

STANDARD MAKING: A CRITICAL RESEARCH FRONTIER FOR INFORMATION SYSTEMS RESEARCH

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Motivation and Goals

Standards have played an important role in the evolution of information and communication technology (ICT). ICTs are defined here as technologies dedicated to information processing, involving the use of digital computers and software to convert, store, protect, process, transmit, and retrieve information (Wikipedia 2005). These technologies, in general, establish the technological infrastructure upon which information system and applications are built.

“A standard defines a uniform set of measures, agreements, conditions, or specifications between parties (buyer-user, manufacturer-user, government-industry, or government-governed, etc.)” (Spivak and Brenner 2001, p. 16). Technology standards offer agreed upon, external points of reference to which the physical and performance characteristics of current or future technologies can be compared (Hawkins 1995, Spivak and Brenner 2001). Of special interest in the ICT arena are anticipatory standards that share three additional characteristics: (1) they are intended to guide future compatibility, or interoperability related to tangible products or systems like 3G systems, or intangible service platforms like Web-Services (David 1995), or data exchange or process standards (Markus et al 2006, Nickerson and zur Muehlen 2006); (2) they are created in international and/or national

institutional regulatory contexts that enable industry coordination (Hawkins 1995); and (3) they are proprietary or public domain agreements to which different parties have open access in that specifications are publicly available and can be influenced through institutional process (Gabel 1991). Because of its innovative nature, anticipatory ICT standardization is akin to cooperative, multi-actor research and development and indicative of collective engineering where standard writers create capabilities to displace existing capabilities (David 1995), and seek new markets (Gabel 1991).

During the last decade, standards have become increasingly critical in developing and managing ICT services as ICTs have become ubiquitous, heterogeneous, networked, and complex. On the supply side, firms that create *de facto* ICT standards can seize significant competitive advantage, while firms that are locked out or lag behind face the risk of losing important markets. Similarly, it is increasingly important for firms to cooperate in standard setting to send positive signals about likely winners in the ICT technology and market race, or to design new types of ICT services or products. On the demand side, firms that use ICT face an increasing number of technology options over a broader range of ICT capabilities, which has made the choice and management of standards and associated infrastructures a critical aspect of every day management of IT. The fast pace and expanded scope of ICT standardization has brought new problems to traditional institutional forms of standardizing, increasing uncertainty and generating new opportunities for stakeholders to jockey for position in the standardization game.

Despite the importance of standardization, the IS field has not pursued research on it vigorously. Scholarly discussions are rare, and strong contributions are lacking. Our rough analysis showed in 2002 that roughly 2 percent of published journal

papers in the field have dealt with ICT standards during the last decade. Most of this work, moreover, has been descriptive and focused on the content of new anticipatory IT standards, rather than examining processes and factors that explain *why* and *how* such standards emerge and diffuse or fail to do so. Notably absent are studies of standardization concepts, processes, the impact of ICT standards on industrial coordination and strategy, or the economics of ICT standards.

To address this void we proposed to Editor-in-Chief Ron Weber in 2002 that *MIS Quarterly* run a special issue on ICT standards. Our plan was to solicit a diverse set of papers, drawing upon multiple and heterogeneous perspectives covering technical, managerial, behavioral, organizational, and economic aspects related to ICT standardization. We hoped to bring together different research discourses relevant for making sense of standardization, and to stimulate debate on novel and intriguing analyses of ICT standardization that would be publishable in a top IS outlet. Our main goal was to launch ICT standardization as an important IS research frontier that would add significant value to the intellectual capital generated within the IS field, and to bring current standardization scholarship closer to the IS community. Ron accepted the proposal, and at his suggestion, we held a workshop on standards in December 2003 in conjunction with the International Conference on Information Systems in Seattle. This workshop involved competitive review and feedback of 43 submitted papers, of which 32 were discussed in small roundtable groups.

Following the workshop, we continued to solicit submissions until the deadline on March 31, 2004. A total of 46 manuscripts were received. A competitive review process involving at least two full rounds of reviews for many papers resulted in seven accepted papers, for an acceptance rate of 15 percent. The primary criteria for acceptance were a theoretically informed analysis drawn from the extant scholarly literature on standardization, and useful contributions to the goal of stimulating research on standards within the IS field. The associate editors and reviewers of the special issue did an excellent job in selecting and encouraging the seven submissions that were accepted.

