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STUDY BASED ON INDUSTRY
CONSORTIUM PERSPECTIVE

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INDUSTRY STANDARDS USE AND ADAPTIVE KNOWLEDGE CREATION: A STUDY BASED ON INDUSTRY CONSORTIUM PERSPECTIVE

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ABSTRACT

In order to facilitate the rapid development of B2B e-business and supply chain, many industry consortia develop industry-specific standards. This paper differentiates between two distinct dimensions characterizing organizations' standards use: breadth and depth. We examine how industry consortia' promotion strategies influence the breadth and depth of standards use, and how standards use influences adaptive knowledge creation. We also examine how firm size moderates the relationship between promotion strategies and standards use. The hypotheses are tested using survey data collected from organizations in China who have implemented RosettaNet standards. The empirical results show that relationship, policies, and technology strategies significantly affect standards use, and firm size moderates the influence. Further, only the depth of standards use influence adaptive knowledge creation.

Keywords: Industry standards, Inter-organizational systems, Supply chain, Industry consortium

1. INTRODUCTION

In today's global economy, organizations strive to improve the interoperability and effectiveness of their supply chain with business partners. However, inter-organizational interoperability and application integration requires organizations to share IT infrastructure with their supply chain partners and undertake joint investments in IT infrastructure. Therefore, many supply chain partners develop inter-organizational systems (IOS) to facilitate data sharing, link business processes, support supply chain management, and improve collaboration via electronic integration. These systems include early proprietary Electronic Data Interchange (EDI) systems and latest supply chain management (SCM) system based on industry-specific open standards (Zhu et al., 2006). These standards are developed by user-led industry consortia are termed vertical information systems (VIS) standards (Markus et al., 2006; Wigand et al., 2005). VIS standards address product identification, data definition, business document layout, and many other B2B E-business issues. These standards facilitate many inter-organizational activities such as order and payment management, logistics, collaborative forecasting, and inventory management. Examples of such standards include XBRL for the accounting industry, RosettaNet for the IT industry and CIDX for the chemicals industry.

First, this paper examines the antecedents of VIS standards use in a new perspective. Prior literature has shown that many external players could influence technology use. We explore the antecedents of VIS standards use in the perspective of industry consortium. Industry consortium uses different strategies (e.g., marketing or coercion) to promote standards. Thus, we explore how different strategies influence VIS standards use based on this new perspective.

Further, prior literature has found that VIS standard use could create operational benefits, such as lower transaction and production costs, quicker response time, and inventory cost saving (Wigand, et al., 2005; Xu et al., 2014). However, supply chain partners also pursue higher-order goals (beyond operational benefits), such as faster market entry and new market development. For example, if a manufacturer wants to refresh product offerings in volatile environments. This requires new product introduction processes that span the manufacturer, wholesale, distributors, and retailers. We propose that the use of VIS standards provide opportunities for enterprises to learn from their partners to better adapt to high-velocity market environments.

In conclusion, **this paper will examine how industry consortia' strategies influence VIS standards use, and how standards use influence the adaptive knowledge creation.** This article is structured as follows: The next section presents theoretical background and hypotheses, then the methodology section describes data collection procedure, measurements and empirical findings, in the discussion part, we highlight the implications of this study, the limitations and the guidance for future research.

2. THEORETICAL FRAMEWORK

2.1 Breadth and depth of VIS standards use

As highlighted by Sambamurthy et al. (2003), IT-enabled inter-organizational work processes

for automating and integrating business process and information flow across trading partners is an important component of an organization's IT capabilities (which they term as "digitized process"). Sambamurthy et al. (2003) point out that a key characteristic of a firm's "digitized process" is its reach. Reach is the extent to which a firm deploys common, integrated, and connected IT-enabled processes across its business. With greater reach, firms can cooperate effectively in more business activities (Venkatraman & Henderson, 1998). Implicit in the definition of reach are two distinct dimensions – (1) the extent to which more business processes are connected using IT, and (2) the extent of IT integration that enables the capture of integrated knowledge about customers and suppliers, and improves interactions among business partners (Sambamurthy, et al., 2003). In VIS standards context, these two dimensions are translated into breadth and depth of VIS standards use: (1) breadth: the range of inter-organizational business processes that VIS standards automate; and (2) depth: the extent to which organizations integrate VIS standards to the back-end system and internal and external business processes of an organization. Hence, in this paper, we identify breadth and depth as two dimensions characterizing VIS standards use.

