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Source: *Information Systems Research*, Vol. 19, No. 4 (December 2008), pp. 417-433
Published by: INFORMS
Stable URL: http://www.jstor.org/stable/23015440
Accessed: 30-08-2016 16:54 UTC

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Information Systems Research
Vol. 19, No. 4, December 2008, pp. 417–433
ISSN 1047-7047 | EISSN 1526-5536 | 08 | 1904 | 0417

DOI 10.1287/isre.1070.0165
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The Consequences of Technostress for End Users in Organizations: Conceptual Development and Empirical Validation

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The research reported in this paper studies the phenomenon of technostress, that is, stress experienced by end users of Information and Communication Technologies (ICTs), and examines its influence on their job satisfaction, commitment to the organization, and intention to stay. Drawing from the Transaction-Based Model of stress and prior research on the effects of ICTs on end users, we first conceptually build a nomological net for technostress to understand the influence of technostress on three variables relating to end users of ICTs: job satisfaction, and organizational and continuance commitment. Because there are no prior instruments to measure constructs related to technostress, we develop and empirically validate two second order constructs: *technostress creators* (i.e., factors that create stress from the use of ICTs) and *technostress inhibitors* (i.e., organizational mechanisms that reduce stress from the use of ICTs). We test our conceptual model using data from the responses of 608 end users of ICTs from multiple organizations to a survey questionnaire. Our results, based on structural equation modeling (SEM), show that technostress creators decrease job satisfaction, leading to decreased organizational and continuance commitment, while Technostress inhibitors increase job satisfaction and organizational and continuance commitment. We also find that age, gender, education, and computer confidence influence technostress. The implications of these results and future research directions are discussed.

Key words: technostress; management of ICTs; job satisfaction; organizational commitment; continuance commitment; survey methods; confirmatory factor analysis; structural equation modeling
History: Ritu Agarwal, Senior Editor; Mani Subramani, Associate Editor. This paper was received on July 13, 2005 and was with the authors $6\frac{1}{2}$ months for 3 revisions. Published online in *Articles in Advance* August 20, 2008.

1. Introduction

The quest to incorporate Information and Communication Technologies (ICTs) in organizational processes and products has exponentially increased the level of user dependence on these technologies. The adoption and use of ICTs have led to redefinition of organizational structures and business processes and have altered means of interaction among and between individuals and the organization. Employees must constantly adapt to new applications, functionalities, and workflows. What are their cognitive responses to this computer-mediated (Zuboff 1988) work environment? What organizational adjustments are needed to effectively manage these responses? Prior research centered in organizational behavior has described various end-user reactions to ICTs, such as anxiety and tension (Heinssen et al. 1987), perceived higher work pressures, job dissatisfaction (Smith et al. 1981), and ambiguity about job demands (Love et al. 1989). Studies in the information systems (IS) stream have focused on stress faced by IS professionals because of the rapid obsolescence of technical skills and demanding end-user support requirements (Thong and Yap 2000, Sethi et al. 2004).

In recent years, there have been a number references to a phenomenon called *technostress* (Clark and Kalin 1996, Weil and Rosen 1997, Brillhart 2004), attributable to the explosive growth of end-user computing and networking technologies. Technostress relates to the phenomenon of stress experienced by end users in

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organizations as a result of their use of ICTs. It is caused by an individual's attempts to deal with constantly evolving ICTs and the changing physical, social, and cognitive responses demanded by their use. Current organizational environments are characterized by the growing importance of knowledge-intensive work, outsourcing, and collaborative work arrangements. They require individuals to continually increase their day-to-day interaction with ICTs, leading to aggravation of the potential negative effects associated with their use. There is practitioner evidence (Weil and Rosen 1997, Brod 1984) that technostress results in perceived work overload, demoralized and frustrated users, information fatigue, loss of motivation, and dissatisfaction at work. It is therefore the premise of this research that technostress is a phenomenon that needs academic investigation because of its impact on several important organizational processes and outcomes. Existing theories of organizational stress (Kahn et al. 1981, Cooper et al. 2001), while recognizing the impact that technology can have on stress, have not sought to provide conceptual and empirical understanding of this pervasive aspect of stress in today's technological environment. In the absence of such understanding, organizations that may wish to analyze the stress-creating effects of ICTs on their employees do not have structured frameworks to facilitate their efforts. This paper develops and validates a conceptual model for understanding technostress and its effects on the individual's job satisfaction, and organizational, and continuance commitment.

Section 2 elaborates on the phenomenon of technostress and the motivation for this study. In §3 we summarize the literature on stress and its outcomes and on work-related effects of ICTs, from the organizational behavior and IS fields. Drawing on these studies, we conceptualize two constructs: *technostress creators* and *technostress inhibitors*, in §4. We then develop a nomological net for technostress, explaining the relationships of these two constructs to three variables that relate to an individual's work context, namely, job satisfaction, organizational commitment, and continuance commitment. In §5, we develop and validate the two constructs and test the model using data from survey responses of 608 ICT users in multiple organizations. Section 6 discusses the findings, highlights the limitations, and identifies future directions for research in this domain.

2. The Phenomenon of Technostress

What is technostress? It is stress experienced by individuals due to the use of ICTs and has been defined as "a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner" (Brod 1984) and as a "state of arousal observed in certain employees who are heavily dependent on computers in their work" (Arnetz and Wiholm 1997).

To what do we attribute this phenomenon? The current technological and work environment has three characteristics. First, there is enormous and increasing dependence of managers on ICTs (such as personal computers, enterprise applications, manufacturing applications, collaborative applications, and connectivity tools) and constant introduction of updated versions of software and hardware. Second, because of the ever-increasing sophistication of ICTs, there is often a significant difference between the knowledge needed to perform various tasks using ICTs and the level of such knowledge among workers and managers. Third, modern ICTs have changed the work environment and culture. Although email, electronic scheduling, and video conferencing make it convenient to organize flexible work schedules, virtual teams, and telecommuting, they also come with increased possibilities for remote supervision, multitasking, social isolation, and abstraction of work (Zuboff 1988). Furthermore, they have eliminated the conventional workday and have made time and distance immaterial to the execution of many organizational tasks. These three characteristics represent a fundamental shift in the nature of the individual's interaction with the workplace. As managers struggle to reorganize familiar work habits and routines and to alter traditional assumptions about their workplace, they experience technostress.

