
What Motivates Firms to Contribute to Consortium-Based E-Business Standardization?

KEXIN ZHAO, MU XIA, AND MICHAEL J. SHAW

KEXIN ZHAO is an assistant professor of management information systems in the Belk College of Business at the University of North Carolina at Charlotte. She received her Ph.D. from the University of Illinois at Urbana–Champaign. Her research interests include economics of information systems, e-business standardization, and electronic commerce. Her papers have been published in journals such as *Journal of Management Information Systems*, *Decision Support Systems*, *International Journal of Electronic Commerce*, and *Electronic Markets*.

MU XIA is an assistant professor in the Department of Operations Management and Information Systems in the Leavey School of Business at Santa Clara University. He also taught at the University of Illinois at Urbana–Champaign. He received his Ph.D. from the University of Texas at Austin’s McCombs School of Business. Dr. Xia’s research interests include e-business standardization; online communities, especially peer-to-peer networks; business models of business-to-business electronic commerce; and combinatorial auctions. His work has been published in scholarly journals including *Information Systems Research*, *Journal of Management Information Systems*, *Communications of the ACM*, *European Journal of Operational Research*, and *Decision Support Systems*. He serves on the editorial boards of *Journal of Database Management* and *Information Systems and e-Business Management*.

MICHAEL J. SHAW is a professor and the Hoeft Endowed Chair of Information Systems in the Department of Business Administration at the University of Illinois at Urbana–Champaign. He is also the director of the Center for IT and E-Business there. He received his Ph.D. from Purdue University. He has published extensively, with over 140 papers in the information systems, e-business, and decision support areas. He was an associate editor of *Information Systems Research*, and has been the co-editor-in-chief of the journal *Information Systems and e-Business Management* since its inauguration in 2003. Dr. Shaw’s research has focused on studying how to make information technology beneficial to large enterprises. Pursuing that interest, he has been working with companies such as Motorola, General Electric, and Caterpillar on research projects. He was a Fulbright Scholar and continues to keep a global perspective in his research and teaching. Over the years, he has been involved in multidisciplinary research. He is affiliated with, in addition to his home department, the National Center for Supercomputing Applications (NCSA) and Information Trust Institute (ITI). His most recent research has focused on the functions of chief information officers, e-business, service management, and IT governance.

ABSTRACT: E-business standards are a key infrastructure for electronic commerce. In many industries, they are collaboratively developed by firms in an open and neutral

industry consortium. It is imperative to understand what drives firms' resource investments in such consortia, as they are critical for the success of e-business standardization. Based on collective action theory, we propose a research model to investigate the drivers of standard development within consortia. We test the model through a data set of 232 firms from 7 consortia. Consistent with collective action theory, our results demonstrate that firms' interests, resource availability, and consortium management effectiveness jointly determine their resource expenditures within the consortium. However, our exploratory investigation indicates differences between vendors and users, as vendors are more motivated by perceived standard benefits whereas users are more motivated by perceived process benefits. Our research provides a deeper understanding of firms' behaviors within consortia and factors driving their standard making.

KEY WORDS AND PHRASES: collective action theory, e-business standards, IT vendors, motivations to contribute, standard consortia, user organizations.

FIRMS INCREASINGLY RELY ON E-BUSINESS, defined as business activities using network or telecommunications technologies [32], to remain competitive in the marketplace. Consequently, e-business standards have become a key infrastructure in today's business world [33, 39]. Modern e-business standards are XML (Extensible Markup Language)-based technical specifications defining how data and information are exchanged over the Internet during a broad range of interorganizational transaction processes [39, 72, 76]. For example, residential mortgage standards developed by the Mortgage Industry Standards Maintenance Organization (MISMO), a standard consortium in the mortgage industry, "cover the entire mortgage life cycle, from origination, automated underwriting and service fulfillment through loan administration and investor reporting" (www.mismo.org/specs.html). Standardization has been recognized as a critical factor to advance e-business by a recent European Commission study [29]. It has also attracted much interest from information systems (IS) researchers, as evidenced by the 2006 *MIS Quarterly* special issue on information technology (IT) standards [37], which features papers on open e-business standards [39, 76].

To develop e-business standards, many firms have chosen to join industry-based or vertical standard consortia (VSCs). Because of changing technologies and increasingly complex supply chain processes, VSCs are actively developing new standards for industry-wide interconnectivity and interoperability. Examples include the Association for Cooperative Operations and Development (ACORD) in the insurance industry and the Open Geospatial Consortium (OGC) in the geospatial industry. Typically, those standards are publicly available and contributions to development from firms are voluntary [39].

Whether they are trading partners or competitors in the final product or service marketplace, VSC members are required to collaborate with one another in the consortium to ensure the success of the standardization effort. However, motivating firms' contributions to the standard development can be problematic, since their investments

in consortia are costly yet the standards generated by their efforts are freely available to others [39, 53]. Thus, it is important to understand what drives firms' contributions in standard consortia. However, scholarly research in this area is limited. A few studies have focused on the *adoption* of such standards in the form of interorganizational systems (IOS) [42, 76], but we are not aware of any quantitative studies of their *development*, beyond Markus et al.'s [39] case study. Indeed, Zhu et al. call for further study of "the development of open standards" in "industry-based standard-making associations" and specifically "what factors drive standards making" [76, p. 532].

To narrow this gap, we propose a research framework based on collective action theory to answer the question: What factors drive firms' contributions to the development of e-business standards in a consortium? Using a data set of 232 firms from seven consortia, we find that firms' interests, resource availability, and consortium management effectiveness jointly determine their resource expenditures within the consortium. However, our exploratory investigation indicates differences between vendors and users, as vendors are more motivated by perceived standard benefits whereas users are more motivated by perceived process benefits.

Our research contributes to the standard literature by systematically examining firms' behaviors during the development stage and exploring heterogeneous interests between the demand side and supply side of standard making. Our investigation of heterogeneous *types* of players and their differences also enrich the collective action studies. In addition, understanding why members contribute may facilitate better VSC management.

It is necessary to emphasize that the focus of this paper is not the firms' decision to join the development process, rather, once they join, how much effort they expend. While much of the literature focuses on the joining decision, to understand standardization we have to examine members' contributions after they have joined the consortium, since VSCs are voluntary organizations and there is little recourse in enforcing active involvement from members beyond required membership dues.

The remainder of the paper is organized as follows. In the next section, we describe features of consortium-based e-business standardization. Then we propose our theoretical framework and hypotheses. Next, we present our empirical study, including instrument development, data collection, and data analysis. To explore whether they have different motivations in contributing to standard consortia, we then split the sample into the vendor group and the user group. Finally, we summarize major findings, limitations, and conclude.

Features of E-Business Standards and Standard Consortia

IN THIS SECTION, WE PRESENT SOME BACKGROUND INFORMATION about e-business standardization. First, we explain why consortium-based standardization, compared with the *de facto* and *de jure* approaches, is suitable for e-business standardization. We also introduce features of open e-business standards that make them the current "dominant model for business-to-business transactions" [76, p. 517]. Second, we explain why a cross-industry study is necessary to enhance our understanding of the phenomenon.