First, VIS standards are defined for varied activities between business partners. For example, CIDX standards can be classified into clusters such as purchase, orders, logistics, financials, and forecasting. Standards in each cluster support transactions for a particular class of business process. RosettaNet standards use Partner Interface Processes (PIPs) to present each business process that could be automated through the standard. PIPs specify the processes and associated business documents for data exchange between business partners. For example, RosettaNet PIPs for order management include request quote (PIP3A1), query price and availability (PIP3A2), request purchase order (PIP3A4), query order status (PIP3A5), distribute order status (PIP3A6), etc. Now RosettaNet has more than 900 unique PIPs. Organizations could negotiate with their business partners about what business processes could be automated through VIS standards. Thus, the number of standards sets that deployed by an organization represent an important dimension of VIS standards use. And we define it as the breadth of VIS standards use.

On the other hand, simply deploying VIS standards does not lead to a perfect integration between this organization and its business partners automatically. VIS standards are typically implemented in an IOS, which may or may not be integrated to the back-end system and internal business processes of this organization. Furthermore, in order to achieve the best result of standard use, business partners need to remove redundancy and inconsistency from the inter-organizational business processes, agree on the protocols to use during the interaction, provide feedback about quality, and use coordinating teams. Such efforts can result in different integration results, ranging from one-sided automation, to manually assisted interchange, to straight-through processing (Wigand, et al., 2005). For example, in an un-integrated system, though invoices and orders are exchanged electronically through VIS standards, users may still print out computer-generated orders or invoices and then enter the information manually into their back-end systems (Markus, 2000). Hence, although VIS standards can enable seamless interconnection among business partners, organizations make their own choice of the integration with internal system and business processes, as well as the business partners' system and business processes. We thus define such integration as depth of VIS standards use.

2.2 Industry consortia' strategies and VIS standards use

In the paper, we focus on industry standard consortium, which is called standard development organization (SDO) in the literature too (Zhao et al., 2007). Although standards development has been highlighted, standards diffusion is another key job of industry consortium. For example, Markus et al. (2006) argued that the VIS standards development and diffusion processes are interrelated problems of collective action.

Based on our field study and literature (Boh et al., 2007), we identify four strategies that standards consortia use to promote VIS standards (Table 1), which eventually influence the breadth and depth of VIS standards use.

Strategy	Method	Example
Marketing strategy: Increase market awareness of the standards	<ul style="list-style-type: none"> • Seminar, Conference • Site visit • Advertising 	<ul style="list-style-type: none"> • CIDX consortium regularly organizes meetings or seminars, while prepare for a large number of advertising materials
Relational strategy: Use the power and influence of major players in the industry	<ul style="list-style-type: none"> • Invite major players join standards consortium, and play a key role. 	<ul style="list-style-type: none"> • Ford and GM require suppliers to use Covisint standards of automotive industry
Policy strategy: Change or use the legal and regulatory environment	<ul style="list-style-type: none"> • Government endorsement • Government subsidizes standard user 	<ul style="list-style-type: none"> • Malaysian government subsidizes enterprises for standards implementation • Philippine government uses RosettaNet standards for country's E-Customs system
Technical strategy: Improve standards' technical advantage to reduce implementation cost, enhance ease of use and usability of standards	<ul style="list-style-type: none"> • User training and support • Joint development and implementation projects 	<ul style="list-style-type: none"> • RosettaNet established a global R&D center and regional R&D centers, optimizing standards development and implementation procedure, while providing a variety of training for implementation and use of standards

Table 1: Promotion strategies of standards consortia

● Marketing strategy and VIS standards use

Marketing strategy could influence VIS standards use through the following ways. First, industry consortia provide plenty of information about VIS standards through different marketing activities (conferences, seminars, adverting, etc.). Such information typically includes explanations of VIS standards, successful implementation cases and analysis of benefits obtained from using VIS standards. These information helps organizations understand what the VIS standards are about, and what the VIS standards can do, thus diminishing the uncertainties they face about the technology. Thus, it influences standards use.

Next, organizations could realize many industry peers, especially competitors are using VIS

standards when they attend marketing activities. Under such a circumstance, normative pressures and mimetic pressures will influence standards diffusion. Normative pressures stem from shared norms and values among members of a relational network (Powell & DiMaggio, 1991). When organizations attend events organized by industry consortia, they are constantly reminded of the need to adopt VIS standards, so that the entire industry can benefit from using the same standards. Organizations thus feel normative pressures to deploy VIS standards, in order to help their community reach the goal of full inter-operability throughout their supply chain. Mimetic pressures arise from uncertainty about appropriate behavior. When organizations observe that other organizations are deploying VIS standards, they will similarly feel compelled to mimic other organizations, to “avoid being perceived as technologically less advanced and as less suitable trading partners than their competitors” (Teo et al. 2003, p. 22).

