Impact of Technostress on End-User Satisfaction and Performance

MONIDEEPA TARAFDAR, QIANG TU, AND T.S. RAGU-NATHAN

Monideepa Tarafdar is an associate professor of information, operations, and technology management at the University of Toledo. She has an undergraduate degree in physics and a graduate degree in telecommunications and electronics engineering from the University of Calcutta, India. Her Ph.D. is in management from the Indian Institute of Management, Calcutta. Her current research interests are in managing individual and organizational adjustments required for effective information technology use, information systems planning for Net-enabled organizations, information systems–business alignment, and business innovation using information systems. Her research has appeared or is forthcoming in *Journal of Management Information Systems, Information Systems Research, Sloan Management Review, Information and Management, Journal of Strategic Information Systems, Journal of Computer Information Systems, Communications of the ACM, Information Resources Management Journal, International Journal of Information Management,* and *Journal of Cases on Information Technology.*

Qiang Tu is a professor of management information systems at the E. Philip Saunders College of Business at the Rochester Institute of Technology. He received a B.S. in management engineering and an M.S. in systems engineering from Jiaotong University, China, and a Ph.D. from the College of Business Administration of the University of Toledo. His research interests include information systems strategy, manufacturing strategy, technology management, and behavioral issues in information systems management. His research has been published in *Information Systems Research, Journal of Management Information Systems, Decision Sciences, Journal of Operations Management, OMEGA: The International Journal of Management Science, Journal of Strategic Information Systems, Communications of the ACM,* and *Information Resources Management Journal.*

T.S. Ragu-Nathan is a professor of information systems and operations management at the College of Business Administration at the University of Toledo. He holds a Ph.D. in management information systems from the University of Pittsburgh. His current research interests are in information systems strategy, quality issues in information systems, and the use of information technology in manufacturing, supply chain management, and e-commerce. His research has been published in several journals, including *Information Systems Research, Journal of Management Information Systems, Decision Sciences, OMEGA: International Journal of Management Science, Journal of Information Systems,* and *Journal of Strategic Information Systems.*

Abstract: Organizational use of information and communications technologies (ICT) is increasingly resulting in negative cognitions in individuals, such as information overload and interruptions. Recent literature has encapsulated these cognitions in

Journal of Management Information Systems / Winter 2010–11, Vol. 27, No. 3, pp. 303–334.

0742–1222 / 2011 $9.50 + 0.00.
DOI 10.2753/MIS0742-1222270311

the concept of technostress, which is stress caused by an inability to cope with the demands of organizational computer usage. Given the critical role of the user in organizational information processing and accomplishing application-enabled workflows, understanding how these cognitions affect users' satisfaction with ICT and their performance in ICT-mediated tasks is an important step in appropriating benefits from current computing environments. The objective of this paper is to (1) understand the negative effects of technostress on the extent to which end users perceive the applications they use to be satisfactory and can utilize them to improve their performance at work and (2) identify mechanisms that can mitigate these effects. Specifically, we draw from the end-user computing and technostress literature to develop and validate a model that analyzes the effects of factors that create technostress on the individual's satisfaction with, and task performance using, ICT. The model also examines how user involvement in ICT development and support mechanisms for innovation can be used to weaken technostress-creating factors and their outcomes. The results, based on survey data analysis from 233 ICT users from two organizations, show that factors that create technostress reduce the satisfaction of individuals with the ICT they use and the extent to which they can utilize ICT for productivity and innovation in their tasks. Mechanisms that facilitate involvement of users, and encourage them to take risks, learn, explore new ideas, and experiment in the context of ICT use, diminish the factors that create technostress and increase satisfaction with the ICT they use. These mechanisms also have a positive effect on users' appropriation of ICT for productivity and innovation in their tasks. The paper contributes to emerging literature on negative outcomes of ICT use by (1) highlighting the influence of technostress on users' satisfaction and performance (i.e., productivity and innovation in ICT-mediated tasks) with ICT, (2) extending the literature on technostress, which has so far looked largely at the general behavioral and psychological domains, to include the domain of end-user computing, and (3) demonstrating the importance of user involvement and innovation support mechanisms in reducing technostress-creating conditions and their ICT use–related outcomes.

Key words and phrases: end-user performance, end-user satisfaction, ICT use, information overload, survey research, technostress, user involvement.

Organizational use of information and communications technologies (ICT) has become complex, real-time, ubiquitous, and functionally pervasive, often requiring users to process information simultaneously and continually from different applications and devices. Consequently, ICT users[1] deal with a surfeit of information, experience frequent interruptions from different computing devices and applications, and engage in multitasking on them. Further, they are increasingly frustrated and overwhelmed by continual efforts required to master the frequent introduction of new ICT. In recent times, therefore, managers have experienced negative cognitions toward ICT. Recent academic literature has encapsulated these cognitions in the concept of technostress [65], which is stress caused by an inability to cope with the demands of organizational computer usage. Technostress describes the stress that users experience as a result of application multitasking, constant connectivity, information overload, frequent system upgrades and consequent uncertainty, continual relearning and consequent job-related insecurities, and technical problems associated with the organizational use of ICT. From the perspective of psychological outcomes, technostress reduces individuals' job satisfaction and commitment to their organization [65]. From the point of view of behavioral outcomes, it reduces individuals' productivity at work [75].

What is the potential effect of these negative cognitions on outcomes relating to the individual's use of ICT? There is research evidence [8, 35, 63] that in spite of continuing sophistication in the functional capabilities of ICT, technology overload and ICT-mediated interruptions reduce the satisfaction of users with the ICT they employ for their tasks and their ability to benefit from them. Emerging practitioner perspectives [22, 78] reinforce these findings, suggesting that excessive information, frequent upgrades, and blurring of work–home boundaries induced by pervasive connectivity result in inaccurate information processing and poor task-related decision making using ICT and in dissatisfaction with ICT. At the same time, organizational computing environments have an important role for the end user in generating, accessing, analyzing, and using business information and in accomplishing application-enabled workflows. In such environments, it is critical that end users be satisfied with the applications and systems they interact with and work on and be able to effectively use them to enhance the quality and efficiency of their work tasks [16, 45, 81]. Understanding how these "negative" or "unconstructive" aspects of ICT and the negative cognitions associated with them affect user satisfaction and ICT-mediated task performance is therefore clearly an important step in managing and appropriating benefits from current commuting environments. Research in this area is emerging and scarce, and there is absence of (1) a theoretical framework for understanding and (2) systematic empirical investigation for demonstrating how these aspects impact the user in his or her day-to-day application of ICT to organizational tasks.

Recognizing that the concept of technostress encompasses user-perceived negative cognitions about ICT, we apply the technostress lens to this research gap and enunciate a twofold objective of this paper. The first objective is to understand the (adverse) effects of technostress on the extent to which end users perceive the applications they use to be satisfactory and can utilize them to improve their performance at work. Second, we identify mechanisms that can reduce these effects.

Specifically, we draw from the end-user computing and organizational stress literature to develop and validate a model that analyzes the effects of factors that create technostress on end-user satisfaction and end-user performance. We further study how stress-alleviating factors, such as mechanisms that facilitate user involvement in ICT development and those that support innovation, can be used to weaken technostress-creating conditions and their outcomes. The results, based on survey data analysis from 233 ICT users from two organizations, show that factors that create technostress reduce users' satisfaction with the ICT they use and the extent to which they utilize ICT for productivity and innovation in their tasks. Mechanisms that facilitate involvement of users and encourage them to take risks, learn, explore new ideas, and experiment in the context of ICT use diminish the factors that create technostress for them and increase their satisfaction with the ICT they use. These mechanisms also have a positive effect on users' appropriation of ICT for productivity and innovation in their tasks. The paper

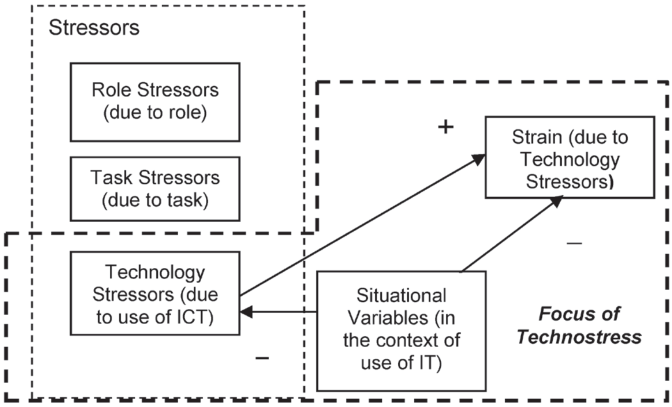

Figure 1. General Relationships Among Stressors, Strain, and Situational Variables

contributes to emerging literature on "negative" outcomes of organizational ICT use by (1) highlighting the importance of technostress on users' satisfaction with ICT and on their performance—that is, their productivity and innovation—in ICT-mediated tasks, (2) extending the literature on technostress, which has so far looked largely at the general behavioral and psychological domains, to include the domain of end-user computing, and (3) demonstrating the importance of user involvement and innovation support mechanisms in reducing technostress-creating conditions and outcomes.

Next, we provide a theoretical background by reviewing studies on stress and technostress, and then we develop the research model and hypotheses. In the fourth section, we describe methods and validate the model. The paper closes with a discussion of the findings and research and managerial implications.