Table 1. Comparison of Three Standardization Approaches

| Standardization approach | Institutions developing the standards | Standard-setting processes | Examples |
|--------------------------|---------------------------------------|--|--|
| Consortium based | Industry consortia | Coordination and consensus seeking among members | MISMO and its mortgage specifications |
| De jure | Regulatory bodies | Established by legal authorities via a due process | Federal Communications Commission and its standards, such as ATSC (Advanced Television Systems Committee) for digital television |
| De facto | Individual firms | Market competition | Microsoft and its proprietary file formats (e.g., .doc files) |

Consortium-Based Standardization for E-Business Standard Development

There are three main standardization approaches. Consortium-based standards are developed through coordination and consensus seeking among consortium members. De jure standards are established by legal authorities via a due process, whereas de facto standards are settled by market competition among individual firms [14, 66]. Table 1 compares their differences. De jure standards, because of their elaborate procedures and policy concerns, often face significant delays, making it difficult to keep pace with rapid innovations in technology [17, 59]. In contrast, de facto standards may not be socially optimal [14] due to bandwagon effects [3] (i.e., standards determined by the population of existing users instead of the intrinsic merit) or path dependency [13] (i.e., standards determined by a series of historical events instead of the intrinsic merit).

Driven by industry needs, consortium-based standardization builds on members' resource contributions. With many of the stakeholders in the development, coordination is easier to achieve [18] and the outcome may be more socially desirable than the de facto approach [14]. Because e-business standardization is purely for the industry and "transparent" for individual consumers, a consortium-based approach, without the need to explicitly address public interests, provides more flexible procedures than a de jure approach [71]. Moreover, the involvement of established firms in the industry and future adopters of the standard ensures the efficiency and relevance of the process.

Another reason why e-business standardization is often done in consortia is their collaborative nature, which is a good fit for developing IOS standards, itself a coordination activity that often spans multiple sectors in the industry. For example, the

organizations involved in standardization in the mortgage industry include mortgage brokers, banks, credit agencies, service providers, and government-sponsored enterprises [39, 72]. These organizations need to cooperate and communicate with one another when processing a mortgage. Indeed, the consortium-based approach is common among e-business standard initiatives, although *de jure* and *de facto* approaches also co-exist [72, 73].

A Cross-Industry Focus

In this paper, we adopted a cross-industry perspective and collected data from multiple VSCs. We chose a cross-industry focus for two reasons. First, the importance of e-business standards has been recognized by many industries, such as high-technology (RosettaNet), insurance (ACORD), and health care (HL7, or Health Level Seven International) industries [73]. It is critical for a firm that just joined or is considering joining a VSC, regardless of the industry it is in, to understand the common motivators of firms' contributions. Data collected from multiple industries also make generalization of our findings more convincing. As suggested by Oliver and Marwell, we should not permit differences among consortia "to obscure the similarities that also exist" [51, p. 251]. Second, by taking on the cross-industry perspective, our work builds on and extends earlier pioneering works such as Markus et al. [39], which examined the same phenomenon within a single industry by using the case study approach. While Markus et al.'s work is more nuanced and reveals the subtleties of standardization, there is also a great need to understand if there are any common factors in this movement despite the industry differences.

The Theoretical Model and Hypotheses

BECAUSE OF ITS OPEN NATURE, an e-business standard is a public good, in that it satisfies the nonexclusivity and nonrivalry conditions [41, p. 350]. It is nonexclusive because anyone can download and implement the standard in their IS. It is nonrivalrous because one firm's implementation of the standard does not rival the implementation by another firm. A significant concern for the provision of a public good is free riding [11, 19]. Free riding can occur in two stages in the development of a standard that is public and freely available [68]. Firms can free ride by not joining the consortium at all and waiting for others to develop. Or, they can partially free ride¹ by joining the consortium as a member but only passively participating with limited actual contribution.

In this paper, we focus on understanding the second type of free riding because of the following two reasons. First, because of the easy-to-satisfy participation requirements of many VSCs, firms often prefer to become a member so as not to be completely left out of what represents the "state of the art" of industry standard development. However, they might not contribute more than the required membership fees. For instance, they might never suggest new standard requirements and never provide feedback on implementation, which are hard to monitor and control through any contractual arrangement by the consortium. The resulting second type of free riding might be more harmful

to the consortium than not participating at all, as the presence of passive members might negatively affect the morale and collaborative environment the consortium tries to cultivate among members. Furthermore, the development of the standard is not a step-good as defined by Hardin [24, p. 55], that is, the output is not binary in nature as in political events. Neither is the input. The continuous nature of the contribution makes it harder to study than the dichotomous joining decision, despite that firms' resource inputs affect the outcome of the standardization effort. Unfortunately, this form of free riding remains understudied in the literature, despite the rapid growth in standard development seen in many industries [39, 48, 74].

Second, the making of a public good can be viewed as a two-stage process [43]. The first stage is participant-level resource contribution in which individuals make their resource contributions. The second stage is collective-level production when the public good is produced. Contributions, as the dependent variable of the first stage, serve as the input of the second stage. Therefore, without a thorough understanding of the first stage, especially the drivers of contributions, the second stage cannot be studied.

We take individual firms' contributions as our dependent variable and employ the collective action theory to construct our theoretical model and hypotheses. Collective action theory is concerned with the making of a public good by self-motivated individuals. Based on collective action theory, many experiments and field studies have been conducted to examine the rate of individual contributions [54]. While seminal work from different areas such as economics [53], political science [24], and sociology [52] disagree on what extent individuals will contribute to a public good, they all share the view that certain factors, such as actors' interests in the collective action, their resource availability, and efficacy of the group, positively affect their contribution level.

To set up our theoretical model, we highlight two important characteristics of e-business standardization that need to be taken into account. First, there exist strong by-products from the collective action process that have to be considered when studying players' incentives [24, p. 31; 53, p. 132]. When participation offers benefits in many aspects, players are driven to contribute more. In the VSC case, participants have opportunities to gain great learning benefits (since the interaction is technically sophisticated) and social capital benefits (since participants get to know their peers who are at the forefront of technology use in their industry). Second, consortium management acts as an institution as it promotes, monitors, and sanctions member activities. Such an institution in general has been found to have significant positive effects on collaboration and contribution [54]. Below, we expand on these points to identify our independent variables and develop our hypotheses.

Based on the work of Olson [53], private benefits related to collective action are the main motivator of individual participation. Many subsequent empirical studies show that "collective-action organizations' members are motivated to become involved by their interests in a variety of incentives" [34, p. 314]. In VSCs, firms are interested in potential benefits provided by the standard as well as the multifirm cooperation process in the consortium.

Therefore, our first independent variable is firms' perceived benefits directly from the standard. Firms value e-business standards differently based on their business needs.

Some firms need to exchange information with many heterogeneous trading partners. For them, a uniform data-sharing interface based on industry-wide standards is more important than for firms that deal with only a limited number of partners.

Existing work in collective action theory posits that it is usually the participants who have very high interests in the public good that will contribute to the collective action and provide the good. In our case, to contribute resources to standard consortia, firms first have to “believe enough in consensus standards” [6, p. 117]. If a firm foresees more benefits from adopting e-business standards, it would be more motivated to invest in the consortium, speed up the development process, and increase the chance to have the standards in the future. Therefore, we expect that:

Hypothesis 1: Firms’ consortium contribution level is positively driven by their perceived standard benefits.