Why is it important to understand technostress? As these examples show, the liberating effects of ICTs that relieve users from repetitive tasks coexist with demands for new work patterns, greater time, and more technology skills. Individuals feel frustrated and distressed as a result (Brod 1984, Hudiburg 1989). ICTs will continue to be an integral part of modern

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organizations, and the phenomenon of technology-related stress remains understudied. It is therefore essential that this phenomenon and its consequences be understood.

3. Conceptual Foundations for the Present Study

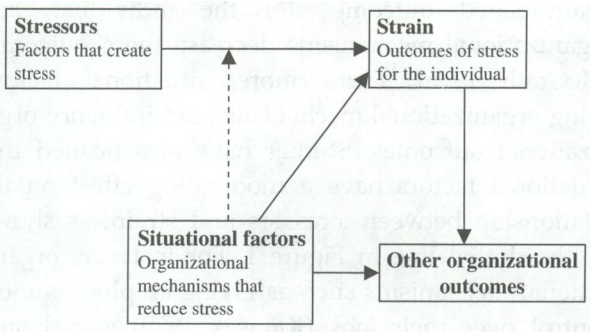
In developing our research model and positioning it in the context of existing literature, we have drawn on two streams of studies. The first is based on research on stress from the organizational behavior literature and describes theoretical perspectives for understanding stress. The second includes studies that explain various work-related effects of the use of ICTs on end users.

3.1. Understanding Stress

The term *being under stress* is defined as a 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" (McGrath 1976, p. 1351). It has also been defined as a "psychological reaction to some sort of an imbalance between a person and the environment" (Cooper et al. 2001) or an "anticipation of inability to respond adequately to perceived demand, accompanied by anticipation of negative consequences for inadequate response" (McGrath 1970, p. 25). For the concept of stress to apply to a situation, the difference or imbalance between the demands from the environment and the person's capability to respond should be substantial and the consequence anticipated from not meeting the demands, significant. In the organizational context, stress leads to outcomes such as dissatisfaction at work, lack of job involvement, and poor job performance (Kahn et al. 1981, Jackson and Schuler 1985, Jex and Beehr 1991).

The Transaction-Based approach (Lazarus 1966, McGrath 1976, Lazarus and Folkman 1984, Cooper et al. 2001) has provided the foundation for several studies on stress. It describes the phenomenon of stress as a combination of a stimulating condition and the individual's response to it. Figure 1

Figure 1 Transaction-Based Model of Stress



shows the four major components of the Transaction-Based approach. *Stressors* are events, demands, stimuli, or conditions encountered by individuals in the work/organizational environment as factors that create stress (Cartwright and Cooper 1997). They can be of two broad types. Role-related stressors include role ambiguity, role conflict (Kahn et al. 1981, Rizzo et al. 1970), and role overload (Ivancevich and Matteson 1980). Task-related stressors (McGrath 1976) describe task characteristics that potentially create stress, such as task difficulty and ambiguity. *Situational factors* are organizational mechanisms that can buffer or reduce the impact of stressors. These mechanisms include job redesign, role restructuring (Burke 1993), stress management training, information sharing, social support, wellness programs, and counseling and assistance (Davis and Gibson 1994). Other situational factors include the level of perceived job control (Karasek 1979) and information provided to employees about job procedures (Jimmieson and Terry 1998). *Strain* refers to the behavioral, psychological, and physiological outcomes of stress that are observed in individuals (Kahn and Byosiere 1992, Cooper et al. 2001). Behavioral strain variables such as job dissatisfaction (Jackson and Schuler 1985), poor task performance, lack of creativity (Hackman 1970), and disruptive behavior (Kahn and Bysosiere 1992) are among the most widely studied in the context of workplace stress. Strain can lead to *Other Organizational Outcomes* (Beehr 1998, Nelson and Kletke 1990). For instance, job dissatisfaction, which is a strain variable, can lead to absenteeism and turnover, which are organizational outcomes.

In the most general case, stressors increase strain, and situational factors decrease strain, as shown in

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Figure 1. That is, factors that create stress increase strain-related outcomes for the individual, and organizational mechanisms decrease these outcomes (McGrath 1976). Furthermore, situational factors, being organizational mechanisms, can influence organizational outcomes. Studies have also posited that situational factors have a moderating effect on the relationship between stressors and strain, as shown by the dotted line in Figure 1. For instance, organizational mechanisms such as giving employees more control over their jobs (Karasek 1979), social support (Van der Doef and Maes 1999), and job-related information (Jimmieson and Terry 1998) moderate the relationship between stressors and strain. Likewise, Cooper et al. (2001) and Fenlason and Beehr (1994) suggest that providing feedback and training can moderate the relationship between stressors and strain variables. However, although the direct link between situational factors and strain has found strong empirical support, evidence for the moderating effect of situational factors has been conflicting (Cooper et al. 2001). While some studies (Karasek 1979, for example) have found that job control moderates the relationship between job demands and worker well-being, others (O'Driscoll and Beehr 2000) have not. Similarly, the moderating effects of social support (as a situational factor) have been found to hold less consistently than direct effects (Kahn and Byosiere 1992).

3.2. Understanding Work-Related Effects of the Use of ICTs

Studies that explore the effects of ICTs on job design and users can be broadly divided into three streams.

First, computer systems embedded in the work environment (such as visual display units, computer-aided design, computer numerically controlled machines, flexible manufacturing systems, and computer- integrated manufacturing) change job design and work processes (Turner and Karasek 1984, Korunka et al. 1993). Use of computer numerically controlled machines has been shown to result in an increase in the number of work shifts (Love et al. 1989). Computer-integrated manufacturing systems cause the work environment to be tightly controlled by software programs, leading to workflow rigidity (Corbett 1987, Corbett et al. 1989). The use of electronic performance monitoring systems has been shown to decrease interpersonal interaction and social support (Carayon 1993).

Second, users of ICTs have shown negative psychological and cognitive reactions and attitudes toward these technologies. Computer anxiety (Heinssen et al. 1987) describes the fear, apprehension, and agitation individuals may experience when interacting with computers (Gaudron and Vignoli 2002). These include, for example, the fear of hitting a wrong key and losing information or hesitation in using computers for fear of making a mistake (Compeau et al. 1999). Technophobia (Brosnan 1998) or computer phobia (Rosen et al. 1987) happens when individuals are scared to use technology. It is a combination of anxiety about interactions with computer-related technology, negative attitudes about computers and their impact, and negative cognition during actual computer use (Weil and Rosen 1994). Computer anxiety and computer phobia describe the immediate, physical reactions of ICT users and are manifested in behaviors such as excessive caution about the use of computers, a sense of feeling hassled when using them, negative remarks about computers, and attempts to minimize the necessary use of computers (Abdul-Gader and Kozar 1995). Computer-based technologies have thus been associated with workplace stress (Carayon 1994).

