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ORGANIZATIONAL MECHANISMS FOR ENHANCING USER INNOVATION IN INFORMATION TECHNOLOGY[1]

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Abstract

Fostering information technology innovation has assumed primacy in discussions of information systems management. Changes in the nature of available information technologies and their potential applications underscore the importance of creating new knowledge for deploying a technology within an organization rather than transferring such knowledge from external sources. Technology users remain a largely untapped source for such knowledge creation. This paper argues that deliberate organizational design actions in the form of mechanisms can enhance technology users' propensity to innovate in information technology. Specifically, a taxonomy of organizational mechanisms is developed based on the ability of various mechanisms to facilitate knowledge acquisition and knowledge conversion. The conceptual taxonomy is populated with specific design actions described in the literature utilizing a Delphi study. The effects of various classes of mechanisms on three key antecedents of user propensity to innovate in IT—technology cognizance, ability to explore a technology, and intention to explore a technology—are tested using a field study. Results provide support for the conceptual taxonomy. Implications for theory and practice are offered.

Keywords: IS innovation, organizational mechanisms, technology cognizance, technology exploration, propensity to innovate

ISRL Categories: DA08, DD0501, DD06, EL05, GB01, GB02, GB03

Introduction

Surveys of senior information technology (IT) executives consistently rank "creativity and innovation" as a critical issue facing IT management (Couger 1988; Niederman, et al. 1991; Zawacki 1993). It is increasingly evident that organizations can no longer afford to wait for suitable problems to occur for information technology deployment; instead, they need to be proactive and scout for opportunities to exploit new information technologies through the conceptualization and

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development of innovative applications (Keen 1993; Luftman et al. 1993). The consequences of not responding promptly to new opportunities are grave; as Keen evocatively notes: "once innovative applications of IT are used to change the rules of competition in an industry, at least fifty percent of the companies in the industry will disappear within a decade" (Keen 1993, p. 12). They would disappear not because they did not implement the IT solution (which they might), but because they failed to recognize the opportunities early enough to act appropriately.

Given the crucial role that innovation in information systems (IS) plays in contemporary business enterprises, a logical question that arises is who is responsible for such creative and innovative activity? Prior research has predominantly tended to focus on enhancing the innovative capabilities of IS professionals (e.g., Couger 1996; Couger et al. 1993) or examined the role of the elite core of an organization (e.g., Rockart 1988) in initiating innovative activity. Technology users, by and large, have been treated as passive recipients of innovative artifacts. Indeed, a dominant view in the IS innovation literature continues to be a technology transfer perspective where the locus of creative activity is the IT organization. A major emphasis in this literature is on the adoption and implementation of IT (Kwon and Zmud 1987), with limited attention being paid to how and where innovative ideas for IT deployment originate and evolve in organizations.

Consider an observation made almost a decade ago by Ed Burke, Otis' Director of MIS. He commented "It was and is George's system. He saw the need. He saw the solution. I helped, but he made it happen" (as quoted in Rockart 1988). George David, the then CEO of Otis Elevator Corporation conceptualized the idea of centralizing elevator information and using it for efficient maintenance and improved product design. While several scholars have quoted this example to emphasize the competitive potential of IT, one important aspect has often been overlooked. The system was conceptualized not by IS personnel, but by a user. It was the user who perceived the business problem and integrated business and technical knowledge to develop a solution. Recent evidence indicates that technology users might represent a largely untapped source of creativity within an organization and offer considerable promise for the initiation of IT innovation (e.g., Korac-Kakabadse and Kouzmin 1996; von Hippel, 1988).

The focus in this paper is on technology users as a source of IT innovation. The research question posed asks, "How can an organization encourage and nurture IT innovation among users?" Specifically, the emphasis is on how managerial action in the form of organizational mechanisms can enable users to identify innovative uses of IT already adopted by the organization. IT innovation initiation is viewed as a process of knowledge creation (Attewell 1992) situated within an organizational context and a social environment. Drawing upon organizational learning theory, a conceptual taxonomy of organizational mechanisms is developed based on their role in such knowledge creation. Although the overall goal is to understand how a user's propensity to innovate in IT can be enhanced, recognizing that such a propensity is an exceedingly complex construct that could conceivably be influenced by many factors, the focus of the study is limited to three key antecedents: technology cognizance, ability to explore, and intention to explore. Propositions regarding the effects of various classes of mechanisms on these three dependent variables are stated. A Delphi study is utilized to populate the conceptual taxonomy with mechanisms identified in extant literature, while results from a survey of 200 technology users provide support for the propositions.

The work presented here offers several theoretical as well as practical contributions. From the perspective of theory development and advancement, the study posits that the varying effects of organizational mechanisms are attributable to their ability to support the key knowledge creation activities of acquisition and conversion. In essence, a fresh perspective is offered on how IS managers should view organizational mechanisms by describing a theory that permits predictions regarding what mechanisms will exhibit positive effects on antecedents of users' propensity to innovate in IT. From a pragmatic standpoint, the empirical results can inform managers about the relative efficacy of alternative mechanisms in facilitating knowledge creation. Managers may use the findings to make important cost benefit tradeoffs in choice of mechanisms.

The remainder of this paper is organized as follows. The next section describes a perspective that views the initiation of IT innovation as a knowledge creation process. The third section examines design choices in the form of mechanisms that can enable knowledge creation and develops a taxonomy for conceptually situating mechanisms. In the fourth section, the dependent variables of interest are described, and three propositions that relate the conceptual taxonomy to the dependent variables are developed. A Delphi study conducted to situate organizational mechanisms in the knowledge creation taxonomy as well as a separate empirical study conducted to test the research propositions are then described, followed by a discussion of the results. The paper concludes by describing the key implications of the findings.

Initiation of IT Innovation as Knowledge Creation

Recent work recognizes that creativity is a crucial prerequisite to all types of innovative activity in organizations (Amabile et al. 1996). Within the information systems field, research on creativity has predominantly tended to focus on the effectiveness of interventions targeted at IS personnel. Creativity intervention studies began to appear in the IS literature in the late 1980s (e.g., Elam and Mead 1990). Some studies have examined specific techniques such as wishful thinking, progressive abstraction, 5Ws and the H, and force field analysis that enhance the creativity of IS personnel, while others have explored how the creativity of IS professionals might be measured (Higgins and Couger 1995). Although the role of users as a source of creative ideas has been acknowledged in the research literature (e.g., Ciborra 1991), it is surprising that there is a paucity of theoretical development and empirical work in this area. The implicit assumption that IT innovation originates from the ideas of IS professionals (albeit, in concert with technology users) and that innovations are subsequently transferred into user environments was perhaps appropriate for a majority of the systems developed and implemented in the past three decades. However, as argued below, important environmental changes underscore the need for a new conceptualization.

The *nature of information technology* has changed considerably. Until recently, the range of uses to which IT could be applied tended to be fairly well defined and limited— in other words, there were a handful of ways in which a technology could be utilized. However, with the emergence of more knowledge intensive technologies such as the World Wide Web and data warehousing, opportunities for their exploitation are not so clearly defined and apparent. Such technologies have been characterized in recent literature as advanced information technologies (DeSanctis and Poole 1994), malleable, and exhibiting greater levels of interpretive flexibility (Orlikowski 1992). Furthermore, the nature of the support provided by information technology has also been altered in a fundamental way. Increasingly IT is being utilized to develop applications that address the business rather than the administrative core of an organization and, indeed, enable the definition and implementation of competitive strategy (Keen 1993). Several metaphors have been used by scholars to describe these phenomena related to the ubiquity and impact of IT: informating (Zuboff 1988), information age organizations (Cash et al. 1994), and the digital economy (Tapscott 1996).

It has been suggested that every technological innovation has two knowledge components: awareness knowledge and how-to knowledge (Rogers 1995; Tornatzky and Fleischer 1990). The former type of knowledge relates to factual information, also called the technological context, while the latter refers to knowledge required to productively utilize the innovation in a particular work context, also called the embedding context (Tornatzky and Fleischer 1990). Although their relative proportions may vary, all technologies are characterized by both types of knowledge. For example, there is likely to be little *how-to* knowledge involved in the deployment of cost accounting software, while electronic commerce might involve a larger degree of how-to knowledge. In other words, the adopting organization needs to understand not only the costs and technological features of the new innovation, it also needs to be able to identify what business processes are likely to benefit from the application of the technology.

The knowledge-based perspective on innovation initiation questions an assumption embedded in the diffusion of innovations perspective: that innovation initiation is a form of knowledge transfer where both awareness as well as how-to knowledge could be obtained from the outside (Rogers 1995; Pierce and Delbecq 1977). It might have been true for the first generation information technologies where both awareness and how-to knowledge associated with an innovation could be transferred from one context to another. The assumption is particularly untenable, however, for the utilization of the more knowledge-intensive and complex technologies, where how-to knowledge "often has to be discovered *de novo* within the user organization" (Attewell 1992, p. 6). In other words, far from being easily transferable to the user organization, the how-to knowledge may face barriers and be relatively immobile (Boyle 1986; Eveland and Tornatzky 1990, p. 139).

A more apropos metaphor for viewing IT innovation initiation, then, is one of successive translations: context-free IT knowledge (emanating from external or internal sources) enters the perceptual space of potential innovators and is attended to. The extent to which organizational value is derived from the knowledge, as manifest in innovative ideas, is a function of how successfully the context-free knowledge is translated into firm-specific knowledge. Leonard-Barton (1995) characterizes such translation as closing the "readiness gap." For example, a successful data warehousing application cannot be developed by merely duplicating an application built elsewhere in a different context. Instead, users have to creatively identify the unique ways through which new knowledge can be derived by integrating data from multiple functional areas within their organization. This will force the organization to go through considerable individual and organizational learning before a new information technology can be marshaled—a learning that may not be valuable in a foreign context. Indeed, prior literature in IS has studied such knowledge barriers in the adoption of CASE technology (Rai 1995; Rai and Howard 1994). As Attewell notes (1992, p. 7), "reinvention and learning by doing are, in part, responses to the difficulty or incompleteness of technical knowledge transfer between firms."

