The effects of technostress within the context of employee use of ICT

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ABSTRACT

The main purpose of the present study is to help managers cope with the negative effects of technostress on employee use of ICT. Drawing on transaction theory of stress (Cooper, Dewe, & O’Driscoll, 2001) and information systems (IS) continuance theory (Bhattacherjee, 2001) we investigate the effects of technostress on employee intentions to extend the use of ICT at work. Our results show that factors that create and inhibit technostress affect both employee satisfaction with the use of ICT and employee intentions to extend the use of ICT. Our findings have important implications for the management of technostress with regard to both individual stress levels and organizational performance. A key implication of our research is that managers should implement strategies for coping with technostress through the theoretical concept of technostress inhibitors.

1. Introduction

The purpose of this paper is to enhance the understanding of how managers can cope with the negative effects experienced by their employees due to the use of information and communication technology (ICT) at work. We focus, particularly, on what managers can do in order to influence employee willingness to extend the use of ICT.

The following downsides of ICT are well known to most employees: “you can’t find the latest version of a document you saved yesterday”, “you are continuously interrupted from tasks to answer urgent email and voicemail messages”, “the job tasks you missed at work are easily accessible from home in the evening”, “your smart phone disturbs you with notifications during a meeting with a customer”, and so on. An unmanageable amount of these situations in an organizational context may be associated with negative stress and may, in the long-run, be a source of health-related problems among employees (Tu, Wang, & Shu, 2005). Negative psychophysical effects of the use of ICT at work are usually termed technostress by IS-researchers. Technostress can generally be defined as the mental stress that employees experience due to the use of ICT at work (Weil & Rosen, 1997), for example, when they are asked to learn and use a new technology.

Based on present research efforts focusing on technostress, we know today that extreme technostress can result in job burnout, job dissatisfaction and even an intention to quit (Tu et al., 2005). However, we have limited knowledge of how technostress influences underlying factors such as employee satisfaction with the use of ICT and their willingness to extend the use of ICT at work. In the absence of such understanding, the actions of managers and IS professionals that wish to implement ICT-related measures against technostress may be partially blinded.

This paper is a response to recent calls for research to enhance the understanding of how technostress may influence the employees’ ICT-related psychological strain and organizational performance. We agree with Wang, Shu, and Tu (2008) and Tu et al. (2005) that managers must take practical measures to cope with technostress. Our study extends their research on the influences of the internal environment on technostress levels in two ways: we focus on specific measures to reduce technostress, and we include factors from the research on information systems (IS) continuance (Bhattacherjee, 2001) as dependent variables. For our study, we have chosen the dependent variables: user satisfaction and continuance intentions. These variables are considered strong predictors of organizational benefits accruing from the use of ICT (Bhattacherjee, 2001; DeLone & McLean, 2003).

In addition to testing the effect of technostress on ICT use variables, we have responded to a call for research from Ragu-Nathan, Tarafdar, Ragu-Nathan, and Tu (2008: 430) to use formative modelling to identify technostress creators and inhibitors. We believe that formative modelling is more consistent with the conceptual nature of technostress creators and inhibitors as these variables...
have been measured in previous research\footnote{It should be noted that Detmar Straub (cf. Petter, Straub, & Rai, 2007) initiated the idea of modelling Ragu-Nathan et al. (2008) measuring instrument as formative in a research seminar in 2011, where Straub was an opponent on an early draft of the present paper.}. The practical implication of formative modelling is that it allows us to identify the technostress creators and inhibitors that contribute most to employee dissatisfaction/satisfaction with ICT. In turn, such knowledge can be used to advise managers to implement specific measures to increase employee levels of satisfaction with ICT.

As indicated above, we have chosen “employee satisfaction with ICT use” and “employee intentions to extend the use of ICT” as dependent variables. In contrast to Ragu-Nathan et al. (2008), who chose “job satisfaction” as the core strain variable, our strain variable is linked direct to the employees’ satisfaction/dissatisfaction with their current use of ICT at work. We believe this difference is important because employees may be satisfied/dissatisfied with their current job situation for many reasons other than their use of ICT tools. Our outcome variable “intentions to extend the use of ICT” indicates employee willingness, not only to extend the use of current ICT tools, but also willingness to learn new tools.