Theoretical Background

Organizational Stress

Stress is a cognitive state experienced by an individual when there is an "environmental situation that is perceived as presenting a demand which threatens to exceed the person's capabilities and resources for meeting it, under conditions where he or she expects a substantial differential in the rewards and costs from meeting the demand versus not meeting it" [56, p. 1351]. It is a reaction to the perceived imbalance between a person and the environment [9, 19], borne out of anticipation of an inability to adequately respond to demand from the imbalance and accompanied by the expectation of negative consequences for inadequate response [56]. As shown in Figure 1, the phenomenon of stress consists of three aspects—stressors, strain, and situational variables [52].

Stressors represent factors or conditions that create stress. These conditions could be due to the individual's role [50] and task [56]. Role stress and task stress have been widely studied.[2] More recently, technology in general and ICT in particular have emerged as conditions for the cause of stress [20]; this is the focus of *technostress. Strain* represents the outcome of stress. Individuals experience strain as a result of being exposed to stressors [19]. Strain due to role and task stress manifests in the form of outcomes such as reduced productivity, job dissatisfaction [47, 50], and task performance [19]. *Situational variables* or *interventions* are organizational mechanisms that provide ways in which stressors can be reduced and their effects alleviated [19, 56]. In the context of role and task stress, they include social support, role redesign, autonomy, control, and personnel policy changes [48]. Stress is therefore a process that involves the individual perceiving the presence of one or more *stressors* and reacting to them, the outward manifestation of the latter being *strain* [19]. In the most general case, stressors increase strain. Situational variables decrease strain and also decrease stressors [19].[3] As shown in Figure 1, the focus of technostress is on *stressors, situational variables,* and *strain* in the context of the use of ICT.

Technostress

Individuals experience technostress [80] as a result of their use of ICT in organizations. It is a problem of adaptation wherein they are unable to cope with requirements related to their use of ICT. These include adjustments to constantly evolving ICT and the changing physical, social, and cognitive requirements related to ICT use. It is a relatively new and understudied area. Stressors associated with technostress are called *technostress creators* [65].

Strains Due to Technostress Creators

Strains, in general, can be *psychological* or *behavioral.* Psychological strains are emotional reactions to stressor conditions and include, among others, dissatisfaction with the job, depression, and negative self-evaluation. Behavioral strains include reduced productivity, increased turnover and absenteeism, and poor task performance [19, 47].

As shown in Figure 2, and consistent with the relationships among stressors, strain, and situational variables described in Figure 1, *technostress creators* (i.e., technology stressors) increase each of these two types of strains. From the point of view of *psychological strain,* technostress creators decrease the job satisfaction and organizational commitment [65] and increase the role stress [75] of the individual, thus reducing the individual's sense of well-being and dedication at the workplace. In the context of *behavioral strain,* technostress creators reduce the productivity of the individual [75]. Both of these types of strains exemplify general job-related outcomes from technostress creators. They occur because of the effects of ICT on organizational tasks, workflows, and processes. For example, traditional ICT such as word-processing systems and advanced manufacturing/automation systems, by virtue of their embeddedness in the work environment, change their users' work processes [79]. They induce workflow rigidity and technologically determined pace and timing of required actions [21]. These changed aspects of tasks result in psychological and

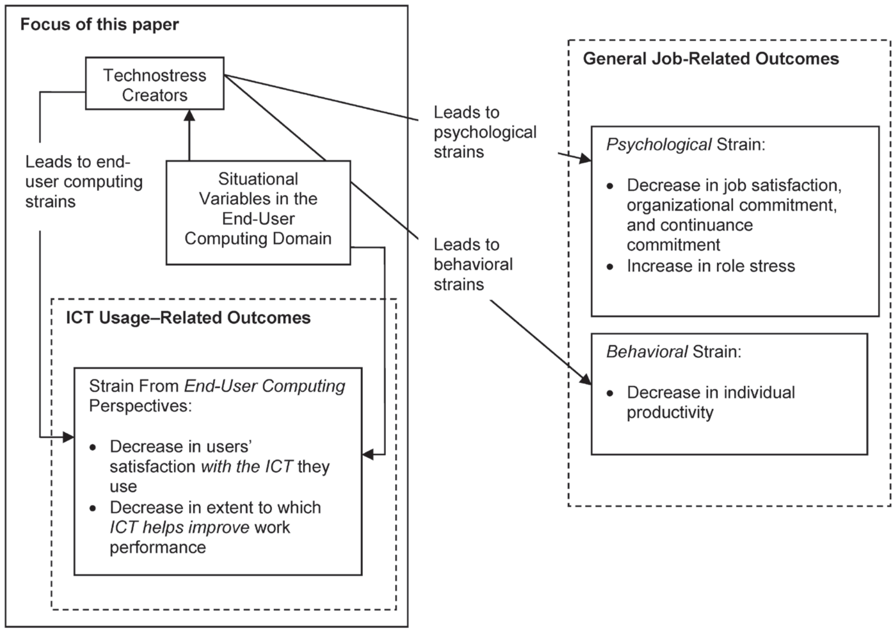

Figure 2. Strains in the Context of Technostress

behavioral strains such as dissatisfaction and boredom, ambiguity about performance expectations, higher perceived task difficulty, increased perceived work demands, and reduced job control [27, 82].

A second effect of the use of ICT is users' negative attitudes and cognitions. These include nervousness and agitation when interacting with computers, known as *computer anxiety* [34], and fear of using them, known as *computer phobia* [13]. Studies of the use of ICT by professionals in sectors such as health care [67], library and reference [29, 71], and education [1] show that requirements for the increased use of electronic order entry, electronic searching and indexing, and classroom applications are associated with use avoidance because users are not favorably disposed toward them.

Negative cognitions about computers also include frustration and dissatisfaction from information overload and ICT-mediated task interruptions. *Information overload* [31, 36, 74] refers to overwhelming volumes of information from different communication channels that ICT users are subject to. Difficulty in discerning and utilizing useful information and the consequent loss of productive time leads to frustration. ICT-mediated interruptions [8, 37] refer to continual task disruptions that users of ICT face from connected devices such as computers and smart phones. Interruptions reduce the ability to sustain mental attention and effort [3], impair task processing, reduce task accuracy [15], and increase the time required for task completion [73]. The inability to process information as soon as it arrives (e.g., via e-mail) results in "attention deficit trait" or "continuous partial attention" [43], mental states in which the user is continually being distracted and frustrated by incoming information. Indeed, recent commentary [12, 38] mentions the use of e-mail management techniques and software, giving an example at Intel, where the annual cost of reduced productivity in the form of time lost to handling e-mail and recovering from information interruptions is nearly $1 billion.[4]

These illustrations show that negative cognitions reduce users' satisfaction with the systems and applications they use and their ability to use them gainfully to enhance their work. Thus, we suggest that in the context of technostress, in addition to behavioral and psychological strains, there is a third type of strain from the perspective of end-user computing, exemplifying *ICT usage-related outcomes,* in particular, the extent to which individuals are satisfied with the applications that they use and can use them to improve their task performance. User satisfaction is an important variable because it is considered a surrogate for the success of the system [7, 59]. Similarly, the performance of end users in terms of how well they use ICT to improve the quality and efficiency of their work [30, 76] is also important because it is critical to the firm's ability to appropriate benefits from ICT. Strains from the perspective of end-user computing are thus clearly detrimental. As shown in Figure 2, studies have looked at technostress-related strain from the psychological and behavioral perspectives [65, 75]. The objective of this paper is to study technostress-related strains from the end-user computing perspective. We focus on the relationships among technostress creators, situational variables, and strains relating to end-user computing. Specifically, we seek to understand the effects of technostress creators on two (inverse) strain variables—the satisfaction and performance of end users—in the context of the ICT that they use, and to identify situational variables for reducing technostress creators and increasing satisfaction and performance.

We use the constructs *end-user satisfaction* and *end-user performance* to describe, respectively, the satisfaction of end users of ICT with the systems and applications they use and the extent to which their task performance is enhanced by them. Our research model, described in Figure 3, proposes that consistent with the relations between stressors and strain described in Figure 1, *technostress creators* reduce *end-user satisfaction* and *end-user performance.* End users' participation and involvement in systems development is important for the acceptance of and successful use of ICT [11, 28] and for reducing the impact of stressful conditions from implementation of new ICT [18]. Similarly, mechanisms that encourage employees to innovate help alleviate stressful conditions arising out of use of new technologies [19]. Therefore, we also include the two constructs *involvement facilitation* and *innovation support,* analogous to situational variables in Figure 2. Consistent with the relations between situational variables, stressors, and strain, we expect that *involvement facilitation* decreases *technostress creators* and increases *end-user satisfaction,* and that *innovation support* increases *end-user satisfaction.* Drawing from studies on end-user computing, we hypothesize that *innovation support* increases *involvement facilitation,* and *end-user satisfaction* increases *end-user performance.* We thus expect that *involvement facilitation* and *innovation support* will increase *end-user performance* through their

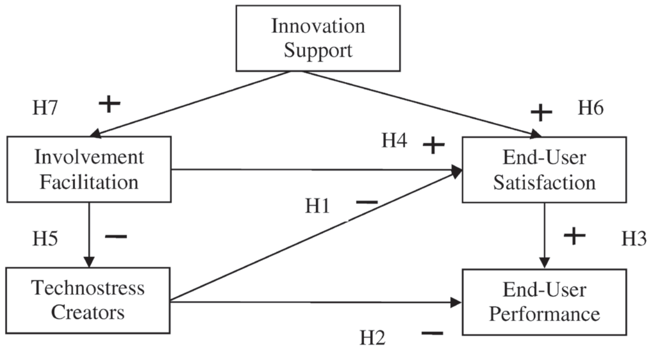

Figure 3. Research Model

effects on *end-user satisfaction.* We next describe the constructs and provide rationale for the anticipated relationships.