The specific focus in this paper is on *technology users* as a source of IT innovation. Consistent with prior literature, it is argued that new IT knowledge is created at the confluence of business expertise and technical mastery. Growing evidence from other high tech industries indicates that technology users can be a highly promising source of innovation (Urban and von Hippel 1988; von Hippel 1978, 1986, 1988). In the IS area, user involvement and participation in information technology related processes have been studied predominantly from the requirements analysis and implementation perspectives (Cavaye 1995; Ives and Olson 1984), while the role of users in the initiation of IT innovation has received limited attention (Swanson 1994). Nevertheless, there is some support for the notion that users can play a crucial role in initiating IT innovations, especially those that involve the integration of IT with the core business technology of the firm (e.g., Beath and Ives 1988; Korac-Kakabadse and Kouzmin 1996; Rockart 1988). Significant business understanding, which exists primarily at the user level, must go into system conception. Thus, as Ciborra (1991) comments, successful strategic IT innovations often emerge from grassroots-level activities (e.g., end-user hacking, prototyping) in user units, rather than from the application of rational planning models. Additional support for the critical role that users play is provided by recent findings from Korac-Kakabadse and Kouzmin's (1996) study of "molecular" innovation in an Australian government office. Although this organization had a functional, hierarchical structure, it used an informal network mechanism as an integrating device for the effective management of bottom-up innovation processes.

In summary, the argument here is that it is important to view the process of IT innovation initiation through a lens of knowledge creation. Also suggested is the need to acknowledge that users, by virtue of their business insights that may not be available to IT professionals, have the potential to be significant actors in the innovation initiation process (Larsen 1993). Thus, while IT innovation has been characterized as a multi-stage activity involving phases such as initiation, adoption, and implementation (e.g., Rogers 1995), the specific emphasis is on this crucial first stage of this process. How can such knowledge creation for initiating IT innovation among users be better facilitated? To answer this question, extant theories of knowledge creation, and the antecedents proposed therein, are examined.

Design Actions for Enabling IT Knowledge Creation

In a recent book, Nonaka and Takeuchi (1995) describe a theory of organizational knowledge creation. At the core of their theory is the notion that there is a distinction between tacit knowledge—that which is personal, context-specific, and difficult to articulate and communicate—and explicit knowledge—that which can be transmitted from one source to another in a systematic manner and that which is relatively objective. They argue that knowledge is created through the interaction and intersection between tacit and explicit knowledge, following four different modes of conversion: socialization, internalization, externalization, and combination. Nonaka and Takeuchi further suggest that each mode of knowledge conversion can be enabled through appropriate activities and structural arrangements; for instance, brainstorming camps are identified as a means of socialization, while creative uses of communication networks and databases can facilitate combination.

Although Nonaka and Takeuchi provide a rich conceptualization of the knowledge creation activity, they developed their theory in the broad context of creating all varieties of organizational knowledge, not IT knowledge per se. Moreover, the specific guidelines they present that can purportedly facilitate knowledge creation are stated at a high level of generality (e.g., two recommendations made by them are to "piggyback on the new-product development process" and "adopt middle-up-down management") and do not provide explicit guidance for organizational design actions. However, their conceptualization provides an important insight that informs the present work: rather than considering creativity and innovation initiation as a fortuitous occurrence of knowledge (or information) transfer, one should view it as an intentional process of knowledge creation that can potentially be encouraged and facilitated by appropriate managerial interventions—i.e., the organization provides the necessary enabling conditions for knowledge creation.

To identify such managerial interventions, we turn to a related stream of research in the IT domain that has examined a variety of design actions, referred to as mechanisms, to facilitate structured and unstructured interactions between technology users and technology providers. A mechanism is defined here as a structural arrangement such as an IT steering committee (Drury 1984; Gupta and Raghunathan 1989; Raghunathan 1992), a relationship manager (Subramani et al. 1995), or an advanced technology group (Zmud 1988), as well as specific activities such as sending users to IT conferences and trade shows (Nilakanta and Scamell 1990).

Empirical results suggest that mechanisms can exhibit differential efficacy with regard to outcomes. For example, visionary teams (e.g., IT steering committees) have been found to provide strategic focus for organizational members and to create contexts for the integration of business and technical knowledge (King and Teo 1994). Mechanisms that establish partnerships (e.g., relationship manager) provide support for maintaining dialogue between users and IS providers (Subramani et al. 1995; Zmud 1988), while educational activities (e.g., attending conferences/trade shows) primarily support technological awareness (Nilakanta and Scamell 1990). Although the role played by such mechanisms in promoting interactions and coordination is widely acknowledged, no work reviewed specifically examines how effective alternative mechanisms are in facilitating the knowledge creation process necessary for IT innovation.

Given the potential variety in the nature of the mechanisms, as well as significant costs associated with implementation, a critical challenge for managers is to make systematic choices among mechanisms. This requires a clear articulation of the rationale for observed variation in effects. In order to obtain a richer understanding of how mechanisms vary in their ability to support knowledge creation, a two-dimensional taxonomy derived from organizational learning theory is offered below (see Figure 1). The two dimensions of the taxonomy are: (1) the type of knowledge that is created and (2) the type of knowledge creation activity that is facilitated.

Type of knowledge: Prior research suggests that an organization desiring to exploit a new technology may need to acquire different types of knowledge (Tornatzky and Fleischer 1990). While many different conceptualizations of knowledge types exist (e.g., Sinkula 1994), three kinds are considered salient here, based on the degree to which the knowledge relates to the business context for technology application.

- *Type 1* is knowledge about an IT without reference to any application context.
- *Type 2* is knowledge about the application of an IT in the general business/industry (external) context.
- *Type 3* is knowledge about the application of an IT in an organization's own (internal) context.

Type 1 and Type 2 knowledge represent awareness knowledge, as they refer to factual and declarative knowledge (Corsini 1987) about a technology and its generic applications (the *know-what* knowledge [Leonard-Barton 1988]). In Nonaka and Takeuchi's framework, Type 1 and Type 2 knowledge fall on the "explicit" end of the knowledge continuum. Type 3 knowledge represents the *know-how* or how-to knowledge as it integrates factual knowledge about the technology with contextual knowledge—business as well as social—of the particular organization. This type of knowledge is likely to be experiential, subjective, and context-specific, all

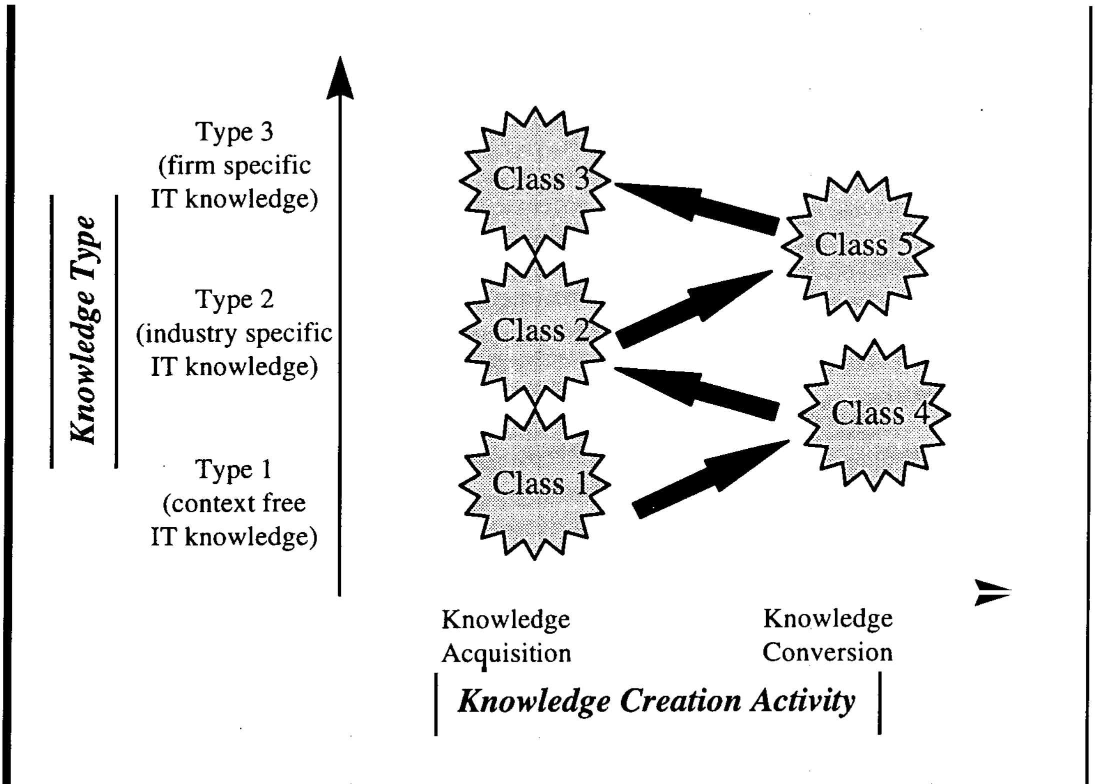

Figure 1. A Taxonomy for Organizational Mechanisms

attributes of tacit knowledge (Nonaka and Takeuchi 1995).