In addition to perceived standard benefits, potential benefits from the development process serve as a by-product for collective action participation, which can also become an important driver of contribution [24, 53]. This is especially true in VSCs. Here, we use the term “perceived process benefits” to represent such benefits that firms anticipate obtaining through participation and interaction with other members. Two features of perceived process benefits make them attractive for members, especially compared to perceived standard benefits. First, obtaining process benefits has a lower risk as it does not require successful diffusion of the standard in the future. As long as a firm actively contributes to development, it will receive the benefits with certainty. Second, benefits from interacting and working closely on advanced technical issues with leaders in the industry are hard to come by in other settings.

Learning is one such process benefit. In the alliance literature, interorganizational learning is identified as an important incentive for firms, as it can enhance their competitive positions [56, 60]. In VSCs, because development is a technically intensive process, the perceived learning benefit is significant as participants expect to gain advance knowledge of the direction of the standard and accumulate standard related expertise for a smooth future adoption [61].

In addition to learning, firms also expect to obtain social capital benefits [16, 44]. Social interactions within the consortium, a noncommercial and collaborative setting, serve many purposes. They can help firms to get to know their potential business partners, establish good reputation among peers and customers [58], and increase their opportunities to form partnerships [1]. Case studies of the Eureka project [45] and MISMO [39] clearly demonstrate the significance of such process benefits as a major organizational motivation behind firms’ contributions in consortia.

If firms foresee the opportunity of interorganizational learning in VSCs, they are more likely to actively participate in the process since “much of the knowledge is tacit, and the deliberations leading to the standard are far more nuanced” [57, p. 750]. Similarly, if firms believe in potential social capital gains from the consortium, they want to be active contributors rather than free riders because valuable social networks are based on mutually beneficial interaction and collaboration. Therefore, perceived process benefits induce firms’ contributions within VSCs and we expect:

Hypothesis 2: Firms' consortium contribution level is positively driven by their perceived process benefits from consortia participation activities.

Collective action theory suggests that firms' participation is also a function of their resource availability, which may differ substantially among members. "Often it is the scarcity of resources that seems to bound out options" [52, p. 529]. High-resource individuals can contribute more, everything else being equal. Two types of resources are needed for a firm to participate in a consortium-based standardization setting: financial resources and technical resources. Financial resources are needed to pay the mandatory membership fee, and to cover the cost of sending representatives to meetings, including travel and time away from their regular jobs. Financial resources act as a threshold—firms need to have at least the minimum amount to be able to participate—but having more does not necessarily lead to greater contributions since standardization involves technical discussions that do not require financial investment directly. By contrast, technical resources enable firms to actively participate in development because standards development is technically sophisticated, as "the [standards] debate often bogs down in arcane technical issues" [14, p. 25]. Firms' technical resources are their capability related to e-business standards [39] and they are critical for firms to be able to engage in development activities and influence the standard-setting process. Therefore, we expect:

Hypothesis 3: Firms' consortium contribution level is positively driven by their technical resources.

Last, consortium as an institution is important in creating and maintaining an environment that promotes social norms among participants that value collaboration. Well-managed collective action can motivate an individual's contribution via normative conformity [34]. Organizers can design rules and mechanisms to reinforce cooperative norms [54]. In addition, efficacy of collective action organizations is important [24, 52] and firms' belief in the group efficacy is predictive of their collective action tendency [24, 40, 64]. In VSCs, effective consortium management is critical in resolving collective action dilemmas [39], achieving coordination among members, reducing delays in standard-setting processes, and increasing members' satisfaction [17]. Firms tend to contribute more to well-managed consortia since these consortia encourage cooperation and coordinate multilateral interactions effectively. Therefore, we expect:

Hypothesis 4: Firms' consortium contribution level is positively driven by consortium management effectiveness.

Our model also controls for firm differences that may affect their consortium contributions. We expect firm size to be positively related to participants' involvement as larger firms have more resources and more power to negotiate and bargain within the consortium [67]. We expect that firms become more involved the longer they participate in a consortium. In addition, we control for consortia heterogeneity, including their size and maturity [50, 53]. Finally, we incorporate two industry-level controls: industry concentration ratio and industry IT intensity. More details about the control variables are given in the next section.

The Empirical Study

WE ADOPTED A SURVEY METHODOLOGY TO TEST OUR PROPOSED MODEL because many variables in the model were perception based and no secondary data were available. Furthermore, a survey enables us to obtain a large statistically testable sample and determine the relevance and significance of variables that motivate or hinder firms' involvement in VSCs [23]. To ensure the generalizability of the results, we surveyed multiple VSCs in multiple industries. In addition to the self-reported survey, we conducted nine semistructured interviews. We interviewed four MISMO members since detailed industry and consortium background information for MISMO was provided by prior research [39, 70]. We also interviewed executives from five VSCs. Qualitative interview data helped us cross-validate our findings from the survey.

Instrument Development

We systematically developed measurement items based on prior studies. All of the constructs were operationalized by multiple seven-point Likert scale items (see the Appendix). Below, we briefly highlight the important operationalizations.

Firm contribution level is a newly developed construct based on practitioner reports [62] and our field observations. It measures firms' resource investment in the consortium, including their participation in various consortium activities (e.g., new requirement proposal, work group meetings, testing, voting, and feedback provision) as well as their promotion of the consortium and its standard [62].

Perceived standard benefits refer to expected business value directly derived from using the e-business standards [28, 76]. Because those standards are still under development and firms cannot apply them at this stage, their benefits are strategic in nature.

Firms' perceived process benefits, modeled as a formative second-order construct, come from two sources: interorganizational learning [60] and social capital [44]. Perceived learning benefits refer to expected knowledge or organizational know-how obtained from consortium participation [35, 60]. Firms expect to understand the direction of standard setting, accumulate standard-related expertise, and reduce costs of future adoption after sharing and acquiring knowledge in the consortium. Perceived social capital benefits measure expected resources obtained by establishing institutionalized relationships with other consortia members [30, 46]. In the consortium, learning opportunities can be provided by other consortium members through repeated interorganizational interactions. Partnerships can be formed between two or multiple consortium members. For example, firms could work together on a new technology innovation after getting to know each other in VSCs. Last, by working with other members, firms have the opportunity to expand their market access.

Technical resources are defined as a firm's expertise in consortium-based standardization. Based on the work of David and Greenstein [14], we developed three subjective measurement items.²

Consortium management effectiveness concerns how effectively the consortium coordinates standard development activities. Indicators suggested by prior literature include having a clear mission [48, 63], being neutral and open to all participants [14,

73], and having strong leadership [69]. Markus et al. [39] recommend open communication and a clear definition of intellectual property rights (IPR) policies. Sound IPR protection motivates members to provide proprietary technologies and prevents future conflicts and lawsuits [39, 62].