Research Model: Constructs and Hypothesis

LINKING BACK TO FIGURE 1, WE FIRST DESCRIBE THE *stressor* (technostress creators) and reverse *strain* (end-user satisfaction and end-user performance)-related constructs and hypothesize relationships among them (H1 through H3). We next describe the situational variable (involvement facilitation and innovations) constructs and develop hypotheses related to them (H4 through H7). Our arguments are based on studies from the technostress and end-user computing literatures.

Technostress Creators

The construct *technostress creators* describes stressors associated with the use of ICT. Tarafdar et al. [75], using survey results from end users of ICT, found that stressors associated with technostress encompass five conditions that end users face as a result of their organizational use of ICT. *Techno-overload* describes situations where ICT force users to work faster and longer. *Techno-invasion* describes the invasive effect of ICT in terms of creating situations where users can potentially be reached any time, employees feel the need to be constantly "connected," and there is a blurring between work-related and personal contexts. *Techno-complexity* describes instances where the complexity associated with ICT makes users feel inadequate as far as their skills are concerned and forces them to spend time and effort in learning and understanding various aspects of ICT. *Techno-insecurity* is associated with situations in which users feel threatened about losing their jobs either to automation resulting from new ICT or to other people who have a better understanding of the ICT. *Techno-uncertainty* refers to contexts where continuing changes and upgrades in ICT unsettle users and create uncertainty for them in that they worry about constantly learning and educating themselves about new ICT.

End-User Satisfaction and End-User Performance

The construct *end-user satisfaction* [4, 28, 59] describes a positive attitude and perception of the individual toward the ICT that he or she uses in the course of performing day-to-day work processes. End-user satisfaction includes factors such as relevance and accuracy of the information provided by an ICT-based system [25] and its ease of use [28]. It has been widely used as a surrogate for a system's usefulness [68] and its overall success [17, 26, 66] as perceived by the end user. Higher satisfaction leads to increased task productivity [25, 30], greater task innovation [26], and improved decision making [46] on the part of end users.

The construct *end-user performance* describes the degree to which individuals use ICT to enhance their work performance and outcomes—that is, the extent to which ICT use contributes positively to their (ICT-mediated) tasks. ICT help users improve their work performance by increasing their task efficiency [30], productivity [46, 76], and innovation [76]. They also lead to greater decision effectiveness, better decision quality, and less time to make decisions [46].

Relationships Among Technostress Creators, End-User Satisfaction, and End-User Performance

Cognitions about computers play a key role in determining the satisfaction and performance of end users in the context of ICT-mediated tasks [4, 68]. Users having positive cognitions about computers show greater satisfaction with ICT. Computer anxiety, for instance, leads to low user satisfaction [40] and poor performance outcomes [42].

Technostress creators decrease *end-user satisfaction* through the five conditions resulting from ICT use mentioned above. Due to techno-overload, managers tend to communicate more information than is necessary [24] and receive more information than they can effectively process and use [32]. They feel compelled to acquire and process information simply because it is available, and have to consequently spend greater time and effort in information processing. At the same time, they are unable to identify information that is actually useful, leading to dissatisfaction with the content and outputs of the applications they use. Techno-invasion leaves end users with the feeling that they are never "free" of technology, that they are always under supervision or "on call," and that their space has been invaded. They perceive a loss of privacy [80]. There is thus a blurring of boundaries between the home and the workplace, leading to dissatisfaction with the applications they use. Emerging practitioner accounts in this context [72] report on legal issues precipitated by employees of organizations where there are apparent requirements for using ICT for work after office hours.

As a result of techno-complexity, users have to spend time and effort in learning how to use ICT, to the possible exclusion of other organizational tasks. Most users find the variety of applications and functions intimidating and do not really understand how or why they should be used [80]. Further, most workflow-oriented ICT such as enterprise resource planning (ERP) and customer relationship management (CRM) systems require extensive modification and configuration before use. It takes time for the hardware and software to stabilize; meanwhile, systems crash, data get lost, applications are slow, and technical help is not always available. Users thus feel that systems are not friendly, timely, or accurate. Dissatisfaction and frustration with ICT result. Techno-uncertainty arises out of endless upgrades to ICT. Employees have to regularly learn how to work with new applications, even as their existing and recently acquired knowledge becomes obsolete [80]. These constant requirements for refreshing and updating lead to dissatisfaction with ICT [60]. As a result of techno-insecurity, end users fear the possibility of losing their jobs, in case of an inability to cope with learning requirements and work process adaptations relating to new and changing ICT. Techno-insecurity results in negative assessments about system user-friendliness and adequacy of computer knowledge, leading to dissatisfaction with the applications used. We therefore have the following hypothesis:

Hypothesis 1: Technostress creators negatively influence end-user satisfaction.

The five conditions associated with technostress creators reduce the effectiveness with which ICT users can use applications to enhance their performance at work. For example, techno-overload leads to multitasking with several applications and accomplishing different information-processing tasks simultaneously. Excessive multitasking leads to hurried and ineffective information processing [32]. Users may have to work longer to accomplish their work, or faster to complete it in the same amount of time. Multitasking leaves insufficient time and attention for accomplishing organizational tasks in any but the most simplistic and unimaginative ways, little time for exploring creative and new work processes [2], and sometimes not even enough time to effectively perform existing processes [40, 42], thus impairing end-user performance.

Techno-invasion, stemming from present-day organizational infrastructures that include pervasive networks and mobile computing devices, enables "anytime anyplace" access through almost constant and ubiquitous connectivity. This may impair performance because of unnecessary interruptions to work and because employees, when working off-site, tend to use only those information resources that they can access remotely, to the possible exclusion of others that may have to be accessed on-site; an ineffective use of ICT for accomplishing work performance is a consequence.

Techno-complexity places requirements on users to frequently develop new skills required for using ICT, something they are often unwilling or unable to do. As they try to unsuccessfully apply existing solutions to the new technologies, initial errors get transmitted and their effects are magnified, leading to reduced performance on ICT-mediated tasks. In addition, users who perceive job-related insecurity and anxiety as a result of techno-insecurity experience low self-confidence and impaired performance at their tasks, especially at those that involve use of ICT [42].

Based on the above arguments, we therefore frame Hypothesis 2 as

Hypothesis 2: Technostress creators negatively influence end-user performance.

High end-user satisfaction implies that users are satisfied with the content, accuracy, and timeliness of the information provided by ICT [28], the ease with which they can be used [25], and their security [53]. ICT that satisfy their users help them to process information faster and more effectively, thus improving the quality of their work [11]. Many present-day applications such as data-mining and analytic tools, and Web-based applications such as clickstream analysis and wikis, enable users to develop creative and innovative ways for acquiring, processing, and analyzing information. End-user satisfaction therefore improves user performance in the form of increased productivity and innovation. This is also consistent with the overarching logic of technology acceptance studies [23] that show that attitude toward ICT (in this case, end-user satisfaction) influences behavior toward it (in this case, the use of it for improving task performance, or end-user performance). We therefore propose Hypothesis 3:

Hypothesis 3: End-user satisfaction positively influences end-user performance.

Involvement Facilitation

Involvement of end users describes their participation in the planning, development, and implementation of ICT. High involvement indicates influential roles of users during different stages of systems development [62]. These include participating in planning, clarifying information input-output screens and formats, approving systems requirements, giving feedback on prototypes during design and implementation, liaising between systems developers and other users, and undertaking training and postimplementation support activities [28, 57, 62].

Involvement facilitation mechanisms that reduce technostress creators and technostress-related strains include considering users' views in discussions on the rationale for new applications, involving them in systems implementation, incorporating their requirements wherever possible into system design and configuration, communicating workflow and process changes, benefits, and opportunities accompanying the introduction of new ICT to users, and encouraging them to use, try out, and assess new applications [18, 60, 65]. The *involvement facilitation* construct describes these mechanisms.

Relationships Among Involvement Facilitation, Technostress Creators, and End-User Satisfaction

Involvement facilitation mechanisms reduce technostress creators in four ways. First, they lead to user familiarity and acquaintance with systems [5, 54]. Users feel less uncertain about capabilities and functionalities of new ICT that the organization may acquire and are more proactive and willing to spend time and effort in upgrading their skills. Involved users have a better appreciation of the larger context in which ICT are implemented and the associated strategic and operational imperatives and issues [57]. They are thus able to better manage their insecurities and fears about losing their jobs. Involved users understand new systems better [28, 69] and consequently do not find them as complex. They can thus use the systems more productively and, in appropriate contexts, avoid situations where the use of ICT is invasive. Techno-complexity, techno-insecurity, and techno-invasion are thus reduced.

Second, involvement facilitation mechanisms enable users to present and clarify their needs from the system [5]. What results is a more accurate and complete definition of user requirements and the reduction of unimportant, irrelevant, or unacceptable system features [69]. Consequently, postimplementation, users spend less time navigating through and learning unnecessary and complex features, thus finding systems to be simple and adequate. Further, they find the information provided by the system useful and are more confident of their ability to use it effectively. As a result, they are less inclined to feel overloaded and overwhelmed by it. Techno-complexity and techno-overload are thus reduced.

