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ADOPTION OF VERTICAL STANDARDS

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Abstract

Over the past decade, the theories of Diffusion of Innovations and of Economics of Standards have been integrated to explain the Diffusion of Standards in Information Technologies. More recently, complex networked technologies unique to particular industries have been identified as a separate category called vertical standards, and the study of their adoption within and across industries has begun. This paper adds to the discourse by developing a theory-based model to explain variance in the adoption of vertical standards by firms. We posit that vertical standards adoption will be influenced by firm-level factors and adopter community-level factors. Key firm-level factors such as prior technology drag, knowledge barriers, and expected benefits, and adopter community-level factors such as standard legitimization and orphaning risk are identified as antecedents of vertical standards adoption. We also identify factors that impact each of these antecedents and put forth a research model interrelating these factors to vertical standards adoption. We expect to test our research model using data collected through a web-based survey of OASIS member firms.

Keywords: technology adoption, vertical standards.

1 INTRODUCTION

Recent technology adoption research has begun to recognize the existence of two distinct classes of standards: horizontal and vertical. While horizontal standards formally describe IT products that apply across multiple industries, vertical standards specifically address data structures, formats, and business processes particular to narrow industries (Markus et al. 2003). Vertical standards hold the promise of cross-platform systems integration, consistent product and service descriptor semantics, and the formalization and codification of best practices in any given industry. Their adoption is recognized to be a complicated interplay of market signals and individual evaluation by organizations, shaped by characteristics inherent to vertical standards as technology artifacts, as well as by community adoption behavior exogenous to the standards. This paper contributes to the emerging literature on IT vertical standards adoption by empirically testing a two-level model of organizational adoption. The model combines firm- and community-level adoption factors drawn from Diffusion of Innovations (DoI) theory and Economic Benefits of Standards (EoS) research.

2 DIFFUSION OF STANDARDS

Firm-level technology adoption has been studied using various combinations of, and extensions to, the five characteristics of innovations (complexity, trialability, compatibility, observability, and relative advantage) originally described by Rogers (1983). While technology complexity increases learning demands on a firm, the degree to which it may be experimented with (trialability) contributes to their reduction. Compatibility protects the firm's investment in existing technology, and the ability to extract observable benefits may lead to relative advantage for the organization. These adoption decision variables are best evaluated at the level of the individual firm, but are influenced dramatically by the effects of behaviors in communities of potential adopters. Behaviors such as the nature of standards development processes, 'herd' adoption, and network externalities leading to critical mass determine the level of legitimacy of technology artifacts and complex technology adoption risks.

Over the past decade, a new stream of technology adoption research that combines organizational adoption concepts with community adoption ideas has materialized. This emerging body of work has been labeled Diffusion of Standards (DoS), and draws from DoI theory and from the extensive literature on EoS. Since its introduction, DoI theory has been adapted to the study of technology innovations, and extended beyond its original paradigm of individuals making voluntary, binary adoption decisions to include organizational (Thong 1999), mandated (Hart & Saunders 1997), and complex networked technology adoption (Lyytinen & Damsgaard 2001, Hovav et al. 2004). The benefits of standards, defined as specifications for product, system, or application compatibility implemented by technology producers and consumers (David & Greenstein 1990, Farrell & Saloner 1992), have been studied extensively using economic theory concepts such as network effects, switching costs, lock-in, and orphaning risk (Shapiro & Varian 1999a, b). The economic models used to complete the majority of EoS research do not adequately reflect real-world variables such as standards sensitive to environmental changes (Damsgaard & Truex 2000), or the role of users, standards developing organizations (SDOs), consortia, and other intermediating institutions during technical development (Kotinurmi et al. 2003, Damsgaard & Lyytinen 2001). DoS theory incorporates variables not used in research based exclusively either on DoI or EoS, allowing for the study of firm-level adoption decisions influenced and shaped by factors specific to a community of potential adopters.