We used annual sales as a proxy for firm size [23, 67]. Consortium size is measured by the number of consortium members, and consortium history refers to years since the consortium inception. Both measures were directly obtained from the consortia. Because consortia in our sample were established at different times, we used *years of a firm's participation in the consortium/consortium history* to measure firm history (FHIS), which reflects firms' relative tenure within the consortium. Industry concentration ratio, a proxy for competitiveness, was obtained from the U.S. Census Bureau. Following Brynjolfsson et al., industry IT intensity was calculated as "a percentage of total tangible wealth" [5, p. 17], with data provided by the Bureau of Economic Analysis's 2006 "Tangible Wealth Survey."

To ensure the content validity of the study, we went through a number of steps to design the survey. First, we developed the questionnaire items based on a comprehensive literature search. Second, two field tests were conducted. Executives from MISMO and Open Standards Consortium for Real Estate (OSCRE) examined our questionnaire in terms of clarity of the items and how they fit into the overall objectives of the research. Based on their feedback, we revised the questionnaire by clarifying ambiguous items and providing additional instructions. We then administered a pilot survey to members of OGC, and collected 16 responses. Respondents provided comments on the cover letter, instructions, and general survey design. We also checked the feasibility of distributing the survey through consortia and the reliability and accessibility of our survey Web site. Because the suggested changes were only minor, these 16 responses were incorporated into our final analysis.

Data Collection

We selected e-business consortia that fit the following criteria. First, the main mission of the organization is to develop standards for a specific industry. We excluded consortia that developed industry-neutral standards, such as Organization for the Advancement of Structured Information Standards (OASIS), because members in such consortia come from different industries and their contributions are affected by their industry's interest in the standards. We also excluded organizations, such as trade associations, for which standard setting was only part of their overall mission. In such cases, the factors that drive members' contribution may be too complex for the purposes of this study. Second, the organization should be nonprofit and use procedures that incorporate the attributes of openness, balance of interests, due process, and voluntary consensus. Third, the organization should be actively developing new standards to address increasing needs to digitize supply chain transaction processes.

We identified candidate VSCs through two major sources. The first was XML.org, a portal that hosts a comprehensive list of e-business standard consortia.³ The second was ConsortiumInfo.org, which provides descriptions and links for over 400 consortia

that develop and promote various types of standards. We contacted 17 consortia from 13 industries; their average size was 214 members. After several rounds of survey invitations and requests, 7 consortia from 6 industries participated in our study.⁴ Table 2 summarizes key characteristics of the participating consortia.

Target respondents for the survey were representatives from consortia member organizations. We set up an online survey via a secure university Web server and asked consortia executives to distribute our survey requests via their member e-mail lists.⁵ Two follow-up reminders were distributed two weeks and four weeks after the initial survey invitation [20]. The data were collected from May 2006 to September 2006. Survey respondents could enter a lottery to win one of five \$50 Amazon.com gift certificates. The survey was distributed to 1,784 member firms from 7 VSCs, out of which 247 firm-level responses were received, yielding a 13.85 percent response rate. The response rate was comparable to other survey-based firm-level studies [75]. Because there were 15 unusable responses due to incomplete data, only 232 were analyzed. Table 3 shows the sample characteristics.

To ensure the quality of the survey data, we conducted three tests. First, we examined the nonresponse bias by comparing early respondents with late respondents [2, 7].⁶ The comparison of all the constructs and firm-level control variables was not statistically significant ($p > 0.1$), suggesting that nonresponse bias should not be a concern.

Second, we checked for common method bias. As Malhotra et al. [38] recommended, the marker-variable technique is an effective tool to test common method variance (CMV). Our analysis showed that only 3 out of 21 significant correlations (14.29 percent) became nonsignificant when adjusted for CMV,⁷ which indicated that common method bias was not a serious problem [12]. We also followed the general factor covariate technique [55]. The nature and significance of the relationship between independent and dependent variables remained unchanged after the first unrotated factor was partialled out.

In addition, we collected consortia meeting attendance records from MISMO and PISCES (Property Information Systems Common Exchange Standard) to corroborate the self-reported measure of firms' consortium contribution level. Using the secondary meeting data as the dependent variable (i.e., the percentage of meetings a firm attended), we obtained qualitatively similar results.⁸ Triangulation of the results using secondary consortia meeting attendance data suggests the validity of the subjective firm contribution measure. It is reasonable to assume that representatives from VSC members have reliable information about their organizations' involvement in standard development.

Finally, selection bias might be a concern because our sample was not randomly selected [25]. To ensure that survey respondents were representative of the consortia members, we checked the breakdown of the organizations in our sample with those available from the consortia in terms of their member types defined by the consortium, such as vertical sectors (ACORD and FPL [FIX Protocol Limited]), member levels (OSCRE and PISCES), and regions (OGC). The comparison indicated a satisfactory representation of our sample. It was also possible that firms answering the survey might be more active in the consortium than nonrespondents. To alleviate this concern, we

Table 2. Consortia Characteristics

| Name | Industry | Founding year | Member size ¹ | Respondents ² (percent) | Functional areas | Vertical sectors represented |
|--------------------|--------------------|---------------|--------------------------|------------------------------------|--|--|
| ACORD | Insurance | 1970 | 482 | 110 (22.8) | Life and annuity Property and casualty/surety Reinsurance | Insurance carriers, reinsurers, agents, brokers, and financial services Associations Vendors |
| FIX Protocol (FPL) | Securities trading | 1994 | 188 | 22 (11.7) | Equity trading Foreign exchange Fixed income Derivative markets | Buy-side institutions Sell-side brokers/dealers Exchanges Vendors |
| MISMO | Mortgage | 1999 | 163 | 42 (25.8) | Residential mortgage Commercial mortgage E-mortgage | Mortgage brokers Mortgage banks Investors and securitizers Service providers Vendors |
| OGC | Geospatial | 1994 | 307 | 16 (5.2) | Digital spatial information: 23 working groups (www.opengeospatial.org/projects/groups/wg) | Data provider Service provider User Vendors |

| | | | | | | |
|---|-------------|------|-----|--------------|--|--|
| OSCRE ³ | Real Estate | 2003 | 42 | 8 (19.0) | Home information pack Investment valuation Lease delivery and exchange Portfolio information exchange Residential conveyancing | Real estate users and investors Service providers Institutions and the government Vendors |
| PISCES | Real Estate | 1997 | 152 | 19 (12.5) | Internal financial reporting External financial reporting Investment, lending, regulation Economic policymaking | Professional and financial services Government and not-for-profit organizations Accounting and trade organizations Vendors |
| Extensible Business Reporting Language (XBRL) | Accounting | 1998 | 450 | 15 (3.3) | | |

¹ Based on 2006 data from each consortium.

² Some consortia had higher response rates, possibly as a result of stronger endorsement from their managers (e.g., sending out the survey requests using consortium managers' personal e-mail account).

³ PISCES founded OSCRE, with PISCES located in the United Kingdom and OSCRE in the United States.