A third stream analyzes antecedents of stress-related outcomes for IS professionals (programmers, system analysts, database administrators, and project managers). IS professionals experience high absenteeism, low job commitment, and high turnover (Igbaria and Siegel 1992). Studies have suggested that these effects stem from particular aspects of their work (Sethi et al. 2004). By the very nature of their work, IS professionals have to cope with rapid skill obsolescence, unexpected user demands, and short deadlines. Any one or all of these lead to stress (Ivancevich et al. 1985). Further, given the continuous adoption of new information technology (IT) by organizations, the IT workforce is always on a learning curve and consequently exhibits low productivity (Sethi et al. 1999).

Two important research gaps emerge from these discussions. First, extant literature on stress implicitly

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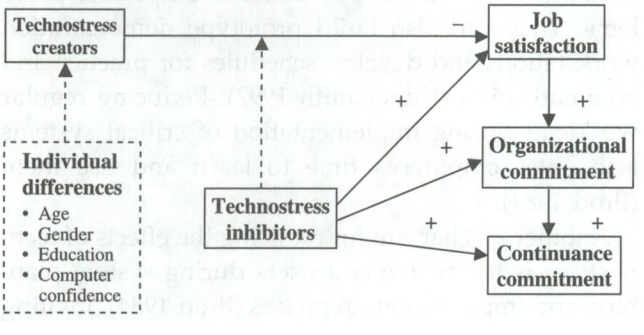
recognizes the existence of technology-related stressors. For example, Kahn et al. (1981) suggest that rapid technological obsolescence, and the consequent experience of discovering that acquired skills are prone to frequent devaluation, leads to anxiety and stress, and Cooper et al. (2001) mention that "teleworking" is also a potential cause for stress. Still, there is no systematic theoretical and empirical analysis of technostress. Second, although there are studies investigating the effects of ICTs on stress and other job-related outcomes experienced by IS professionals, empirical research on ICT-related stressors for end users is practically nonexistent. Several studies (Cooper et al. 2001, Burke and Nelson 1997) have pointed out that although it is important for organizations to understand the origins and effects of ICT-induced stress on users, this area of inquiry continues to be an understudied.

4. Conceptual Model for Understanding Technostress

Figure 2 presents the conceptual model for understanding technostress. It is based on the theoretical perspectives of the Transaction-Based Model from Figure 1. *Technostress creators* in Figure 2 parallel *stressors* in Figure 1, *technostress inhibitors* correspond to *situational factors*, *job satisfaction* is equivalent to *strain*, and *organizational commitment* and *continuance commitment* parallel *other organizational outcomes*. Further, differences in age, education, prior experience, and familiarity with IT, etc., have been found to be germane to individual beliefs about the usefulness and ease of use of IT (Agarwal and Prasad 1999, Burton-Jones and Hubona 2005). These variables also affect

Figure 2 Conceptual Model for Understanding Technostress



enduser reactions to computer technologies (Compeau and Higgins 1995, Hudiberg and Necessary 1996). We expect these variables to influence ICT-related stress and have therefore included *individual differences* in the model.

4.1. Technostress Creators

Technostress creators represent the factors that create technostress in the organization. To understand the aspects associated with technostress creators, we refer to extant literature as well as practitioner observations.

ICTs can create stress in a number of ways. First, their capabilities for *constant connectivity* extend the regular work day. Employees work odd hours, using e-mail applications and wireless e-mail devices (Mandel 2005). They can be contacted anywhere and anytime, and often feel forced to respond to the extent that not connecting becomes disquieting. This kind of continual exposure leads individuals to feel that they are never free of these technologies and that their time and space have been invaded. Hence, their sense of job satisfaction is negatively affected.

Second, mobile communication tools such as laptops and smart phones and applications such as collaborative software and the browser have made it routine for employees to *simultaneously* handle different streams of information from internal and external sources. This has resulted in communication and information overload—individuals are exposed to more information than they can efficiently handle and effectively use (Fisher and Wesolkowski 1999). They feel inundated, are unable to set practical cutoffs and priorities with respect to new information (Kupersmith 1992), and are forced to work faster to cope with increased processing requirements. These factors result in what is known as "information fatigue" (Weil and Rosen 1997) and "data smog" (Brilhart 2004). A recent international survey of about 8,000 managers revealed that a quarter of the executives at large companies think that their voice mail and e-mail are unmanageable, and nearly half spend half a day to a full day every week on communications that are not useful for their work (Mandel 2005). Information overload may create stress and leave users feeling frustrated and dissatisfied.

Third, competitive pressures to keep using the latest hardware, software, and applications have

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increased; at the same time, technical capabilities and terminology associated with ICTs have become more complex. New applications can take months to learn, and manuals can be complex. Studies from the organizational behavior literature have shown that users may experience a kind of phobia (Heinssen et al. 1987), aversion, fear, anxiety, or sense of hassle (Yaverbaum 1988) when required to use computer technologies that they perceive to be complex. Scope and required job skills may increase, and they experience greater task difficulty and ambiguity about performance expectations (Dolan and Tziner 1988, Love et al. 1989). Practitioner findings (Brod 1984, Weil and Rosen 1997) also confirm that end users find the variety of applications, functionality, and jargon intimidating and difficult to understand, leading to stress and job dissatisfaction.

Fourth, organizations adopt ICT products and applications that *change rapidly*. Consequently there is no chance for users to find meaningful patterns or develop a base of experience (Kupersmith 1992). Past studies on the use of visual display units (Love et al. 1989, Sainfort 1990) show that changing capabilities of these technologies resulted in ambiguity about present and future job demands. In the context of modern ICTs, although managers may initially be enthusiastic about learning new applications and technologies, constant requirements for refreshing and updating can eventually lead to frustration, stress, and interpersonal conflict (Brod 1984, Zorn 2002). This leads to job dissatisfaction.

