The Impact of Technostress on Role Stress and Productivity

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

MONIDEEPA TARAFDAR is an Assistant Professor of Information Systems 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 from the Indian Institute of Management, Calcutta. Her research interests are in the areas of information systems management and planning, specifically at the interface of information systems and business innovation, in managing individual and organizational adjustments required for effective information technology use, and in information systems planning for Net-enabled organizations. Her research has appeared in *Journal of Computer Information Systems, Information Resources Management Journal, International Journal of Information Management, Journal of Strategic Information Systems,* and *Journal of Cases on Information Technology.*

QIANG TU is an Associate Professor of Management Information Systems at the E. Philip Saunders College of Business of Rochester Institute of Technology. He received his B.S. in Management Engineering and M.S. in Systems Engineering from Jiaotong University, China. He holds 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. He has published in academic journals, including *Information Systems Research, 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.*

BHANU S. RAGU-NATHAN is a Professor of Accounting in the College of Business Administration at the University of Toledo. She holds a Ph.D. from the University of Pittsburgh. Her current research interests are in information systems strategy, ethical issues in information systems, and behavioral issues in managerial accounting and control systems. She has published in *Information Systems Research, Journal of Management Information Systems, Decision Sciences, OMEGA: The International Journal of Management Science, Research in Accounting Regulation, Accounting Horizons,* and *Journal of Strategic Information Systems.*

T.S. RAGU-NATHAN is a Professor of Information Systems and Operations Management in 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 use of information technology in manufacturing, supply-chain management, and e-commerce. Has published in several journals, including *Information*

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Abstract: Based on empirical survey data, this paper uses concepts from sociotechnical theory and role theory to explore the effects of stress created by information and computer technology (ICT)—that is, "technostress"—on role stress and on individual productivity. We first explain different ways in which ICTs can create stress in users and identify factors that create technostress. We next propose three hypotheses: (1) technostress is inversely related to individual productivity, (2) role stress is inversely related to individual productivity, and (3) technostress is directly related to role stress. We then use structural equation modeling on survey data from ICT users in 223 organizations to test the hypotheses. The results show support for them. Theoretically, the paper contributes in three ways. First, the different dimensions of technostress identified here add to existing concepts on stress experienced by individuals in organizations. Second, by showing that technostress inversely affects productivity, the paper reinforces that failure to manage the effects of ICT-induced stress can offset expected increases in productivity. Third, validation of the positive relationship between technostress and role stress adds a new conceptual thread to literature analyzing the relationship between technology and organizational roles and structure. In the practical domain, the paper proposes a diagnostic tool to evaluate the extent to which technostress is present in an organization and suggests that the adverse effects of technostress can be partly countered by strategies that reduce role conflict and role overload.

Key words and phrases: human resource management, role conflict, role overload, role stress, role theory, structural equation modeling, survey methods, technostress.

Information and communication technologies (ICTs) have resulted in significant payback for organizations over the past four decades in terms of reduced operational costs, greater process efficiencies, new strategic alternatives, and possibilities for innovation [8, 18, 42]. At the same time, however, researchers agree that the organizational effects of ICTs are very broad and indirect, and that the implementation of ICTs leads to effects that have a "dual nature." In particular, along with generating obvious business benefits, ICTs can also cause negative reactions in individuals and require them to adjust in various ways [31]. A number of studies have documented these dual, and sometimes dark, effects of the implementation and use of ICTs [54, 55].

First, ICTs have been known to induce anxiety and tension in users [47]. Depending on an individual's disposition toward ICTs, his or her interaction with computers can be fraught with nervousness and apprehension. This can create psychological effects such as insecurity about ICTs, and can decrease confidence and overall comfort about their use. Such conditions could lead to feelings of helplessness and of being hassled, and can result in aversion to [2] and phobia about [30] the use of computers.

Second, the use of ICTs creates stress in users. This phenomenon, known as *technostress,* is caused by an inability to adapt or cope with new ICTs in a healthy manner [7, 82]. For instance, the pervasiveness of modern ICTs often results in almost constant "connectivity" through e-mail, the Internet, and the phone. Individuals feel that because they are always connected, they are "on call." This leads them to believe that they have lost control over their time and space, which creates feelings of being stressed out. To give another example, ICT users are regularly inundated with information from many different sources. Such information is frequently more than they can effectively process. This, combined with increasing levels of complexity in the ever changing ICTs, creates feelings of being unable to cope and leads to stress. Technostress, therefore, is one of the fallouts of an individual's attempts and struggles to deal with constantly evolving ICTs and the changing cognitive and social requirements related to their use. Its effects have become increasingly apparent over the past few years with the rapid proliferation of ICTs in the workplace.

Third, ICTs change the role of the individual in the organization [4]. For instance, when enterprise applications are implemented, they are often accompanied by process reengineering, such that the way in which organizational work is accomplished is altered. Also, tasks become computer mediated and possibly more abstract, as interaction with physical work-artifacts decreases and that with data or information increases [87]. Finally, ICT implementation often creates new structures of power, authority, and decision making, as processes are reengineered, old functions are eliminated, and new ones are created.

As these examples show, organizational effects of ICT-triggered changes are manifest in two ways [39]. First, there is a direct effect, as is visible in ICT-induced changes in the "technical system"—that is, changes in tasks and processes. Second, there is an indirect effect that is evident in changes in the "social system"—that is, in roles, reward systems, and authority structures. Both of these effects can be significant sources of stress for individuals in the organization and can have adverse effects on individual productivity and performance [19].

The effect of ICTs on stress in individuals is an important area of inquiry that has so far not been adequately addressed [9, 14, 76]. A few studies [6, 50, 55] have discussed individuals' attempts to deal with feelings of anxiety and stress in their efforts to reorganize familiar work habits and deal with increased possibilities for remote supervision, multitasking, and pervasive connectivity. There have also been studies on the stress experienced by information systems (IS) personnel [35, 45, 71, 76]. However, there is little systematic research that tries to understand the stress-creating aspects of ICTs and their effects on the *users* of ICTs in organizations. Given the rapid and ever changing developments in ICTs in recent years, there have been dramatic and irreversible changes in the workplace, and new concerns have emerged with regard to managing these changes [48]. For the most part, the use of ICTs in the workplace is not optional. It is therefore important to understand the stress-creating effects of ICTs.

This paper uses concepts from sociotechnical theory [79] and role theory [26] to explore the effects of ICT-created stress—that is, technostress—on role stress and on productivity. It first explains the different ways in which ICTs can create stress in users and identifies factors that create technostress. Next, it establishes that lower technostress leads to higher individual productivity. Then it explains and validates the influence of technostress on role stress. Finally, it examines an indirect effect of technostress on productivity through its influence on role stress. The study is based on a survey of 233 users of ICTs in multiple organizations.