Table 3. Sample Profile ($n = 232$)

| Category | Percentage |
|--|----------------------|
| Annual sales (\$ million) | |
| < 1 | 10.3 |
| 1–19 | 19 |
| 20–49 | 6.9 |
| 50–99 | 9.1 |
| 100–499 | 15.9 |
| 500–999 | 8.2 |
| 1,000–4,999 | 26.3 |
| > 5,000 | 4.3 |
| Respondent title | |
| Chief executive officer, owner | 4.6 |
| Chief technology officer/chief information officer/vice president of R&D | 16.5 17.7 29.1 |
| IS manager, director | 32.1 |
| IT analyst, engineer | |
| Business manager | |
| Firm type | |
| Vendors | 38.4 |
| Users | 61.6 |

compared the secondary meeting attendance records between survey respondents and nonrespondents and found no statistically significant difference.

In addition to the aforementioned tests, we received multiple responses from 39 firms (16.8 percent of the full sample). Multiple respondents from a single organization can offset the bias of individual respondents, thus reducing the measurement error [27]. To check the consistency, we calculated both Cronbach's α and the correlation coefficient (Pearson product moment method) between multiple respondents' answers to all of the survey items [4]. If an organization had more than two respondents, we computed correlation coefficients for all pairs of respondents, which were then averaged. The results indicated high consistency among the majority of firms (over 85 percent), with Cronbach's α above 0.60 and correlation value of more than 0.40 [4, 49]. We then averaged the responses to generate the firm-level measure. For the six firms that had wide dispersion in responses, the answer from the respondent in a more senior-level position was used.

Measurement Model Validation

We used partial least squares (PLS)–based structural equation modeling (SEM) to analyze our data. PLS-based SEM was chosen for two reasons. First, the model incorporates formative second-order constructs and PLS “maps formative observed

variables” [22]. Second, the study is a preliminary effort to examine firms’ VSC contributions, as previous quantitative studies are limited. PLS is suited for theory development and exploratory research [22, 76]. We used PLS-Graph 3.0 to run the structural model.⁹

Following guidelines suggested by Gefen and Straub [21], we applied PLS-Graph to conduct confirmatory factor analysis (CFA) to ensure factorial validity. As shown in Table 4, all the measurement items have significant path loadings ($p < 0.01$) with acceptable magnitude [9]. Also, the average variance extracted (AVE) for all of the constructs exceeds 0.50 [21]. Thus, convergent validity is established. The composite reliability and Cronbach’s α for all the constructs exceed 0.60, which satisfies the criteria for reliability. Discriminant validity is established since the square root of a construct’s AVE is greater than its correlation with other constructs (Table 5). Results of the hypotheses testing are presented below.

Results

We fitted the structural model to test our hypotheses and show the results in Figure 1. Acceptable R -square ($R^2 = 0.41$) [76], the significance and magnitudes of path loadings, and high internal consistency together suggest good overall model fit [9, 22]. Consistent with collective action theory, firms’ contributions within consortia are driven by their interests in the perceived process benefits ($b = 0.266, p < 0.01$), resource availability ($b = 0.287, p < 0.001$), and perceived management effectiveness of the consortium ($b = 0.143, p < 0.05$), supporting H2, H3, and H4, respectively. However, the effect of perceived standard benefits is insignificant; thus H1 is not supported. One possible explanation is that e-business standards developed by consortia are freely available to any interested firms and are a public good. Thus, perceived standard benefits may not sufficiently motivate firms to contribute because firms can free ride. By contrast, only active participants can obtain learning and social capital benefits. Next, we examine the subdimensions underlying the second-order constructs: perceived process benefits. The results confirm that the perceived process benefits are formed by perceived learning as well as social capital benefits.

We then examine the effects of control variables. The impact of firm history is positive ($b = 0.088, p < 0.1$), which suggests that senior members tend to contribute more than relatively new members. Consortia characteristics matter, as consortia size has a significant and positive effect on members’ contribution level ($b = 0.719, p < 0.001$), whereas consortia history has a significant and negative effect ($b = 0.863, p < 0.001$). The negative effect of consortia history is counterintuitive and warrants some explanation. The fact that a younger consortium is conducive to contribution could be due to the novelty, excitement, and more opportunities to shape future directions in the early days before the mundane sets in. In addition, a consortium might need more resources early on to establish and improve its organizational structures and procedures. Firms in less IT-intensive industries tend to contribute more ($b = -0.224, p < 0.01$), perhaps because they might want to catch up and obtain advantages offered by XML-based open e-business standards.

Table 4. Results of Confirmatory Factor Analysis

| | Loading | <i>t</i> -value | AVE | Composite reliability | Alpha |
|----------|---------|-----------------|------|-----------------------|-------|
| CONTRI01 | 0.78 | 19.89 | 0.68 | 0.95 | 0.94 |
| CONTRI02 | 0.88 | 43.77 | | | |
| CONTRI03 | 0.79 | 26.22 | | | |
| CONTRI04 | 0.85 | 32.74 | | | |
| CONTRI05 | 0.88 | 48.62 | | | |
| CONTRI06 | 0.84 | 39.45 | | | |
| CONTRI07 | 0.88 | 46.44 | | | |
| CONTRI08 | 0.88 | 49.61 | | | |
| CONTRI09 | 0.64 | 13.14 | | | |
| STABEN01 | 0.71 | 8.16 | 0.57 | 0.87 | 0.82 |
| STABEN02 | 0.71 | 6.63 | | | |
| STABEN03 | 0.78 | 19.85 | | | |
| STABEN04 | 0.79 | 19.03 | | | |
| STABEN05 | 0.78 | 16.53 | | | |
| LEARNB01 | 0.82 | 18.38 | 0.64 | 0.84 | 0.69 |
| LEARNB02 | 0.86 | 38.64 | | | |
| LEARNB03 | 0.71 | 12.50 | | | |
| SOCIAL01 | 0.72 | 15.35 | 0.68 | 0.87 | 0.77 |
| SOCIAL02 | 0.90 | 70.02 | | | |
| SOCIAL03 | 0.85 | 43.41 | | | |
| TECRES01 | 0.76 | 13.64 | 0.66 | 0.85 | 0.73 |
| TECRES02 | 0.85 | 26.46 | | | |
| TECRES03 | 0.82 | 29.24 | | | |
| MANAGT01 | 0.65 | 9.90 | 0.56 | 0.91 | 0.89 |
| MANAGT02 | 0.75 | 17.95 | | | |
| MANAGT03 | 0.77 | 18.80 | | | |
| MANAGT04 | 0.76 | 16.95 | | | |
| MANAGT05 | 0.83 | 22.19 | | | |
| MANAGT06 | 0.75 | 10.70 | | | |
| MANAGT07 | 0.64 | 15.93 | | | |
| MANAGT08 | 0.84 | 32.80 | | | |

Vendors Versus Users: An Exploratory Analysis

USERS AND VENDORS ARE TWO MAJOR STAKEHOLDERS IN E-BUSINESS VSCs, and their co-existence differentiates e-business VSCs from traditional vendor-dominated IT consortia [31]. Vendors and users have different interests in the standards. Vendors need to develop and deliver proprietary solutions that are standard-compliant to their business customers. Thus, e-business standards are an integral and critical part of the final products that vendors sell. Even though standards are a public good, they are embedded in IS, a private good for vendors. In comparison, for users, e-business standards are just part of the infrastructure that helps them develop and deliver their final products or services, such as insurance contracts and accounting reports. Because of these