Knowledge Creation Activity: Two types of knowledge creation activity are identified based on Huber's (1991) classification. Knowledge acquisition is defined as the set of activities associated with acquiring IT knowledge from internal and external sources and distributing it to relevant members of the organization. This relates to Huber's learning processes of acquisition and information distribution; in essence, "distribution" is equivalent to "acquisition" when viewed from the perspective of the recipient. Knowledge conversion is defined as the set of activities associated with transforming knowledge from one type to another (e.g., Type 2 to Type 3). The transformation step calls for interpreting factual knowledge about a technology within the business context (information interpretation as per Huber), storing/retrieving knowledge from organizational memory (Huber 1991), and synthesizing new knowledge by combining existing knowledge elements.

It is evident that in order to effectively utilize a new technology in an innovative manner, an organization requires Type 3 knowledge. Organizational actors need to understand *both* what the technology is capable of providing, as well as how it might best be utilized within the constraints imposed by the existing organizational environment and work processes. An organization may either acquire Type 3 knowledge directly, or acquire Type 1/Type 2 knowledge and convert it into Type 3. Although it is possible that in certain instances the acquisition and conversion of knowledge might be fortuitous or accidental (Ciborra 1991), such cases are not of interest here as they are not directly amenable to managerial intervention. More often than not, knowledge acquisition and conversion is facilitated by deliberate managerial design actions—i.e., organizational mechanisms enable the acquisition of one or more types of knowledge and/or conversion of knowledge from one type to another. Hence, based on the above taxonomy, it is possible to conceptually situate organizational mechanisms into five classes.

- Class 1: Acquisition of Type 1 knowledge
- Class 2: Acquisition of Type 2 knowledge
- Class 3: Acquisition of Type 3 knowledge
- Class 4: Conversion of Type 1 knowledge into Type 2 knowledge
- Class 5: Conversion of Type 1 or Type 2 knowledge into Type 3 knowledge

There are parallels between the classification scheme and the four knowledge conversion modes identified by Nonaka and Takeuchi. Specifically, mechanisms in Classes 1, 2, and 4 support *combination* as they facilitate the acquisition and conversion of explicit to explicit knowledge. Mechanisms in Class 3 enable visionaries within the organization to *convert* explicit knowledge about business strategy and objectives into tacit knowledge about technology application opportunities and priorities that can then be used by technology users to direct their exploration efforts. In other words, Class 3 mechanisms permit users to *internalize* how the technology might fit with the firm's business model. On the other hand, mechanisms in Class 5 primarily support *socialization* (tacit to tacit conversion) through dialogue and the sharing of mental models, and to a limited extent, *externalization* (tacit to explicit conversion) through hands-on experimentation and prototyping or through specific roles that bridge technology and business contexts. This comparison is revisited subsequently in the paper while discussing empirical results.

The classification scheme above constitutes a theory-based taxonomy of organizational mechanisms. However, recall that the major emphasis in this study is on the effects of mechanisms that belong to each of the classes on a technology user's propensity to innovate in the use and application of IT that has already been adopted by the organization. In order to establish the nature of these effects, it is important to clearly articulate the meaning of a user's propensity to innovate. A conceptual definition of this construct is offered below, and then three key antecedents of propensity to innovate are described. Predictions about the effects of the different mechanism classes on these antecedents are discussed.

The Elements of Knowledge Creation: Cognizance, Ability, and Intention

Much of the prior literature on user innovativeness in IT domains has focused on users' role in the *acceptance* rather than in the *creation* of new technology applications. In other words, the emphasis has been on users' readiness to adopt a new technology or application (e.g., Agarwal and Prasad 1998). The user has a relatively passive role to play here since the application has already developed and he/she has only to decide whether to adopt or not. This literature has primarily considered individual characteristics or personality traits (e.g., age, education, tenure, risk taking propensity) and organizational or contextual variables (e.g., degree of formalization, organization slack, diversity of IT, communication networks) as indicators of user innovativeness (e.g., Brancheau and Wetherbe 1990; Harrison and Rainer 1992). In contrast, the focus here is on users' innovativeness in the IT domain as related to their role in the creation of new applications using information technologies that have already been adopted by the organization. Thus, compared to the earlier literature, here a less passive role for users is presumed, since they have to actively pursue various ideas to deploy the technology in their immediate work context.

Consistent with the emphasis of the study, user propensity to innovate in IT is conceptualized as the user's predisposition to "create" new applications of IT in their work context. The study identifies and focuses on three important antecedents of this propensity: (1) technology cognizance, (2) ability to explore, and (3) intention to explore a technology. While it is true that in addition to these factors, individual or personality traits may be important antecedents of users' propensity to innovate, the perspective adopted here does not view the propensity to innovate as an individual trait—one that is relatively stable over time and is an intrinsic aspect of personality. Rather, it is viewed as a learned disposition that evolves interactively over time during the organizational tenure of an individual. The selection of the above three factors reflects this study's focus on the "learned disposition" aspect of the propensity to innovate, as it examines how organizational mechanisms can contribute to the "learning" that needs to precede technology innovation. Each of the three dependent variables, together with the mechanisms predicted to influence it, is described below.

Technology cognizance: This variable relates to a user's knowledge about the capabilities of a technology, its features, potential use, and cost and benefits, i.e., it relates to *awareness-knowledge* (Rogers 1995). Technology cognizance is a critical prerequisite for acquiring or creating the how-to knowledge related to an IT innovation. Cognizance may be variously labeled as attention, consciousness, and noticing; in essence, it represents knowledge about "facts" in the domain of information technology (Corsini 1987). Cognizance is the foundation for the initiation process: users may not contribute to the creative activity in the initiation phase of an information system unless they understand the technology, the tasks involved, and the environment within which the system will operate (Anderson 1985). In the conceptual description of the mechanism classes, it was noted that mechanisms belonging to Class 1 and Class 2 primarily facilitate the acquisition of declarative and factual knowledge either about technology *per se*, or about technology and its applications within a general industry and business context. Hence, the prediction that:

> **Proposition 1:** Mechanisms that belong to Classes 1 and 2 are positively associated with users' technology cognizance.

Ability to explore: The ability variable refers to a user's perceived competence in marshaling the cognitive and physical resources required for technology exploration. As argued previously, information technology is typically value free and devoid of context. In order for it to be utilized in a value-adding manner, it needs to be reinterpreted within a given work context. Such technology interpretation is key to the creation of the *how-to* knowledge necessary for deploying the technology—it involves reconfiguring or combining different features of one or more technologies and integrating them with accumulated business knowledge. In other words, it requires the user to "make connections" (Sternberg 1988) between new IT capabilities and current or potential business problems.

The user's ability to explore a technology can be further examined along three facets: (1) support for technology experimentation or "tinkering" (Ciborra 1991); (2) support for conducting dialogue with other relevant organization members through formal (e.g., presentations, seminars) or informal (e.g., story-telling) means (Brown and Duguid 1991; Henderson 1990); and, (3) support for storing and retrieving IT and business-related knowledge from organizational memory (Paper and Johnson 1997). In the conceptual taxonomy of mechanisms, Classes 4 and 5 facilitate the conversion of one type of knowledge to another; hence, the prediction that:

> **Proposition 2:** Mechanisms that belong to Classes 4 and 5 are positively associated with users' ability to explore.

Intention to explore: A third indicator of user propensity to innovate in IT, intention to explore a technology, reflects a user's willingness and purpose to explore a new technology and find potential use. Following a robust theory base in social psychology as developed in the work of Ajzen and Fishbein (1980) and Ajzen (1991), intention is treated as a predictor of future behavior (e.g., technology exploration). Thus, intention to explore is conceptualized as a user's purpose and motivation to innovate based on the perceived business related benefits she will derive from IT deployment. Indeed, it has been shown that a user's willingness to participate in systems development increases if the proposed system and its output are perceived to be important by the user (Locke and Schweiger 1979).

Mechanisms belonging to Class 3 support the acquisition of firm-specific IT knowledge. There are at least three ways in which such mechanisms can enhance intention to explore. One, because the knowledge imparted by such mechanisms is contextual, users can better understand the potential promise of a particular application or technology and, hence, be more motivated to explore. Two, the fact that an organizational mechanism expands upon a particular application area or technology indicates the priority placed by the firm on the specific technology or application, again, enhancing a user's motivation to explore. Three, even if a user is technologically cognizant and an environment exists for knowledge conversion, a key hurdle in technology exploration may be a lack of focus. Class 3 mechanisms provide the first level of integration between technology and organizational context, i.e., they can *direct* efforts for technology exploration. Hence, the prediction that:

> **Proposition 3:** Mechanisms that belong to Class 3 are positively associated with users' intention to explore.

Clearly, all three outcomes are important for the creation of new IT knowledge. For example, a user may be cognizant of a technology and have the ability to explore, but may not actually do so due to a lack of perceived urgency for innovation in his/her work context (Leonard-Barton 1995). On the other hand, while a user may have a positive intention to explore a new technology, the lack of an effective partnership with IS providers may severely curtail his/her ability to explore (Henderson 1990).

Empirical support for the theorized effects of mechanisms on the three dependent variables was obtained through a field study, as described below.

Methodology

Two separate empirical studies were conducted: a Delphi study to populate the knowledge creation taxonomy and a field study to test the research propositions.