Fifth, most off-the-shelf ICT applications used in present organizational environments cannot be used "as is" without major modifications. The implementation of enterprise resource planning systems, for instance, requires making important decisions about configuration and customization, which is often a highly political and stressful process. Even after modifications have been made, end users may experience problems related to poor documentation, programming errors, lost data and programs (Weil and Rosen 1999), application crashes (Hudiberg 1989, Carayon-Sainfort 1992), and absence of adequate technical resources and support (Kupersmith 1992). All of this creates job dissatisfaction and a feeling of being unable to cope (Brod 1984, Fisher and Wesolkowski 1999).

Finally, ICTs aid in multitasking, thus helping to accomplish more in less time. However, there are limits to effective multitasking, and the use of ICTs often pushes individuals to exceed those limits. Study subjects exposed to excessive multitasking in controlled experiments have shown increased tension, diminished perceived control, and decreased job satisfaction (Brillhart 2004, Weil and Rosen 1997).

In summary, ICTs create stress because they are complex and change frequently, involve significantly steep learning curves, require more work, lead to excessive multitasking, and are accompanied by technical problems and errors.

4.2. Technostress Inhibitors

Technostress inhibitors represent the situational variables in Figure 1 and describe organizational mechanisms that have the potential to reduce the effects of technostress. In describing the aspects of technostress inhibitors, we draw on academic literature and practitioner experience that propose organizational mechanisms and adjustments through which negative outcomes from ICT use can be alleviated. One of these mechanisms is organizational and technical support for end users (Nelson 1990). Because new ICTs are often introduced at a rapid rate, end users need training and guidance on how to use new systems, especially during the early days, to help reduce their anxiety (Clark and Kalin 1996). A study of ICT users (results reported at http://www.technostress.com/busstudy2000.htm) showed that those who had "excellent to good" training had more positive reactions to new applications than those who had received "fair to terrible" training. IT technical support is also important. Yaverbaum (1988) and Zorn (2002) suggest that when new ICTs are implemented, IT professionals should encourage users to explore and retool and should provide help desk and technical support to resolve end user problems. They can also build prototype demonstration workstations and develop schedules for practice and acclimatization (Kupersmith 1992). Reducing regular workload during implementation of critical systems also gives employees time to learn and use them (Brod 1984).

Another mechanism for reducing the effects of technostress is to involve end users during system planning and implementation phases (Brod 1984). Inviting

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end users to participate in discussions on how new applications could be used and soliciting and incorporating their requirements into system design and configuration helps them become familiar with new applications from the beginning, thus decreasing the impact of stressful situations during use (Clark and Kalin 1996, Karasek 1979, Nelson and Kletke 1990). Communicating the changes (e.g., workflow and process changes), benefits, and opportunities accompanying the introduction of new ICTs reduces stress-related outcomes (Parsons et al. 1991) and helps users get over ICT-related fear and anxiety.

4.3. Job Satisfaction

Job satisfaction reflects (inversely) the strain construct in Figure 1. It is defined as "a pleasurable or positive emotional state resulting from the appraisal of one's job or job experiences" (Locke 1976, p. 1300). The choice of job satisfaction as a behavioral strain variable has been considered appropriate for three reasons. First, behavioral strain variables have been considered germane to the study of workplace-related outcomes of stress (Cooper et al. 2001, Jex and Beehr 1991). Second, job satisfaction is an important and frequently studied outcome variable in the research on stress (Igbaria and Guimaraes 1993, Baroudi 1985) because of its impact on employee functioning, and resulting substantial costs to the organization. Third, job satisfaction among ICT users is one of the desired results from the implementation and use of ICTs (Cheney and Scarpello 1985), predicated on its importance as an outcome in numerous, seminal studies on the work-related effects of physical/technological and social conditions (Herzeberg 1966, Locke 1973). Hence, any change in job satisfaction as a result of stress stemming from ICT use is clearly an important outcome to be measured.

As explained in §4.1, different aspects associated with the construct technostress creators lead to dissatisfaction at work. We therefore expect technostress creators to decrease job satisfaction. This relationship finds theoretical support in the organizational behavior literature as well. Smith et al. (1981) report that users of visual display units encountered high dissatisfaction because of stress, and Corbett et al. (1989) found work changes resulting from the use of computer-based manufacturing technologies to be associated with decreased job satisfaction. The construct technostress inhibitors, as described in §4.2, represents organizational mechanisms such as end-user training, support, and participation, which are relevant in the context of ICT implementation and use. These mechanisms make ICTs easier to use and can lead to positive job appraisals, among other benefits, for end users. We therefore expect the construct technostress inhibitors to increase job satisfaction.

As shown by the dotted line in Figure 2, we also expect the possibility that technostress inhibitors moderate the relationship between technostress creators and job satisfaction. That is, we posit that stress inhibiting mechanisms embodied in technostress inhibitors could reduce the effect of the stress creating effects of technostress creators. This is consistent with the moderating effects of situational factors on the relationship between stressors and strain as discussed in the stress literature and as shown in Figure 1. It is also consistent with studies in the IS end-user literature suggesting that organizational mechanisms such as social support, workplace discussion/information forums, and management communication (Wastell and Newman 1993, Nelson and Kletke 1990) moderate the relationship between ICT-related sources of stress and individual outcomes such as job dissatisfaction.

4.4. Organizational Commitment and Continuance Commitment

We further study the effects of technostress on two broader organizational outcomes, employees' commitment to the organization and their intention to remain on their job. These are represented, respectively, by *organizational commitment* and *continuance commitment*. An individual's commitment to the organization has been defined as the relative strength of his or her identification with, and involvement in, the organization and is characterized by belief in and acceptance of the organization's goals and values (Mowday et al. 1982). Beehr (1998) and Jex and Beehr (1991) suggest that the strains experienced by individuals (e.g., job dissatisfaction) lead to a lack of organizational commitment. A number of other studies (Cheloha and Farr 1980, Rabinowitz and Hall 1977) have also found correlations between job satisfaction

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and organizational commitment. These findings suggest a positive relationship between job satisfaction and organizational commitment.

Continuance commitment describes the need that an employee feels to stay in the organization, based on his or her assessment of the perceived costs of leaving (Meyer and Allen 1991). It is predicated on the employee's recognition of the profits (costs) associated with staying (or leaving). Research (Allen and Meyer 1990, Glazer and Beehr 2005, Gellatly et al. 2006, Snape and Redman 2003) suggests a positive relationship between organizational commitment and continuance commitment. That is, the greater the individual's commitment to the organization, the higher the involvement and identification with the organization's goals, the higher the perceived costs of leaving (or the lower the attractiveness of other alternatives) and hence the greater the continuance commitment. Consistent with the Transaction-based Model, we expect that technostress inhibitors, as organizational mechanisms, would increase organizational and continuance commitment.