Summarized, the main purpose of the present paper is to investigate direct and moderating effects of technostress variables on employee use of ICT at work, particularly in order to identify specific measures to cope with negative effects of technostress, both to support the employees and to improve organisational performance. An important related sub-goal is to demonstrate that technostress creators and inhibitors as they have been measured in previous research should be treated as formative variables. To our knowledge, a technostress study has not been conducted on specific IS continuance constructs. Furthermore, no studies have modelled technostress creators and inhibitors as formative second order variables.

The rest of this paper is organized as follows: the next section elaborates on the phenomenon of technostress and on creators and inhibitors of technostress. Then, we present arguments for the chosen research model and the hypotheses. In the fourth section we describe the research methodology and data analysis techniques that were utilized to test the research model. The fifth section presents the results, and the paper concludes with a discussion of implications for theory and practice, limitations, and suggestions for further research.

### 2. Transaction theory perspective on technostress

When examining technostress and factors that create and inhibit such stress in organizations, recent studies have relied mainly on the transaction theory of stress; see, for example, the papers by Al-Fudail and Mellar (2008) and Ragu-Nathan et al. (2008). This theory is rooted in a cognitive paradigm where stress emerges through a phenomenological process reflected in the relationship between the individual and the demands placed by the environment (Ayagari, Grover, & Purvis, 2011). In connection with use of ICT, this means that stress arises when e.g. ICT competence requirements exceed the users’ actual competence level, thereby threatening user well-being. This overall transactional process, where demands placed by the environment exceed individual resources, is referred to as stress (Ayagari et al., 2011).

The transaction theory consists of four major components (Cooper, Dewe, & O’Driscoll, 2001): stressors, situational factors, strain and outcomes. Stressors are, in general, all of the conditions, events, demands or stimuli in an environment with a potential to create stress. Typical examples of stressors in connection with an employee’s use of ICT include frequent changes in work habits and a feeling of one’s personal life being invaded by job email, job SMS and business-oriented social networking sites. Situational factors are organizational mechanisms that can buffer or reduce the impact of stressors. In connection with ICT usage, such factors might typically be user participation in change processes and computer training. Strain refers to psychological and behavioural responses to stressors that are observed in employees that utilize ICT in work environments. Such responses can typically constitute a combination of high levels of discomfort, exhaustion and a distant attitude toward ICT use (Salanova, Llorens, & Cifre, 2013). We propose employee dissatisfaction with ICT use as an important strain variable in connection with employee use of ICT at work. Dissatisfaction can be classified as a mental state that reflects the perception of the use of ICT as a threat, and the perception of a lack of control over its consequences (Beaudry & Pinsonneault, 2010). Finally, the outcome component refers to potential outcomes of strain, such as absenteeism and turnover. We propose employee intentions to extend the use of ICT as an important outcome variable in connection with employee use of ICT at work. Intentions to extend the use of technology deal with users’ postadoptive intentions (Jasperson, Carter, & Zmud, 2005), and therefore, a user’s willingness to continuously exploit and extend the functionality built into ICT applications. Both the variable satisfaction with ICT use (i.e. strain) and the variable usage intentions (i.e. an outcome) are among the most widely used measures of information systems success (DeLone & McLean, 2003).

The present study is based on the transaction theory of stress, with a focus on stressors, situational factors, strain and outcome. In recent IS research, stressors are termed technostress creators, and situational factors are called technostress inhibitors (Ragu-Nathan et al., 2008; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2011; Wang et al., 2008); therefore, these concepts will be used in the following. Strain will be used interchangeably with “employee dissatisfaction with ICT” and outcome interchangeably with “employee intentions to extend the use of ICT”. The next two sections elaborate on the phenomena of technostress creators and inhibitors.