The Delphi Study

Mechanisms initially identified in extant literature and subsequently refined based on insights from practicing managers were utilized to populate the knowledge creation taxonomy. Salient mechanisms were located in two stages. First, an extensive review of the IS literature resulted in a preliminary set of 19 mechanisms. Next, each mechanism was clearly defined and presented to practicing IS managers in six organizations using semistructured interviews. Apart from unveiling new mechanisms that are in use but not reported in the literature, these interviews were also aimed at capturing the essence of each mechanism from the variations depicted in the different real world examples. This exercise resulted in a smaller set of 14 mechanisms (see Appendix A for definitions of the mechanisms).

A Delphi study was conducted to classify mechanisms into the conceptual taxonomy.[2] The Delphi technique is deemed appropriate when judgmental information is indispensable (Rowe et al. 1991). The participants of the Delphi study were a carefully selected set of practicing senior managers from diverse industries to guarantee a wider knowledge base (Linstone 1978). They included four CIOs/directors of information systems, one IS manager, and one user manager from six organizations (three from the manufacturing industry and one each from the healthcare, education, and insurance industries). One of the researchers met with each participant separately and explained the research objective and the Delphi study process. These interviews also enabled the researcher to further refine the definition of each mechanism.

The Delphi study was a three-round iterative process. In the first round, each participant was provided a set of documents that included a brief abstract of the study, a description of each organizational mechanism, and the conceptual taxonomy. The participants were requested to allocate each mechanism, using a predefined format, into one of the five categories or classes. If they thought that a mechanism belonged to more than one category, they were asked to indicate that using a ranking of 1, 2, and 3 (where a ranking of 1 meant that the mechanism primarily belonged to that category).

The weighted averages of the points given to each mechanism by the six participants were determined to prepare the classification chart (group opinion). This information was fed back to the participants in the second round. The participants were asked to indicate whether they concurred with the group opinion, and if not, the reason for differing (the reasons presented were also fed back to all participants in each round). All participants responded within a week with their agreement (or lack thereof) with the group opinion. The process was repeated in the third round and the output from this round showed overall consensus on the classification of all organizational mechanisms. Seven out of the 14 mechanisms were unambiguously classified in the first round. These include IT journals, IT conferences, advanced technology group, vendor demonstrations, IT steering committee, customer support unit, and user lab. Five additional mechanisms were unambiguously classified in the second round. These include user group, relationship manager, IT task group, joint ventures, and IT strategic planning team. The remaining two mechanisms, IT benchmarking project and IT advisory board, were unambiguously classified in the third round.

As the goal of the Delphi study was to use "expert" opinion to classify mechanisms, unambiguous classification was deemed more important than consensus. Although the level of ambiguity inherent in the classification of IT benchmarking project and IT advisory board dropped from the first to the second round and the ratings given by the experts who consented last to their classification also changed gradually from the first to the second to the third round, it was still not clear whether this was a response to group pressure or a "true" classification. The mechanisms classified in the third round were therefore eliminated from subsequent analysis. The final classification is shown in Table 1 and described below.

Class 1: The conceptual definition of this category is design actions that primarily support the acquisition of technological knowledge without reference to any particular application context. The participants of the Delphi study felt that

[2]The original conceptual taxonomy contained seven mechanism classes: an additional knowledge acquisition class for mechanisms that enable the acquisition of knowledge related to the application of IT in a particular user's work context (Type 4 knowledge), and an additional knowledge conversion class for mechanisms that permit the conversion of Type 1 or Type 2 knowledge into Type 4 knowledge. These two categories were subsequently excluded because of the desire to keep the conceptual taxonomy parsimonious and because, given the granularity of the mechanism descriptions, it was not possible to clearly distinguish between Type 3 and Type 4 knowledge.

Table 1. Results of Delphi Study: Classification of Mechanisms

Knowledge Creation Activity	*Knowledge Type* →		
	Type 1 Knowledge	**Type 2 Knowledge**	**Type 3 Knowledge**
Knowledge Acquisition	***Class 1*** Advanced Technology IT Journals IT Conferences	***Class 2*** Vendor Demonstration Joint Venture IT Task Group	***Class 3*** IT Steering Committee IT Planning Team
Knowledge Conversion		***Class 4***	***Class 5*** Customer Support Unit User Group User Lab Relationship Manager

attending IT conferences, advanced technology groups, and *subscribing to IT journals* belong to this class. The emphasis of all these three mechanisms is on providing factual knowledge about new technologies and less so on providing relevant contextual knowledge about their application. This classification of mechanisms finds support in prior literature that has studied the effectiveness of such "mass media" mechanisms in facilitating information transfer and, thereby, technology adoption (Rai 1995; Nilakanta and Scamell 1990; Zmud 1983).

Class 2: *Vendor demonstrations* and *joint ventures* are expected to deliver knowledge about the generic, industry-wide applications of new technologies. For example, vendors, in their sales efforts, often demonstrate how other firms in the same or related industries have used their technology. Similarly, IT advisory boards (which often include paid external consultants) and joint ventures provide opportunities for users to learn how other firms are leveraging new technologies.

Class 3: Delphi participants agreed that *IT steering committees, strategic IT planning teams,* and *IT task groups* provide more contextual knowledge about potential applications of new technologies. Indeed, steering committees and strategic planning teams provide guidelines on the key business areas where IT should be applied (Zmud 1988), while IT task groups enable users to understand the benefits that can be realized by applying IT in certain specific business areas or work contexts within an organization.

Class 4: Surprisingly, none of the listed mechanisms were categorized into this class. A couple of plausible explanations for this finding are offered. As explained earlier, Class 4 mechanisms focus on the conversion of Type 1 knowledge to Type 2 knowledge. Such mechanisms may be more useful for technology consultants (who advise specific industries) and software application vendors (like SAP and PeopleSoft) than for individual user organizations. Hence, one explanation for the lack of any mechanisms classified in this category could be that most mechanisms considered in this study originated from the IS literature, which primarily focuses on user organizations. Another could be that the specific profile of the Delphi study participants (all of them were from user organizations) led to a lack of "technology vendor" perspective in making the classification. Thus, for example, although some of the Delphi study participants noted that vendor demonstrations and technology trade shows could potentially facilitate conversion of Type 1 to Type 2 knowledge, they felt that the primary impact would be on the *acquisition* of technology knowledge.

Class 5: *Customer support units, user groups, user lab,* and *relationship manager* support the conversion of generic industry knowledge about technology into firm-specific application knowledge. Customer support units and relationship managers provide personal help to users in identifying and evolving new technology application ideas. Similarly, user groups provide formal and informal forums for users to exchange ideas about technology deployment and get feedback from other users based on their own experience. User labs provide the infrastructure that is critical for technology exploration.

The Field Study

Data to empirically test the research propositions were collected as a part of a larger field study of technology users. Three medium-size organizations located in the Northeastern United States participated in this study. Firm A is a bank with approximately 260 employees (approximate number of PC users: 190) and $150 million annual turnover. Firm B is an insurance company with approximately 225 employees (approximate number of PC users: 165) and a turnover of approximately $135 million. Firm C is a large manufacturer of medical equipment devices with approximately 1,500 employees (approximate number of PC users: 290) and an annual turnover of $800 million. The sample was carefully chosen such that all 14 mechanisms were in place in all three firms. The study elected to utilize firms from both major industry sectors (manufacturing and service) to enhance the external validity and to avoid the introduction of bias by focusing on only one type of industry. Although the three firms do represent a convenience sample, their selection was also dictated by the need to study "typical" user organizations. Based on the details gathered about each firm, there is no reason to believe that any of these firms can be categorized as "innovators" or trend setters in IT deployment and, as such, they are in no way unique or uncharacteristic of the broader population of user organizations.

In each organization, the CIO and a set of users were interviewed before administering the survey. During the interview with each CIO, the researcher explained the purpose of the study and described the potential respondent as a person who belongs to a function other than IS and who uses any type of information technology for purposes of his/her work. No conditions were set regarding the level or position of the respondent.

The survey instrument operationalized most variables using a seven-point Likert-type scale. The use of a specific organizational mechanism, the independent variable, was operationalized using a single item that measured how intensely the user interacted with that mechanism, i.e., how directly/indirectly did the user utilize the mechanism? However, the questionnaire also included an item that measured whether the user was aware of the deployment of the organizational mechanism within his/her division/unit. This item, while not part of the independent variable scale, was used in interpreting the results. To protect against recall errors, respondents were prompted to rate their degree of utilization in the immediately preceding two years.

The three dependent variables included technology cognizance, the ability to explore a new technology, and the intention to explore a new technology. Technology cognizance was operationalized using a five-item scale that measured the user's perception of his/her knowledge about the features, cost, benefits, and potential application of a set of information technologies. The set of technologies was arrived at after discussion with the IS managers of the three participating organizations. The goal was to define a set of contemporary technologies that were being used in all three organizations, i.e., the organization had already adopted the technology and made it available to users. The technologies selected include database, spreadsheet, the Internet, and e-mail. Respondents were instructed to consider the various technologies as a unit in responding to the survey.

Ability to explore was operationalized using a 13-item scale that measured the user's ability along three facets: support for technology experimentation, support for internal communication, and support for accessing organizational memory. No validated scales exist for this construct, hence items were drawn primarily from the organizational learning and educational psychology literatures. Intent to explore was operationalized using a three-item scale. The items measured the user's motivation to explore technology arising from the work context and his/her willingness to expend time and effort for this purpose. The instrument validation process followed Straub's (1989) guidelines. All scales and items, as well as the process for scale validation, are described in Appendix B. As described in that appendix, based on the results of a factor analysis procedure, one item was dropped from the 13-item ability to explore scale.