Third, involvement facilitation mechanisms provide greater control to end users by enabling them to influence the processes by which ICT are adopted, developed, and implemented. Greater control increases users' understanding of applicability and task changes in the context of particular applications [6]. It also increases the predictability that they associate with the implementation process, reducing their uncertainty about new ICT. Techno-complexity and techno-uncertainty are thus reduced.

Fourth, involvement mechanisms lead to greater communication and collaboration between users and information systems (IS) professionals [58]. Users can clarify their requirements and concerns, and IS professionals can express their views and constraints, leading to more effective negotiation and conflict resolution during system design and implementation. Consequently, users find the implementation process less stressful. Collaboration and conflict resolution between users and IS professionals also lead to increased user acceptance and ownership of applications and systems that they will eventually use [69], thus resulting in less overall stress in the context of their use.

In summary, therefore, involvement mechanisms reduce technostress creators by enhancing end users' understanding of ICT, providing greater control and predictability vis-à-vis the deployment and use of ICT, accurately capturing their requirements, and facilitating their collaboration and communication with IS professionals for effective negotiation and conflict resolution during system development/implementation. We therefore frame Hypothesis 4 as

> *Hypothesis 4: Involvement facilitation negatively influences technostress creators.*

Users who are involved in the planning, introduction, and assimilation processes for ICT can influence system attributes in accordance with their needs [69]. They thus attach a high degree of personal relevance to ICT and have a positive attitude toward them [5, 41]. Involving end users enables development and deployment of applications that are better understood by users [7], appropriately configured [28], more valued and better accepted by them [14, 58], and perceived to be useful [33], thus resulting in greater user satisfaction. Mechanisms that facilitate the involvement and participation of end users in ICT implementation and reward them for doing so are therefore expected to increase their satisfaction with the ICT they use.[5] We therefore frame Hypothesis 5 as

Hypothesis 5: Involvement facilitation positively influences end-user satisfaction.

Innovation Support

The implementation of technological innovations introduces changes in individuals' work routines and organizational processes. Mechanisms that provide support for innovation, encourage communication, encourage new ideas, and promote supportive relationships among employees in general facilitate the learning and adjustment necessary for understanding and accepting these changes. These mechanisms are embodied in the construct *innovation support.* Organizational processes that reward and encourage experimentation and learning facilitate quicker familiarity with technology [51]. Similarly, a high tolerance for risk taking decreases the perceived negative consequences of failure from experimentation with new technology. In the context of stress that comes from technology, mechanisms that encourage employees to experiment and learn about new things in general help alleviate some of that stress [19].

Relationships Among Innovation Support, Involvement Facilitation, and End-User Satisfaction

ICT implementation may be accompanied by problems of inaccurate or irrelevant information, difficult-to-use features, and outputs that are not useful to the user. Mechanisms that encourage communication among managers, facilitate supportive work relationships in general, and indicate openness toward new ideas make it possible for users to have dialog with the IS department and with one another, and thus to find ways to solve these problems [58]. Support for innovation and experimentation by users enables them to find out how to navigate functionalities afforded by the system, assess available information outputs, and increase their familiarity with system features. When users thus perceive that the system provides easy-to-use and familiar features, and relevant outputs, their satisfaction with it increases. We therefore frame Hypothesis 6 as

Hypothesis 6: Innovation support positively influences end-user satisfaction.

Mechanisms that support innovation in general facilitate better adaptation to technology changes. In the particular context of ICT implementation, innovation support mechanisms enable users to better navigate changes associated with the introduction of new ICT [60]. Further, they facilitate quicker familiarity with new ICT [51, 77], which encourages use and greater involvement of the user in trying out new ICT. We therefore expect that mechanisms that support innovation, experimentation, and risk taking would facilitate user involvement in implementation and experimentation vis-à-vis new ICT. We therefore frame Hypothesis 7 as

Hypothesis 7: Innovation support positively influences involvement facilitation.

Research Methodology, Analysis, and Results

We used the survey methodology to collect data and test our research model. We discuss below the steps pertaining to questionnaire development, data collection, construct validation, and model testing.

Step 1: Item Development and Questionnaire Design

Items for *innovation support* were developed from the literature discussions in the previous section. Specifically, they addressed issues of communication, encouragement for learning and experimentation, and supportive relations among managers of different departments. *End-user performance* items were adapted from Torkzadeh and Doll [76] and included questions about productivity, quality, and innovation in the context of ICT use for organizational tasks. Items for *technostress creators* and *involvement facilitation* were adopted from Ragu-Nathan et al. [65]. Items for *end-user satisfaction* were adapted from Doll and Torkzadeh [28]. All the items were measured on a five-point Likert scale anchored with 1 = "strongly disagree" and 5 = "strongly agree." A sixth option of "not applicable" or "I do not know" was also provided. Further content validation involved interviews with 10 end users of ICT from one university and from two business organizations. The end users at the university were secretaries and administration employees. Those at the business organizations were at the middle-management level. All these users had work environments like that of the survey respondents of our research. During these interviews, we asked them to comment on the relevance of the questions in the context of technostress situations experienced by them. Subsequent to the interviews, we found the questionnaire items relevant and appropriate for large-scale study.

Step 2: Data Collection

Two public-sector organizations in the midwestern region of the United States were the sites for data collection. One was an organization that sheltered abandoned children and the other a firm that provided job training and placement services for the unemployed. They were of similar size, had similar ICT systems, and had similar technical support, help desk, and training for users. They used locally developed systems for maintenance of transaction-processing records. They also used word-processing applications for documentation and spreadsheet analysis for decision support. For each organization, we solicited support for this study, conducted in 2006–7, through the chief executive officer or the head of the IS department. We sent a total of 320 e-mails (to all the employees of the respective organizations) describing the nature and purpose of the study. These employees were end users of ICT and most of them worked at operational levels in middle-management positions. They were instructed to ask for a printed questionnaire if they were interested in participating and to return the completed questionnaire in a sealed envelope. The employees were informed that participation was voluntary and that the confidentiality of their responses would be assured. A total of 264 questionnaires were picked up, of which 233 were returned, representing a response rate of 88.2 percent based on the number of questionnaires requested and 73 percent based on the number of e-mails sent. Sample demographics are given in Table 1, including gender, education, years working, and years in current organization. From Table 1, it can be seen that the sample is dominated by females (78 percent). Most respondents are well educated. Ninety-five percent of the respondents have more than five years of work experience, and over 70 percent have worked in the particular organization for more than five years. These demographics indicate that the respondents were familiar with their organizational work environment, procedures, and policies and were capable of answering the questions regarding technology changes and their effects.

Step 3: Exploratory Factor Analysis to Identify Factor Structure

Our first task was to check the factor structures of the constructs and confirm them with the original studies where applicable. To do this, exploratory factor analysis was conducted in two steps. In the first step, items for all the constructs except those for *end-user satisfaction* were factor analyzed, yielding nine factors, as shown in Table 2a, Next, *end-user satisfaction* was factor analyzed, and the results are shown in Table 2b. *End-user satisfaction* was factor analyzed separately to maintain consistency with the five-factor structure, as was done in the original study [28]. These two-factor analysis steps yielded 14 first-order factors, with items as shown in Table 3. All the factor loadings in Table 2 are at an acceptable level, and there were no cross-loadings above 0.4 (loadings below 0.4 are not shown in the table to maintain clarity). The factor reliabilities (Cronbach's alpha), means, and standard deviations are shown in Table 3. All the reliabilities are above 0.8 and thus considered good [61]. Table 4 shows the correlation matrix. In addition, we also followed the procedure suggested by Harman's single-factor test for common method bias [64] and found that no single factor explains the majority of the variance in the variables, thereby providing evidence against single-respondent bias.

Step 4: Tests for Convergent and Discriminant Validity Through Confirmatory Factor Analysis Using Structural Equation Modeling Analysis

Even though exploratory factor analysis provides a measure of convergent and discriminant validity of constructs, it does not test for possible error correlations among items. We therefore developed measurement models using confirmatory factor analysis for each first-order construct. We used structural equation modeling through Amos version 16. We then ran a first-order correlated model of the measurement models of the 14 factors to identify significant correlations among their error terms, if any.

Table 1. Sample Demographics

	Number	Percentage
Panel A: Gender		
Female	181	78
Male	40	17
Missing	12	5
Total	233	100
Panel B: Education		
High school	37	16
Two-year college	45	19
Bachelor's degree	108	46
Master's degree	33	14
Others	10	5
Total	233	100
Panel C: Years Working		
1–5	9	4
6–10	27	12
11–15	31	13
16 and over	155	66
Missing	11	5
Total	233	100
Panel D: Years in Current Organization		
1–5	62	27
6–10	49	21
11–15	39	17
16 and over	71	30
Missing	12	5
Total	233	100

The model fit indices were chi-square/degrees of freedom = 1.7, goodness-of-fit index (GFI) = 0.90, adjusted goodness-of-fit index (AGFI) = 0.87, normed fit index (NFI) = 0.90, Tucker–Lewis index (TLI) = 0.95, comparative fit index (CFI) = 0.96, and root mean square error of approximation (RMSEA) = 0.054. Appropriate values for chi-square/degrees of freedom should exceed 1 and should be less than 5 [70]. GFI > 0.85 and AGFI > 0.8 represent an acceptable fit [39]. Recommended values for NFI and TLI are > 0.90, and for CFI > 0.90 [70]. RMSEA values below 0.1 signify a good fit [44, 70]. We thus found all the model fit indices to be equal to or greater than acceptable levels, thus showing that there were no significant correlations of error terms and providing confirmatory factor analysis of convergent and discriminant validity among the factors.