Overview of the Content of the Special Issue

The seven accepted papers cover a broad range of topics and approaches relevant for understanding standardization contexts, antecedents, and outcomes. Table 1 summarizes the main contours of each paper along the following dimensions:

- *Type of standard investigated:* reference, regulatory, anticipatory, compatibility/interoperability, and their combinations
- *Level of analysis:* firm, industry, or function/feature in IT domain
- *Stage in standard development and use:* development and design, acceptance and enforcement, choice and diffusion, impacts
- *Type of theory:* sociological/political, economics, institutional theory
- *Research approach:* theory development, modeling and simulation, field study/survey methodology, case study
- *Unit of analysis:* single standard, standardization process, events or actors
- *Main findings:* main contribution to the extant literature on IS and IT standards

We have organized the papers in an order that starts with papers seeking to explain how standards are created and to identify factors that contribute to specific technical designs or references, followed by papers that analyze standard choice problems, and concluding with papers that investigate standardization and its impacts in particular organizational or industrial settings.

The first paper by James Backhouse, Carol Hsu, and Leiser Silva, titled "Circuits of Power in Creating *de jure* Standards: Shaping an International Information Systems Security Standard," analyzes the emergence of a global ISO-backed IT security standard from the view point of political persuasion and mobilization. They show how different circuits of power become endemic to the creation of this standard and how its creation both draws upon multiple sources of power and at the same time generates new power bases.

The second paper by Lynne Markus, Charles Steinfield, Rolf Wigand, and Gabe Minton, titled "Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry," examines conditions under which industry-wide collaborative standards defining data and process elements can be created. They recognize specific collective action dilemmas to standard creation under situations where standard creators are also standard users, but at the same time their use of standards is dependent on the mobilization and support of other stakeholders including small businesses, vendors, or software development organiza-

Table 1. Summary of Research Contributions

Article	Type of Standard	Level of Analysis	Standardization Phase	Theory Base	Research Methodology	Main Findings
Backhouse, Hsu, and Silva, "Circuits of Power in Creating <i>de Jure</i> Standards: Shaping an International Information Systems Security Standard"	Reference/regulatory standard.	IT security functions and controls	Standard creation and acceptance/enforcement across national and international standardization bodies	Clegg's Circuits of power theory: <ul style="list-style-type: none"> episodic power social power systemic power obligatory passage points 	<ul style="list-style-type: none"> Longitudinal case study using interviews and archival data Unit of analysis: standardization process and its outcomes 	<ul style="list-style-type: none"> All facets of power mobilized in standard creation and enforcement Exogenous contingencies necessary to mobilize bias and generate episodic power Memberships and alliances give credibility and promote social power that make standards legitimate
Markus, Steinfield, Wigand, and Minton, "Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage industry"	Anticipatory interoperability vertical industry standard for IS services.	Industry level analysis	Interactions between standard development, choice and diffusion and associated action dilemmas	Collective action theory	<ul style="list-style-type: none"> Longitudinal case study using archival data and interviews Unit of analysis: standards and organization of standardization efforts 	<ul style="list-style-type: none"> Definition of vertical IS standards as a special instance of standardization Increased heterogeneity of standardizing actors can threaten successful outcomes Formulation of structural conditions and tactics which promote complete and successful standards
Nickerson and zur Muehlen, "The Ecology of Standards Processes: Insights from Internet Standard Making"	Anticipatory interoperability standards for business workflow.	IT functionality across applications	Standard creation	New institutionalism through the analysis of social ecologies	<ul style="list-style-type: none"> Longitudinal case study using archival data and participation Unit of analysis: standardization events analyzed as movement of ideas, generation of institutions that legitimate designs 	<ul style="list-style-type: none"> During early stages significant anticipatory standard ideas seek institutions to become legitimized Institutions seek ideas, participants and actors to increase their power and authority High turbulence as ideas and actors move around institutions Norms and values aligned with institutions explain actor's behaviors and standardization outcomes

Table 1. Summary of Research Contributions (Continued)