3 ORGANIZATIONAL ADOPTION OF VERTICAL STANDARDS

Current research acknowledges the role of various properties of standards in their adoption. The difference between physical or information-based products (Kotinurmi et al. 2003), timing of introduction (Baskin et al. 1998), complexity and wholeness (Libicki et al. 2000), and source of their authority (David & Greenstein 1990, Farrell & Saloner 1992) have all been suggested as potential shapers of standards adoption. Additionally, and of primary interest to this effort, standards have been identified as being either *horizontal* or *vertical*, based on the specificity of their domain (Markus et al. 2003). Horizontal standards describe basic levels of connectivity and are applicable across various industries. For example, EDI describes simple document formats that are reusable across several industries, and the base XML recommendation is broad enough to fit any domain. By contrast, vertical standards focus on data and business processes by developing common vocabularies, metadata, and processes that can be customized to the needs of very specific niches, and are designed to promote greater process and systems integration within a particular industry. Differences between the adoption behaviors of horizontal and vertical standards have been suggested in the literature (Jain & Zhao 2003), and while empirical models of adoption for horizontal standards abound, the model described here is the first one we are aware of for vertical standards.

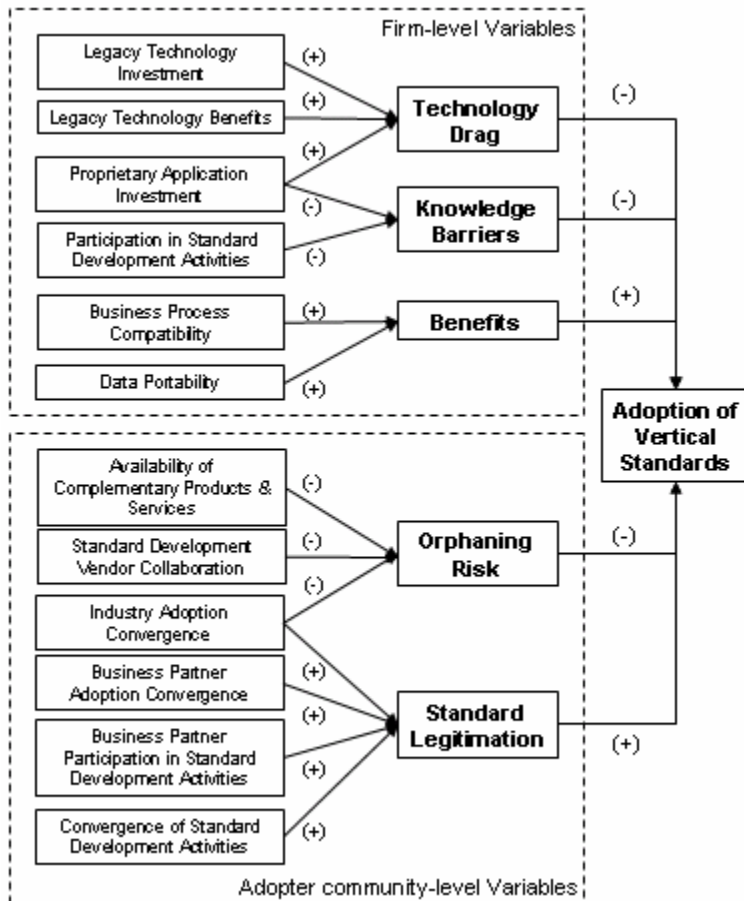


Figure 1. Factors impacting the adoption of vertical standards.

This paper uses a DoS theoretical lens to develop an organizational model of adoption of vertical standards (Figure 1). Since DoS theory is a combination of well-known effects found in DoI theory and in the literature on economic benefits of standards the model incorporates, implicitly and

explicitly, the major constructs found in both theories. DoI innovation characteristics such as compatibility and complexity are combined with economic effects such as network externalities and lock-in to generate a model that combines firm-level and community- adoption variables. Firm-level adoption is explored via DoI variables such as Technology Drag, which reflects compatibility concerns of new technology. Knowledge Barriers captures the tension between increased learning demands due to complexity and their reduction through trialability. In addition, observable benefits of compatibility with business processes and data structures, which may lead to relative advantage for the firm, are considered under the Benefits factor. Salient variables at the level of the community of adopters, such as network externalities and lock-in, are included in our treatment of Orphaning Risk and Standards Legitimation. The model will be tested empirically using data obtained from the membership of OASIS, an organization focused on the development, convergence, and adoption of electronic business standards.