Although we argue that marketing strategy could influence the breadth of standards use, we do not assume it will influence the depth of standards use. As we define, the depth of VIS standards use presents both internal integration and external integration through VIS standards. By attending simple marketing activities, organizations cannot get necessary knowledge and capabilities to create such complex integration. On the other hand, although organizations could observe that many industry peers and competitors are using VIS standards, what they can find is whether other organizations deploy a specific standard set or not. Internal and external integrations are difficult to be observed. Hence, we hypothesize:

H1: Marketing strategy is positively related to the breadth of VIS standards use

- Relational strategy and VIS standards use

In order to get support from the major players in the industry, industry consortia often invite them join consortium and play a key role, such as Ford and GM in the automobile industry, Intel and Dell in the IT industry. These powerful stakeholders have the resources and the power, and exert coercive pressures on their trading partners to adopt the technology. Supplier firms are often not in the position to decide whether they should adopt the standards or not, due to the dominant position of buyers (Subramani, 2004). Relational strategy thus could be very influential on the breadth of VIS standards use.

Relational strategy, however, may only influence the breadth of VIS standards use. Organizations have little influence over business partners' integration decisions, especially their internal business processes and application systems. System and business integration requires the support and commitment of senior management, and the availability of appropriate resources and expertise. Therefore, managers may succumb to coercive pressures to deploy VIS standards, and they will engage in ceremonial adoption to show their commitment to their customer, but may not expend effort for integration. Hence, we hypothesize:

H2: Relational strategy is positively related to the breadth of VIS standards use

- Policy strategy and VIS standards use

The influence of policy and government on IT diffusion has been highlighted in prior literature. Industry consortia also actively pursue government supports. First, industry consortia try to gain endorsement from government. They can invite senior government officials to assume leadership positions, or get the standard recommended in a country's e-business plans (Boh, et al., 2007). For example, the Philippine and Malaysian governments use RosettaNet PIPs for their own

national electronic customs declaration systems. The U.S. Securities and Exchange Commission (SEC) asked all listed companies using XBRL technology for the preparation and submission of financial reports. In addition to direct pressures, government's support and financial subsidies also have a great impact on the VIS standards use. For example, the governments of Singapore and Malaysia provide grants for companies to subsidize the cost of their RosettaNet implementations. When organizations realize the pressures and supports from government, policy strategy could be very influential on the breadth of VIS standards use.

Although policy strategy affects the breadth of VIS standards use, we argue that it will not affect the depth of VIS standards use. The logic is similar to the explanation of relational strategy. The depth of VIS standards use involves internal and external integration, which is difficult to be controlled by government. Furthermore, when governments promote a specific technology, they usually focus on scope and speed of technology diffusion, rather than internal integration. Hence, we hypothesize:

H3: Policy strategy is positively related to the breadth of VIS standards use

- Technical strategy and VIS standards use

Industry consortia use many different methods to lower the implementation cost and increase the ease of implementation and usability. For example, RosettaNet established a global R&D center and regional R&D centers that target on technical problems. And they also provide many trainings and joint development and implementation opportunities. First, technical strategy influences the breadth of VIS standards use. Iacovou et al. (1995) indicated that organizational readiness significantly influence EDI diffusion. Organizational readiness includes two aspects: financial readiness and technical readiness. Thus, if industry consortia could use technical strategy to reduce VIS standards adoption cost and increase ease of implementation and use, it will finally affect standards diffusion.

Compared to other strategies, we argue that technical strategy could influence the depth of VIS standards use. The task of integrating the back-end systems to the IOS, changing the internal business processes, and coordinating with business partners on external integration is a complex endeavor. When organizations participate in conference and seminar, they hardly can learn these complex knowledge and capabilities. Alavi and Leidner (2001) indicated that tacit and complex knowledge is best transferred through collaboration, shared experience, and rich interpersonal interactions over time. With repeated interactions through formal sessions and informal conversations, firm representatives increase the level of trust, fine-grained information exchange, and joint problem-solving efforts (Uzzi, 1997). This enables organizations to learn how they can better utilize VIS standards and increase the level of systems and business process integration with their business partners. For example, Wigand et al. (2005) described how a mortgage services firm worked with a leading lender on a joint project, and how the two firms learned from each other to reengineer their joint business process, thus enabling a high level of integration between the firms and rapid processing of re-financing cases. Hence, we hypothesize:

H4a: Technical strategy is positively related to the breadth of VIS standards use

H4b: Technical strategy is positively related to the depth of VIS standards use

2.3 The moderating effect of firm size

We have discussed how different strategies influence VIS standards use in the above section. However, we also realize that the effect of strategies could be varied for different types of organizations. Firm size is a typical organization characteristic, and many studies have indicated that small businesses and large businesses have different motivators and inhibitors of technology adoption and use (Cragg & King, 1993; Thong et al., 1996). Therefore, we next examine how firm size moderates the effect between strategies and standards use.