Approximately 550 questionnaires were sent to the three organizations and 200 usable responses were obtained (74 from Firm A, 43 from Firm B, and 83 from Firm C). The majority of the respondents hold bachelors degrees, work in the marketing, finance, or operations areas, and are situated three to four hierarchical positions away from the firms' CEO. Further, almost all of the respondents indicated that they had at least five years of computer experience and used four to five information systems applications in their day-to-day work. Table 2 summarizes salient sample demographics. Descriptive data for all research variables is presented in Table 3. As the data indicate, the reliabilities of all multi-item scales are above the 0.7 level generally deemed sufficient for field work (Nunnally 1978).

Two individual level variables, a user's prior experience with computers and a user's position in the organizational hierarchy, were utilized as controls in the analysis. Prior studies have considered the level of experience with computers as a significant variable in determining individual innovativeness in the IT domain (Harrison and Rainer 1992; Levin and Gordon 1989). In the present context, prior experience with computers

Table 2. Sample Demographics

	Frequency (n = 200)[a]	Percentage
Education Level		
High School	16	8
Associate	30	15
Bachelors	98	49
Graduate	50	25
Functional Area		
Finance	66	33
Marketing/Sales	50	25
Operations	40	20
Accounting	12	6
Purchase	12	6
Other	20	10
Hierarchical Position[b, c]		
1	11	5
2	28	14
3	65	33
4	67	34
> 4	29	14
Computer Experience (years)[c]		
< 2	22	11
2 - 4	44	22
5 - 10	104	52
> 10	30	15

[a]Figures may not add up due to missing data.
[b]In terms of number of positions away from the CEO.
[c]Used as control variables in multivariate analysis.

Table 3. Descriptive Statistics

Construct	Mean	SD
Technology cognizance	4.97	1.36
Ability to explore	3.77	0.95
Intention to explore	4.98	1.61
Class 1 Mechanisms		
Advanced Technology Group	1.98	1.59
IT Journals	2.98	1.26
IT Conferences	3.52	1.65
Class 2 Mechanisms		
Vendor Demonstrations	3.87	1.62
Joint Ventures	3.67	1.35
Class 3 Mechanisms		
IT Steering Committee	4.22	1.44
Strategic IT Planning Team	3.84	1.67
IT Task Group	4.22	1.41
Class 5 Mechanisms		
Customer Support Unit	4.87	1.77
User Group	3.83	1.95
User Lab	3.49	1.84
Relationship Manager	4.12	1.39
Control Variables		
Hierarchical Position	4.40	1.01
Computer Experience	3.17	0.83

n = 200
Reliability of dependent variables (Cronbach alpha):
Technology cognizance: 0.86
Ability to explore: 0.78
Intention to explore: 0.93

may significantly influence users' technology cognizance as well as their ability to explore new technologies. Similarly, the position in the organizational hierarchy may also influence the user's propensity to innovate in IT. It is well established that the diversity of a user's organization-related knowledge (e.g., business strategies and organizational priorities) increases with his/her hierarchical position (Larsen 1993). Thus, hierarchical position may have a significant positive effect on intention to explore, by virtue of the fact that those higher in the organizational hierarchy recognize the importance of IT for the firm. Hence, the need to control for the above two variables. To test for organization effects, two additional indicator variables representing the three firms were included in the analysis.

A major objective of this study was to provide some rich insights, derived from theory, into the various organizational mechanisms that can facilitate a user's role in the initiation of IT innovation. Because the three dependent variables were expected to be significantly correlated with each other, support for the propositions was sought using multivariate analysis of variance methods. The relationships discovered in the data between the mechanisms and the three dimensions of user propensity to innovate in IT are discussed below.

Table 4. Multivariate Analysis of Variance Results

Wilks' Lambda: F = 6.48 p = .0001
Pillai's Trace: F = 5.84 p = .0001

Independent Variables	Dependent Variables*					
Organizational Mechanism	**Technology Cognizance**		**Ability to Explore**		**Intention to Explore**	
	t-value	**p-value**	**t-value**	**p-value**	**t-value**	**p-value**
Class 1 Mechanisms						
Advanced Technology Group	1.401	*0.16*	1.095	0.27	0.082	0.93
IT Journals	2.717	**0.00**	1.246	0.21	3.504	**0.00**
IT Conferences	2.323	**0.02**	1.038	0.30	1.093	0.28
Class 2 Mechanisms						
Vendor Demonstrations	2.397	**0.02**	1.563	0.12	3.194	**0.00**
Joint Ventures	2.873	**0.00**	0.430	0.67	1.390	0.17
Class 3 Mechanisms						
IT Steering Committee	0.889	0.37	0.941	0.35	2.244	**0.03**
Strategic IT Planning Team	0.869	0.39	2.658	**0.00**	4.068	**0.00**
IT Task Group	1.768	0.08	1.298	0.20	2.455	**0.02**
Class 5 Mechanisms						
Customer Support Unit	2.068	**0.04**	2.480	**0.01**	0.499	0.62
User Group	0.047	0.96	4.393	**0.00**	1.320	0.19
User Lab	1.436	0.15	3.396	**0.00**	0.049	0.96
Relationship Manager	1.425	0.16	2.113	**0.04**	2.401	**0.02**
Control Variables						
Hierarchical Position	0.612	0.54	1.674	0.10	0.332	0.74
Computer Experience	2.131	**0.04**	2.400	**0.01**	1.596	0.11
X1 (Firm indicator variable)	1.769	0.08	1.316	0.19	0.290	0.77
X2 (Firm indicator variable)	0.619	0.54	1.683	0.09	0.540	0.59

Notes: Theoretically predicted significant relationships are shown in shaded areas.
Boldface, underlined p-values were predicted to be significant and found significant.
Boldface p-values were not predicted to be significant and found significant.
Italicized, underlined p-values were predicted to be significant and found not significant.

Results and Discussion

Table 4 presents the results of the multivariate analysis of variance. The analysis was conducted utilizing the 12 mechanisms as covariates,[3] three dependent variables, and four controls. All 200 responses from the three firms were pooled together for the data analysis. None of the indicator variables were significant, suggesting that there were no organizational effects. Furthermore, interviews with the CIOs and several users in each organization revealed no systematic differences between the three organizations with regard to the types of users. Also, performing a firm by firm analysis would reduce the statistical power, given the large number of independent variables, and not contribute any additional insights. Thus, it was deemed appropriate to pool the data. The overall multivariate rela-

[3]Scales for mechanisms were treated as continuous; hence their inclusion as covariates. This does not alter the interpretation of the results in any way.

tionship using both Pillai's criterion and Wilk's Lambda was significant at $p < .001$. Results reported in Table 4 show the relationship between each individual organizational mechanism and the dependent variables: technology cognizance, ability to explore, and intention to explore. A majority of the results obtained are consistent with the predictions derived from the theoretical model, although additional relationships were also discovered. Of the 12 relationships predicted to be significant, 11 were supported empirically while one was not. Furthermore, five significant relationships not initially predicted were observed.

Mechanisms Associated With Technology Cognizance

Consistent with the predictions of this study, a majority of the mechanisms belonging to Classes 1 and 2, viz., attending IT conferences, subscription to IT journals, joint ventures, and vendor demonstrations, were found to be significant determinants of technology cognizance. The results further support earlier findings regarding the role played by "mass media" mechanisms (e.g., journals, trade shows) in the initiation of IS innovations (Nilakanta and Scamell 1990; Rai 1995). All these mechanisms facilitate the acquisition of information about new technologies, and, as noted earlier, the emphasis is not so much on the relevance of the knowledge to the user's particular work context as it is on delivering factual information on new technologies and their generic applications.

In the interviews with users, the importance of attending trade shows and conferences was repeatedly emphasized for gaining knowledge about new applications of IT. For example, firm A (one of the three organizations studied) is an IBM AS400 shop and many users in that organization rated the annual AS400 Business Users' Conference an excellent source of information on new information systems applications. Indeed, without overt organizational efforts to infuse such external knowledge, a user's absorptive capacity (Cohen and Levinthal 1990) may never have an opportunity to develop.

Joint ventures in the development and deployment of information systems provide excellent opportunities for users of an organization to interact with the users and IS personnel of another organization. The knowledge that is transferred in such situations is not usually limited to the issue of focus (i.e., the system being developed). Users also gather information on other new technologies or applications, although they may not acquire knowledge that is directly relevant to the organization's own context. For example, firm A, a community bank, had a joint venture with another bank and a technology vendor for the development of an electronic cash management system. A manager who was part of the project team noted that in the process of discussing the new system, he became cognizant about a data mining application which the other bank had recently developed. While the particular application as such was not relevant to his firm, the knowledge gained was invaluable in starting an exploratory study on data mining applications in his own organization. In short, informal contacts that are developed through such joint ventures provide a rich medium to transfer knowledge about new technologies, thereby promoting innovation-initiation behavior (Rai 1995).

Vendor demonstrations play a key role in exposing users to new technological developments that may have potential value for them. Although vendor demonstrations are typically targeted at a focused business application, nonetheless attending such events can broaden the knowledge base of users in all areas or organizational work. For example, users in firm B, a financial institution, found vendor demonstrations to be an effective mechanism for gaining a good understanding of a relatively emergent technology, the Internet. Several managers noted that demonstrations and presentations by technology vendors were effective in not only unraveling the relative merits and demerits of the various Internet technologies and features, but more importantly in showing them how some of the features/technologies had been used by their peer firms. Indeed, it is the capability of the technology vendor to combine information about a technology feature with its usage in a relevant business activity that makes it appealing to the end user.