Theoretical Framework and Hypotheses Development

In this section, we describe the conceptual foundations and derive the hypotheses for this study. First, we explain, against the backdrop of theoretical concepts in stress, ways in which the use of ICTs can create stress in individuals and negatively affect productivity. Second, we describe the concepts of "role overload" and "role conflict" and explain how they create "role stress," which has a negative effect on individual productivity. Third, based on ideas from role theory and sociotechnical theory, we describe how the implementation of technology influences an individual's role in the organization. Fourth, we explain how the factors that create technostress can increase role stress by increasing role conflict and role overload, and hence indirectly affect productivity. The research model proposed and tested in the study is shown in Figure 1.

Development of Hypothesis 1

Stress is a cognitive response that individuals experience when they anticipate their inability to respond adequately to the perceived demands of a given situation, accompanied by an anticipation of substantial negative consequences due to inadequate response. It is a response to an imbalance between a person and the demands of the environment [14], and is created in situations that are perceived by an individual as presenting requirements that threaten to exceed his or her capabilities and resources [52]. The consequences of stress include low productivity, dissatisfaction at work, lack of job involvement, and poor job performance [36, 37, 40].

Research on stress suggests that technology is one of the factors that causes stress [14, 52]. In this context, given the proliferation of ICTs in the workplace in recent years, there are a number of ways in which their use can create stress for people using them. Practitioner literature [7, 82] has termed the stress-creating effects of ICTs as *technostress.* Technostress is a problem of adaptation that an individual experiences when he or she is unable to cope with, or get used to, ICTs. In the organizational context, technostress is caused by individuals' attempts and struggles to deal with constantly evolving ICTs and the changing physical, social, and cognitive requirements related to their use. Technostress results in a variety of outcomes such as dissatisfaction, fatigue, anxiety, and overwork, leading to a negative effect on individual productivity [55, 65]. This can happen in a number of ways.

First, networks (such as the Internet) and mobile and wireless computing devices (such as cell phones and PDAs) have capabilities for ubiquitous and continual connectivity. The use of these leads users to feel that they are never free of technology, are always under supervision or "on call," and that their space has been invaded. Such conditions of constant connectivity create stress [13], as employees spend significant

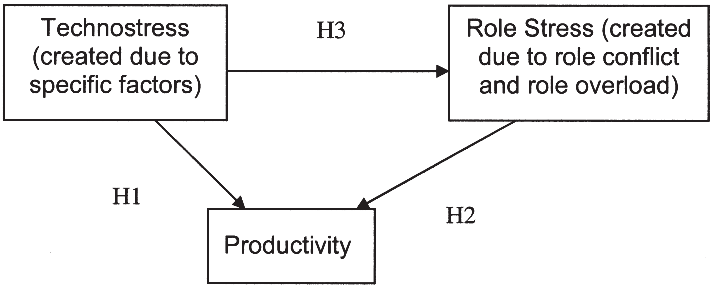

Figure 1. Research Model: The Impact of Technostress on Role Stress and Productivity

time connected, and in often ineffectively trying to handle continuous streams of communication from different sources such as e-mails, short messages, cell phones, and PDAs. Moreover, the workday tends to extend and enter into all other areas of life. All of this ultimately leads to a loss in individual productivity.

Second, the pressure to keep using the latest technology for fear of getting left behind has increased, so that organizations often go from one cycle of ICT upgrades to the next, with little time in between [22]. To add to that, new ICT-based products and applications have very short life cycles. This results in employees having to regularly learn how to work with new applications, as their existing knowledge becomes obsolete [82]. Although employees may initially be enthusiastic about learning how to use new applications and technologies, constant requirements for refreshing and updating can eventually lead to frustration and stress [38, 54]. Indeed, users are often unwilling or unable to develop the *frequent* new skills required for using the *ever evolving* ICTs in their organizations. As they try to unsuccessfully apply existing solutions to the new technologies, initial errors get transmitted and their effects magnified, leading to low productivity. Chilton et al. [11] state that frequent technology changes cause stress in IS personnel. Information technology (IT) departments in American organizations are only half as productive as their foreign counterparts, primarily because these organizations continually deploy new technologies. There is such a high innovation rate that the workforce is always learning. The constant coping and learning required of IS professionals leads to loss of productivity [68, 70].

Third, the complexity of technical capabilities and terminology associated with ICTs has increased significantly in recent years. Anecdotal findings and trade surveys [82] suggest that most people find the variety of applications, functions, and technical jargon intimidating, and do not really understand what many of the words mean or how the technologies associated with them can be used. Fear and anxiety are common reactions to this ever increasing complexity of ICTs [16, 86]. Further, although most ICT applications, such as enterprise resource planning (ERP) systems, are quite complex, they do not completely meet business requirements and cannot be used without major modifications. Even after these modifications have been made, computers crash, applications are slow, and it takes time to troubleshoot and get help.

This creates dissatisfaction and a feeling of being unable to cope [22], often leading to low productivity.

Fourth, the use of ICTs enables information input from multiple channels, such as internal company sources, the Internet, and other external sources. Individuals are therefore exposed to more information than they can efficiently handle and effectively use [7, 83]. They feel inundated with information and are forced to work faster to cope with increased processing requirements. Also, they feel compelled to acquire and process the information simply because it is available. This may actually impair performance and lead to stress. This has been referred to as "information fatigue" [82] and "data smog" [6].

Fifth, ICTs help in multitasking and hence help accomplish more tasks at the same time. It is common, for example, to have several applications running simultaneously and to carry out many different information-processing tasks at the same time. However, there are limits to which individuals can effectively engage in multitasking, and the use of ICTs can lead individuals to exceed these limits, resulting in exhaustion. Prolonged multitasking, aided by the use of ICTs, often leads to burnout and adversely affects productivity. Based on the above discussions, it can be hypothesized that there is an inverse relationship between technostress and productivity. Hence,

Hypothesis 1: Technostress is inversely related to individual productivity.

Development of Hypothesis 2

Every position in an organization has a specific set of tasks or responsibilities associated with it, which determines the person's role in the organization. Roles therefore determine an individual's behavior in the organization [25, 60] and define the requirements of his or her organizational tasks [14, p. 37]. One's role becomes the cause of stress when there is lack of clarity regarding the scope of one's responsibilities, when one is given more roles than one can handle, or when one is faced with contradictory requirements from different aspects of one's role or from different people that one interacts with. Role stress [40, 52] has been a widely studied phenomenon. "Role conflict" and "role overload" are two major factors that contribute to role stress.