- Marketing strategy and moderating effect

Marketing strategy could influence both large and small businesses. For large businesses, they are often the members of industry consortium and the representative enterprises in the industry. When large businesses attend different marketing events, they are constantly reminded that entire industry can benefit from using the same standards. Due to their representative roles or statuses in the industry, normative pressures will have greater influence on them. Compared with large businesses, marketing strategy influences small businesses in another way. Small businesses usually do not have too much knowledge about current development and trend of the technology. Therefore, different marketing activities provide such information for small businesses. The information will allow small businesses understand why use VIS standards, what are the benefits and so on. Because the market strategy influences both large and small businesses, we do not give any hypothesis here.

- Relational strategy and moderating effect

Prior literature has indicated that dominant trading partners often require small businesses to invest in IOS and improve interoperability (Riggins & Mukhopadhyay, 1994). Small businesses usually are unable to refuse the requirement due to low bargaining power. In contrast, large businesses have more bargaining power to resist the coercive pressures. In some extreme case, the largest businesses are exerting coercive pressure on their business partner. Thus, we think relational strategy will have more influences on small businesses. Hence, we hypothesize:

H5: Firm size negatively moderates the relationship between relational strategy and the breadth of VIS standards use

- Policy strategy and moderating effect

When governments promote many technologies, they usually focus on large enterprises while relaxing control over small ones in the early stage. For example, when the U.S. SEC promoted XBRL technology in all listed companies, they first required 500 large companies to use the technology in 2009, and then promote it to small and mid-size businesses (SMBs) later. Likewise, when the Chinese government promotes XBRL technology, they also asked large state-owned enterprises to use the technology in 2012. We also find similar strategies in the diffusion of other technologies, such as ERP (Liang et al., 2007). VIS standards is quite new technology, we thus argue that policy strategy will have more influences on large businesses. Hence, we hypothesize:

H6: Firm size positively moderates the relationship between policy strategy and the breadth of VIS standards use

- Technical strategy and moderating effect

Compared to large businesses, small businesses do not have enough capital, experience, and

technology capability. They are rarely willing to invest to those technological innovations that cannot create benefits immediately (Cragg & King, 1993). Under such a circumstance, the support and training from industry consortium is more important for small businesses. For example, RosettaNet developed a program called RosettaNet Automated Enablement, which targets increased usability and ease of implementation for SMBs (Boh, et al., 2007). We thus argue that technical strategy will have more influences on small businesses. It not only promotes standards adoption, but also helps them to create better integration. Hence, we hypothesize:

H7a: Firm size negatively moderates the relationship between technical strategy and the breadth of VIS standards use

H7b: Firm size negatively moderates the relationship between technical strategy and the depth of VIS standards use

2.4 VIS standards use and adaptive knowledge creation

Prior research has identified the benefits of VIS standards use. In this paper, we focus on how VIS standards use influences adaptive knowledge creation. Adaptive knowledge creation refers to an organization's ability to leverage the knowledge resources of its partner to create the knowledge required to adapt to market environment (Malhotra et al., 2007). In the evolution of current supply chain, the traditional roles in the supply chain are transforming. For example, retailers are helping design products and services, while distributors are assembling products. Thus, successful adaptation is enabled by the development of relevant knowledge to understand the market environment, diagnose current capabilities, anticipate future needs for capabilities, and redesign underlying processes (Day, 1994). Supply chain partnerships can be leveraged to create two distinct types of adaptive knowledge: (a) sensing related—understanding of patterns related to the external market (key markets, customers, competitors, or suppliers) and (b) response related—execution skills and capabilities. VIS standards allow organizations to exchange information with partners and assimilate the information to create new knowledge (Malhotra, et al., 2007).

Organizations can create more adaptive knowledge from a higher extent of internal and external integration. First, investing in external integration enables organizations to create relation-specific assets with business partner. For example, organizations may customize their business processes to cater to the specific requirements of business partners (Subramani, 2004). In addition, establishing systems and business integration requires organizations to work closely with their business partners, creating joint learning opportunities and enhancing the level of interaction, trust, and cooperation between the two parties (Dyer & Singh, 1998; Patnayakuni et al., 2006). These close relationship can help each other better interpret market signals as well as develop the knowledge requisite for adaptation. Hence, we hypothesize:

H8a: The depth of VIS standards use is positively associated with adaptive knowledge creation

Prior literature has indicated that IOS implementation strengthens the business relationship between customers and suppliers (Mukhopadhyay & Kekre, 2002). Narrow deployment of VIS standards for a limited set of practices is not sufficient to create a basis for competitive advantage. It is those companies who are willing to invest heavily in a large array of standards that really signal their commitment to their business partners and therefore can create more adaptive

knowledge through better ties and relationships with their business partners. The extension of VIS standards to automate a wider range of business processes cements a closer relationship between the two parties and confers upon organizations greater ease of communication and deeper cooperation with business partners (Dyer & Singh, 1998). Hence, we hypothesize:

H8b: The breadth of VIS standards use is positively associated with adaptive knowledge creation

Finally, we present an overview of the proposed research model in figure 1 below.