Table 5. Correlations Between Latent Variables and Firm-Level Control Variables

| | Mean (standard deviation) | CONTRI | STABEN | LEARNB | SOCIAL | TECRES | MANAGT | FSIZE | FHIS |
|--------|---------------------------------|---------|---------|---------|--------|---------|--------|-------|------|
| CONTRI | 5.02 (1.73) | 0.82 | | | | | | | |
| STABEN | 5.85 (1.07) | 0.32*** | 0.75 | | | | | | |
| LEARNB | 5.49 (1.14) | 0.43*** | 0.47*** | 0.80 | | | | | |
| SOCIAL | 5.49 (1.19) | 0.42*** | 0.47*** | 0.45*** | 0.82 | | | | |
| TECRES | 5.56 (1.40) | 0.40*** | 0.18*** | 0.37*** | 0.26** | 0.81 | | | |
| MANAGT | 5.37 (1.20) | 0.37*** | 0.44*** | 0.46*** | 0.33** | 0.22*** | 0.75 | | |
| FSIZE | 4.57 (2.25) | 0.08 | -0.11 | -0.06 | -0.03 | 0.17*** | 0.11 | N/A | |
| FHIS | 0.45 (0.28) | 0.22*** | 0.14** | 0.14** | 0.15** | 0.09 | 0.10 | 0.08 | N/A |

Notes: The diagonal shows the square root of a construct's AVE. See the Appendix for definitions of the variables and a list of the measurement items. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; N/A = not applicable.

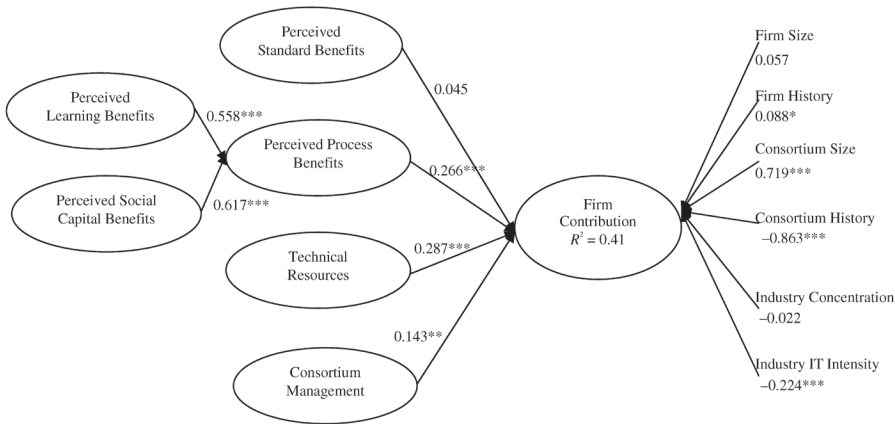


Figure 1. Results for Data Analysis—Full Sample

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

differences, we are interested in examining whether vendors and users have different motives to contribute to VSCs. Because previous literature comparing vendors and users in standard consortia is limited, our investigation is exploratory in nature. Our purpose is not to test any particular theories but rather to use the findings generated to explore differences between vendors and users in VSCs.

We split the data into two subsamples (vendors and users) and show the breakdown within each industry in Table 6. To lay a common ground for the between-group comparison, all items should be applicable to both vendors and users [26]. Among all the constructs, perceived standard benefits require some justification. For users, standardized data sharing and business transactions lead to better process efficiency, which can improve customer satisfaction (STABEN01) and relationship with trading partners (STABEN02). E-business standards also facilitate connection with new partners via common supply chain interfaces, thus bringing users potential business opportunities (STABEN03). In addition, users prefer industry-wide standards for better interoperability and less lock-in. Such standards will succeed only if they are critical and beneficial to the entire industry (STABEN04 and STABEN05). For vendors, by adopting an industry-wide e-business standard, they can improve customer satisfaction by alleviating their concern of being locked in by vendors' proprietary implementations (STABEN01) [15]. They can improve their relationships with their trading partners (e.g., users and supporting contractors) by delivering standard-based interfaces more efficiently (STABEN02). The prevalence of industry-wide standards can also increase vendors' potential customer base (STABEN04 and STABEN05) and enable them to provide new systems or complementary services based on the standards (STABEN03).

We reexamined the measurement model separately for the two groups [65]. The factor loading patterns are similar across the two groups and the full sample, which suggests that our measurement items can be used for hypotheses testing and between-group

Table 6. Vendor and User Breakdown Within Each Industry

| | Vendors | Users |
|--------|---------|-------|
| ACORD | 37 | 73 |
| FPL | 12 | 10 |
| MISMO | 14 | 28 |
| OGC | 9 | 7 |
| OSCRE | 4 | 4 |
| PISCES | 6 | 13 |
| XBRL | 7 | 8 |
| Total | 89 | 143 |

comparison [26]. Then we tested the structural model in the vendor subsample and the user subsample separately. To test whether the difference between the vendor group and user group was significant, we followed the procedures described in Chin [10] to calculate the significance of path coefficient difference between vendors and users (formula (1)). Table 7 summarizes the results.

$$t = \frac{\text{Path}_{\text{Vendor}} - \text{Path}_{\text{User}}}{\sqrt{\frac{(m-1)^2}{(m+n-2)} \text{S.E.}_{\text{Vendor}}^2 + \frac{(n-1)^2}{(m+n-2)} \text{S.E.}_{\text{User}}^2} \sqrt{\frac{1}{m} + \frac{1}{n}}}, \quad (1)$$

where m is the sample size of the vendor group, n is the sample size of the user group, and S.E. is the standard error estimates of the path coefficients based on bootstrap resamplings.

Our analysis indicates that vendors and users are motivated to contribute to consortium-based standardization if they are more interested, have more technical resources, and perceive more effectiveness of consortium management. Thus, collective action theory can be used to explain both groups' incentives in working in a consortium. However, our findings reveal that vendors are only motivated by perceived standard benefits, whereas users are only motivated by perceived process benefits. This interesting result warrants some explanation.

There are two possible reasons that perceived standard benefits cannot provide sufficient incentives to users. First is the diffusion of responsibility effect. According to social psychologists [36, 52], diffusion of responsibility happens if people assume someone else will make the contribution and provide the public good. We extend this notion to the cross-group setting. Because vendors are the producer and provider of standard-based systems, users have the option of depending on vendors to develop standard specifications. Second, users are on the demand side of the standard and vendors are on the supply side. Standards, as a public good, have different implications for the two sides. Since standards are open, they can be easily accessed by nonmembers. Without contributing to the development process, users can still obtain the same industry-wide standard when it becomes available. Thus, perceived standard benefits might not sufficiently motivate users' involvement. On the other hand, for vendors, standards are an integral part of their final product to be sold in the