An individual experiences role conflict when he or she is exposed to contradictory, incompatible, or incongruent role requirements [40, 64]. This can happen when he or she is asked to fulfill the requirements of more than one role, the expectations from which may be at odds with another, such that compliance with one makes compliance with the others difficult [41, 52]. For instance, persons occupying positions where they have to drive organizational innovation tend to experience role conflict. This is because they are placed in a situation where they have to simultaneously push change by introducing new ideas, and contend with both existing bureaucratic procedures and those who have an interest in maintaining the status quo. Role conflict can also happen when different members of an individual's social network at work hold different or contradictory expectations of a person's behavior [25, 40, 52]. This often happens in the case of a "boundary" role—that is, a role that crosses departmental or organizational boundaries [74, 80].

Role overload happens when the requirements from an individual's role exceed his or her capacity in terms of the level of difficulty or the amount of work [1, 40, 52]. Quantitative role overload describes situations where there is simply too much to do. Qualitative role overload relates to instances where the job that is required to be done is too difficult for the individual to accomplish [34, 41]. Role overload can also happen when a person has to fulfill a number of different roles, more than what he or she can effectively manage [40]. In such a situation, the individual is exposed to too many requirements from different roles and simply becomes overwhelmed.

Various studies [1, 36, 57, 72, 80] have found that role stress negatively affects performance. It decreases work quality and productivity because it creates conditions that impair an individual's ability to effectively accomplish his or her tasks. It has also been known to lead to other dysfunctional outcomes, such as dissatisfaction with the job [14]. Hence, we hypothesize that there is an inverse relationship between role stress and productivity.

Hypothesis 2: Role stress is inversely related to individual productivity.

Development of Hypothesis 3

Technology Influences Organizational Roles

According to the sociotechnical approach [21, 63, 79], organizations are sociotechnical systems—that is, they consist of two aspects. The first is the social aspect, concerned with skills, attitudes, and values of people; the roles they enact; and the reward systems and authority structures. The second is the technical, or task-related, aspect and has to do with the actual work that is performed by individuals and the related processes and technologies.

Roles are determined in two ways. The first is related to tasks that individuals perform and the technical systems with which they interact [25, 41, 51]. The second is through the social systems in which individuals function. These systems consist of the hierarchy, reporting systems, departmental structure, and authority structure within the organization [25, 41]. Social systems determine the sets of people that an individual reports to, supervises, and works with—that is, his or her peers, subordinates, and supervisors [52]. Therefore, they establish the "role set" of a person [41].

The general influence of technology on organizational roles finds description in studies by Perrow [61], Thompson [75], and Woodward [85], who suggest that technology determines departmental structures, coordinating mechanisms, span of control, control processes, standardization of rules, and extent of centralization/decentralization. Other studies [20, 87] corroborate these ideas. Recent studies (e.g., [60]) suggest that roles are not static, but are "emergent" or "dynamic." New technologies usually first alter tasks and skills. These changes subsequently create opportunities and imperatives for changing structures and processes [4]. Therefore, at a general level, changes in technology effect changes in an individual's role. More specifically, Giddens [24] and Orlikowski [58] described ways in which the implementation and use of ICTs create new ways of working and new forms of organization structure, and affect the individual's role. This takes place in two ways.

First, ICTs mediate the working environment [87] and change the task-related aspects of one's role. For instance, automation of routine information-processing activities enables managers to focus on complex decision-making activities [28]. Second, because organizational tasks are interdependent, changes in individuals' tasks can lead to wider structural changes in formalization, span of control, communication mechanisms, and centralization [29, 43, 44]. This changes the relationships between different roles.

From the above discussions, it is clear that ICTs change organizational roles by transforming tasks as well as social processes [4, 51, 54]. Based on this conceptual background, we next explain how the factors that create technostress can increase role stress by increasing role conflict and role overload.

Technostress Increases Role Stress

There are a number of reasons why conditions that create technostress also increase role stress. First, modern ICTs are complex. Researchers have suggested that complex technologies are associated with role overload because users have to work harder to understand these technologies and use them [5, 53, 78]. Many times applications do not work as expected, and managers make mistakes and have to revisit their tasks often. Further, because ICTs change frequently, employees hardly get accustomed to one kind of application before they are forced to learn another. This results in "skill discrepancy" [59], where existing skills are not sufficient and people spend much of their time learning how to use the new ICTs. All of the accompanying tasks, such as loading or changing software, organizing files, tweaking formats, or experimenting with new features, add to work done that does not address one's direct work requirements [69]. This creates role stress by increasing role overload.

Second, the use of ICTs comes with expectations for greater productivity. Parallel to the introduction of ICTs, there is almost always the effort to create a leaner organization [3]. People are simply expected to work faster and do more in less time. ICTs enable the progress of work to be quantified, such as measuring the time taken to answer one customer service call, recording the amount of information gleaned from customers per minute, or counting the number of items rung up per minute [82]. All of these lead to a relentless and compulsive feeling of being required to accomplish more in less time for fear of negative consequences [7], leading to pressures to work faster and do more. This creates role stress by increasing role overload.

Third, the use of ICTs enables multitasking. Hence, people find themselves working simultaneously on a number of applications associated with different tasks [83]. This leads to a feeling of having to do too many things or solving too many problems at the same time [13]. Excessive multitasking makes it difficult to concentrate on one thing for a reasonable length of time, as thoughts of other unfinished tasks come to mind. This leads to exhaustion. Hence, the greater the extent to which multitasking is attempted, the more time it takes to complete tasks. This results in the perception that there are too many things to be done and not enough time to do them, thus increasing the role overload component of role stress.

Fourth, the use of ICTs enables the extension of the workday. Telecommuting has effectively extended the office hours round-the-clock [14]. Laptops accompany holidays and one often feels, for example, that one has to respond to e-mail or has to work when not at the office, to the extent that not connecting actually becomes disquieting. The workplace therefore extends and intrudes into other areas of life, results in greater workload, and hence adds to role stress.

Fifth, the use of ICTs creates more information than can be effectively handled. In order to find the useful components of official communication, individuals have to spend time and effort in sorting through and managing an endless, and often overwhelming, stream of e-mail, text messages, and voice mail. This means that people spend more time trying to communicate than actually communicating. This adds to the work that needs to be done and results in role stress.