4.5. Individual Differences

We have considered the effect of differences in four individual characteristics on technostress: education, age, gender, and computer confidence. Education positively influences perceived ease of use with respect to ICTs (Igbaria and Parsuraman 1989, Agarwal and Prasad 1999), the assumption being that more educated users would have less anxiety about learning how to use new ICTs and would learn faster than less educated users. Hence, we expect that the more educated users would experience less technostress. Findings with respect to the effect of age on individual reactions to ICTs vary. In the technology acceptance literature, Burton-Jones and Hubona (2005) found that age negatively influences perceived ease of ICT use. Studies on computer-related stress, however, suggest that age does not affect computer phobia (Rosen and Maguire 1990) or computer-related stress (Hudiberg and Necessary 1996). That is, older people do not experience more computer anxiety or computer phobia than younger people. Perhaps, because of their maturity, older people are better able to handle stressors. We expect, therefore, that age would not have an effect on technostress. With respect to gender, studies suggest that men and women are influenced by different factors in their decision to use IT. Women are influenced by subjective organizational norms and perceived behavioral control, and men by their attitudes towards the technology (Venkatesh and Morris 2000). Women are less likely to use computers in the workplace (Venkatesh and Morris 2000, Gefen and Straub 1997) and find software less easy to use than men (Gefen and Straub 1997). Women also tend to have higher computer anxiety (Igbaria and Chakrabarti 1990, Whitley 1997) and computer phobia (Rosen and Maguire 1990) than men. Based on these arguments we expect that women would experience greater technostress than men. Research demonstrates a strong link between computer confidence and self-efficacy and individual reactions to computing technology (Compeau and Higgins 1995b, Taylor and Todd 1995). Higher computer self-efficacy leads to lower computer-related anxiety and computer phobia (Compeau and Higgins 1995). Therefore, we expect that individuals with greater confidence in their ability to use ICTs will experience less technostress.

5. Research Methodology, Analysis, and Results

This research was conducted in three phases. First we developed the questionnaire for measuring the constructs in the conceptual model. Second, we developed and validated the constructs "Technostress Creators" and "Technostress Inhibitors." Third, we tested the relationships of the conceptual model. We describe the phases below.

5.1. Item Development, Questionnaire Design, and Data Collection

Step 1: Item Development and Questionnaire Design. In developing the scales for technostress creators and technostress inhibitors, we first conceptualized questions based on the literature discussed in §§4.1 and 4.2. Content validation involved interviews with four end users from business organizations and six end users from a university. During these interviews, we asked them to comment on the relevance and clarity of the questions within the context of technostress situations and associated organizational response mechanisms as they experienced them. Based on their feedback, we developed the

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final measurement items for large scale data collection. This strategy follows similar methods adopted in comparable papers in recent literature (Salisbury et al. 2002, Chin et al. 1997), given the lack of prior theoretical research on technostress. Job Satisfaction was measured using the job satisfaction survey scale as defined in Spector (1985). Organizational and continuance commitment were measured using scales from Meyer and Allen (1997). All items were measured on a five-point Likert scale: from 1 ("strongly disagree") to 5 ("strongly agree"). A sixth option of "Not Applicable" or "I do not know" was also provided.

Step 2: Data Collection. Data were collected from end users of ICTs in five organizations (two government, one manufacturing, and two financial). These end users were white collar employees who used ICTs as part of their day-to-day work processes. Support from the organizations was solicited through the CEOs/senior vice presidents. Respondents were then contacted through the head of the IS department. First, emails were sent out to employees describing the nature and purpose of the study and asking them if they would be interested in participating. They were requested to ask for the questionnaire if they were interested and to return the completed questionnaire in a sealed envelope to the sponsoring individuals. Employees were informed that participation was voluntary and that their responses would be confidential. A total of 680 questionnaires was distributed, of which 608 were returned, representing a response rate of 89.4%. Sample characteristics are given in Tables 1(a)–(d).

Table 1 Sample Characteristics

Gender	Frequency
1(a): Gender	
Male	368
Female	212
Missing	28
Total	608
Age	**Frequency**
1(b): Age	
Below 26	91
26 to 35	180
36 to 45	151
46 to 55	138
56 to 65	33
Above 65	1
Missing	14
Total	608
Education	**Frequency**
1(c): Education	
High school	42
Two-year college	61
Bachelor's degree	360
Master's degree	108
Others	28
Missing	9
Total	608
1(d): Computer confidence	
Measured on a 10-point scale from (1)—Not at all confident to (10)—Totally confident	
Mean: 5.35; std. deviation: 2	

5.2. Development and Validation of Technostress Creators and Technostress Inhibitors Constructs

Step 3: Exploratory Factor Analysis Using Set 1. The sample was randomly split into two sets. Set 1 (400 cases) was used for developing the constructs. Set 2 (208 cases) was used as a holdout sample to validate the results from Set 1. There were 25 items for technostress creators and 13 items for technostress inhibitors in the survey questionnaire. Exploratory factor analysis of Set 1 yielded a five-factor structure for technostress creators consisting of 23 of these 25 items, and a three-factor structure for technostress inhibitors consisting of all 13 items. The results are shown in Tables 1(a) and 1(b) of the appendix.[1]

Step 4: Confirmatory Factor Analysis (CFA) Using Set 1 and Validation Using Set 2. We next did CFA using AMOS 5.0 on Set 1. Items having high correlation among their error terms were appropriately deleted. The final factor structures, shown in Table 2, were validated through CFA on Set 2, the holdout sample.

Based on item contents, the five factors for technostress creators were named techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. These factors can be regarded

[1] Results are contained in an online appendix to this paper that is available on the *Information Systems Research* website (http://isr.pubs.informs.org/ecompanion.html).