Article	Type of Standard	Level of Analysis	Standardization Phase	Theory Base	Research Methodology	Main Findings
Weitzel, Beimbom, and König, "A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects, and Network Topology"	Compatibility and interoperability standards.	Industry level: patterns of standard adoption Firm level: rational models for standard choice and its timing	Standard choice and diffusion	Economics of standards	Modeling and simulation	<ul style="list-style-type: none"> What accounts for standardization gap (i.e., why don't standards diffuse despite their benefits for actors) What generates penguin effects (i.e., situations where standard diffusion stalls due to disincentives for early adopters) How do network topology and density affect standardization outcomes
Zhu, Kraemer, Gurbaxani, and Xu, "Migration to Open Standard Interorganizational Systems: Network Effects, switching costs and path dependency"	Migration to open standards that enable interorganizational systems. In particular the impact of networks effects, switching costs and path dependency on the adoption decision	Open standard adoption by firms in multiple industries	Standard choice and diffusion	Economics of standards, network effect, diffusion of innovation theory	Field study using a survey instrument	<ul style="list-style-type: none"> Development of a model to estimate standard switching outcomes in interorganizational IS Impacts of network effects and switching costs in standard migration
Chen and Forman, "Can Vendors Influence Switching Costs and Compatibility in an Environment with Open Standards?"	Compatibility standards for IT products	Firm level: vendor choice and adoption of routers and switches using TCP/IP	Open standard diffusion and its impacts	Economics of standards, switching costs to maintain barriers to entry	Econometric modeling and analysis	<ul style="list-style-type: none"> How vendors can maintain switching costs in IT industries based on open standards Use of both vertical and horizontal compatibility tactics Bundling of products and expanding product lines Segmentation of markets
Hanseth, Jacucci, Grisot, and Aanestad, "Reflexive Standardization: Side Effects and Complexity in Standard Making"	Reflexive standardization: side effects and complexity of standard making	Firm and inter-firm interactions	Vertical IS standard diffusion and its impacts	Actor network theory, theory of reflexive modernization (Beck) and complexity theories	Longitudinal case study about standardization of EMR content and functionality	<ul style="list-style-type: none"> Standard implementation beyond control Standardization efforts result in contradictory results (self destructive feedback)

tions among others. Their case study demonstrates how these collective action dilemmas have been resolved during the ongoing standardization of vertical industry standards in the U.S. mortgage industry.

The third paper by Jeffrey Nickerson and Michael zur Muehlen, titled "The Ecology of Standards Processes: Insights from Internet Standard Making," analyzes the emergence of new Web service standards in the workflow management arena. They trace a decade of workflow standardization processes as a set of legitimizing moves where actors, ideas, and institutions constantly and randomly collide to create a standard, which is technically acceptable and institutionally "forceful" for future adoption. Their analysis shows that institutional ecologies associated with Internet standards are not driven solely by economic calculus but that other norms and values, like elegance, design spirit, or technical wizardry, count in making ecologies viable.

The fourth paper by Tim Weitzel, Daniel Beimbom, and Wolfgang König, titled "A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects, and Network Topology," examines economics of standard adoption. In particular it asks: What drives the diffusion of a communication standard and what diffusion results can we expect under different circumstances? They formulate a formal unified model of standard choice and then, using simulations, examine how changes in different model parameters can affect the resolution of standard choice problems including the penguin effect, alternative diffusion paths, and the impact of network density and communication patterns.

The fifth paper by Kevin Zhu, Kenneth Kraemer, Vijay Gurbaxani, and Sean Xu, titled "Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency," explores the problem of standard switching from one IT platform to another, more versatile platform. In particular, they examine to what extent the presence of positive network externalities, switching costs, and adoption costs affect the adoption of a new set of standards. Their analysis shows that network effects play a significant role in new standard adoptions, while adoption and switching costs can vary depending on earlier standard choices. They use a large data set on EDI and Web standard adoptions in e-commerce to validate the proposed adoption model.

The sixth paper by Pei-yu Chen and Chris Forman, titled "Can Vendors Influence Switching Costs and Compatibility in an Environment with Open Standards?," probes how vendors can maintain switching costs in the context where product features

are mainly defined by open standards and thus possibilities for product differentiation are decreased. They show that, despite the threats of lowered product differentiation, vendors have been able to maintain market "barriers" by manipulating horizontal compatibility between comparable rival products, and vertical compatibility between complementary products, maintaining a broader product line, creating product suites, and targeting specific market segments.