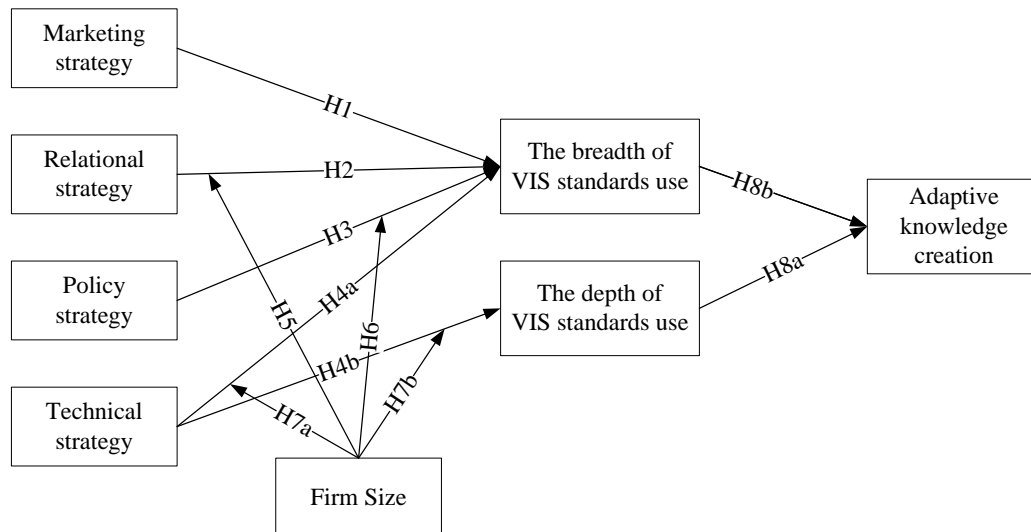


Figure 1. Research Model

3. METHODOLOGY

To test the hypotheses, we conducted an in-depth study of organizations that have adopted RosettaNet standards. RosettaNet (www.rosettanet.org) is a nonprofit consortium that aims to facilitate B2B e-business in the high-tech industry (e.g., electronic components, semiconductor manufacturing, and telecommunications). In the preliminary stage, we conducted 1 to 1.5 hour face-to-face and telephone interviews with 20 key executives (seven RosettaNet regional directors, eight RosettaNet global staff and five IT or business managers of client companies who have implemented RosettaNet standards). These interviews helped us to obtain an understanding of RosettaNet operations and organizational issues with RosettaNet's standards implementation, and to further ground our theoretical arguments and operationalize key constructs. We then generated the survey and reviewed the questionnaire with several RosettaNet executives and users to examine the face validity of the items. RosettaNet standards have been used worldwide. To avoid the influence of national or countries' characteristics, we focus on the organizations that have adopted RosettaNet PIPs in China. Thus, the questionnaire was translated into Chinese using the forward-backward translation method – where the questionnaire that was translated into Chinese was then translated back into English by an independent translator, and the translated English questionnaire was compared to the original version for discrepancies.

We then distributed the survey through two different channels. First, China Association for

Standardization helped us to identify the key RosettaNet champion in each enterprise, and then we emailed our survey to these champions. The China Association for Standardization consists of organizations and individuals engaged in voluntary standardization on a nation-wide basis. It is a society that is led by the Ministry of Civil Affairs with a membership of 30,000 individuals and 400 institutions. Second, hard copy questionnaires were given to participants in two RosettaNet related conferences in China. These two conferences were attended by organizations who were interested in or already implementing E-business and supply chain standards. In order to identify RosettaNet users, the first author waited at the registration counter and asked each participant whether his/her company used RosettaNet standards. If the answer was “Yes”, a hard copy questionnaire was given to the participant, along with a pre-stamped return envelope and a small gift of appreciation.

All respondents were requested to obtain the relevant information for each section of the survey from the manager most likely to provide accurate responses. For instance, IT managers answered the questions related to RosettaNet standards use, whereas the business managers answered the questions related to the adaptive knowledge creation. We randomly called 20 organizations to double check on the process that was adopted to answer the survey, and found that this process was adopted for all the respondents 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 and 186 questionnaires were usable for data analysis, showing an effective response rate of 36 percent.

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 ($p > .05$).

3.1 Operationalization of constructs

We identified the appropriate measures for the constructs by using existing scales from the literature, with some adaptations to the VIS standards context. The measures of the constructs and the source of the items are shown in Appendix A. As prior studies on IOS and VIS standards have not measured marketing strategy and technical strategy, measures for these two constructs were not readily available in the literature. In order to generate the measures for these two constructs, we coded the transcripts of the preliminary interviews to identify the strategies adopted by RosettaNet to promote the standards. We then compared the items derived from the interviews to the list of strategies obtained by a comprehensive search of the literature in marketing, strategy and technology adoption. The RosettaNet managers were then consulted about the comprehensiveness of the items identified through this process.