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Table 2 Mean, Standard Deviation, Reliability (Alpha), and Measurement Items of Technostress Creators, Technostress Inhibitors, Job Satisfaction, Job Commitment, and Turnover Intention After CFA

	Mean	Standard deviation
Technostress creators		
Techno-overload (Reliability = 0.82)	3.00	0.91
I1_1—I am forced by this technology to work much faster.*		
I1_2—I am forced by this technology to do more work than I can handle.		
I1_3—I am forced by this technology to work with very tight time schedules.		
I1_4—I am forced to change my work habits to adapt to new technologies.		
I1_5—I have a higher workload because of increased technology complexity.		
Techno-invasion (Reliability = 0.80)	2.21	0.83
I1_8—I spend less time with my family due to this technology.*		
I1_9—I have to be in touch with my work even during my vacation due to this technology.		
I1_10—I have to sacrifice my vacation and weekend time to keep current on new technologies.		
I1_11—I feel my personal life is being invaded by this technology.		
Techno-complexity (Reliability = 0.77)	2.71	0.75
I1_12—I do not know enough about this technology to handle my job satisfactorily.		
I1_13—I need a long time to understand and use new technologies.		
I1_14—I do not find enough time to study and upgrade my technology skills.		
I1_15—I find new recruits to this organization know more about computer technology than I do.		
I1_16—I often find it too complex for me to understand and use new technologies.		
Techno-insecurity (Reliability = 0.78)	2.53	0.80
I1_17—I feel constant threat to my job security due to new technologies.		
I1_18—I have to constantly update my skills to avoid being replaced.		
I1_19—I am threatened by coworkers with newer technology skills.		
I1_20—I do not share my knowledge with my coworkers for fear of being replaced.*		
I1_21—I feel there is less sharing of knowledge among coworkers for fear of being replaced.		
Techno-uncertainty (Reliability = 0.83)	3.33	0.76
I1_22—There are always new developments in the technologies we use in our organization.		
I1_23—There are constant changes in computer software in our organization.		
I1_24—There are constant changes in computer hardware in our organization.		
I1_25—There are frequent upgrades in computer networks in our organization.		
Technostress inhibitors		
Literacy facilitation (Reliability = 0.85)	3.31	0.85
I2_1—Our organization encourages knowledge sharing to help deal with new technology.*		
I2_2—Our organization emphasizes teamwork in dealing with new technology-related problems.		
I2_3—Our organization provides end-user training before the introduction of new technology.		
I2_4—Our organization fosters a good relationship between IT department and end users.		
I2_5—Our organization provides clear documentation to end users on using new technologies.		
Technical support provision (Reliability = 0.86)	3.59	0.78
I2_6—Our end-user help desk does a good job of answering questions about technology.*		
I2_7—Our end-user help desk is well staffed by knowledgeable individuals.		
I2_8—Our end-user help desk is easily accessible.		
I2_9—Our end-user help desk is responsive to end-user requests.		
Involvement facilitation (Reliability = 0.87)	2.79	0.90
I2_10—Our end users are encouraged to try out new technologies.*		
I2_11—Our end users are rewarded for using new technologies.		
I2_12—Our end users are consulted before introduction of new technology.		
I2_13—Our end users are involved in technology change and/or implementation.		
Job satisfaction (Reliability = 0.87)	3.73	0.76
I3_1—I like doing the things I do at work.		
I3_2—I feel a sense of pride in doing my job.		
I3_3—My job is enjoyable.		

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Table 2 (Cont'd.)

	Mean	Standard deviation
Technostress inhibitors		
Organizational commitment (Reliability = 0.82)	3.37	0.88
I4_1—I would be happy to spend the rest of my career in this organization.		
I4_2—I enjoy discussing my organization with people outside it.		
I4_3—I really feel as if this organization's problems are my own.		
I4_4—This organization has great deal of personal meaning for me.		
Continuance commitment (Reliability = 0.71)	3.31	0.78
I5_1—Too much of my life would be disrupted if I decided I want to leave my organization right now.		
I5_2—Right now staying with my organization is a matter of necessity as much as desire.		
I5_3—I believe that I have too few options to consider leaving this organization.		
I5_4—It would be very hard for me to leave my organization right now even if I wanted to		

*These items were deleted after checking for error correlation using CFA in Steps 4 and 5. Details are given in the appendix.

as different aspects or dimensions of technostress. *Techno-overload* describes situations where ICTs force users to work faster and longer. *Techno-invasion* describes the invasive effect of ICTs in situations where employees can be reached anytime and feel the need to be constantly connected, thus blurring work-related and personal contexts. *Techno-complexity* describes situations where the complexity associated with ICTs leads users to feel inadequate with regard to their computer skills and forces them to spend time and effort in learning and understanding ICTs. *Techno-insecurity* is associated with situations where users feel threatened about losing their jobs, either because of automation from ICTs or to other people who have a better understanding of ICTs. *Techno-uncertainty* refers to contexts where continuing ICT changes and upgrades unsettle users and create uncertainty so that they must constantly learn and educate themselves about new ICTs.

The three factors for technostress inhibitors were named literacy facilitation, technical support provision, and involvement facilitation. These represent organizational and managerial mechanisms that decrease the effect of technology-related stress. *Literacy facilitation* describes mechanisms that encourage and foster the sharing of ICT-related knowledge within the organization. Literacy facilitation reduces technostress because it helps users understand ICTs and their uses, and enables them to cope with the demands of learning new ICTs. *Technical support provision* describes activities related to end-user support that reduce the effects of technostress by solving users' ICT problems relating. *Involvement facilitation* helps alleviate technostress by keeping users informed about the rationale for introducing new ICTs, by letting them know about the effects of such introduction, and by encouraging them to use and experiment with new ICTs.

5.3. Conceptual Model Testing on the Full Sample

Step 5: Construct Reliability. The reliability of the eleven constructs—techno-overload, techno-invasion, techno-uncertainty, techno-insecurity, techno-complexity, literacy facilitation, technical support provision, involvement facilitation, job satisfaction, organizational commitment, and continuance commitment—was calculated on the combined sample (Set 1 and Set 2). Means, standard deviation, and reliability are shown in Table 2. The Cronbach's alpha values range from 0.91 to 0.71 and are greater than the recommended minimum value of 0.7 (Nunnally 1978, Hair et al. 1998).

Step 6: Discriminant Validity of the Conceptual Model Through a First-Order Correlated Measurement Model of All Constructs. To check for the discriminant and convergent validities of the 11 constructs, we ran a first order correlated measurement model ("Model 1") in Table 3. There were no significant error correlations among any of the items, thus indicating good discriminant and convergent validities. The values of the model-fit indices exceed recommended values as explained below.