Table 2a. Factor Loadings of All Items Except End-User Satisfaction

	Innovation support	Involvement facilitation	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	ICT-enabled productivity	ICT-enabled innovation
IS1	0.75								
IS2	0.67								
IS3	0.81								
IS4	0.77								
IS5	0.75								
IF1		–0.67							
IF2		–0.80							
IF3		–0.88							
IF4		–0.84							
OV1			0.83						
OV2			0.85						
OV3			0.85						
OV4			0.64						
OV5			0.72						
IN1				0.60					
IN2				0.84					
IN3				0.87					
IN4				0.60					

(continues)

Table 2a. Continued

	Innovation support	Involvement facilitation	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	ICT-enabled productivity	ICT-enabled innovation
CO1					0.64				
CO2					0.81				
CO3					0.67				
CO4					0.72				
CO5					0.69				
INS1						0.59			
INS2						0.84			
INS3						0.87			
INS4						0.59			
UN1							–0.70		
UN2							–0.87		
UN3							–0.81		
UN4							–0.78		
PR1								0.90	
PR2								0.91	
PR3								0.88	
PR4								0.85	
INN1									–0.71
INN2									–0.75
INN3									–0.74

Notes: Kaiser–Meyer–Olkin measure of sampling adequacy = 0.852, significance = 0.000, cumulative percentage of variance = 72 percent. Cross-loadings below 0.4 are not shown. The table indicates that none of the items cross-loaded above 0.4.

Table 2b. Factor Loadings of End-User Satisfaction

	Content	Accuracy	Output	Ease of use	Timeliness
EC1	0.84				
EC2	0.81				
EC3	0.89				
EC4	0.83				
EA1		–0.95			
EA2		–0.91			
EO1			–0.89		
EO2			–0.71		
EU1				–0.99	
EU2				–0.80	
ET1					–0.86
ET2					–0.91

Notes: Kaiser–Meyer–Olkin measure of sampling adequacy = 0.866, significance = 0.000, cumulative percentage of variance = 87 percent. Cross-loadings below 0.4 are not shown. The table indicates that none of the items cross-loaded above 0.4.

Step 5: Verification of Second-Order Constructs

We verified for the existence of second-order constructs for *technostress creators, end-user satisfaction,* and *end-user performance.* To do this, we first ran first-order correlated measurement models (with the first-order factors) for the *technostress creators* and *end-user satisfaction* constructs. We next ran a second-order measurement model for each of them. We then calculated the target coefficient [55], which is the ratio of the chi-square values of the first-order correlated and second-order models and which indicates the percentage of variance explained by the second-order model compared to the first-order correlated model. The recommended value for this coefficient is 0.8 [55]. We found the *t*-coefficient in the case of *technostress creators* to be 0.98 and *end-user satisfaction* to be 0.90, indicating the evidence of the second-order models. In the case of *end-user performance,* because we had only two subconstructs, we could not run a second-order model and hence could not conduct this particular test for the existence of the second-order construct. However, the second-order coefficients in the measurement model were found to be significant at the 0.05 level, indicating the presence of the second-order construct. Following these tests, therefore, we conceptualized *technostress creators, end-user satisfaction,* and *end-user performance* as second-order constructs. *Technostress creators* encompass five first-order subconstructs—techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. *End-user satisfaction* has five first-order subconstructs—content, accuracy, output, ease of use, and timeliness. *End-user performance* has two first-order subconstructs—ICT-enabled productivity and ICT-enabled innovation. *Involvement facilitation* and *innovation support* were modeled as first-order constructs.

Step 6: Testing of Research Model and Hypotheses

We next ran the path model in Amos with measurement models; all the constructs were modeled as first-order constructs. In the case of the three second-order constructs,

Table 3. Construct Items, Reliability, Mean, and Standard Deviation

	Mean	Standard deviation
Innovation support (reliability = 0.86)	2.20	0.79
IS1: We have a very open communications environment.		
IS2: Employees and functional managers are supportive of each other.		
IS3: Employees at all levels are rewarded for learning new skills.		
IS4: Management encourages experimental mind-set and risk taking.		
IS5: New ideas are easy to be implemented.		
Involvement facilitation (reliability = 0.87)	2.79	0.90
IF1: Our end users are encouraged to try out new technologies.		
IF2: Our end users are rewarded for using new technologies.		
IF3: Our end users are consulted before introduction of new technology.		
IF4: Our end users are involved in technology change and/or implementation.		
Technostress creators		
Techno-overload (OV) (reliability = 0.89)	2.97	1.00
OV1: I am forced by this technology* to work much faster.		
OV2: I am forced by this technology to do more work than I can handle.		
OV3: I am forced by this technology to work with very tight time schedules.		
OV4: I am forced to change my work habits to adapt to new technologies.		
OV5: I have a higher workload because of increased technology complexity.		
Techno-invasion (IN) (reliability = 0.81)	1.91	0.77
IN1: I spend less time with my family due to this technology.		
IN2: I have to be in touch with my work even during my vacation due to this technology.		
IN3: I have to sacrifice my vacation and weekend time to keep current on new technologies.		
IN4: I feel my personal life is being invaded by this technology.		
Techno-complexity (CO) (reliability = 0.84)	2.54	0.83
CO1: I do not know enough about this technology to handle my job satisfactorily.		
CO2: I need a long time to understand and use new technologies.		
CO3: I do not find enough time to study and upgrade my technology skills.		
CO4: I find new recruits to this organization know more about computer technology than I do.		
CO5: I often find it too complex for me to understand and use new technologies.		
Techno-insecurity (INS) (reliability = 0.84)	2.00	0.71
INS1: I feel a constant threat to my job security due to new technologies.		
INS2: I have to constantly update my skills to avoid being replaced.		
INS3: I am threatened by co-workers with newer technology skills.		

	Mean	Standard deviation
INS4: I do not share my knowledge with my co-workers for fear of being replaced.		
INS5: I feel there is less sharing of knowledge among co-workers for fearing of being replaced.		
Techno-uncertainty (UN) (reliability = 0.82)	3.15	0.80
UN1: There are always new developments in the technologies we use in our organization.		
UN2: There are constant changes in computer software in our organization.		
UN3: There are constant changes in computer hardware in our organization.		
UN4: There are frequent upgrades in computer networks in our organization.		
End-user satisfaction:		
Content (EC) (reliability = 0.90)	3.40	0.79
EC1: The system provides the precise information I need.		
EC2: The information content meets with my needs.		
EC3: The system provides reports that seem to be just about exactly what I need.		
EC4: The system provides me with sufficient information.		
Accuracy (EA) (reliability = 0.95)	3.38	0.90
EA1: The system is accurate.		
EA2: I am satisfied with the accuracy of the system.		
Output (EO) (reliability = 0.88)	3.45	0.83
EO1: I think the output is presented in a useful format.		
EO2: The information provided by the system is clear.		
Ease of use (EU) (reliability = 0.91)	3.51	0.84
EU1: The system is user friendly.		
EU2: The system is easy to use.		
Timeliness (ET) (reliability = 0.85)	3.50	0.82
ET1: I get the information I need in time.		
ET2: The system provides up-to-date information.		
End-user performance		
ICT-enabled productivity (PR) (reliability = 0.91)	3.80	0.85
PR1: This technology helps to improve the quality of my work.		
PR2: This technology helps to improve my productivity.		
PR3: This technology helps me to accomplish more work than would otherwise be possible.		
PR4: This technology helps me to perform my job better.		
ICT-enabled innovation (INN) (reliability = 0.94)	3.36	1.03
INN1: This technology helps me to identify innovative ways of doing my job.		
INN2: This technology helps me to come up with new ideas relating to my job.		
INN3: This technology helps me to try out innovative ideas.		

* The term *this technology* refers to the day-to-day computer-based applications you use in your job, such as e-mail, office automation system, networked devices, database systems, and application development tools.

