for Practice**

First, the empirical results show that simply deploying VIS standards without investing in integration generate limited operational benefits. One approach is to start with a narrow set of VIS standards and ensure that these are well integrated with internal systems and processes, before moving on to deploy additional standards. Early project success also provides confidence to both the top management and system users to continue investing in expanding the implementation of VIS standards.

Second, coercive pressures on organizations will only influence organizations' deployment decisions, but will not influence their integration decisions. Benefits will not be achieved when organizations merely deploy VIS standards.

From the supplier's perspective, our results indicate that a supplier who deploys VIS standards due to customer coercive pressures with neither a good understanding of the standards nor proper integration, will be unlikely to gain significant benefits from adoption, beyond signaling their commitment to the customer.

From the customer's perspective, our results show that attempting to coerce suppliers to adopt VIS standards will only result in benefits for the customer, at the expense of the supplier. To generate a win-win situation where all benefit from adopting the standards, a customer should consider helping its suppliers to understand the VIS standards implementation process and increase their level of integration.

## **7.3 Limitations**

Our research had several limitations. First, the study used cross-sectional survey data, which limited our ability to draw definitive conclusions about causality. Nevertheless, the framework proposed that various factors (institutional pressures and learning) influence different aspects of use, which in turn influenced the benefits derived from their use. This

mitigates the possibility of reverse causalities amongst the constructs. In addition, the research provided some insights about how organizations would change their decisions after the initial adoption decision.

## **8. Conclusion**

We differentiated between two distinct dimensions characterizing organizations' use of VIS standards: the extent of deploying VIS standards across a range of business processes, and the extent of systems and business process integration. By drawing on institutional and learning theories, we examined how other organizations influence the extent of deployment and integration of the VIS standards. Our study thus extended the socio-political perspective on IOS adoption, by examining how the learning perspective complements the institutional pressures perspective. We also generated an integrated view of the influence of institutional pressures and inter-organizational learning on standards deployment and integration as two dimensions of standards use, as well as the benefits arising from the use of VIS standards.

## **Acknowledgements**

We gratefully acknowledge Nanyang Technological University for their financial support of this project. This research is also supported by National Social Science Foundation of China (13CGL143), Major Program of National Natural Science Foundation of China (91218301), Key Program of National Social Science Foundation of China (11AZD077), and the Fundamental Research Funds for the Central Universities (JBK120505).

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## Appendix A. Item Measures

| Research construct        | Measures   |
|---------------------------|--|
| Strategic benefits        | <p>To what extent do you agree that these results follow from the use of RosettaNet PIPs:</p> <p>SB1. We learn a lot about the customers (e.g. buying patterns)</p> <p>SB2. We learn a lot about the markets for our products</p> <p>SB3. We develop new business opportunities with the customers</p> <p>SB4. Purchases from my firm are increasing from the customers</p>  |
| Operation benefits        | <p>To what extent do you agree that these results follow from the use of RosettaNet PIPs:</p> <p>OB1. Sales cycle time is reduced</p> <p>OB2. Inventory cost is reduced</p> <p>OB3. Productivity is improved through automation</p> <p>OB4. Operations costs is reduced</p> <p>OB5. We get timely and accurate information for decision making</p> <p>OB6. Clerical efficiency is improved through reduced paperwork</p>   |
| VIS standards deployment  | How many PIPs have you implemented in each of the RosettaNet Clusters (i.e. Order, Payment, Logistics, Demand Creation, Manufacture, Design, and Forecast)?  |
| VIS standards integration | <p>To what extent do you agree with the following statements:</p> <p>BI1. Redundant activities have been removed from the inter-organizational business processes that cross my firm and the customer.</p> <p>BI2. The gaps and conflicts between business processes of my firm and the customer have been solved</p> <p>BI3. Our internal business processes facilitate our communication and cooperation</p> <p>BI4. Feedback about the problems relating to inter-organizational business processes across my firm and the customer are handled in a timely manner</p> <p>BI5. An inter-functional team from our business unit, together with the teams from the customer, has meetings to figure out how to work better together</p> <p>SI1. Data from the customer must be re-keyed, as they are used and reused by different employees within my firm (Reversed)</p> <p>SI2. Electronic data flows smoothly from RosettaNet system into our internal ERP system</p> <p>SI3. Our internal systems can easily transmit and process data from the customer.</p> |
| Coercive pressures        | <p>With regard to my main customers that have adopted RosettaNet PIPs,</p> <p>CP1. My firm's well-being depends on their purchases.</p> <p>CP2. My firm MUST maintain good relationships with them.</p> <p>CP3. They are the largest customers in the industry</p> <p>CP4. These customers have great influence on our firm's decision of whether or not to adopt RosettaNet PIPs</p>  |
| Mimetic pressures         | <p>With regard to my main competitors that have adopted RosettaNet PIPs</p> <p>MP1. They have benefited greatly.</p> <p>MP2. They are perceived favorably by others in the same industry.</p> <p>MP3. They are perceived favorably by their customers.</p> <p>MP4. RosettaNet PIPs are widely adopted by our firm's competitors</p>  |
| Normative pressures       | <p>To what extent do you agree with the following statements:</p> <p>NP1. My perceptions of RosettaNet PIPs' usefulness are influenced by the views of other RosettaNet users</p> <p>NP2. Participating in some RosettaNet promotion events generates some pressures on our organization to adopt RosettaNet PIPs</p>  |