Surprisingly, empirical results did not support the predicted significant influence of advanced technology groups (ATG) on technology cognizance. Advanced technology groups provide a forum for users to share knowledge about new technologies; indeed, several users mentioned that membership in such groups was invaluable to keep up with the latest technologies. Further, contrary to the popular notion, such groups are often led not by IS personnel but by user managers. For example, in firm C, a manufacturing organization, the ATG was established and led by the general manager of finance. This had implications for not only the types of issues receiving focus but also the level of participation of the user community. The speculation is that the non-significant finding may be due to a couple of reasons. First, the low awareness score indicates that perhaps this mechanism was not sufficiently "advertised" in the three organizations, leading to poor utilization. On the other hand, non-significance may be an outcome of insufficient variance in the sample data. However, the non-significant findings must be interpreted with caution, as the qualitative data as well as the theoretical arguments support a significant relationship between advanced technology groups and technology cognizance.

Mechanisms Associated With Ability to Explore

All four mechanisms that belong to Class 5–user groups, customer support unit, user lab, and relationship manager–were significant determinants of a user's ability to explore a technology. These mechanisms either directly support the process of knowledge creation or provide the environment that is necessary for technology exploration. Customer support units and relationship managers enable IS personnel to establish partnerships (through personal relationships) with the users. Such partnerships are critical for evolving new ideas for technology deployment into feasible products (Henderson 1990). On the other hand, both user group and user lab directly support the process, either through dialogue and feedback sessions (as in the case of user groups) or hands-on technology exploration (for user labs) that is key for the creation of IT application knowledge.

A relationship manager (RM) has been found to play a key role in enabling users to integrate technical and business knowledge. The very fact that such individuals are tightly linked to the users in a specific business area (say, marketing) ensures that they have sufficient knowledge about the business context and are capable of acting as an effective interface between the IS and the users. Often, IS managers and top management envision corporate IT strategies that are not easily comprehended by everyday users of the technology. RMs can narrow this gap between the vision (of top management) and the reality (experienced by users) by facilitating conversion of tacit knowledge held by both groups with respect to technology applications into explicit knowledge about specific products and application ideas. In other words, the RM may be an effective operational means of implementing the middle-up-down management (Nonaka and Takeuchi 1995) that is crucial for knowledge creation. However, given that technology exploration is very time consuming and often involves overcoming potential knowledge barriers, the right partnership between the user and the RM is key to its success. Thus, there is also a risk that the RM may become a "lightning rod" if the political climate between the user department and the IS function is not favorable (Subramani et al. 1995).

A user group plays a crucial role in facilitating dialogue among organization members, thereby supporting the development of innovative ideas and problem solving (e.g., Brown and Duguid 1991; Leonard-Barton 1995). Such user groups are different from task groups as they normally do not have a fixed agenda (i.e., are not focused on any particular business area) and are often very informal in their operation. Further, the very fact that membership is voluntary results in the creation of a more effective networking environment. The focus is on the sharing of mental models and relevant experiences that enable the acquisition or transfer of tacit knowledge about technology application. It enables the progressive evolution of an idea through a process of continuous critiquing and refinement where individual participants contribute elements of tacit knowledge (drawn from their own prior related experiences) that are key for "connecting" particular features of a new technology to an application. Thus, discussions in user groups help surface tacit knowledge elements that are often the building blocks through which innovative application ideas are developed. A user group is similar in spirit to Nonaka and Takeuchi's characterization of a high density field of interaction, "an environment in which frequent and intensive interactions among crew members take place" (1995, p. 230).

The concept of customer support unit (or help desk) was introduced in the early 1980s with the explosion of PC usage and the resulting focus on end-users. However, the nature of support provided by such units has changed significantly in recent times—from solving common PC usage problems to being a center for seeding new application ideas. The source of new technology application ideas is often dissatisfaction or problems with existing systems, and, as such, the support units provide a forum where new ideas are first expressed and explored. Indeed, their role in supporting IT innovation arises primarily from their proximity to users at the grassroots level. This proximity ensures that new ideas are given relatively more freedom to evolve and are facilitated without any attendant problems involving IS red tape and bureaucracy.

User labs are intended to be facilities where employees can explore new and emerging technologies (e.g., a demo version of a new data mining software package). Since some of the new technologies can be applied to a variety of contexts, organizations desire users in the different business areas to explore potential applications of these new technologies. In such situations, a central facility is more beneficial and feasible rather than, say, setting up a demo software package on user workstations in different departments. Hands-on exploration allows a user to examine the varied combinations of features of the new technology and to conduct an internal dialogue that is key for generating new application ideas. Indeed, through such individual reflective sessions, tacit knowledge about a business need may be converted to explicit knowledge about the fit of a technology to an application area (Nonaka and Takeuchi refer to such knowledge conversion as "externalization"). The explicit knowledge that is created may be in the form of a particular combination of technology features that addresses a given business need and hence can be understood and further built upon by IS professionals.

Mechanisms Associated With Intention to Explore

Of the mechanisms examined here, three were predicted to be significantly associated with user intention to explore. The results provide support for a significant relationship for all three: IT steering committee, strategic IT planning team, and IT task group.

Two of these mechanisms, IT steering committee and strategic IT planning team, are essentially agenda setting forums within an organization (Zmud 1988). In other words, they are primarily a means to enhance the user's intent to explore a technology by providing clear and specific business rationale and direction for technology deployment (King and Teo 1994). These mechanisms enable the conversion of explicit knowledge about the business objectives and strategy to tacit knowledge about the technology application priorities and focus, i.e., they enable the user to internalize the technology vision that is being projected by top management. As Nonaka and Takeuchi (1995) note, such a knowledge vision provides a sense of direction to the type of knowledge the organization members ought to be seeking and fosters a higher degree of commitment. At the same time, the knowledge vision should only provide a framework for users to interpret a new technology and not be too restrictive. It should also be noted that the two mechanisms focused on here play an important role in communicating technology development priorities not only to groups of organizational members (e.g., departments), but also to individual users. It is such micro-level communication that is most critical in initiating IT innovations.

The IT task group provides users with a focus for technology utilization; typically, a task group is assigned to address a specific technology application issue, and it is this focus that enables the user to clearly identify the linkage between the technology, its application, and potential benefits. This is likely to exhibit a positive effect on the user's intention to be further involved in technology exploration for solving the associated business problem. However, it should be noted that depending on how the task group is structured in practice, the user's intent to explore a new technology may vary. For example, if the involvement of the user in such a task group is involuntary or mandated (as is often the practice in large organizations), the impact may not be that significant (Donnellon 1993).

The empirical data provides initial support for the propositions framed here and increases confidence in the underlying theoretical framework. Although additional significant relationships were observed, the fundamental argument underlying the conceptual model—that different mechanisms exhibit variable efficacy with regard to the three dependent variables—is nevertheless valid. The data also reveal other interesting patterns. Detailed examination of the multivariate analysis of variance results shows that very few mechanisms are significant determinants of more than one dependent variable. No single mechanism is significantly associated with all three variables and only five mechanisms exhibit significant effects on two variables.

The significant results related to one of the control variables, computer experience, are supportive of prior findings (eg., Harrison and Rainer 1992). Prior experience with IT can enhance the absorptive capacity of a user (Cohen and Levinthal 1990) and also provide a broader perspective for undertaking new technology exploration.

Limitations

Prior to discussing the theoretical and practical implications that ensue from these findings, limitations that circumscribe the interpretation of the results must be acknowledged. The Delphi study utilized to populate the conceptual taxonomy with organizational mechanisms was conducted with a limited number of "experts." While this is a widely used approach that has garnered considerable empirical support, the precise classification of mechanisms is in need of further refinement. Of the original set consisting of 14 mechanisms, two—benchmarking projects and IT advisory board—were unambiguously classified only in the third round of the Delphi study. Although a decision was made to drop these two mechanisms for further empirical testing, it is nevertheless important to understand what the effects of these mechanisms might be.

Further, the fact that not all predicted results were found, while additional findings were obtained that were not predicted, points to the need for additional work in mechanism classification. Specifically, the findings related to the five significant relationships that were contrary to theoretical expectations indicate the limitations of the present classification as well as provide direction for future research. A likely reason for the unexpected findings is the granularity of the mechanisms considered in this study. While during the Delphi study the potential effects of one mechanism on multiple knowledge creation activities were acknowledged, by classifying mechanisms based solely on the highest rating given by the experts the focus was narrowed to the *dominant* effect (or property) of each mechanism. In other words, the classification did not capture additional properties of a mechanism that may contribute to its influence on other aspects of knowledge creation. Future studies may address this issue by decomposing mechanisms into a finer-grained classification. For instance, a refined decomposition of the mechanism IT journals could include generic IT journals, industry specific IT magazines, and internal newsletters distributed by the IT function. Such decomposition is likely to promote the derivation of more refined hypotheses that reflect the varied properties and impact of alternative mechanisms on different knowledge creation activities.

Consider, for example, the intriguing finding that strategic IT planning teams (a Class 3 mechanism) had an unexpected positive influence on ability to explore. One plausible explanation might be the existence of potential overlap in the classification scheme in that some effects posited to belong to Class 3 mechanisms are also being exhibited by other classes. A second could be the specific operationalization of the mechanism in participating organizations. For instance, recall that Class 5 mechanisms support the conversion of Type 1 or Type 2 knowledge into Type 3 knowledge. In so far as strategic IT planning teams establish linkages between a firm's strategic objectives and its IT portfolio, they were posited to enhance intention to explore by directing a user's technology exploration efforts. Nonetheless, depending on the specific agenda of these teams and interactions that took place among team members, participation may also have contributed to a better understanding of the specific use of technology in the context of the business. Future research could fruitfully focus on trying to partial out such effects and examining which explanation is more appropriate.