We evaluated the model fit on the basis of multiple indices—chi square, chi square/df, GFI, AGFI,

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Table 3 Tests for Discriminant Validity

	Model	χ^2	df	χ^2/df	$\chi^2_{Baseline}$	$Df_{Baseline}$	GFI	AGFI	NFI-δ1	RMR	IFI-δ2	RFI-ρ1	TLI-ρ2	CFI
Model 1	First order correlated model*	1,641	685	2.40	11,518	780	0.88	0.86	0.86	0.05	0.91	0.84	0.90	0.91
Model 2	Technostress creators second order model	531	165	3.21	4,972	190	0.92	0.90	0.89	0.06	0.92	0.88	0.91	0.92
Model 3	Technostress inhibitors second order model	146	32	4.57	3,491	45	0.97	0.93	0.96	0.04	0.97	0.94	0.95	0.97

*Techno-overload, techno-invasion, techno-uncertainty, techno-complexity, techno-insecurity, literacy facilitation, technical support provision, involvement facilitation, job satisfaction, job commitment, continuance commitment.

NFI, CFI, RMR, IFI, RFI, TLI.[2] Appropriate values for chi square/df should exceed 1 and be less than 5 (Salisbury et al. 2002, Chin et al. 1997). GFI and AGFI scores of 0.90 and above represent good fit. GFI > 0.85 and AGFI > 0.8 are also acceptable (Hadjistavropoulos et al. 1999 and Hair et al. 1998). Recommended values for NFI are >0.90 (Salisbury et al. 2002); values >0.8 are also acceptable (Hair et al. 1998, Hadjistavropoulos et al. 1999). CFI should be >0.90 (Bentler and Bonnet 1980, Salisbury et al. 2002). RMR values below 0.1 signify good fit (Salisbury et al. 2002). Suggested values of IFI and RFI for good fit are >0.90 (Bollen 1989, Salisbury et al. 2002). Recommended values of TLI (or NNFI) are >0.90 (Salisbury et al. 2002) as well as >0.8 (Hair et al. 1998, Hadjistavropoulos et al. 1999). The more liberal values are considered appropriate for development of new models and theories (Vassend and Skrondal 1997).

Step 7: Verification of Second Order Constructs for Technostress Creators and Technostress Inhibitors. To verify that the five-factor structure indicated a second order technostress creators construct and the three-factor structure a second order technostress inhibitor construct, a first order correlated model was compared with a second order model for each construct. The gamma values were statistically significant. The fit indices, shown as "Model 2" and "Model 3" in Table 3, exceed recommended values. The target coefficient (Marsh and Hocevar 1985), i.e., the ratio of the chi square value for the first order model to that for the second order model, exceeded the recommended value of 80%. For technostress creators (Model 2), the chi square value for the first order model was 516 and for the second order model was 530, giving a target coefficient of 97.4%. For technostress inhibitors (Model 3), the chi square value for the first order model was 146 and for the second order model was 146, giving a target coefficient of 100%. Hence the values of the gamma coefficient, fit indices, and the target coefficient show evidence of second order constructs.[3]

Step 8: Test of the Relationships in the Conceptual Model. In this step, we tested the relationships among technostress creators, technostress inhibitors, job satisfaction, and organizational and continuance commitment. The results of the structural equation modeling (SEM) analysis show that the fit

[2] The chi square index is sensitive to sample size and sample departures from multivariate normality. Chi square/df adjusts for the degrees of freedom. Goodness-of-Fit Index (GFI) indicates the relative amount of variance and covariance explained by the model. Adjusted Goodness-of-Fit index (AGFI) adjusts GFI for the degrees of freedom. Normed Fit Index (NFI) and Comparative Fit Index (CFI) assess model fit by comparing the theoretical model to a baseline model. Root Mean Square Residual (RMR) measures the average discrepancy between the elements in the sample covariance matrix and the model-generated covariance matrix. The incremental index of fit (IFI) addresses the issue of parsimony, taking into account the degrees of freedom. Reflexive Fit Index (RFI) is a derivative on NFI. Tucker-Lewis coefficient (TLI) also known as NNFI, adjusts NFI for the degrees of freedom.

[3] We have conceptualized technostress creators and technostress inhibitors as reflective or superordinate (Edwards 2001, Law and Wong 1999) constructs. This implies that (1) each of the first order constructs represents a *facet* or *manifestation* and can be viewed as one of its dimensions and the direction of causality is from the second order construct to its facets, the first order constructs, (2) the first order constructs are interchangeable, (3) covariation among the first order constructs is not unexpected, and (4) the nomological networks associated with them are expected to be similar (Jarvis et al. 2003). Our representation is consistent with previous literature on stress that models stress as a reflective construct (Law et al. 1998).

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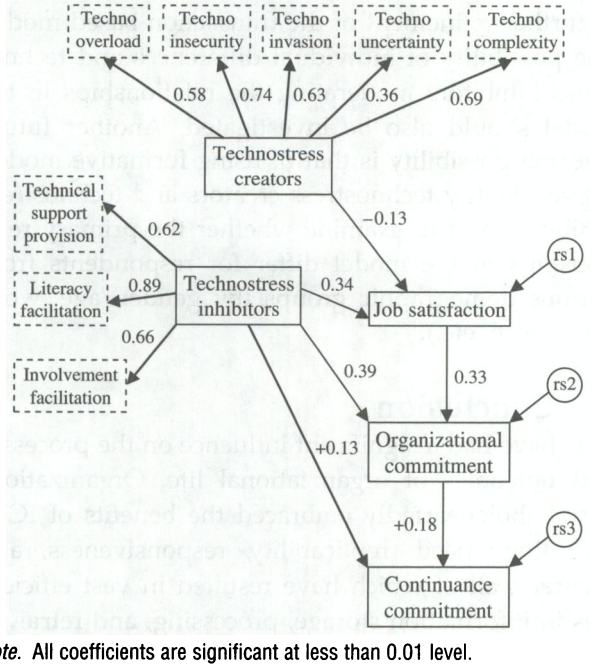
Table 4 Results of SEM Analysis (Figure 3)

	χ^2	df	χ^2/df	$\chi^2_{Baseline}$	$Df_{Baseline}$	GFI	AGFI	NFI-δ1	RMR	IFI-δ2	RFI-ρ1	TLI-ρ2	CFI
Model 4	150	40	3.75	1,636	55	0.91	0.90	0.91	0.05	0.93	0.88	0.91	0.93

indices are satisfactory ("Model 4", Table 4) and the path coefficients are significant (Figure 3). We interpret the results to prove that technostress creators decrease job satisfaction and technostress inhibitors increase job satisfaction, and organizational and continuance commitment. Also organizational commitment increases continuance commitment.