|   |   |
|---|---|
| Learning from trading partners <sup>3</sup> | <p>To what extent does your organization participate in the following activities:<br/> PC1. Routine meetings with customers on issues of RosettaNet PIPs use<br/> PC2. Engage help on private business process reengineering (BPR) from customers</p> <p>To what extent does your organization learn from the following activities:<br/> LC1. Routine meetings with customers on issues of RosettaNet PIPs use<br/> LC2. Engage help on private business process reengineering (BPR) from customers</p>   |
| Learning from standards consortia           | <p>To what extent does your organization participate in the following activities organized by the RosettaNet consortium:<br/> PR1. Conferences /Workshops / Seminars / Forums, etc<br/> PR2. Personal communication with other members of RosettaNet consortium --- e.g. sharing experience or asking advice of RosettaNet PIPs?</p> <p>To what extent does your organization learn from the following activities organized by the RosettaNet consortium: (1 = very low; 5 = very high)<br/> LR1. Conferences /Workshops / Seminars / Forums, etc<br/> LR2. Personal communication with other members of RosettaNet consortium --- e.g. sharing experience or asking advice of RosettaNet PIPs?</p> |
| Firm Size                                   | <p>How much is your sales revenue? (Less than US\$1 mill. -- US\$1 mill. to US\$10 mill. -- US\$10 mill. to US\$100 mill. -- US\$100 mill. to US\$ 1 billion -- More than US\$1 billion)</p> <p>How many employees do you have? (Less than 50 -- 50 to 99 -- 100 to 999 -- 1,000 to 5,000 -- More than 5000)</p>  |
| IT capability                               | <p>What is the ratio of number of PCs per employee? (Below 1/10 -- 1/10 -- 1/5 -- 1/5 -- 1/2 -- 1/2 -- 1 -- Above 1)</p> <p>How many IT professionals do you have? (Below 10 -- 10-50 -- 50 -- 100 -- 100 -- 500 -- Above 500)</p>  |
| Experience                                  | <p>How many years of experience does your organization have with automated communication systems (e.g. EDI)? _____Years</p> <p>How many years of experience does your organization have with RosettaNet PIPs? _____Years</p>  |
| Connection                                  | <p>How many customers/suppliers/logistic providers/financial institutions/other partners do you connect with using RosettaNet PIPs?</p>   |

<sup>3</sup> We conducted sensitivity analysis by including either two participation or two learning items in the analysis separately, the results remained unchanged.

## Appendix B. Item Loadings and Cross Loadings

|     | Coercive pressures | Normative pressures | Operational benefits | Strategic benefits |
|-----|--------------------|---------------------|----------------------|--------------------|
| CP1 | <b>0.875</b>       | 0.312               | 0.212                | 0.298              |
| CP2 | <b>0.844</b>       | 0.215               | -0.035               | 0.203              |
| CP3 | <b>0.832</b>       | 0.157               | 0.141                | 0.216              |
| CP4 | <b>0.856</b>       | 0.024               | -0.054               | 0.181              |
| NP1 | 0.112              | <b>0.856</b>        | 0.154                | 0.172              |
| NP2 | 0.198              | <b>0.893</b>        | 0.137                | 0.232              |
| OP1 | 0.115              | 0.123               | <b>0.805</b>         | 0.273              |
| OP2 | 0.212              | 0.321               | <b>0.873</b>         | 0.356              |
| OP3 | -0.045             | 0.013               | <b>0.821</b>         | 0.312              |
| OP4 | -0.043             | 0.312               | <b>0.843</b>         | 0.217              |
| OP5 | 0.024              | 0.014               | <b>0.897</b>         | 0.309              |
| OP6 | 0.049              | 0.178               | <b>0.818</b>         | 0.387              |
| SB1 | 0.298              | 0.192               | 0.312                | <b>0.896</b>       |
| SB2 | 0.241              | 0.154               | 0.321                | <b>0.883</b>       |
| SB3 | 0.217              | 0.198               | 0.432                | <b>0.895</b>       |
| SB4 | 0.397              | 0.213               | 0.304                | <b>0.824</b>       |

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