Sixth, given that capabilities of ICTs have increased considerably, the implementation of certain ICTs is accompanied by significant process changes. Increasingly, most applications, such as ERP systems, are bought off-the-shelf and configured to organizational specifics during implementation. Users may not agree with the "best practices" offered by these applications. They feel that they are no longer in control of their roles and work because they are told what to do by the application [7, 38]. Hence they experience role stress through role conflict, and actually often work around the mandates of the system [81].

Seventh, the use of systems such as ERP, customer relationship management (CRM), or business-to-business applications requires integrative perspectives. They create interdependencies, and require interactions and collaborative efforts between different functions within the organization or with partners across organizational and geographic boundaries [84]. This means that people have to understand how other functions and other organizations work. Such integrative thinking goes against traditional practices of "silo management" and there is inevitable conflict based on perspective, culture, and competencies. This increases role stress as a result of increased role conflict, as managers may be required to act against their better judgment.

Eighth, the use of ICTs increases the individual's role set. In general, the pervasiveness of ICTs has increased the overall communication and correspondence that takes place in the organization [23, 73]. This has led to a larger number of individuals participating as information sources in the making of a decision [29], and has enabled activities such as collaborative product development and offshore project management. In the context of globalization and outsourcing, new ICT-enabled organizational forms (such as virtual teams) have emerged [15]. An individual may be part of two or more teams that operate quite differently. One of the consequences of all of this is that the role set of the individual increases. He or she has to process inputs from more people and reconcile a wider variety of opinions. This creates role conflict and increases role stress. Based on the above discussions, we hypothesize that conditions leading to technostress also increase role stress. That is,

Hypothesis 3: Technostress is positively related to role stress.

Research Methodology

This research analyzes the relationships among technostress, role stress, and productivity. For operationalizing technostress, we first identified a broad list of items that create technostress from existing literature. We next established a five-factor structure through exploratory factor analysis of these items. Each of these subfactors forms a specific dimension of technostress. We applied four measures of construct validity to ensure instrument validity for each of the five subfactors—content validity, reliability, unidimensionality/convergent validity, and discriminant validity. In general, content validity ensures that appropriate items are included in the definition of the construct [12], and has to be addressed during the development of the questionnaire. The other dimensions of validity are tested during the analysis of the data.

Role stress, as we discussed earlier, is created due to role conflict and role overload. Two scales have been widely used to measure role conflict and role overload. These are attributed to Rizzo et al. [64], Katz and Kahn [41], and to the stress diagnostic survey [34]. For measuring role conflict, we used the scales from Rizzo et al. [64]. In order to measure role overload, we used the scale developed and validated by Imoisili [33], which is derived from Katz and Kahn [41]. The measurement instrument for user productivity was adapted from the measure for task productivity as developed and validated by Torkzadeh and Doll [77].

We ensured content validity in two ways. First, we used the literature survey findings to identify the initial list of items. We next conducted a prepilot study in which we presented this initial list to a group of end users for them to comment on the validity and meaning of each item. The group included four end users from business organizations and six end users from a university. We analyzed the comments and responses, and found that certain common patterns emerged. Based on these, the measurement items were further revised and made ready for the large-scale data collection phase. All items were measured on five-point Likert scale anchored with "strongly disagree" and "strongly agree." A sixth option of "not applicable" or "I do not know" was also provided.

Data Collection

Data were collected from two public-sector organizations in the United States, both of which had similar client–server PC-based networked systems. Technical support available for users, in terms of help desks, training, and so on, was similar in both places. Support from the organizations was solicited through the head of the IS departments in both organizations. First, 320 e-mails were sent 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. The employees were informed that participation in this study was voluntary and that the confidentiality of their responses would be assured. A total of 264 questionnaires

Table 1. Sample Demographics

	Frequency	Percentage	Cumulative percentage
Panel a. Gender			
Female	181	78	78
Male	40	17	95
Missing	12	5	100
Total	233	100	
Panel b. Education			
High school	37	16	16
Two-year college	45	19	35
Bachelor's degree	108	46	81
Master's degree	33	14	95
Others	10	5	100
Total	233	100	
Panel c. Years of work experience			
1–5	9	4	4
6–10	27	12	16
11–15	31	13	29
16 and above	155	66	95
Missing	11	5	100
Total	233	100	
Panel d. Years in current organization			
1–5	62	27	27
6–10	49	21	48
11–15	39	17	65
15 and above	71	30	95
Missing	12	5	100
Total	233	100	

were picked, of which 233 were returned, representing a response rate of 88.2 percent based on the questionnaires picked and 73 percent based on the total number of e-mails sent. The high response rate is attributable to support by the organizations' top management for this research. Sample demographics are given in Table 1. From this table, it can be seen that the sample is highly dominated by females, 78 percent. It is also noteworthy that most of them are well educated. Ninety-five percent of the respondents have more than five years of work experience and more than 8 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.

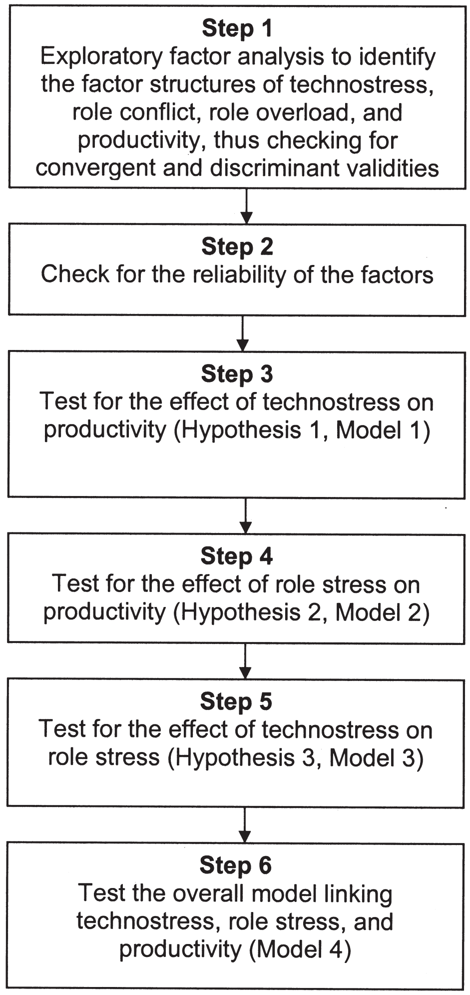

Figure 2. Steps Followed for Analyzing the Data

Data Analysis and Results

We describe below the steps followed during data analysis (also shown in Figure 2). Factor analysis identifies the underlying factor structure and thus provides initial unidimensionality (convergent validity) among the items in a factor. It also provides discriminant validity across factors. There were 39 items that were originally identified for conditions that create technostress, for role overload, for role conflict, and for productivity. We subsequently conducted exploratory factor analysis (EFA) to identify the factor structure of the 39 measurement items. An eight-factor structure was identified. The first five factors described specific reasons why ICTs create stress—that is, described particular contexts in which technostress was created. The next three factors corresponded to role conflict, role overload, and productivity. All items had factor loadings above 0.5, and there was no cross-loading above 0.4. Items I6, I7, and I31