All items were measured with a five-point Likert scale. Reflective indicators were used for all constructs, with the exceptions of marketing and technical strategy. Furthermore, we included controls for an organization’s IT experience and capability as a proxy for organizational readiness.

4. DATA ANALYSIS

We used PLS Graph for data analysis since our research model contains both reflective and formative constructs. Following Straub (1989), we conducted several tests to validate the construct operationalizations.

4.1 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 0.812 to 0.930 and are itemized in Table 2. Regarding the reliability of formative constructs, Petter et al.(2007) suggests that in order to evaluate reliability, we can examine multicollinearity to determine if $VIF < 3.3$ for formative constructs. The highest VIF is 2.54 for formative constructs in our paper. The PLS measurement validation also provides the loadings of individual items on their variables. The items loaded highly (>0.50) in their respective constructs and the t-values of the Outer Model Loadings are above 1.96 (Gefen & Straub, 2005).

Construct	Mean (SD)	1	2	3	4	5	6	7	8
1. Adaptive knowledge creation	3.15 (0.91)	.88							
2. Breadth of standards use	7.37 (8.21)	.52**	N.A.						
3. Depth of standards use	3.61 (0.94)	.50**	.18	.81					
4. Marketing Strategy	3.06 (1.21)	.19	.24	.14	N.A.				
5. Relational Strategy	3.84 (0.81)	.25*	.48**	.07	.21	.87			
6. Policy Strategy	3.11 (0.94)	.26	.42**	.13	.27*	.33*	.80		
7. Technical Strategy	3.18 (0.94)	.31*	.40**	.42**	.14*	.17	.21*	N.A.	
8. Firm Size	3.04 (1.05)	.23*	.32**	.44**	.28*	.12	.37*	.26*	.92
Cronbach Alpha		.894	N.A.	.823	N.A.	.846	0.812	N.A.	.930

* $p < 0.05$, ** $p < 0.01$

Table 2. Correlations among Major Constructs

Table 2 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 .50, indicating that the measurements are reliable and the latent construct account for at least 50 percent 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. In sum, these results provide strong empirical support for the reliability, discriminant validity and convergent validity of the scales used in this study.

Common Method Bias Assessment. Harman's one-factor test was conducted test for common method bias (Harman, 1967). If a significant amount of common method bias exists in the data, a factor analysis of all the variables will generate a single factor that accounts for most of the variance. Unrotated factor analysis using the eigenvalue-greater-than-one criterion revealed eleven factors, and the first factor explained only 32 percent of the variance in the data. We can conclude that common method bias is unlikely to be a serious concern.

4.2 Structural model results

Figure 2 shows the PLS path coefficients and explained variances. All interaction variables were computed following the procedure of Chin et al. (2003) by cross-multiplying the standardized items of each construct.