3.1 Technology Drag

Technology drag arises when investment on an installed base of legacy technology prevents the adoption of newer solutions (Fichman & Kemerer 1993). Technology development and installation, support skills acquisition, and end-user training increase investment value. Potential disruptions to process integration between partners also contribute to technology drag (Holland & Lockett 1997). It is suggested here that extensive investment in legacy technologies increases technology drag, which in turn reduces the likelihood of adoption of vertical standards. However, legacy technologies provide organizations with a number of operational and strategic benefits proven to shape their adoption (Arunachalam 1995, Iacovou et al. 1995), and it is proposed here these benefits also contribute to an increase in technology drag. Lastly, organizations with extensive investment in proprietary applications seek to maximize their benefits which leads to an increase in technology drag when replacement technologies to support vertical standards are considered. In summary, the following hypotheses are offered:

- **Hypothesis 1** – High levels of technology drag are associated with a lowered likelihood of adoption of vertical standards by an organization.
- **Hypothesis 1a** – High levels of legacy technology investment increase technology drag.
- **Hypothesis 1b** – High levels of legacy technology benefits increase technology drag.
- **Hypothesis 1c** – High levels of proprietary application investment increase technology drag.

3.2 Knowledge Barriers

Knowledge barriers are low levels of expertise with new technology evaluation, its applications, and required management and support processes, and are associated with lowered likelihood of complex technology adoption (Attewell 1992). In addition to its effect on technology drag, proprietary application investment is hypothesized to reduce knowledge barriers by helping the organization acquire the application, procedural, and evaluative expertise (Ravichandran) described above. Also, DoS research explicitly recognizes the role of users in the development of standards (Dedrick & West 2003, Nickerson & Muehlen 2003, Kotinurmi et al. 2003). We offer that firm participation in vertical standards development activities reduces knowledge barriers because it increases IT skills sophistication and familiarity with system development and integration activities required by the standard, as it progresses through development. In summary, we posit that

- **Hypothesis 2** – High knowledge barriers are associated with a lowered likelihood of adoption of vertical standards by an organization.

- **Hypothesis 2a** – High levels of proprietary application investment lower organizational knowledge barriers.
- **Hypothesis 2b** – Participation in the development of industry vertical standards reduces organizational knowledge barriers.

3.3 Benefits

Despite extensive research efforts, a single theory explaining how, or if, IT provides competitive advantage across industries has not yet emerged. Existing literature suggests that complementary and co-specialized assets (Dedrick & West 2003, Subramani 2004), systems integration, and business reengineering (Swatman et al. 1994) are critical to the firm's ability to extract maximum benefits from IT. We hypothesize that the primary benefits of vertical standards are systems integration and business process reengineering enabled by their adoption. Systems integration is enabled by the formalization and codification of industry-specific data formats in vertical standards. For the same reason, firms may maximize the benefits of business process reengineering because they can more closely match the processes formalized and codified in any adopted standards. In short, the following is proposed

- **Hypothesis 3** – High levels of business benefits are associated with a higher likelihood of adoption of vertical standards by an organization.
- **Hypothesis 3a** – High levels of business process compatibility with vertical standards increase organizational benefits.
- **Hypothesis 3b** – High levels of data portability through the use of vertical standards increase organizational benefits.