Table 2. Rotated Component Matrix

	Component							
	1	2	3	4	5	6	7	8
I1	0.814							
I2	0.852							
I3	0.840							
I4	0.567							
I5	0.682							
I8		0.610						
I9		0.803						
I10		0.843						
I11		0.599						
I12			0.648					
I13			0.797					
I14			0.648					
I15			0.669					
I16			0.715					
I17				0.631				
I18				0.649				
I19				0.782				
I20				0.752				
I21				0.760				
I22					0.703			
I23					0.853			
I24					0.795			
I25					0.764			
I26						0.569		
I27						0.639		
I28						0.621		
I29						0.757		
I30						0.661		
I32							0.711	
I33							0.805	
I34							0.704	
I35							0.573	
I36								0.848
I37								0.893
I38								0.888
I39								0.877

did not load well on any factor and hence were dropped from further analysis. The results of the factor analysis are shown in Table 2.

After identifying the subfactors, we calculated their reliability. The means, standard deviation, and reliability are shown in Table 3. The reliability values for each subfactor were calculated using Cronbach's alpha, with all results above 0.80, which is well above the recommended minimum value of 0.7 [56]. Based on item contents, the first five subfactors were named techno-overload, techno-invasion, techno-complexity, techno-

Table 3. Reliability Assessment of the Constructs

Technostress creators	Mean	Standard deviation
Techno-overload (reliability = 0.89)	2.97	1.00
I1. I am forced by this technology* to work much faster.		
I2. I am forced by this technology to do more work than I can handle.		
I3. I am forced by this technology to work with very tight time schedules.		
I4. I am forced to change my work habits to adapt to new technologies.		
I5. I have a higher workload because of increased technology complexity.		
Techno-invasion (reliability = 0.81)	1.91	0.77
I8. I spend less time with my family due to this technology.		
I9. I have to be in touch with my work even during my vacation due to this technology.		
I10. I have to sacrifice my vacation and weekend time to keep current on new technologies.		
I11. I feel my personal life is being invaded by this technology.		
Techno-complexity (reliability = 0.84)	2.54	0.83
I12. I do not know enough about this technology to handle my job satisfactorily.		
I13. I need a long time to understand and use new technologies.		
I14. I do not find enough time to study and upgrade my technology skills.		
I15. I find new recruits to this organization know more about computer technology than I do.		
I16. I often find it too complex for me to understand and use new technologies.		
Techno-insecurity (reliability = 0.84)	2.00	0.71
I17. I feel constant threat to my job security due to new technologies.		
I18. I have to constantly update my skills to avoid being replaced.		
I19. I am threatened by coworkers with newer technology skills.		
I20. I do not share my knowledge with my coworkers for fear of being replaced.		
I21. I feel there is less sharing of knowledge among coworkers for fear of being replaced.		
Techno-uncertainty (reliability = 0.82)	3.15	0.80
I22. There are always new developments in the technologies we use in our organization.		
I23. There are constant changes in computer software in our organization.		
I24. There are constant changes in computer hardware in our organization.		
I25. There are frequent upgrades in computer networks in our organization.		

(continues)

Role stressors and productivity	Mean	Standard deviation
Role overload (reliability = 0.78)	3.39	0.81
I26. I often have to do more work than I can handle.		
I27. I am often required to do difficult tasks.		
I28. I often work beyond actual or official working hours.		
I29. I often attend to many problems or assignments at the same time.		
I30. I never seem to have enough time to do my actual work.		
Role conflict (reliability = 0.75)	3.10	0.70
I32. I am often asked to do things that are against my better judgment.		
I33. I often receive an assignment without adequate resources and materials to execute them.		
I34. I often have to bend rules or policy in order to carry out an assignment.		
I35. I often receive incomplete requests from two or more people.		
Productivity (reliability = 0.92)	3.80	0.85
I36. This technology helps to improve the quality of my work.		
I37. This technology helps to improve my productivity.		
I38. This technology helps me to accomplish more work than would otherwise be possible.		
I39. This technology helps me to perform my job better.		

* We had indicated at the beginning of the questionnaire the following: "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, database systems, and application development tools."

insecurity, and techno-uncertainty. The individual items for each subfactor are listed in Table 3. "Techno-overload" describes situations where ICTs force users to work faster and longer. "Techno-invasion" describes the invasive effect of ICTs in terms of creating situations where users can potentially be reached anytime, employees feel the need to be constantly "connected," and there is a blurring between work-related and personal contexts. "Techno-complexity" describes situations where the complexity associated with ICTs 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 ICTs. "Techno-insecurity" is associated with situations where users feel threatened about losing their jobs as a result of a new ICT replacing them, or to other people who have a better understanding of the ICT. "Techno-uncertainty" refers to contexts where continuing changes and upgrades in an ICT unsettle users and create uncertainty for them, in that they have to constantly learn and educate themselves about the new ICTs. For role overload, role conflict, and productivity, the means, standard deviation, and reliability are also shown in Table 3. The reliability values for each variable were calculated using Cronbach's alpha, with all results above 0.75.

For examining the relationship between technostress and productivity, the structural equation modeling (SEM) package AMOS was used. The five subfactors were modeled into a second-order construct—technostress. Technostress was then related to

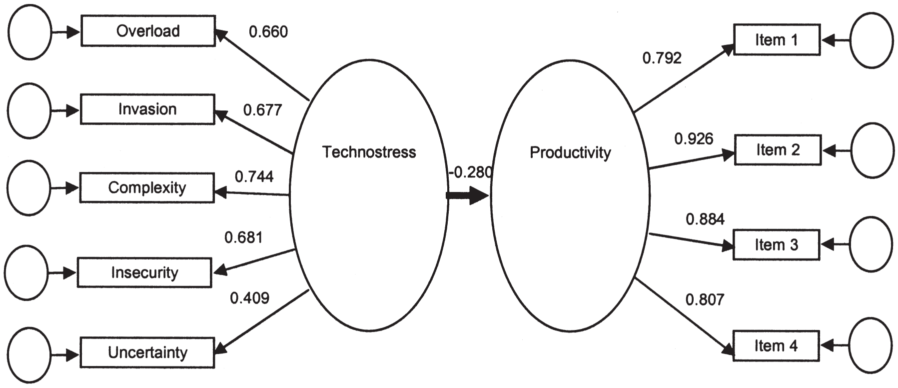

Figure 3. Model 1: Relationship Between Technostress and Productivity

Table 4. Model 1: Relationship Between Technostress and Productivity

Estimates

		Standardized estimates
Productivity	← Technostress	–0.280***
Techno-overload	← Technostress	0.660***
Techno-invasion	← Technostress	0.677***
Techno-complexity	← Technostress	0.744***
Techno-insecurity	← Technostress	0.681***
Techno-uncertainty	← Technostress	0.409***
Item 1	← Productivity	0.792***
Item 2	← Productivity	0.926***
Item 3	← Productivity	0.884***
Item 4	← Productivity	0.807***