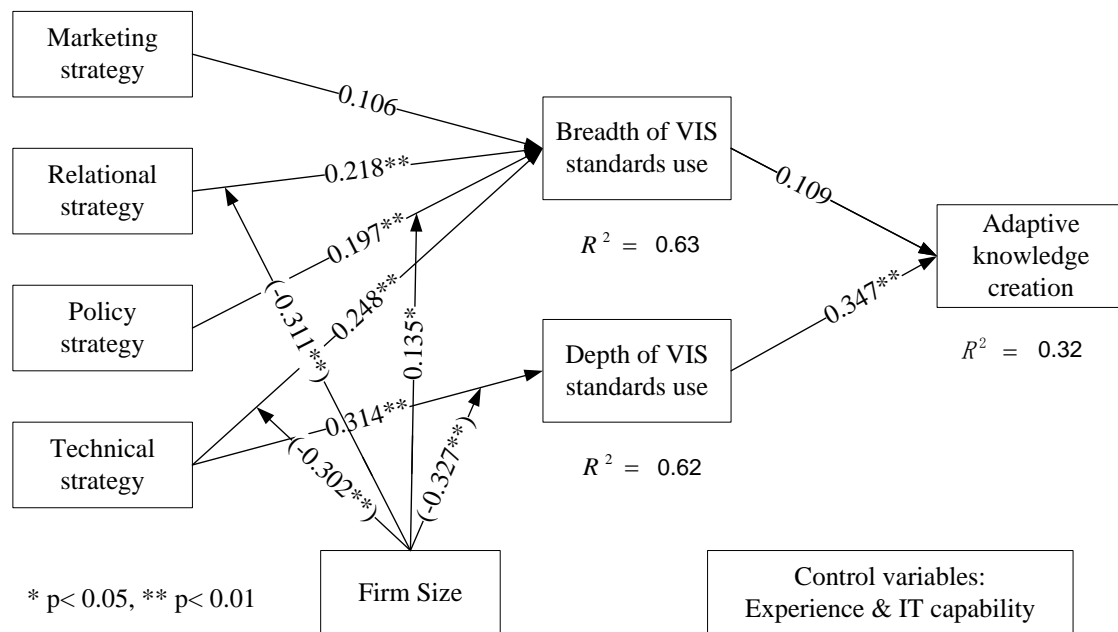


Figure 2. Parameter Estimates for Final Structural Model

The results show that marketing strategy has an insignificant influence on the breadth of standards use (path coefficient = 0.106, $p > 0.1$), thus providing no support for H1. Relational strategy has a significant influence on the breadth of standards use (path coefficient = 0.218, $p < 0.01$). This provides support for H2. Policy strategy has significant influence on the breadth of standards use (path coefficient = 0.197, $p < 0.01$), showing support for H3. Technical strategy has a significant influence on both the breadth of standards use (path coefficient = 0.248, $p < 0.01$) and the depth of standards use (path coefficient = 0.314, $p < 0.01$), thus providing support for H4a and H4b. Adaptive knowledge creation is positively influenced by the depth of standards use (path

coefficient = 0.347, $p < 0.01$), providing support for H8a. However, the breadth of standards use has an insignificant influence on adaptive knowledge creation (path coefficient = 0.109, $p > 0.1$), providing no support for H8b.

Moderating role of firm size. The tests for the moderated relationships followed Carte and Russell (2003), testing whether the variance explained due to the moderated effects is significant beyond the main effects, using the following F-statistic:

$$F(df_{interaction} - df_{main}, N - df_{interaction} - 1) = \frac{\Delta R^2 / (df_{interaction} - df_{main})}{(1 - R^2_{interaction}) / (N - df_{interaction} - 1)}$$

Tests comparing the R^2 values between the main and interaction effects were also performed using Cohen's f^2 , following Chin et al. (2003):

$$\text{Cohen's } f^2 = [R^2(\text{interaction model}) - R^2(\text{main effect model})] / [1 - R^2(\text{main effect model})]$$

As shown in Table 3, all F-statistics are significant and the Cohen's f^2 moderating size effects are sizeable (following the guidelines of Chin et al. 2003), thereby supporting all the proposed moderating effects of firm size.

Moderating effect	F-statistics	Cohen's f^2	Hypothesis	Effect size
Firm size * Relational strategy on standards use breadth	1.61($p < 0.01$)	0.22	H5	Medium/Large
Firm size * Policy strategy on standards use breadth	1.04($p < 0.05$)	0.08	H6	Small/Medium
Firm size * Technical strategy on standards use depth	1.54($p < 0.01$)	0.21	H7a	Medium/Large
Firm size * Technical strategy on standards use depth	1.68($p < 0.01$)	0.23	H7b	Medium/Large

Table 3 F-statistics and Cohen's f^2 of the proposed moderating effects

5. DISCUSSION

This paper differentiates between two distinct dimensions characterizing VIS standards use: breadth and depth. We examine how industry consortium strategies influence VIS standards use, and how VIS standards use differentially influences adaptive knowledge creation. The hypotheses are tested using survey data collected from organizations in China who have implemented RosettaNet standards.

We found that marketing strategy is not significantly associated with the breadth of VIS standards use. These finding should be interpreted in light of our results on the benefits from IT use and the effect of learning. Mindless implementations of IT innovations due to the fashionableness of the innovation will be dampened when organizations begin to observe and realize that the benefits of adoption cannot be rapidly and easily achieved (Swanson & Ramiller, 2004). 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. These organizations may serve to dampen the effect of marketing strategy. The influence of marketing strategy weakens when organizations are aware that adopting the VIS standards does not automatically lead to the benefits from deployment

We found that relational strategy and policy strategy significantly influenced the breadth of VIS standards use, but not the depth. This shows that relational strategy and policy strategy can only make organizations deploy the VIS standards, but will not influence organizations' decisions

to invest in integration. This, together with our results about the adaptive knowledge creation, suggests that organizations that respond to external pressure to deploy the VIS standards without integration will not enjoy further benefits.

Technical strategy was shown to be significantly related to the breadth and depth of VIS standards use. This highlights the need for researchers and organizations to be more cognizant of the importance of helping organizations reduce the knowledge gap in IT assimilation (Swanson & Ramiller, 2004). It may be more effective for the industry consortia, business partners, and government to help organizations learn about the benefits of VIS standards adoption, and how these can be achieved through the implementation and integration, rather than to use pressure tactics.

We also found that firm size moderates the relationship between strategies and VIS standards use. Relational and technical strategies have greater influences on small businesses, while policy strategy has more influence on large businesses. This suggests industry consortia could use different strategies to promote standards more effectively.

In terms of the consequences of VIS standards use, our analyses show that only users with high integration can create more adaptive knowledge. Ceremonial users who adopt VIS standards only for symbolic reasons to signal their commitment to their trading partners, without investing in integration will not really learn from their partners, and eventually cannot make significant adaptation in the high-velocity market environments.