3.4 Orphaning Risk

Orphaning risk is the potential of adopting a technically-inferior technology or one that does not become the dominant standard (Besen 1992), and may result in large legacy and switching costs (Shapiro & Varian 1999a, b) for the firm. When orphaning risk in an industry is sufficiently high, potential adopters wait for clearer market signals before making an adoption decision (Besen & Johnson 1986), reducing vertical standard adoption rates. Competing standards are a threat to adoption convergence in an industry, which increases orphaning risks for organizations forced to adopt several standards due to business partner pressures (Mendoza & Jahng 2003, Nickerson & Muehlen 2003). Conversely, we suggest that industry convergence towards one or few standards reduces overall industry orphaning risk. The availability of standards-compliant complementary products and services has been shown to be critical to standards success (Schilling 1999) and is a signal of convergence on one or few standards. Increases in the pool of available products and services should lead to a corresponding decrease in orphaning risk in an industry. Besen (1995) identified collaborative and noncollaborative vendor strategies during a standard's development and early adoption stages as important to its success. Collaborative strategies serve overall industry needs, while noncollaborative strategies disrupt adoption convergence for an individual firm's benefit. We suggest that collaborative vendor strategies lead to a reduction of orphaning risks in an industry. In light of the above discussion, we propose that

- **Hypothesis 4** – High levels of orphaning risk are associated with a lower likelihood of adoption of vertical standards by potential adopters.
- **Hypothesis 4a** – Industry adoption convergence reduces orphaning risk for potential adopters.
- **Hypothesis 4b** – Availability of complementary products and services reduces orphaning risk for potential adopters.

- **Hypothesis 4c** – Collaborative vendor strategies during standard development reduce orphaning risk for potential adopters.

3.5 Standard Legitimation

Legitimation is a social process that establishes use patterns for a technical innovation as a preferred solution for an industry (Emerson 1962, Lyytinen & Damsgaard 2001), and it has been suggested as important to technology adoption (Swanson & Ramiller 1997). It is argued here that a complex set of industry adoption signals drives the legitimacy of vertical standards, which in turn propels their adoption. Empirical evidence points to the increased likelihood of technology adoption by organizations participating in the activities of intermediating institutions (Teo et al. 2003) such as SDOs, and of “herd” effects in the adoption of complex networked technologies (Damsgaard and Lyytinen 1998). Together, these ideas suggest that participation of a firm’s business partners in development activities for a vertical standard increase the legitimacy of the standard as a choice for adoption for the firm. Competition amongst several potential vertical standards has been identified as a barrier to adoption (Libicki et al. 2000, Chen et al. 2003). Since network effects can delay technology adoption until a “winner” emerges (Angeles et al. 2001) but also accelerate it once it starts (Farrell & Saloner 2001), we suggest that a decreasing number of SDOs in an industry signals that a single standard will emerge as the eventual “winner,” increasing its legitimacy as an adoption choice, and stimulating adoption by industry members. Owing to the nature of network effects, growing industry adoption will increase the legitimacy of a vertical standard for other industry members, inducing further adoption. Lastly, it has been shown that business partners with significant business potential for an organization have the ability to prompt, sometimes compel, technology adoption (Bouchard 1993, Mendoza & Jahng 2003). However, in the absence of mandated adoption, business partner adoption convergence will increase the legitimacy of a vertical standard as an adoption choice for any firm. In light of the preceding discussion, we offer the following hypotheses

- **Hypothesis 5** – Higher levels of standard legitimation are associated with a higher likelihood of adoption of a vertical standard by organizations.
- **Hypothesis 5a** – Participation in the development of industry vertical standards by an organization’s business partners increases standard legitimation for an organization.
- **Hypothesis 5b** – Convergence of vertical standard development activities increases standard legitimation for an organization.
- **Hypothesis 5c** – Industry adoption convergence increases vertical standard legitimation for an organization.
- **Hypothesis 5d** – Business partner adoption convergence increases vertical standard legitimation for an organization.

4 CONCLUSION

Vertical standards adoption requires the use of multiple theoretical lenses, research methodologies, and consideration to variables external to the technology and the adopter (Lyytinen & Damsgaard 2001, Dedrick & West 2003, Nickerson & Muehlen 2003). The blending of classical DoI variables with EoS theory allows integrative research that combines organizational and community adoption variables to explain their adoption. Individually, the constructs described in this paper are not new, but their combined application to the study of vertical standards adoption is a new approach. The model presented in this paper will be tested empirically in order to determine the extent to which the factors presented contribute and shape vertical standards adoption.

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