Model fit indexes

Chi-square (df)	60 (26)
Chi-square/df	2.31
GFI	0.945
AGFI	0.906
NFI	0.941
NNFI	0.952
CFI	0.965
RMR	0.040

*** $p < 0.01$; based on one-tailed t-test.

productivity. This was named Model 1. The model and results are shown in Figure 3 and Table 4. All model fit parameters were found to be significant, indicating an inverse relationship between technostress and productivity. We discuss below the model fit parameters.

Fit measures can be categorized by three types—absolute, relative, and adjusted (or parsimonious) indexes [49]. Each of the statistical packages provides most of the commonly used fit measures. Absolute fit indexes provide information about how closely the models fit compared to a perfect fit. This can be measured by a χ^2 test, goodness-of-fit index (GFI), and root mean residual (RMR). A low χ^2 value, which would have a p-value greater than 0.05, indicates that the actual and predicted are not significantly different. The goodness of fit ranges from zero to one, with one indicating a perfect fit. Researchers interpret GFI scores in the 0.80 to 0.89 range as representing reasonable fit [17]. A value of 0.90 or higher is considered good [67]. A third index is the RMR [49]. The lower the value of RMR, the better the fit, with a 0.1 or lower indicating good fit [10]. Relative fit indexes, also known as comparative fit indexes (CFI), include normed fit index (NFI), nonnormed fit index (NNFI), and CFI [49]. A recommended value of fit for both NFI and CFI is 0.90 [27]. Good-fitting models generally yield an NNFI value of at least 0.90. Adjusted indexes, or parsimonious fit indexes, look at how a model combines fit and parsimony [49]. One common indicator of parsimony is adjusted goodness-of-fit index (AGFI). A value of 0.80 or higher for AGFI is considered a good fit [67].

Table 4 shows that GFI = 0.945, AGFI = 0.906, NFI = 0.941, CFI = 0.965, and RMR = 0.040, indicating that all fit indexes meet or exceed the recommended values. Table 3 shows the mean values for technostress and productivity scales. From these results, it is clear that there is an inverse relationship between technostress and productivity—that is, lower technostress leads to higher productivity for the individual. H1 is therefore supported. Although the stress literature lists several major sources of job stress, including tasks, management style, interpersonal relationships, roles, and career concerns [14], the role of ICTs in creating stress has not been studied. Similarly, while the influence of job stress on productivity has been well researched, the effect of stress created due to the use of ICTs on productivity has not been studied. Support for H1 clearly shows that lower levels of technostress are associated with higher levels of individual productivity. Therefore, it is desirable for organizations to reduce ICT-created stress experienced by their employees.

For examining the effects of role stress on productivity, we tested the relationship as shown in Model 2. Role stress was modeled as a second-order construct made of role conflict and role overload, as shown in Figure 4. The results from Model 2 are shown in Table 5. The fit indexes have the following values: GFI = 0.93 AGFI = 0.90, NFI = 0.906, CFI = 0.954, and RMR = 0.061. All parameters were found to be significant, indicating an inverse relationship between role stress and productivity. H2 is therefore supported. That is, role stress is inversely related to productivity. This confirms the general stress literature findings that role stress is an important component of job stress and leads to productivity loss [14, 52].

Next, we examined the relationship between technostress and role stress, as shown by Model 3 in Figure 5. The results, in Table 6, show that the fit indexes GFI = 0.918, AGFI = 0.886, NFI = 0.852, CFI = 0.922, and RMR = 0.070. All of the parameters were found to be significant, thus showing support for H3—that is, for the notion that there is a direct relationship between technostress and role stress. The implication of

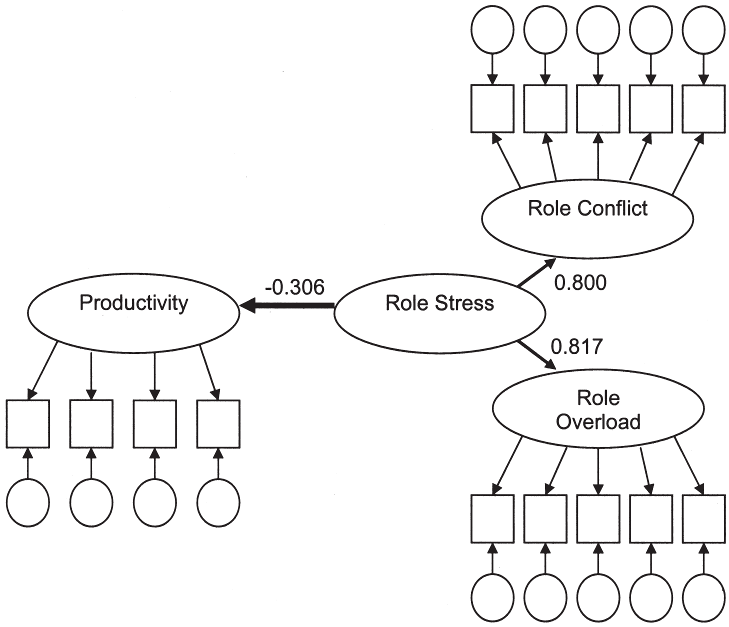

Figure 4. Model 2: Relationship Between Role Stress and Productivity

Table 5. Model 2: Relationship Between Role Stress and Productivity

Estimates

		Standardized estimates
Productivity	← Role stress	–0.306***
Role overload	← Role stress	0.817***
Role conflict	← Role stress	0.800***
Item 1	← Productivity	0.793***
Item 2	← Productivity	0.925***
Item 3	← Productivity	0.884***
Item 4	← Productivity	0.808***

Model fit indexes

Chi-square (df)	136(74)
Chi-square/df	1.838
GFI	0.930
AGFI	0.900
NFI	0.906
NNFI	0.944
CFI	0.954
RMR	0.061