The seventh paper by Ole Hanseth, Edoardo Jacucci, Miria Grisot, and Margunn Aanestad, titled "Reflexive Standardization: Side Effects and Complexity in Standard Making," discusses the contradictory outcomes of standardization efforts at the level of a community of health care organization. Standardized medical care data and processes are expected to provide order, efficiencies, and better informed medical decisions. Due to the complexity of the standardization processes and their environments these efforts are often undermined and increased disorder and less standardized data result. The authors apply ideas from actor network theory and complexity analyses to discuss and reflect upon the contradictory outcomes of health care standardization that they observed.

As can be noted the accepted papers embody a rich variety of approaches to account for standardization processes and outcomes. Studies focusing on standard creation draw mainly upon institutional analyses, power analyses or collective action theory and associated action dilemmas (e.g. prisoner's dilemma). Standards choice draws from economic theories of network effects, path dependency and switching costs. Standards impact embodies theories of how firms at the industry level can mitigate against increased transparency and lower barriers to entry created by open standards, as well as sociological analyses that try to explain *why* expected benefits of standardization orders did not emerge. The papers overall exhibit a significant variation in levels and unit of analysis, from individual firms to industries to types of standards or standardization outcome, and research methodology, from modeling and simulation to ethnographic studies of standardization processes. This shows how IS standardization research is likely to benefit from multiple research methodologies that also promote cross-pollination of ideas.

The papers also demonstrate *why* IS researchers should adopt, expand and revise the extant theories of standardization formulated in other reference disciplines. Information systems research brings to standardization research new contexts and problems that go beyond traditional economic or sociological analyses of standards creation and choice in industrial contexts. Examples include Markus et al.'s novel definition of vertical IS standards as a new subclass of IT standards ignored by earlier standard research, and Nickerson and zur

Muehlen's lively discussion of the "spirit of Web" and emerging standardization ecologies in the highly turbulent and uncertain realm of Internet standardization.

This special issue testifies that IS standardization is a growing and significant research topic that deserves attention and active theoretical work in years to come. We regard this special issue as a "legitimizing" move in making IS research on standards more routine. The selected papers show that bold theoretical developments and rigorous empirical studies are both possible and useful as standardization challenges grow in the IS arena. Several topics, in particular, need increased attention.

- The role of standard development and standardization in architectural design for industry level coordination and service development
- The explanation of standardization process outcomes using multiple theoretical frameworks
- Efforts to combine theories of standard making and choice
- Attention to the organization and structure of social and institutional networks that affect standards content, scope, and diffusion
- Interpretive story telling, linking the creation of standards to the creation of possible future worlds

We hope this special issue sows the seeds of an intellectual movement that will carry out an expanded research agenda on the topic of standardization. This movement need not be limited to routine forms of scholarly discourse, although we have observed the emergence of a dedicated journal in this area. We are encouraged by the results that can be obtained by following the path that we followed in creating this special issue: invite smart people to a temporary open forum and let them figure out what is challenging and interesting, and then select the best papers from the ensuing discussion.

Acknowledgments

This special issue would not have seen light without the support of many dedicated people. First, we want to thank our colleagues Wlad Fomin and Joel West for managing and organizing the standards workshop in 2003 at ICIS (Seattle) and helping us organize the review process. We also thank Janice DeGross and Jennifer Syverson from the *MIS Quarterly* office for their profes-

sional support. We owe a great deal to Kathy King, who helped in the final stages by editing some manuscripts. Special thanks go to Editors-in-Chiefs of *MIS Quarterly*, Ron Weber and Carol Saunders, who supported our idea of a special issue, and agreed with us that standards are important. We also express our gratitude to our excellent group of associate editors who carried out the review process in a timely manner following *MIS Quarterly*'s high expectations of scholarly quality. In particular, we are thankful that they went to extraordinary efforts to find reviewers, the list of whom reads like "who's Who" in standards research.

We end with a special tribute to the legacy of Professor Claudio Ciborra, who sent the final decisions on the papers he was managing from his hospital bed in the summer of 2004, just a few months before his untimely death. This special issue is dedicated to his memory. Claudio, we miss your laughs, and your stubborn readiness to fight for the sake of intellectual quality.

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