Table 4. First-Order Factor Correlation Matrix

	IS	IF	OV	IN	CO	INS	UN
Innovation support (IS)	1						
Involvement facilitation (IF)	0.51**	1					
Techno-overload (OV)	–0.33**	–0.10	1				
Techno-invasion (IN)	–0.16*	–0.09	0.47**	1			
Techno-complexity (CO)	–0.19**	–0.10	0.50**	0.46**	1		
Techno-insecurity (INS)	–0.20**	–0.14*	0.41**	0.47**	0.55**	1	
Techno-uncertainty (UN)	–0.02	0.02	0.22**	0.33**	0.30**	0.29**	1
Content (EC)	0.25**	0.30**	–0.13*	–0.08	–0.04	–0.09	0.16*
Accuracy (EA)	0.36**	0.32**	–0.19**	–0.09	–0.16*	–0.18**	0.10
Output (EO)	0.36**	0.35**	–0.23**	–0.14*	–0.14*	–0.22**	0.15*
Ease of use (EU)	0.29**	0.32**	–0.26**	–0.19**	–0.27**	–0.21**	0.04
Timeliness (ET)	0.31**	0.27**	–0.19**	–0.14*	–0.17**	–0.18**	0.13*
Productivity (PR)	0.15*	0.17**	–0.23**	–0.19**	–0.23**	–0.11	0.01
Innovation (INN)	0.24**	0.25**	–0.33**	–0.20**	–0.25**	–0.20**	–0.02

	EC	EA	EO	EU	ET	PR	INN
Innovation support (IS)							
Involvement facilitation (IF)							
Techno-overload (OV)							
Techno-invasion (IN)							
Techno-complexity (CO)							
Techno-insecurity (INS)							
Techno-uncertainty (UN)							
Content (EC)	1						
Accuracy (EA)	0.64**	1					
Output (EO)	0.63**	0.64**	1				
Ease of use (EU)	0.56**	0.55**	0.69**	1			
Timeliness (ET)	0.68**	0.69**	0.70**	0.64**	1		
Productivity (PR)	0.11	0.19**	0.16*	0.24**	0.20**	1	
Innovation (INN)	0.11	0.19**	0.15*	0.17*	0.22**	0.67**	1

* Correlation is significant at the 0.05 level (two-tailed); ** correlation is significant at the 0.01 level (two-tailed).

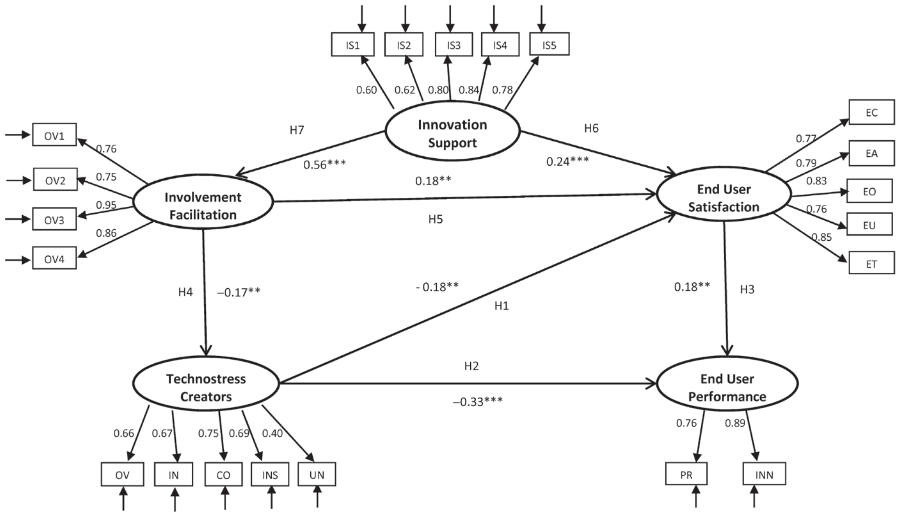

Figure 4. Path Analysis Results
Notes: Standardized path coefficients, factor loadings, and significance values are shown.
*** $p < 0.01$; ** $p < 0.05$.

the averages of the first-order subconstructs were considered as items to the respective first-order models. Figure 4 shows the path model and path coefficients only, along with the significance levels. Table 5 provides the path coefficients for the path model and item loadings with the standardized coefficients for the measurement models, along with their significance. The path coefficients (for two-tailed tests) and factor loadings are significant at $p < 0.05$. All the path coefficients are of the expected sign, showing support for our research hypotheses, as shown in Table 5. The model fit indices of the path model are chi-square/degrees of freedom = 1.7, GFI = 0.90, AGFI = 0.87, NFI = 0.90, TLI = 0.95, CFI = 0.96, and RMSEA = 0.056. These values indicate acceptable model fit, as explained in Step 4. Further, we introduced *organization* as a dummy control variable to the dependent variable (*end-user performance*) in the model. There was no change in any of the significance of the paths. The coefficient of the dummy variable to the dependent variable was 0.027 and therefore not significant.

Discussion

Support for the research hypotheses establishes that (1) technostress creators impair innovation and productivity in tasks that require the use of ICT, both directly and indirectly, the latter by reducing the satisfaction of users with the applications and systems they use; (2) mechanisms that facilitate user involvement reduce technostress-creating factors and offset their user satisfaction–reducing effects by increasing the latter; (3) organizational mechanisms that support innovation increase end-user satisfaction

Table 5. Path Analysis Results

From → to	Estimate	Hypothesis
Innovation support → Involvement facilitation	0.56***	H7
Innovation support → End-user satisfaction	0.24***	H6
Involvement facilitation → End-user satisfaction	0.18**	H5
Involvement facilitation → Technostress creators	–0.17**	H4
Technostress creators → End-user satisfaction	–0.18**	H1
Technostress creators → End-user performance	–0.33***	H2
End-user satisfaction → End-user performance	0.18**	H3
Innovation support → IS1	0.60***	
Innovation support → IS2	0.62***	
Innovation support → IS3	0.80***	
Innovation support → IS4	0.84***	
Innovation support → IS5	0.78***	
Involvement facilitation → IF1	0.76***	
Involvement facilitation → IF2	0.75***	
Involvement facilitation → IF3	0.95***	
Involvement facilitation → IF4	0.86***	
End-user satisfaction → EC	0.77***	
End-user satisfaction → EA	0.79***	
End-user satisfaction → EO	0.83***	
End-user satisfaction → EU	0.76***	
End-user satisfaction → ET	0.85***	
Technostress creators → OV	0.66***	
Technostress creators → IN	0.67***	
Technostress creators → CO	0.75***	
Technostress creators → INS	0.69***	
Technostress creators → UN	0.40***	
End-user performance → PR	0.76***	
End-user performance → INN	0.89***	

Notes: Significance levels based on two-tailed tests. One-tailed tests (since the directions are provided by the hypotheses) might have yielded significance at a lower *p*-value. Path coefficients are standardized. Abbreviations are explained in Table 3. *** $p < 0.01$; ** $p < 0.05$.

and reduce factors that create technostress by positively affecting those that support involvement facilitation; and (4) mechanisms that facilitate user involvement and support innovation indirectly increase individual productivity and innovation in ICT-mediated tasks through their positive influence on end-user satisfaction. In particular, the *technostress creators → end-user satisfaction* and *technostress creators → end-user performance* paths substantiate the stress-strain relationship between these two pairs of variables, as envisioned in Figure 2. The paths for *involvement facilitation → technostress creators* and *involvement facilitation → end-user satisfaction* point to the role of the *involvement facilitation* construct as a situational variable in the context of Figure 2. We describe below the research- and practice-related implications of the results and the limitations and possible extensions of the study.

Research-Related Implications

Recent research [8, 49] and practitioner conversation [43] have begun to emphasize the importance of negative and overwhelming effects of ICT for the end user. This paper contributes to this emerging stream of study in three ways. First, by showing that factors that create technostress negatively affect the satisfaction of end users with the applications they use, and their productivity and innovation in tasks that use these applications, the paper establishes that the phenomenon of technostress has important consequences for the domain of end-user computing. It thus conceptually extends the literature in this domain, which has hitherto addressed system characteristics such as, among others, ease of use, perceived benefits, system quality, and information quality as predictors of system use and satisfaction. In particular, our results show that technostress-creating conditions from ICT-related overload, ICT-related job insecurity, complexity associated with ICT use, invasive and intrusive aspects of ICT, and ICT-related upgrades and uncertainty (as encapsulated in technostress creators) negatively affect the user's perception of the accuracy, ease of use, timeliness, and usefulness of applications (as encapsulated in end-user satisfaction) that he or she uses. Given the relatively low levels of structure and high levels of individual adaptation required for using many current and emerging applications, users who are thus dissatisfied would likely limit their use of ICT to the minimum possible levels. Further, their productivity and innovation for tasks requiring the use of these applications would be low. Thus, the findings that technostress-creating conditions adversely affect end-user performance and satisfaction demonstrate that these conditions are antecedents of organizations not being able to appropriate benefits from ICT.

Second, this paper broadens the nascent literature in technostress by theorizing and demonstrating the presence of strains specifically in the context of ICT usage in addition to the more general psychological and behavioral strains examined thus far. Our findings show that further to reducing job satisfaction, organizational commitment, and job productivity, and increasing role stress, factors that create technostress negatively affect ICT users' satisfaction with the applications and systems they use and inhibit their ability to use them for productive and innovative performance outcomes in the context of ICT-mediated tasks. That is, not only does technostress have adverse behavioral and psychological outcomes but it also has negative outcomes in the end-user computing domain.

Third, the study highlights the importance of end-user involvement and innovation support mechanisms for reducing stress-creating conditions (technostress creators) and ICT usage–related strains (end-user dissatisfaction and end-user performance) associated with technostress. Some studies (e.g., [25, 58]) have identified the positive effects of involvement and participation, such as increased system acceptance and better system quality. Our results show that in addition to these benefits, mechanisms that facilitate end-user involvement in planning for new ICT and encourage users to experiment with ICT reduce the intensity of ICT-related stressors, thus mitigating their negative effects on end-user satisfaction and performance. Such mechanisms also increase the satisfaction of users with the applications they use (directly) and their productivity and innovation vis-à-vis ICT-mediated tasks (indirectly). Research [77] affirms that organizational support for experimentation and innovation by the individual increases his or her ability to adapt to technology-induced change in general. The present study extends these findings by showing that mechanisms that facilitate innovation, communication among users, and a supportive environment in general reduce the intensity of ICT-related stressors by bolstering the effects of particular technostress-reducing mechanisms such as involvement facilitation.