Table 7. Structural Model Testing Between Vendor Group and User Group

| | Vendor | User | Difference |
|---|----------|----------|------------|
| Sample size | 89 | 143 | |
| R^2 | 0.43 | 0.48 | |
| First-order constructs (perceived process benefits) | | | |
| Perceived learning benefits | 0.54*** | 0.56*** | n.s. |
| Perceived social capital | 0.62*** | 0.63*** | n.s. |
| Hypotheses | | | |
| Perceived standard benefits | 0.21* | 0.01 | * |
| Perceived process benefits | -0.01 | 0.39*** | *** |
| Technical resources | 0.40*** | 0.26** | n.s. |
| Management effectiveness | 0.23* | 0.13* | n.s. |
| Control | | | |
| Firm size | -0.16* | 0.10 | *** |
| Firm history | 0.19* | 0.05 | n.s. |
| Consortium size | 0.66** | 0.92*** | n.s. |
| Consortium history | -0.76*** | -1.03*** | n.s. |
| Industry concentration ratio | 0.06 | -0.06 | * |
| Industry IT intensity | -0.10 | -0.28** | n.s. |

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; n.s. = nonsignificant.

marketplace. Standard specifications developed by the consortium are public goods, but standard-compliant systems and solutions are private goods and can be manipulated by vendors [8]. Vendors prefer selling products based on their own design to selling something developed by others. If a vendor perceives that the standard can be valuable, it will have a strong motivation to participate in the development rather than wait. Developing standards also has a signaling effect for vendors—to show that they are at the forefront of the industry and have superior capability to provide standard-compliant products and services—to inside and outside observers, especially users who are their potential customers.

Since perceived standard benefits are vendors' main incentive to contribute, perceived process benefits, which they still can enjoy, play only a supplementary role in motivating their contributions. By contrast, for users, due to the nonrival utilization of the standards [19], the diffusion of responsibility effect, and their more passive adopting role in standardization, users' perceived standard benefits alone may not be as much of a driving force as they are for vendors. Users can easily free ride them by implementing publicly available standards. However, it is difficult for free riders to obtain process benefits. Users are motivated to actively participate in the development process if they expect the value from acquiring tacit collaborative know-how [57, 60] or developing the network of relationships [30] more than offsets the costs. Thus, consistent with prior research [19, 39], perceived process benefits play a critical role in giving users motivation to contribute instead of free riding in the consortium, and the effect of perceived process benefits are more pronounced for users than for vendors.

The effects of consortium size and history are similar between vendors and users. However, firm size and history have different implications for those two groups. Small vendors tend to contribute more than larger vendors. A possible explanation is that smaller vendors rely more on the consortium to develop their standard-compliant products and reach potential customers. Firms' tenure within the consortia motivates only vendors' contribution level ($b = 0.15$, $p < 0.1$) and has no significant effect on users. The explanation may be because of the fact that vendors contribute more technical knowledge, which can increase within the consortium. However, users contribute more business domain knowledge, which grows mainly outside the consortium.

Discussion

OUR RESULTS IDENTIFY MAJOR FACTORS that encourage firms' resource contributions within standard consortia and highlight the different motivations between vendors and users. These findings have significant implications for the collective action literature, the consortium standardization literature, as well as the management of e-business standard consortia.

Consortium-Based E-Business Standardization as a Collective Action

Collective action theory has been applied extensively in sociology and economics to examine the collaborative provision of public goods and individual rates of contribution. Consistent with prior literature [39, 40, 52], our empirical results confirm that firms' interests, resource availability, and consortium management effectiveness jointly determine their resource contributions within the consortium. Firms' interests influence how they perceive benefits generated by the collective action. Their resource availability affects the amount of their possible resource contributions. Consortium management has effects on the effectiveness of multilateral coordination and cooperation reinforcement [54].

A unique aspect of consortium-based standard development as a collective action is the participation of multiple *types* of players. In this paper, we examine the differences in drivers of their contributions between users and vendors as they are on the opposite sides of the standard market. Furthermore, in the extant collective action theory literature, it is widely accepted that heterogeneity in players leads to higher success rates of collective actions [24, 52, 53]. Is this also true when heterogeneity is extended to multiple *types*? To answer this question, we conducted an ad hoc analysis by checking the correlation between an individual firm's contribution and average contribution from all the other firms (Table 8).

The results show that a firm's contribution is positively and significantly correlated with other members' average contribution, implying the cooperative nature of members' contributions. Theoretically, while it is well known that standard adoption has very strong and positive network effects, we show that at the *development* stage, network effects are also positive and strong. More interestingly, we observed cross-group

Table 8. Correlation Between a Firm's Contribution and Others' Contribution

| | Other members' average contribution | Other members' average contribution (from the vendor group) | Other members' average contribution (from the user group) |
|--------|--|--|---|
| Vendor | 0.236** | 0.145 | 0.283** |
| User | 0.240** | 0.282** | 0.197** |

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

complementarity: contribution from the other group is positively and significantly correlated to a focal firm's contribution. The cross-group correlation is also stronger than the overall correlation (first column) and same-group correlation. Such cross-group complementarity is easy to understand: vendors' contributions benefit users by ensuring the technical feasibility of the standard development and availability of complementary standard-compliant products and services in the future market. Similarly, users' contributions benefit vendors by providing business knowledge and through the higher probability of the standard being adopted because of their mere presence. Overall, the results show that collective action can be enhanced by the participation of multiple *types* of players whose incentives and actions complement one another. This can be a contribution to collective action theory research.

Perceived Standard Benefits, Perceived Process Benefits, and Their Differences

In this paper, we identify two types of benefits firms expect to receive from the collective action: perceived standard benefits and perceived process benefits. Perceived standard benefits are the direct benefits member firms expect to receive, as their goal is to have a successful collective action that delivers the standards. Perceived process benefits are the by-product of the collective action, and they complement standard benefits in motivating participants' resource contribution. Our results show that, indeed, the roles of these two benefits in motivating firms' resource contribution are different between the two groups. Perceived standard benefits—that is, benefits from the standard as an output of the collective action—motivate only vendors' contribution, not the users' contribution. By contrast, perceived process benefits—that is, benefits from participating in the development process—motivate only users' contribution and not vendors' contribution.

The reason for such differences is that the two kinds of benefits differ in their vulnerability to free riding. Since e-business standards are publicly available, they are subject to free riding. Users can depend on vendors to provide the standards due to the diffusion of responsibility effect. Users can access the same standards even if they are not consortium members. Thus, it is easier for users to free ride while still obtaining

standard benefits. However, process benefits are difficult to free ride. Consequently, perceived process benefits serve as the major motivator for users, and they can effectively offset their free-riding concerns. While standard specifications provided by the consortium are publicly available, vendors can still create private solutions based on open standards [8]. They are motivated to develop the standards, a critical part of their final products, if they see the value. For vendors, additional incentives provided by perceived process benefits are less important.

Our results have implications to collective action theory. Not only can by-products be a critical incentive for contribution to the collective action, but their relative importance varies across different *types* of players. Understanding such nuanced differences can help to better manage collective action efforts.

Implications for Management

Our study helps consortium managers to better understand members' incentives to contribute to standard development. To encourage their participation, consortium managers should emphasize not only benefits from future standards but also benefits from cooperating with peers in the consortium. Consortia should also carefully govern the standard-making process, which can encourage cooperative efforts and alleviate free-riding problems. Our results also suggest that consortium managers should pay attention to grow its member size. The more members there are in a consortium, the more contribution a firm will make. For standards, more developers imply not only more available resources but also the higher likelihood of standard diffusion in the future.