5.1 Limitations and Future Research

Our paper should be interpreted in view of several limitations. First, we only collect data from organizations in China who have implemented RosettaNet standards. Although our sample includes both international and local companies, generalizability could be a concern. Future study should include more industry consortia and standards users from different countries. Second, as this study uses cross-sectional survey data, the usual caveats relating to the limits to drawing definitive conclusions about causality apply. Nevertheless, the research framework proposes that various strategies influence different aspects of VIS standards use, which in turn influences the results derived from VIS standards. This logical sequence of factors mitigates the possibility of reverse causalities amongst the constructs. Hence, future research should examine VIS standards adoption and use in a longitudinal study to examine the dynamics.

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Appendix A. Item Measures

Research construct	Measures	Origin of item scales
Marketing strategy (formative measures)	<p>To what extent do you agree with the following statements about RosettaNet consortium:</p> <p>MS1. They often provide advertising and educational materials of RosettaNet standards</p> <p>MS2. They have organized many related conference and seminar of RosettaNet standards</p> <p>MS3. They have introduced many successful cases of RosettaNet implementation</p>	Conceptualization based on field interviews
Relational strategy	<p>With regard to my main customers that have adopted RosettaNet PIPs,</p> <p>RS1. My firm's well-being depends on their purchases.</p> <p>RS2. My firm MUST maintain good relationships with them.</p> <p>RS3. They are the largest customers in the industry</p> <p>RS4. These customers have great influence on our firm's decision of whether or not to adopt RosettaNet PIPs</p>	Teo et al. (2003)
Policy strategy	<p>To what extent do you agree with the following statements:</p> <p>PS1. Government provides incentive for RosettaNet implementation</p> <p>PS2. Government requires our firm to use RosettaNet</p> <p>PS3. RosettaNet is recommended by our government</p>	Liang et al. (2007) Zhu and Kraemer (2005)
Technical strategy (formative measures)	<p>To what extent do you agree with the following statements:</p> <p>TS1. RosettaNet consortium provides high quality of customer support and training</p> <p>TS2. RosettaNet consortium offers a lot of joint development and implementation projects</p> <p>TS3. RosettaNet consortium often launches new program, which is very helpful for RosettaNet standards implementation and use</p>	Conceptualization based on field interviews
Standards use Breadth	How many RosettaNet PIPs have you implemented?	Conceptualization based on field interviews
Standards use depth	<p>To what extent do you agree with the following statements:</p> <p>SUD1. Redundant activities have been removed from the inter-organizational business processes that cross my firm and the customer.</p> <p>SUD2. The gaps and conflicts between business processes of my firm and the customer have been solved</p> <p>SUD3. Feedback about the problems relating to inter-organizational business processes across my firm and the customer are handled in a timely manner</p>	Markus (2000)

Research construct	Measures	Origin of item scales
	SUD4. Data from the customer must be re-keyed, as they are used and reused by different employees within my firm (Reversed) SUD5. Electronic data flows smoothly from RosettaNet system into our internal ERP system	
Adaptive knowledge creation	To what extent do you agree that these results follow from the use of RosettaNet PIPs: AKC1. Help us better understand the capabilities and intentions of our competitors. AKC2. Help us better understand the evolving roles of channel players. AKC3. Help us learn how to perform new (additional) roles in the channel. AKC4. Led our company to analyze and redesign processes linked to channel partners to improve the performance of the channel on the whole.	Malhotra (2007)
Firm size	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) How many employees do you have? (Less than 50 -- 50 to 99 -- 100 to 999 -- 1,000 to 5,000 -- More than 5000)	Zhu and Kraemer (2005)
Experience	How many years of experience does your organization have with automated communication systems (e.g. EDI)? How many years of experience does your organization have with RosettaNet PIPs?	Zhu and Kraemer (2005)
IT capability	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) How many IT professionals do you have? (Below 10 -- 10-50 -- 50 – 100 -- 100 – 500 -- Above 500)	Zhu and Kraemer (2005)

Appendix B. Item Loadings and Cross Loadings

	Relational strategy	Policy strategy	Standards use depth	Adaptive knowledge creation
RS1	.875	.277	.254	.298
RS2	.844	.216	.238	.203
RS3	.832	.154	.187	.216
RS4	.856	.193	.279	.181
PS1	.244	.787	.164	.025
PS2	.102	.832	.214	.231
PS3	.173	.829	.156	.032
SUD1	.256	.158	.829	.024
SUD2	.373	.144	.837	.202
SUD3	.184	.154	.842	.157
SUD4	.160	.157	.793	.217
SUD5	.121	.137	.831	.169
AKC1	.298	.162	.307	.896
AKC 2	.241	.048	.369	.883
AKC 3	.217	.269	.056	.895
AKC 4	.297	.21	.129	.824