Practice-Related Implications

Our findings contribute to managerial practice in two ways. First, many current systems are evolving toward platforms (such as intranets and Web 2.0-based applications) that support highly customizable and adaptable applications. Benefits that firms hope to harness from these technologies will depend, to a large extent, on how satisfied the user is with these applications and how well he or she can use them for innovation at work. This paper shows that firms need to be cognizant that stress-creating factors such as overload, invasion, and continual upgrades generate dissatisfaction in the user about the benefits and usefulness of ICT and reduce anticipated ICT-enabled task productivity and innovation. Second, managers should find the results useful in developing and evaluating mechanisms that encourage ICT-related involvement and experimentation for reducing the intensity of technostress-creating conditions and the associated strains.

Limitations and Extensions

Certain limitations are to be considered while interpreting the results. First, the sample is not completely random in the sense that the organizations were selected on the basis of the authors' contacts. Second, the questionnaires were not distributed; instead, potential respondents were instructed to request them if they wanted to participate. Thus, there is the self-selection issue of respondents, which could possibly mean that the sample is biased toward those who perceived a high level of technostress and hence were interested in participating in the study. Third, this study was done in government organizations only and generalization across various sectors has to be accompanied by caution. Finally, the items for the *end-user performance* construct reflect the respondents' own perceived work performance rather than independent assessments by a supervisor or a peer. Thus, a certain degree of subjective bias in measuring this construct may be involved.

The results can be used as a basis for extending the technostress literature into other aspects of ICT use. For instance, longitudinal studies on the use of ICT in specific individual and group processes such as product development, project management, and strategic planning can lead to a better understanding of how technostress affects the individual's performance in particular work contexts. In addition, emerging applications such as wikis, virtual environments, and blogs are subject to significant structuration by the user. Understanding the influence of technostress on how users engage in the structuration process is, the authors feel, an important aspect of managing the latter.

Conclusion

Technostress is an unintended, but perhaps an inevitable, consequence of the sustained and near-continuous use of computers in the organizational context. It can lead to strains and thereby adversely affect desired outcomes in different domains. This paper represents an attempt to identify the effects of technostress creators on two variables in the domain of end-user computing—the satisfaction of users with the ICT they use and on their task performance using them. Our findings highlight the unfavorable effects of technostress on managers' ability to effectively use ICT and provide evidence of mechanisms to mitigate these effects.

Acknowledgments: The authors thank Bhanu Ragu-Nathan for ideas and suggestions in guiding and shaping this research. They also thank the Editor, Vladimir Zwass, and three anonymous reviewers for their valuable input in improving this paper.

Notes

1. *ICT users, end users,* and *users* are used interchangeably; all three terms refer to individuals in organizations who use computer applications and systems for accomplishing tasks at work.
2. For detailed reviews of role- and task-related stress, see Cooper et al. [19] and McGrath [56].
3. *Situational variables* can also negatively moderate the relationship between *stressors* and *strain.* However, while the direct link between *situational variables* and *strain* has found strong empirical support, there has been conflicting evidence for the moderating effect [19]. Ragu-Nathan et al. [65] did not find moderating effects in the context of technostress.
4. The benefits from advanced ICT can, of course, greatly reduce the amount of time and effort in information processing. Similarly, users may find that connectivity can offer them convenience rather than invasion of privacy, and may find it exciting to learn to use new and complex technologies. This paper does not discount such scenarios. However, it focuses on the emerging and very real problems of negative cognitions associated with some of the characteristics of modern ICT in the domain of end-user computing.
5. There are conditions under which involvement may not increase the satisfaction of end users with the applications they use [10, 28, 62]. Doll and Torkzadeh [28] suggest that this may occur when the level of involvement that users perceive they actually have is substantially less than the level of involvement that they desire. In the most general case, however, and in the absence of specific knowledge about the discrepancy between actual and desired involvement levels, involvement leads to positive effects on user satisfaction.

References

1. Al-Fudai, M., and Mellar, H. Investigating teacher stress when using technology. *Computers & Education, 51,* 3 (2008), 1103–1110.
2. Amabile, T.; Conti, R.; Coon, H.; Lazenby, J.; and Herron, M. Assessing the work environment for creativity. *Academy of Management Journal, 39,* 5 (1996), 1154–1184.
3. Baecker, R.M.; Grudin, J.; Buxton, W.A.; and Greenberg, S. *Readings in Human–Computer Interaction: Toward the Year 2000.* San Francisco: Morgan Kauffman, 1995.

4. Bailey, J.E., and Pearson, S.W. Development of a tool for measuring and analyzing computer user satisfaction. *Management Science, 29,* 5 (1983), 530–545.

5. Barki, H., and Hartwick, J. Rethinking the concept of user involvement. *MIS Quarterly, 13,* 1 (1989), 53–63.

6. Baronas, A., and Louis, M. Restoring a sense of control during implementation: How user involvement leads to system acceptance. *MIS Quarterly, 12,* 1 (1988), 110–124.

7. Baroudi. J.; Olson, M.; and Ives. B. An empirical study of the impact of user involvement on system usage and information satisfaction. *Communications of the ACM, 29,* 3 (1986), 232–238.

8. Basoglu, A. Technology mediated interruptions: Attention analysis and impact on task performance. In R. Nickerson and R. Sharda (eds.), *Proceedings of the Fifteenth Americas Conference on Information Systems.* Atlanta: Association for Information Systems, pp. 1–9.

9. Beehr, T.A., and Glazer, S. Organizational role stress. In J. Barling, E.K. Kelloway, and M.R. Frone (eds.), *Handbook of Work Stress.* Thousand Oaks, CA: Sage, 2005, pp. 7–34.

10. Benard, R., and Satir, A. User satisfaction with EIS. *Information Systems Management, 10,* 4 (1993), 21–29.

11. Blili, S.; Raymond, L.; and Rivard, S. Impact of task uncertainty, end-user involvement, and competence on the success of end-user computing. *Information and Management, 33,* 3 (1998), 137–153.

12. Boehret, K. A program that makes your inbox less scary. *Wall Street Journal* (September 10, 2009) (available at http://online.wsj.com/article/SB1000142405297020434880457440790380843688.html).

13. Brosnan, M.J. *Technophobia—The Psychological Impact of Information Technology.* London: Routledge, 1998.

14. Carayon, P., and Karsh, B.T. Socio-technical issues in implementation of imaging technology. *Behavior and Information Technology, 19,* 4 (2000), 247–262.

15. Cellier, J., and Eyrolle, H. Interference between switched tasks. *Ergonomics, 35,* 1 (1992), 25–36.

16. Chang, J., and King, W. Measuring the performance of information systems: A functional scorecard. *Journal of Information Systems, 22,* 1 (2005), 85–115.

17. Chen, L.; Gillenson, M.; and Sherrell, D. Enticing online consumers: An extended technology acceptance perspective. *Information and Management, 39,* 8 (2002), 705–719.

18. Clark, K., and Kalin, S. Technostressed out? How to cope in the digital age. *Library Journal, 21,* 8 (1996), 30–32.

19. Cooper, C.L.; Dewe, P.; and O'Driscoll, M.P. *Organizational Stress: A Review and Critique of Theory, Research, and Applications.* Thousand Oaks, CA: Sage, 2001.

20. Coovert, M.D.; Thompson, L.F.; and Craiger, J.P. Technology. In J. Barling, E.K. Kelloway, and M.R. Frone (eds.), *Handbook of Work Stress.* Thousand Oaks, CA: Sage, 2005, pp. 299–324.

21. Corbett, J.M.; Martin, R.; Wall, T.D.; and Clegg, C.W. Technological coupling as a predictor of intrinsic job satisfaction: A replication study. *Journal of Organization Behavior, 10,* 1 (1987), 91–95.

22. Crovitz, G.L. Unloading information overload. *Wall Street Journal* (July 7, 2008) (available at http://online.wsj.com/article/SB121538872997031145.html).

23. Davis, F.; Bagozzi, R.; and Warshaw, P. User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35,* 8 (1989), 982–1003.

24. Davis, G., Anytime/anyplace computing and the future of knowledge work. *Communications of the ACM, 45,* 2 (2002), 67–73.

25. DeLone, W.H., and McLean, E.R. Information systems success: The quest for the dependent variable. *Information Systems Research, 3,* 1 (1992), 60–95.

26. DeLone, W.H., and McLean, E.R. The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19,* 4 (Spring 2003), 9–30.

27. Dolan, S.A., and Tziner, A. Implementing computer-based automation in the office: A study of experience stress. *Journal of Organizational Behavior, 9,* 2 (1988), 183–187.

28. Doll, W., and Torkzadeh, G. A discrepancy model of end-user computing involvement. *Management Science, 35,* 10 (1989), 1151–1171.

29. Ennis, L.A. The evolution of technostress. *Computers in Libraries, 25,* 8 (2005), 10–12.

30. Etezadi-Amoli, J., and Farhoomand, A. A structural model of end user computing satisfaction and user performance. *Information and Management, 30,* 2 (1996), 65–73.

31. Farhoomand, A.F., and Drury, D.H. Managerial information overload. *Communications of the ACM, 45,* 10 (2002), 127–131.