*** $p < 0.01$; based on one-tailed t-test.

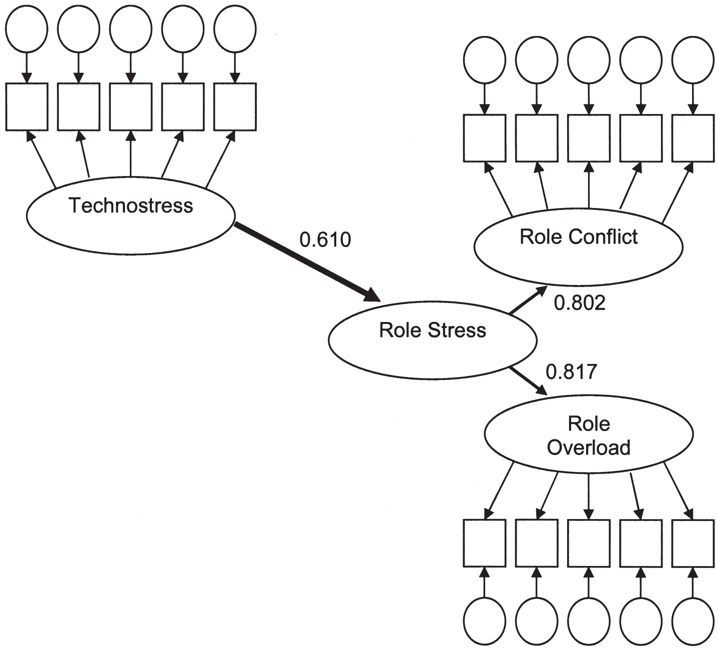

Figure 5. Model 3: Relationship Between Technostress and Role Stress

Table 6. Model 3: Relationship Between Technostress and Role Stress

Estimates

		Standardized estimates
Role stress	← Technostress	0.610***
Role overload	← Role stress	0.817***
Role conflict	← Role stress	0.802***
Techno-overload	← Technostress	0.695***
Techno-invasion	← Technostress	0.668***
Techno-complexity	← Technostress	0.734***
Techno-insecurity	← Technostress	0.701***
Techno-uncertainty	← Technostress	0.384***

Model fit indexes

Chi-square (df)	168(87)
Chi-square/df	1.93
GFI	0.918
AGFI	0.886
NFI	0.852
NNFI	0.906
CFI	0.922
RMR	0.070

*** $p < 0.01$; based on one-tailed t-test.

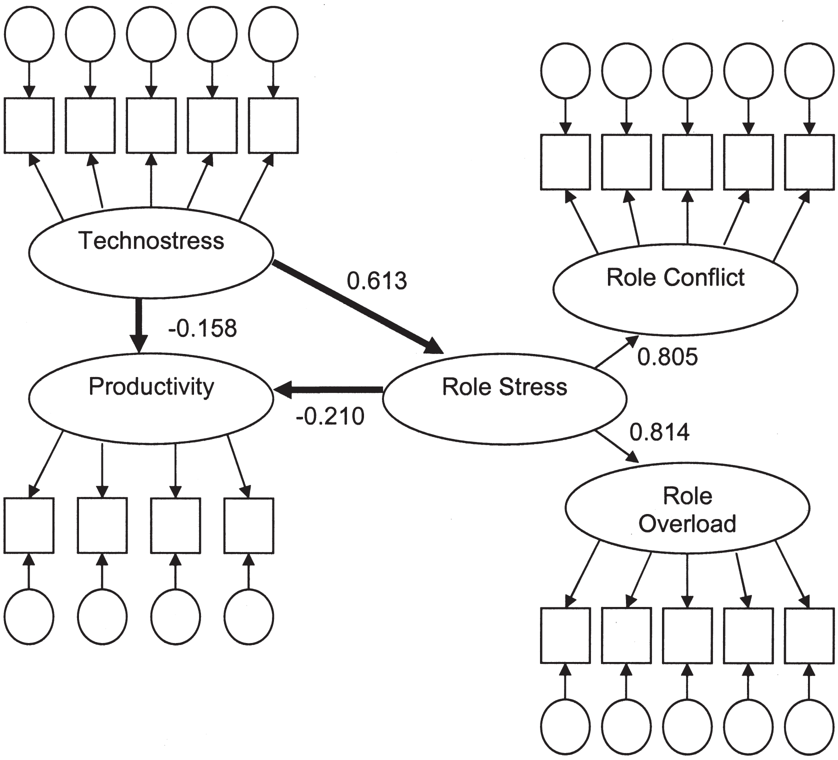

Figure 6. Model 4: Relationships Among Technostress, Role Stress, and Productivity—Indirect Effect of Technostress on Productivity Through Its Effect on Role Stress

H3 is especially important in the present context because modern technologies are dramatically changing the way we work and live. While ICTs make it much easier to share information, users are often overloaded by vast amounts of information, disturbed by the blurring of work time and family time, invaded by losing privacy, and frustrated by the complexity of new technology. In today's technology-intensive work environment, the introduction of new technology often means completing the same amount of work with fewer people and through leaner organization structures. This implies that technology is an important antecedent to role stress, in which context the notion of technostress leading to role stress adds a new and important dimension to the role stress literature, which has so far not considered the effects of ICTs on role conflict and role overload.

Finally, we tested the combined model involving technostress, role stress, and productivity. The resulting Model 4 is shown in Figure 6. The results are shown in Table 7. Table 7 shows that fit indexes GFI = 0.901, AGFI = 0.872, NFI = 0.867, CFI = 0.939, and RMR = 0.063. All fit indexes were better than accepted values, and all estimates and relationships were found to be significant, indicating that the model is valid. That is, based on the mean values from Table 3, lower levels of technostress and role stress lead to higher productivity. At the same time, considering the direct

Table 7. Model 4: Relationships Among Technostress, Role Stress, and Productivity

Estimates

		Standardized estimates
Productivity	← Technostress	–0.158*
Productivity	← Role stress	–0.210**
Role stress	← Technostress	0.613***
Techno-overload	← Technostress	0.701***
Techno-invasion	← Technostress	0.663***
Techno-complexity	← Technostress	0.732***
Techno-insecurity	← Technostress	0.674***
Techno-uncertainty	← Technostress	0.383***
Role overload	← Role stress	0.814***
Role conflict	← Role stress	0.805***
Item 1	← Productivity	0.792***
Item 2	← Productivity	0.927***
Item 3	← Productivity	0.883***
Item 4	← Productivity	0.807***

Model fit indexes

Chi-square (df)	253 (147)
Chi-square/df	1.718
GFI	0.901
AGFI	0.872
NFI	0.867
NNFI	0.929
CFI	0.939
RMR	0.063

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$; based on one-tailed *t*-test.

relationship between technostress and role stress, lower levels of technostress result in lower levels of role stress and hence in eventually higher levels of productivity. Increase of productivity is one of the most common objectives for the adoption of ICTs. Support for Model 4 shows that reducing the technostress not only increases individual productivity but it also decreases role stress experienced by ICT users, thus further increasing productivity through the indirect path as well.