To test for possible moderating effects of technostress inhibitors on the relationship between technostress creators and job satisfaction, we followed the methodology discussed by Sharma et al. (1981) and McKeen et al. (1994). We first regressed job satisfaction against technostress creators, technostress inhibitors and their product, with the regression coefficient of the product signifying the effect of the moderating relationship. We repeated this for each of the first order factors of technostress creators and technostress inhibitors for a total of 16 models. The results, as shown in Table 2 of the appendix, do not support a moderating effect. In this context, Wall et al. (1996) and Landsbergis et al. (1995) note that most studies from the stress literature in which moderator relations have found support use objective rather than perceptive measures for the stressors.

Figure 3 Results of SEM Analysis



Note. All coefficients are significant at less than 0.01 level.

We tested for the effects of the four individual characteristics (gender, age, education, and computer confidence) on technostress by regressing these variables on technostress creators. Gender was recorded as "male" or "female." Age was measured on a 1 to 6 ordinal scale, "1" being below 26 years and "6" being above 65 years. Education was measured on a 1 to 4 ordinal scale, "1" corresponding to high school level education and "4" to master's level education. Computer confidence was measured on a 1 to 10 scale varying from "not at all confident" to "totally confident." The regression coefficients were significant for all the variables. Our results showed that males experienced more technostress than females and that technostress decreased as age, education, and computer confidence increased. The finding with respect to gender is contrary to what we expected. This result could be sample specific—the female respondents might have had greater organizational tenure or task autonomy that enabled them to better handle the stress creating effects of ICTs in their organizational environment. In this context, literature suggests that negative effects of stress and overwork in women are less for those with greater organizational tenure (Baroudi and Igbaria 1994/1995). Past research also indicates that for women, greater autonomy ameliorates the negative effects of work overload associated with IT innovations (Ahuja and Thatcher 2005). Additionally, recent research (Morris et al. 2005) suggests that gender differences in the adoption of technology are not significant for younger employees. The fact that more than 50% of our sample is under 45 years old could thus contribute to the unexpected finding. With respect to age, we expected that it would not affect technostress, whereas our findings show that older people experience less technostress. This result can be explained by possible greater organizational tenure

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of older employees, leading to more organization-specific experience and better understanding of how to assimilate the stress creating effects of ICTs in their work context. This finding may be sample specific.[4]

6. Discussion

The research-related contribution of this paper is in two domains. In IS research, this study gives conceptual shape and empirical validation to the idea of technostress and investigates its relationship to individual and organizational outcomes. In the organizational behavior domain, the study adds to the transaction-based approach by identifying and validating stressors associated with the use of ICTs. Note that the first order constructs for technostress creators are similar to constructs describing other forms of stress such as role and task based stress. Techno-uncertainty is similar to role ambiguity in that both describe situations involving ambiguity about expectations and outcomes associated with the particular stress creating condition. Techno-overload is similar to role overload in that both imply the presence of changed or increased demands on the individual as a result of the stress creating condition. Techno-complexity is similar to task difficulty (McGrath 1976), and implies the presence of conditions the individual finds difficult to understand. These instances affirm that technostress can be analyzed in terms of, and considered a conceptual enhancement to, existing theoretical frameworks for studying stress.

In the domain of managerial practice, the study identifies specific organizational conditions that signify the existence of technostress among employees and relates them to job satisfaction and commitment, which are important work-related outcomes. Managers can use the items described in Table 2 to ascertain the presence or absence of factors that create technostress. They may also recognize that the organizational mechanisms described in technostress inhibitors can be effectively used to increase job satisfaction and commitment, and thus mitigate the negative outcomes of technostress. The findings with respect to relationships between the variables related to individual differences and technostress creators have implications for managing the effects of age, gender, education, and computer confidence on technostress.

In terms of limitations, although our empirical results can be generalized to frame theoretical relationships about technostress (Lee and Baskerville 2003), they may be considered in the light of (a) the firm-specific nature of the respondent sample—most respondents were male and had at least a bachelor's degree, (b) the selection of organizations on the basis of the researchers' contacts, and (c) self-selection of respondents. We also note that replicating this study in other sectors, such as health care, for example, would lead to empirical generalization of these theoretical relationships (Lee and Baskerville 2003). Our results with respect to the effect of gender on technostress are somewhat contrary to previous research and should be explored further.

In terms of future studies, alternate methods such as field experimentation and longitudinal studies can be used to measure technostress before and after the implementation of specific inhibitor mechanisms. Investigation of the impact of technostress creators and technostress inhibitors on other outcomes such as productivity should considerably enhance our understanding of technostress. Exploring relationships between technostress and role stress would lead to further refinement of the transaction-based model. The possibility of individual differences and technostress inhibitors moderating the relationships in the model should also be investigated. Another future research possibility is that of using formative modeling to identify technostress creators and technostress inhibitors and to examine whether the primary relationships in the model differ for respondents from various demographic groups (by gender, age, work experience, etc.).

7. Conclusion

ICTs have had a significant influence on the processes and outcomes of organizational life. Organizations have wholeheartedly embraced the benefits of ICTs, including speed, replicability, responsiveness, and accuracy, all of which have resulted in vast efficiencies in information storage, processing, and retrieval. At the same time, ICTs often force employees to try

[4] We tested for common method variance using Harman's technique (Malhotra et al. 2006). The results indicate that there was no common variance.

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and accomplish more tasks in less time, result in elimination of manual jobs, and affect relationships with colleagues. ICTs change our jobs and eventually our behaviors in ways that we do not completely understand. Stress literature is being increasingly recognized as a potential basis for understanding user attitudes toward ICTs in the workplace (Ahuja and Thatcher 2005); technostress is an important fallout of the inevitable use of ICTs in organizations and illustrates the bivalent nature of their organizational influence. This research represents an attempt to develop a conceptual and empirical understanding of technostress and its outcomes. We believe that the definitions and relationships developed in this paper can be used as bases for future studies in this area.

Acknowledgments

The authors thank three anonymous reviewers, the associate editor, and the senior editor for their suggestions, which significantly improved the paper.

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