32. Fisher, W., and Wesolkowski, S. Tempering technostress. *IEEE Technology and Society Magazine, 18,* 1 (1999), 28–33.

33. Franz, C., and Robey, D. Organizational context, user involvement, and the usefulness of information systems. *Decision Sciences, 17,* 3 (1986), 329–356.

34. Gaudron, J.P., and Vignoli, E. Assessing computer anxiety with the interaction model of anxiety: Development and validation of the computer anxiety trait subscale. *Computers in Human Behavior, 18,* 3 (2002), 315–325.

35. Grandhi, S.A.; Jones, Q.; and Hiltz, S.R. Technology overload: Is there a technological panacea? In D. Robey and R. Santhanam (eds.), *Proceedings of the Eleventh Americas Conference on Information Systems.* Atlanta: Association for Information Systems, 2005, pp. 2291–2297.

36. Grisé, M., and Gallupe, R.B. Information overload: Addressing the productivity paradox in face-to-face electronic meetings. *Journal of Management Information Systems, 16,* 3 (Winter 1999–2000), 157–185.

37. Gupta, A., and Li, H. Being interrupted by instant messaging: Does it matter who is interrupting—The boss or the coworker? In I. Benbasat and A.R. Montazemi (eds.), *Proceedings of the Fourteenth Americas Conference on Information Systems.* Atlanta: Association for Information Systems, 2008, pp. 1–7.

38. Gupta, A.; Sharda, R.; Ducheneaut, N.; Zhao, J.L.; and Weber, R. E-mail management: A techno-managerial research perspective. *Communications of the AIS, 17,* 1 (2006), 941–961.

39. Hair, J.F.; Anderson, R.E.; Tatham, R.L.; and Black, W. *Multivariate Data Analysis with Readings.* Upper Saddle River, NJ: Prentice Hall, 1998.

40. Harrison, A., and Rainer, R. A general measure of user computing satisfaction. *Computers in Human Behavior, 12,* 1 (1996), 79–92.

41. Hartwick, J., and Barki, H. Explaining the role of user participation in information system use. *Management Science, 40,* 4 (1994), 440–465.

42. Heinssen, R., Jr.; Glass, C.; and Knight, L. Assessing computer anxiety: Development and validation of the computer anxiety rating scale. *Computers in Human Behavior, 3,* 1 (1987), 49–59.

43. Hemp, P. Death by information overload. *Harvard Business Review, 87,* 9 (September 2009), 49–53.

44. Hu, L.T., and Bentler, P.M. Evaluating model fit. In R.H. Hoyle (ed.), *Structural Equation Modeling: Concepts, Issues, and Applications.* Thousand Oaks, CA: Sage, 1995, pp. 76–99.

45. Huang, J.; Yang, C.; Jin, B.; and Chiu, H. Measuring satisfaction with business-to-employee systems. *Computers in Human Behavior, 20,* 1 (2004), 17–35.

46. Igbaria, M., and Tan, M. The consequences of information technology acceptance on subsequent individual performance. *Information and Management, 32,* 3 (1997), 113–121.

47. Jex, S.M., and Beehr, T.A. Emerging theoretical and methodological issues in the study of work-related stress. In K. Rowland and G. Ferris (eds.), *Research in Personnel and Human Resources Management,* vol. 9. Greenwich, CT: JAI Press, 1991, pp. 311–365.

48. Jimmieson, N.L., and Terry, D.J. An experiment study of the effects of work stress, work control, and task information on adjustment. *Applied Psychology: An International Review, 47,* 3 (1998), 343–369.

49. Jones, Q.; Ravid, G.; and Rafaeli, S. Information overload and the message dynamics of online interaction spaces. *Information Systems Research, 15,* 2 (2004), 194–210,

50. Kahn, R.L.; Wolfe, D.M.; Quinn, R.P.; and Snoek, J.D. *Organizational Stress: Studies in Role Conflict and Ambiguity.* Malabar, FL: Krieger, 1981.

51. Kanter, E. *The Change Masters.* New York: Touchstone, 1983.

52. Lazarus, R.S. Psychological stress in the workplace. *Journal of Social Behavior and Personality, 6,* 1 (1991), 1–13.

53. Liao, Z., and Cheung, M. Internet-based e-shopping and consumer attitudes: An empirical study. *Information & Management, 38,* 5 (2001), 299–306.

54. Lin, W., and Shao, B. The relationship between user participation and system success: A simultaneous contingency approach. *Information and Management, 37,* 6 (2000), 283–295.

55. Marsh, H.W., and Hocevar, D. Application of confirmatory factor analysis to the study of self-concept: First- and higher-order factor models and their invariance across groups. *Psychological Bulletin, 97,* 3 (1985), 562–582.

56. McGrath, J. Stress and behavior in organizations. In M. Dunnette (eds.), *Handbook of Industrial and Organizational Psychology.* Chicago: Rand-McNally, 1976, pp. 1351–1395.

57. McKeen, J., and Guimaraes, T. Successful strategies for user participation in systems development. *Journal of Management Information Systems, 14,* 2 (Fall 1997), 133–150.

58. McKeen, J.; Guimaraes, T.; and Wetherbe, J. The relationship between user participation and user satisfaction: An investigation of four contingency factors. *MIS Quarterly, 18,* 4 (1994), 427–451.

59. Melone, N. Theoretical assessment of the user satisfaction construct in information systems. *Management Science, 36,* 1 (1990), 76–91.

60. Nelson, D., and Kletke, M. Individual adjustment during technological innovation: A research framework. *Behavior and Information Technology, 9,* 4 (1990), 257–271.

61. Nunnally, J.C. *Psychometric Theory.* New York: McGraw-Hill, 1978.

62. Olson, M.H., and Ives, B. User involvement in system design: An empirical test of alternative approaches. *Information and Management, 4,* 4 (1981),183–195.

63. Pearson, A.; Pearson, J.M.; and Griffin, C. Innovating with technology: The impact of overload, autonomy, and work and family conflict. *Journal of Information Technology Theory and Applications, 9,* 4 (2009), 41–65.

64. Podsakoff, P.M.; MacKenzie, S.B.; Lee, J.Y.; and Podsakoff, N.P. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88,* 5 (2003), 879–903.

65. Ragu-Nathan, T.S.; Tarafdar, M.; Ragu-Nathan, B.; and Tu, Q. The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information Systems Research, 19,* 4 (2008), 417–433.

66. Rai, A.; Lang, S.; and Welker, R. Assessing the validity of IS success models: An empirical test and theoretical analysis. *Information Systems Research, 13,* 1 (2002), 50–69.

67. Raitoharju, R. When acceptance is not enough—Taking TAM-model into healthcare. In R.H. Sprague (ed.), *Proceedings of the 38th Annual Hawaii International Conference on System Sciences.* Los Alamitos, CA: IEEE Computer Society, 2005.

68. Rivard, S., and Huff, S. Factors of success for end-user computing. *Communications of the ACM, 31,* 5 (1988), 552–561.

69. Robey, D., and Farrow, D. User involvement in information system development: A conflict model and empirical test. *Management Science, 26,* 1 (1982), 73–85.

70. Salisbury, W.D.; Chin, W.W.; Gopal, A.; and Newsted, P.R. Research report: Better theory through measurement—Developing a scale to capture consensus on appropriation. *Information Systems Research, 13,* 1 (2002), 91–103.

71. Sami, L.K., and Pangannaiah, N.B. "Technostress": A literature survey on the effect of information technology on library users. *Library Review, 55,* 7 (2006), 429–439.

72. Sanserino, M. Lawsuits question after-hours demands of email and cellphones. *Wall Street Journal* (August 10, 2009) (available at http://online.wsj.com/article/SB124986371466018299.html).

73. Schiffman, N., and Griest-Bousquet, S. Optimal shopping performance under graphic and numeric CRT formatting. *Human Factors, 27,* 4 (1992), 433–444.

74. Speier, C., and Price, M.F. Using aggregated data under time pressure: A mechanism for coping with information overload. In R.H. Sprague (ed.), *Proceedings of the 31st Annual Hawaii International Conference on System Sciences.* Los Alamitos, CA: IEEE Computer Society, 1998, pp. 4–13.

75. Tarafdar, M.; Tu, Q.; Ragu-Nathan, B.S.; and Ragu-Nathan, T.S. The impact of technostress on role stress and productivity. *Journal of Management Information Systems, 24,* 1 (Summer 2007), 301–328.

76. Torkzadeh, G., and Doll, W. The development of a tool for measuring the perceived impact of information technology on work. *OMEGA: The International Journal of Management Science, 27,* 3 (1999), 327–339.

77. Tushman, M., and Nadler, D. Organizing for innovation. *California Management Review, 27,* 3 (1986), 74–92.

78. Wailgum, T. Information overload is killing you and your productivity. *CIO* (January 4, 2008) (available at www.cio.com/article/169200/Information_Overload_Is_Killing_You_and_Your_Productivity/).

79. Wastell, D.G., and Newman, N. The behavioral dynamics of information system development: A stress perspective. *Accounting Management and Information Technology, 3,* 2 (1993), 121–148.

80. Weil, M., and Rosen, L. *TechnoStress: Coping with Technology @work @home @play.* New York: John Wiley, 1997.

81. Yaverbaum, G. Critical factors in the user environment: An experimental study of users, organizations, and tasks. *MIS Quarterly, 12,* 1 (1988), 75–88.

82. Zuboff, S. *In the Age of the Smart Machine: The Future of Work and Power.* New York: Basic Books, 1988.