The choice in this study was to focus on three dependent variables that are argued to be antecedents of a user's propensity to innovate in IT. Although the relationship between these three variables and a generalized tendency to innovate in IT does find support in prior theorizing, the relationship was not tested empirically. Moreover, though beyond the scope of the current paper, as discussed below, there is a need to develop a more robust and complete conceptualization of propensity to innovate in IT.

Although careful attention was paid to the construction of the instruments for this study, the organizational mechanisms were measured using a single item (utilization) for which reliability cannot be assessed. Future studies may incorporate additional items that reflect the extent of usage (say, number of years) of the mechanisms as well as their perceived importance. Even though the firms in this study constitute a convenience sample, there is no evidence that the firms are unique or different in any substantive way with regard to their overall innovativeness in the IT domain.

Another limitation relates to the cross-sectional nature of the study. The potential for method bias arises from contemporaneous measurement of independent and dependent variables from the same source in the same questionnaire. Harman's one-factor test (Schriesheim 1979) did not show any significant common method bias. Factors such as social-desirability bias may have influenced individual responses and should be kept in mind while interpreting the results of the study. Due to lack of data on non-respondents (the questionnaire was distributed by the CIOs of the three firms among the PC users), it was not possible to perform tests for non-respondent bias. However, based on an examination of the demographic data of the respondents, there is no reason to believe that there was any systematic bias introduced by non-response. Finally, specific differences between mechanism implementation across different organizations were not directly addressed in the data collection procedure. Nevertheless, prior to the survey, the definitions of the 14 mechanisms were discussed with the CIOs of the three organizations to ensure there was no significant disparity in their implementation and also that all mechanisms have been in place for at least two years. In addition, post survey interviews with users suggested that respondents had interpreted the mechanism to be reflective of the specific implementation in their own organization.

Implications and Conclusions

Several scholars in the organizational innovation area (Day 1994; Wheelwright and Clark 1992) have emphasized the lack of focus on the front-end of the innovation process, namely, initiation. While there are several success stories and some anecdotal evidence that involves users in the innovative use of IT, there have been few discussions on how to encourage and support users in such an innovative process. The objective at the outset of this study was to address the broad question: what can managers do to facilitate the initiation of innovative ideas for IT among technology users? To this end, IT innovation initiation was viewed as a process of knowledge creation, and it was argued that managerial design actions in the form of mechanisms can enable such knowledge creation. A taxonomy was derived from the organizational learning literature that allowed the statement of propositions regarding the effects of different classes of mechanisms on a user's propensity to innovate in IT. Preliminary evidence shows that different organizational mechanisms vary in the nature of support they provide for the initiation process.

The implications of this work for theory development and advancement include extensions and refinements of the ideas proposed here. The theory of mechanism effects presented here is admittedly modest and in need of further extension. For example, it might be possible to identify additional categories of knowledge that are relevant to IT innovation and, hence, to propose a more comprehensive taxonomy. The empirical study focused on mechanisms that have been discussed in prior literature. This may have led to the inadvertent omission of other mechanisms that have yet to be the subject of empirical or theoretical scrutiny. This might be one plausible reason for why the experts in the Delphi study did not identify any of the selected mechanisms as belonging to Class 4—those that facilitate the conversion of Type 1 to Type 2 knowledge. Furthermore, this study does not explicitly incorporate mechanism costs, which are likely to be an important consideration in making cost-benefit trade-offs.

Another interesting extension relates to the environment in which mechanisms are implemented. For example, mechanisms that influence ability to explore involve close interaction between IT staff and users and it has been shown that, unless trust and a positive climate exist, such interactions may not be productive (Cusumano and Shelby 1995; Henderson 1990; Wheelwright and Clark 1992). On the other hand, most mechanisms that enable knowledge acquisition call for voluntary involvement of the user on an individual basis (e.g., reading an IT journal) and, unless the user is personally innovative, such opportunities may go unexploited (Amabile 1988). Important contextual factors, which might be included in an extended model that explores the effectiveness of organizational mechanisms for knowledge creation, include the user's satisfaction with existing IS service (Pitt et al. 1995), the psychological climate for innovation (Scott and Bruce 1990), the diversity of the organization's IS portfolio (Swanson 1994), and the degree of coupling between the IS unit and the business units (Swanson 1994). In addition, demographic factors, such as education, tenure, age, etc., may also assume significance. An organization may need to carefully manage such contextual factors so as to create a positive environment for innovation. This study only focused on the "learned disposition" antecedents of a user's propensity to innovate in IT. Future studies, in the spirit of the conceptualization presented by Lewis and Seibold (1993), may focus on extending this conceptualization by including other relevant antecedents, notably, individual or personality traits, as well as contextual influences.

From a pragmatic standpoint, it is suggested that, in so far as a user's propensity to innovate in IT will eventually lead to the identification of innovative IT applications, it is clearly desirable for managers to pay close attention to mechanisms that can positively increase such a propensity. The results of this study point to several mechanisms that can be efficacious in this regard. More important, there is support for the notion that a *mix and match of mechanisms* may be needed to enhance all three dimensions of a user's propensity to innovate in IT. This suggests the need for a *portfolio* approach to choice of mechanisms. As one user pointed out, it is not enough to send an employee to a conference and expect her to come back and immediately apply the newly acquired knowledge in the organization. Mechanisms that direct technology deployment and support its interpretation within the work context are also required. In short, if the mechanisms support only a part of the initiation process (say, knowledge acquisition) and not the entire knowledge creation process, the likelihood of innovative ideas being generated may be remote.

Nonaka and Takeuchi (1995) label the continu ous knowledge creation process that occurs at different ontological and epistemological levels as the "cross-leveling of knowledge." From this study, it is clear that, within the IS context, only by deploying a portfolio of mechanisms can an organization ensure that such intraorganizational cross-leveling of knowledge is achieved. Although the deployment of one or two mechanisms may fortuitously result in isolated innovative activity, it may never form a sustained effort. For example, tacit knowledge related to a technology application held by an organizational actor may never surface in the absence of mechanisms that support externalization.

An important related issue is that of sequencing user exposure to the various organizational mechanisms. While this study has not explicitly focused on the progression of innovative activity among users in an organization, it is clear from the review of the literature that users need to first acquire factual knowledge about a technology and then gradually convert it into more contextual knowledge. Thus, the speculation is that while mass media mechanisms (e.g., IT conference, IT journals) may provide the required initial awareness of a new technology, such awareness may then be refined by more direct or personal contact with technology vendors, other industry people, etc. Following this, organizations may signal priorities through steering committee statements and induce users to utilize the facilities and support provided for direct technology exploration. Future studies can focus on how organizations can ensure that users are exposed to the various mechanisms in a manner that follows the natural or logical flow of knowledge creation activities.

It is evident that several of the mechanisms examined here address themes similar to the key implications of the framework proposed by Nonaka and Takeuchi (1995). For example, relationship managers, by virtue of their unique positioning in the organizational context, can facilitate middle-up-down management. User groups provide an important means to "build a high density field of interaction," one that will facilitate and trigger social interaction that is key for knowledge creation (Brown and Duguid 1991). Similarly, the IT strategic committee or planning team can play a key role in providing a vision for knowledge creation. What is the implication of this similarity for IS managers? While many of these mechanisms have been in use for a long time, IS managers need to view them with a fresh perspective—that of knowledge creation. For example, a customer support unit (or help desk) has traditionally been viewed as the one-stop center for attending to user complaints about their computer systems. However, because of their close and frequent interaction with the grassroots level user, it may be that a customer support unit can play a more proactive and valuable role in facilitating new technology exploration by users, thereby generating ideas for IT innovation. In short, an important implication of this study is the need for IS managers to unravel the higher-level roles that various organizational mechanisms can play (for knowledge creation), roles that have hitherto not been noticed or emphasized.

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APPENDIX A

Definitions of Organizational Mechanisms

1. *Advanced technology group:* Permanent interdisciplinary group set up to maintain an awareness of, disseminate knowledge about, and manage the introduction of new information technologies (also referred to as the technology transfer group).

2. *Subscription to IT journals:* A firm may subscribe to various IT journals and make them accessible to users in different departments. These may include journals aimed at the business community in general, as well as journals meant for a specific type of users (say, IT magazine for financial managers).

3. *Attending IT conferences/trade shows:* Organizations often send users to IT conferences and trade shows to enable them learn about new IT deployment opportunities.

4. *IT advisory board:* A top-management team (that often includes paid external consultants), which has strictly advisory power on IT deployment, as distinct from an IT steering committee, which has executive power. Such teams are established to suggest items for review by the steering committee and to encourage the formation of partnership relations within the organization.

5. *Vendor Demonstrations:* IT vendors are invited to demonstrate new technologies or their applications to users and to answer their queries regarding costs, benefits, etc.

6. *Joint ventures:* Cooperative arrangements (full ownership or partial ownership) with external agencies (peer firms, IT vendors, etc.) to investigate and develop IT applications. Firms opt for such joint ventures when they do not have the in-house expertise to develop such systems and/or the costs of developing such expertise are prohibitively high.

7. *IT steering committee:* A top-management permanent team established to set priorities for IT deployment, allocate resources, and champion/monitor IS projects. A steering committee has managers representing various political interests and, hence, can also serve as arbitration points within an organization.

8. *Strategic IT planning team:* Ad hoc or permanent team set up to establish the linkage between the firm's strategic objectives and its IS portfolio. Such a team can include external entities (e.g., consultants) and may have limited power since plans may need to be ratified by a steering committee.

9. *IT benchmarking projects:* Organizationally sanctioned surveys and studies of IT practices in peer/competitor firms. Such studies often include users although they may be led by IS personnel.