Consortium participation is costly and firms need to carefully evaluate this strategic investment. The amount they contribute depends on how they value the future product, the learning and social capital benefits expected from the development process, their in-house knowledge base, and the effectiveness of the consortium operation.

By analyzing data collected from all seven consortia, we found that, on average, firms' perception of consortium management was higher in smaller consortia than in larger ones. It confirms prior studies that it is more difficult to coordinate collective action in large groups [50]. In addition, well-established consortia had better management effectiveness perception than relatively newer ones, possibly due to their experience in managing multilateral cooperation.

Limitations and Future Research

Our data set and methodology have a few limitations that warrant future research. First, our examination of vendor and user differences is exploratory. Future research can develop further based on our preliminary findings. For instance, future studies can decompose benefits and resources constructs further to reflect the differences between vendors and users (e.g., perceived standard benefits that are unique to either users or vendors).

Second, our cross-sectional data cannot fully capture the dynamic process of standardization and interdependency between firms' contributions. Also, the cross-sectional design of this study precludes empirically testing causality of proposed relationships. Future research could use longitudinal data to explore the dynamics in the process, that is, how firms' consortium participation leads to realized benefits, which might affect their future perception and resource allocation decisions.

Third, in-depth cross-industry comparisons can be made to take into account the industry context and explain different actions firms take. Future study should also explore the external validity of the current study because generalizability of our findings to all e-business standard consortia might be limited due to the possibility of selection bias and a nonrandom sample [47].

In this study, we examined factors motivating firms' contributions after joining a consortium. Future studies can investigate how firms make their joining decision. Based on anecdotal evidence, we observed that firms chose not to join the consortium mainly due to lack of interest in standards or lack of resources (e.g., budget concerns).

Concluding Remarks

STANDARD CONSORTIA PLAY AN INCREASINGLY IMPORTANT ROLE in developing and diffusing e-business standards. To ensure consortia sustainability and the success of e-business standardization, we need to understand the factors that drive firms' resource contributions within consortia. Using collective action theory as the theoretical framework, our research finds that firms will determine their investments in consortia by weighing their potential benefits from both the consortia output and participation process, evaluating their internal resources, and considering the effectiveness of consortium management. Because of the divergent interests between the vendors and users, our exploratory investigation also found that vendors are more motivated by perceived standard benefits and users are more motivated by perceived process benefits. We believe that consortia, as a new organizational form that has been successfully employed by industries to accomplish certain tasks such as standardization, deserve more attention from researchers for their ability to facilitate innovation, diffusion of knowledge, and adoption of standards. We hope that our theoretical perspectives and empirical findings will encourage more research on this important phenomenon and provide insights to practitioners.

NOTES

1. In our sample, 9.9 percent of respondents might be considered the second type of free riders, as their average contribution levels were between 1 and 3 in the 7-point Likert scale measure.

2. To corroborate the self-reported measures, we collected patent data from the Delphion database. Since only 14.6 percent of vendors and 7 percent of users had been granted e-business standard-related patents, we did not include patent data in our model analysis. The cutoff date was May 2006 when we initiated the survey. We found that firms that had received IS or business

processes-related patents had significantly ($p < 0.05$) higher self-reported technical resources value than those that had not received any patents relevant to e-business standards.

3. XML.org was launched by OASIS in 1999 to “minimize overlap and duplication in XML languages and standard initiatives.” Over the years, XML.org has evolved from a central repository of XML schemas into several focused communities, such as IDtrust.XML.org for identity and trusted infrastructure standards (www.xml.org/about/).

4. We dropped two consortia from the final sample due to limited responses (one consortium had 1 response and the other consortium had 2 responses). Information of consortia that we contacted but did not include in the final sample is available upon request of the authors.

5. Most consortia do not disclose their member mailing lists as part of their policy.

6. We could not reach nonrespondents directly because only consortia had the contact information of the members to whom they distributed the survey.

7. We used both the smallest positive correlation and the second-smallest positive correlation as the proxy in computing the CMV-adjusted correlation.

8. Using the secondary meeting data as the dependent variable, we obtained the following path coefficients: $b = 0.028$ (nonsignificant) for perceived standard benefits, $b = 0.157$ ($p < 0.1$) for perceived process benefits, $b = 0.332$ ($p < 0.001$) for resource availability, and $b = 0.319$ ($p < 0.1$) for perceived consortium management effectiveness. They were qualitatively similar to results presented in Figure 1. We did not include control variables in the analysis due to the small sample size constraint ($n = 61$ based on MISMO and PISCES data).

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Appendix: Measurement Items

Firm Contribution Level (CONTRI) (seven-point Likert scale)

- Frequently suggests new standard requirements to this VSC (CONTRI01).
- Actively participates in standard development activities via working groups, VSC meetings, online forums, and so forth. (CONTRI02).
- Is involved in the standard testing (CONTRI03).
- Always participates in the VSC voting process (CONTRI04).
- Keeps providing feedback of standards implementation to this VSC (CONTRI05).
- Actively sends representatives to participate in VSC activities (CONTRI06).
- Attends VSC meetings on a regular basis (CONTRI07).
- Is an important stakeholder in deciding the policies and directions of this VSC (CONTRI08).
- Actively promotes this VSC and its standards (CONTRI09).

Perceived Standard Benefit (STABEN) (seven-point Likert scale)

- Can improve customer satisfaction (STABEN01).
- Can improve your firm's relationship with your trading partners (STABEN02).
- Adopting the standards can bring potential business opportunities to your firm (STABEN03).
- The standard development is critical to the industry in which this VSC is working (STABEN04).
- The standards are beneficial to the entire community (STABEN05).

Perceived Process Benefits-Learning (LEARNB) (seven-point Likert scale)

- Can understand the direction of the standard setting in advance (LEARNB01).
- Can accumulate standard-related expertise (LEARNB02).
- Can reduce costs of standard adoption by participating in the VSC (LEARNB03).

Perceived Process Benefits-Social Capital (SOCIAL) (seven-point Likert scale)

- Can learn from other VSC participants (SOCIAL01).
- Expects to establish partnerships with other VSC participants (SOCIAL02).
- Expects to improve market access through other VSC participants (SOCIAL03).

Firm Technical Resources (TECRES) (seven-point Likert scale)

Your firm has employees who understand technical details of the standards (TECRES01).

Your firm has experience in developing IT standards (TECRES02).

Your firm has gained experience from working in other standards consortia (TECRES03).

Consortium Management Effectiveness (MANAGT) (seven-point Likert scale)

The goals and objectives of this VSC are clear and well understood (MANAGT01).

This VSC is neutral and independent with respect to all firms participating in the consortia (MANAGT02).

The standard development process in this VSC is open (MANAGT03).

This VSC disseminates information accurately and responsively (MANAGT04).

The rules and procedures of this VSC are clear and fair (MANAGT05).

This VSC has a strong and efficient leadership (MANAGT06).

This VSC provides sound intellectual property rights policies and protection (MANAGT07).

This VSC promotes trust and compatibility among members (MANAGT08).

Firm Size (FSIZE)

Firm's annual sales (\$)

Firm Type

Is your firm an IT vendor or a user of the standards?

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