Discussions

Contributions

The evolving, and often reciprocal, relationship between technology and organizational roles and structure has been the subject of much study [4, 58, 79], primarily because of the insights on technology management that can be gained from such investigation. In this paper, we explored this relationship from the perspective of how some of the "dark" effects of ICTs (namely, technostress) can accentuate some of the dysfunctional aspects associated with organizational roles (namely, role overload and role conflict). The paper contributes to the theory of technostress and opens up interesting avenues for future research in this important area.

First, the paper conceptualizes and provides theoretical and empirical shape to the concept of technostress. Although various authors, mostly in practitioner writing, have described various ways in which ICTs can cause stress, a rigorous definition of the creators of technostress has so far been lacking in the literature. The dimensions of technostress, as defined in this paper, add to existing concepts on stress experienced by individuals in organizations. They can be used for further investigation of the organizational effects of technostress such as its possible influence on job satisfaction, job commitment, and innovation.

Second, the paper conceptually explains and empirically validates the relationship between technostress and role stress. Such a relationship adds a new conceptual dimension to the considerable body of work that has investigated the relationship between technology and organizational roles and structure by suggesting that stress caused by technology can increase the existing stress due to aspects of the individual's role. This offers interesting possibilities for further study about the organizational effects of technostress, such as increase in task-related stress [52].

Third, the paper demonstrates that productivity and technostress are inversely related. It is important to note that in this sample, based on the mean values, it can be interpreted that lower technostress results in higher productivity. It is possible that, in a different sample, higher technostress would exhibit lower productivity. This raises interesting issues related to the "productivity paradox" and reinforces the belief that failure to manage the effects of ICT-induced stress can offset expected increases in productivity. This also has implications for future research on possible demographic factors and organizational actions that may moderate the relationship between technostress and productivity.

Limitations and Future Research Directions

Even though every effort has been made to ensure the validity of our research findings, the results should be considered in the light of some limitations. First, the participants of this study selected themselves. Therefore, the analysis is not based on random sampling. This could possibly have a bearing on the findings, in that the participants might have experienced greater technostress and hence were more interested in the study. Second, the measurement instrument for individual productivity is a self-reported scale. Hence, the results actually point to effects of technostress and role stress on perceived individual productivity. We hope that future studies can adopt direct measures of productivity to further validate our findings.

There are a number of ways in which the findings from this study can be extended in future research. First, the relationship between technostress and role stress can be studied in greater detail by distinguishing between "qualitative" role overload and "quantitative" role overload [34]. We expect that technostress would increase qualitative and quantitative overload in varying degrees. Second, professionals in different fields experience stress from different sources. In this context, the stress diagnostic survey (SDS) [34] has been adapted to different contexts and has been used to measure the job stress of professionals in different areas such as nursing and IS [35, 62]. Using the definition of technostress as conceptualized in this paper, SDS would generate interesting and worthwhile possibilities for measuring technostress and job stress experienced by professionals in different fields, such as physicians and teachers. Third, the results can be further refined by analyzing the effects of characteristics such as experience, age, and education on technostress.

Last, the empirical findings in this paper can provide some insights to another important but underdeveloped research area—the occupational stress of IS professionals [32, 46, 76]. Even though the focus of this study is on the technostress of ICT end users of ICTs, the technology-intensive nature of today's work environment is common to both the end-user group and the IS professional group. In fact, the five subdimensions of end-user technostress identified in this study share some common elements with the sources of IS professional stress identified by Lim and Teo [46] and Sethi et al. [71]. Adapting the technostress scale to the IS professional environment and measuring the technostress experienced by IS professionals should be important to effective IS personnel management.

Implications for Managers

The results of this paper should prove interesting for managers in a number of ways. First, a look at the individual factors that create technostress—that is, techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty—reveals the conditions under which users of ICTs experience technostress. This can be used by managers as a diagnostic tool to evaluate the extent to which technostress is present in the organization.

Second, managers need to be aware that appropriate management mechanisms to reduce technostress should be put in place to counter the inverse relationship between technostress and productivity. For instance, training on new ICTs and organizational communication about the need and rationale for their use can serve to reduce technostress and possibly stem the decrease in productivity.

Finally, the link between technostress and role stress suggests that ICTs not only create stress by themselves but also increase the stress associated with the individual's role in the organization. Organizations can therefore partly counter the adverse effects of technostress by implementing strategies that reduce role conflict and role overload. Such strategies could include, for example, regular and extensive communication between members of ICT-enabled virtual teams, so that potential role conflict can be addressed.

Conclusion

Stress arises when a person experiences an inability to fulfill multiple, possibly conflicting, responsibilities or to deal with the level of difficulty and complexity of tasks on hand. This frustration often translates into physical illness, fatigue, and mental disorders that eventually lead to excessive absenteeism, turnover, and decreased performance on the job. According to estimates by the American Institute of Stress, job stress costs U.S. industries over $300 billion annually as a result of lower productivity, accidents, absenteeism, and employee turnover [66].

We believe that one important reason for this high stress level in U.S. workers is the widespread adoption of advanced ICTs at workplaces. This paper shows that the use of ICTs can cause technostress in five distinctive ways, which include technology-imposed information and work overload, technology invading personal life and privacy, inability to deal with technology complexity, technology threatening job security, and fear of technology uncertainty. ICT users may be subject to one or more of the above technostress creators, which collectively determine their technostress level.

To conclude, this paper explores the dual nature of the introduction of ICTs from the point of view of technostress that is caused by ICT use. It establishes that failure to reduce technostress experienced by individuals can offset expected gains in productivity. It can also accentuate the effects of stress that they experience from their organizational roles. The findings extend existing ideas on the relationship between technology and organizational roles, and point to possible organizational strategies for yet another aspect of managing the implementation and use of ICTs. Given the ever increasing complexity and ubiquity of modern ICTs, we believe that this paper identifies critical issues that organizations must address in order to facilitate appropriate individual adjustments toward more effective utilization of ICTs.

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