10. *IT task group:* Temporary work groups given a well-defined mandate with respect to a specific IT deployment project. In most cases, such groups are interdisciplinary and will be focused on initiating an IS project rather than on the actual development of an information system.

11. *Customer support unit:* A unit set up to help users in day-to-day IS operations and to channel their feedback to the internal IS group. Such a unit will be manned by IS personnel and positioned either in the user departments or in a central location.

12. *User groups:* Organization sanctioned user groups that convene periodically to discuss IT deployment issues and to provide feedback on existing/planned IS applications. Membership is often voluntary and group meetings are often informal and unstructured.

13. *User lab:* Specially constructed computer labs for users to experiment with new information technologies. Usually, such labs will have IS personnel to assist users in their technology exploration (hence, also referred to as a facilitated lab) and to demonstrate specific software packages.

14. *Relationship manager:* A full-time specialized position created to manage the relationship between IS and line groups. Such positions are manned by middle level or senior management personnel drawn from the IS department with significant exposure and understanding of the business of the firm. Also known as account manager, account executive, and functional interface manager.

APPENDIX B

Validation of Dependent Variables Scales

This appendix summarizes the development and validation of measurement scales for the three dependent variables: technology cognizance, ability to explore, and intention to explore. The scale validation process followed Straub's (1989) guidelines.

Scale Development

Content Validity

Content validity is the representativeness or sampling adequacy of the construct domain; in other words, it is the extent to which an instrument covers the range of meanings included in the concept (Nunnally 1978). In order to ensure such validity in the current study, a review of the literature was combined with interviews of IS managers and users. Items for technology cognizance and intent to explore were drawn primarily from the IS literature. The reference domains for the items for the ability to explore construct were organizational learning and education psychology. Table B1 shows the constructs and the items. Once all the items for the different constructs were identified, the instrument was subjected to a pretest.

Construct Validity

In the pretest, the draft scales were subject to qualitative testing for construct validity. Personal interviews were conducted with five IS managers and 16 users in three organizations in order to locate and correct weaknesses in the questionnaire. Interviews were designed to move progressively from an open-ended general discussion format to a structured item-by-item examination of the draft instrument. Most participants chose to dialogue in a running commentary format as they reviewed each question.

Table B1. Constructs and Items

Construct: Technology Cognizance	
TC1:	I know the features of the technologies
TC2:	I am aware of the cost of deploying the technologies
TC3:	I *don't* know the type of benefits that can be derived by deploying the technologies
TC4:	I know the extent of benefits that can be derived by deploying the technologies
TC5:	I *don't* know the type of business activities in which these technologies have been/can be deployed
Construct: Ability to Explore	
AE1:	I have easy access to tools for building prototypes
AE2:	I have access to internal forums (inside my organization) to exchange information regarding my experiences with IT
AE3:	I have access to external forums (outside my organization) to exchange information regarding my experiences with IT
AE4:	I *don't* have access to communication tools to interact with other organizational members
AE5:	The existing climate in my department is not supportive of interaction with other organizational members
AE6:	I was permitted to use a new technology on a trial basis long enough to see what it could do
AE7:	I am *not* capable of experimenting with the technology as necessary
AE8:	I *did not* have to expend very much effort to try out different technologies
AE9:	There are people in my organization I could rely on in helping me with the use of a technology
AE10:	I have few opportunities to obtain feedback from within my organization with regard to the use of IT
AE11:	I have access to knowledge about the prior use of IT within my organization
AE12:	Knowledge about the prior use of IT is documented
AE13:	The extent of bureaucracy involved in accessing experience-based knowledge in other parts of my organization is minimal
Construct: Intention to Explore	
IE1:	I intend to explore new IT for potential application in my work context
IE2:	I intend to explore new IT for enhancing the effectiveness of my work
IE3:	I intend to spend considerable time and effort this year in exploring new IT for potential applications

Because misunderstanding of questions would contribute to measurement error in the instrument, attention was paid to possible discrepancies or variations in answers.

To obtain a measure of construct validity for the scales, the card sorting methodology was used (Moore and Benbasat 1991). Judges were asked to sort the items into different construct categories. Two rounds of sorting were done and three judges participated in each round. The participants were all graduate students from varied fields to ensure that a range of perceptions would be included in the analysis. In the first round, the judges were not told what the underlying constructs were, but were asked to provide their own labels for the constructs. The three judges then met as a group and carried out the same task. In the second round, the judges were asked to sort the items based on construct labels that were provided. A "too ambigous/doesn't fit" category was also included to ensure that judges did not force fit any item into a particular category.

The item placement ratio (developed by Moore and Benbasat) was used to measure construct validity. The method required analysis of the overall frequency with which all judges placed items within the intended theoretical construct. "Scales based on categories which have a high degree of correct placement of items within the 'target' (theoretical) construct can be considered to have a high degree of construct validity, with a high potential for good reliability scores" (Moore and Benbasat 1991, p. 201).

Table B2 shows the labels provided by the judges in the first round. Tables B3 and B4 show the item placement ratio for the two rounds. The overall placement ratio of items within target constructs was 88% in the first round and 93% in the second round, indicating that, overall, all three scales demonstrate construct validity.

Reliability

The questionnaire was pilot tested in a manufacturing organization. The objective of the pilot test was to make an initial reliability assessment of the scales and to provide a testing ground or dry run for final administration of the instrument. The respondents were encouraged to comment on the length, wording, and instructions of the instrument. It was distributed to 40 individuals by the CIO; 19 completed responses were obtained. The analysis of the responses included a review of comments about question wording and meaning. As a result, a few items were reworded to correct ambiguity which may have discouraged respondents or elicited inaccurate responses. The data were also used to assess the reliability of the construct scales. All the key constructs displayed acceptable reliability levels (see Table B5).

Table B2. Construct Labels Given by Individual Judges (First Round)

Construct	Judge A	Judge B	Judge C
Technology Cognizance (TC)	IT Knowledge	Technology Knowledge	Technology Application Knowledge
Ability to Explore (AE)	Experimentation Capability	Support for Experimentation	Capability of User to Examine New Technology
Intention to Explore (IE)	Intention to Experiment	Readiness to Innovate	Willingness to Examine New Technology

Table B3. Item Placement Ratios (First Round)

Target Category	Actual Categories					
	TC	AE	IE	N/A	Total	Target %
Technology Cognizance (TC)	17	1	0	0	18	94
Ability to Explore (AE)	1	36	0	5	42	85
Intention to Explore (IE)	0	0	8	1	9	88
Total Item Placements: 69	Hits: 61	Overall Hit Ratio: 88%				

Table B4. Item Placement Ratios (Second Round)

Target Category	Actual Categories					
	TC	AE	IE	N/A	Total	Target %
Technology Cognizance (TC)	18	0	0	0	18	100
Ability to Explore (AE)	0	36	0	3	39	92
Intention to Explore (IE)	0	0	8	1	9	88
Total Item Placements: 66	Hits: 62	Overall Hit Ratio: 93%				

Table B5. Cronbach Alpha Scores for UPIT (Pilot Test)

Construct	Reliability*
Technology Cognizance	0.74
Ability to Explore	0.71
Intention to Explore	0.89

Notes: * Standardized Cronbach alpha.
n = 19.

Scale Validation for Empirical Study

Discriminant Validity

The card sorting procedure and pretest reliability provided initial evidence for the validity of the scales comprising the three dimensions of UPIT. Further support was sought through a factor analysis procedure applied to the larger pool of data collected in the main study. One item (A4) from the 13 item ability to explore scale cross loaded on both technology cognizance and ability to explore and was, hence, dropped from further analysis. A three-factor principal components solution with varimax rotation on the remaining items comprising the TC, AE, and IE scales is shown in Table B6. The three factors collectively explained 62.3% of the variance. All indicators loaded on the latent variables they measured with no cross-loading of items.

Confirmatory factor analysis with three latent variables using Lisrel 8 (Joreskog and Sorbom 1993) was performed on the above items. The model fit the data well. Although the overall model fit was significant (χ^2= 278.3, df = 147, p = 0.00), other fit indicators were within acceptable parameters (Joreskog and Sorbom 1993; Taylor and Todd 1995). The root mean square error of approximation (RMSEA) was 0.067, standardized root mean residual (RMR) was 0.076, while the goodness of fit index (GFI) and the adjusted goodness of fit index (AGFI) were 0.89 and 0.84, respectively. Additionally, all items loaded significantly on the appropriate latent variables. These analyses collectively point to the convergent and discriminant validity of the dependent variables.

Table B6. Factor Structure for Dependent Variables

Item	Factor 1	Factor 2	Factor 3
TC1	**0.61**	0.12	0.18
TC2	**0.42**	0.21	0.33
TC3	**0.90**	0.10	0.10
TC4	**0.77**	0.09	0.10
TC5	**0.79**	0.03	0.02
AE1	0.05	**0.46**	0.36
AE2	0.07	**0.61**	0.26
AE3	0.01	**0.50**	0.37
AE5	0.29	**0.54**	0.41
AE6	0.01	**0.52**	0.15
AE7	0.30	**0.44**	0.21
AE8	0.08	**0.51**	0.06
AE9	0.24	**0.68**	0.10
AE10	0.27	**0.61**	0.13
AE11	0.09	**0.62**	0.18
AE12	0.29	**0.74**	0.01
AE13	0.05	**0.67**	0.29
IE1	0.05	0.01	**0.90**
IE2	0.00	0.07	**0.90**
IE3	0.03	0.01	**0.83**
Eigen value	5.53	2.55	2.15
Percent of variance	27.7	12.8	10.8

Note: Significant factor loadings are in bold.
n = 200.