#### 2.1. Technostress creators

Ragu-Nathan et al. (2008) described technostress as a problem of adaptation resulting from an employee’s inability to cope with or to become used to ICT. The phenomena that create this potential ICT adaptation problem are referred to as technostress creators. Stated differently, technostress creators refer to ICT circumstances or factors that have the potential to create ICT and job-related strain outcomes among employees in an organization. Examples of such creators include frequent software and hardware updates, continuous information overload and expectations of constant connectivity. Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan (2007) conceptualized technostress creators as consisting of five main categories or components:

- **Techno-overload** refers to ICT’s potential to drive an employee to work faster.
- **Techno-invasion** refers to ICT’s potential to invade an employee’s personal life with possibilities to, for example, perform job tasks.
- **Techno-complexity** refers to an inherent quality of ICT that makes employees feel incompetent.
- **Techno-insecurity** refers to the premise that ICT’s nature is to change regularly, and that this may threaten employee job security.
- **Techno-uncertainty** refers to the constant changes and upgrades of software and hardware that may impose stress on employees.
Each of these five components has the potential to increase strain-related ICT outcomes for employees. For a more in-depth understanding of each of these five components, see Tarafdar et al. (2007).

2.2. Technostress inhibitors

Inhibitors refer to mechanisms that have the potential to reduce employee levels of ICT and job-related strain outcomes. Examples of such mechanisms are end user training, technical support and user participation in the planning and implementation of new ICT solutions. Ragu-Nathan et al. (2008) conceptualized technostress inhibitors as consisting of three main categories or components:

- **Technical support provision** refers to support mechanisms in the sense of institutionalized support (e.g., providing a help-desk).
- **Literacy facilitation** refers to mechanisms that increase employee levels of ICT literacy (e.g., establishment of a close relationship with the IS department and encouragement of ICT knowledge sharing among co-workers).
- **Involvement facilitation** refers to mechanisms that strengthen employee engagement in new technology (e.g., incentive systems connected to usage and participation in process changes).

Each of these three mechanisms has the potential to reduce the effect of technostress creators on strain-related ICT outcomes for employees. For a more in-depth understanding of each of these three mechanisms, see Ragu-Nathan et al. (2008).

3. Research model and hypothesis development

As emphasized in the previous section, the present study builds on the transaction theory of stress, together with previous research efforts on technostress (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2007). Fig. 1 shows our conceptual research model.

According to the transaction theory of stress, technostress creators are expected to increase strain for the employees, and technostress inhibitors are expected to decrease strain (McGrath, 1976). To conceptualize strain and the outcome variable in the context of ICT usage, we have chosen to utilize core variables from DeLone and McLean (2003) and Bhattacherjee (2001): user satisfaction and continuance intentions.

Based on McGrath’s (1976) description of workplace stress, we expect the technostress creators to represent “an environmental situation that is perceived as presenting a demand which threatens to exceed the person’s capabilities and resources for meeting it”. Technostress creators could put a pressure on employees, who could exceed their capabilities for meeting this pressure, and the results may include an increase in their strain level. We propose that employee dissatisfaction with the use of ICT is a strain variable (Tarafdar, Tu, & Ragu-Nathan, 2010: 306) of particular importance in connection with technostress, because dissatisfaction with ICT use may lead to underutilization and/or inefficient use (Brown, Massey, Montoya-Weiss, & Burkman, 2002). Stated more specifically, employees that experience a high level of technostress creators in their environment are expected to end up being dissatisfied ICT users. Tu et al. (2005) asserted the latter when they described extreme stress in connection with ICT usage as a phenomenon that can result in dissatisfaction among employees. Moreover, Tarafdar et al. (2011) found, in an empirical study of technostress, that technostress creators had direct effects on end user satisfaction. It seems reasonable to assume that technostress creators have a negative impact on employee satisfaction with the use of ICT. Thus, we hypothesize:

**H1.** Employee perceptions of the existence of technostress creators in their organizational environment are negatively associated with their level of satisfaction with ICT use.

In the most general case, the transaction theory of stress predicts technostress inhibitors to decrease individual strain levels. In the context of ICT usage among employees, technostress inhibitors represent supportive mechanisms. These mechanisms are also described as facilitating conditions in the IS literature, and refer to individual perceptions of the availability of resources (e.g., knowledge, instruction and assistance) that can remove barriers to using a system (Venkatesh, Thong, & Xu, 2012). Tarafdar et al. (2011) support this assumption in a study of technostress, where they found that the presence of inhibiting mechanisms generally increased IS use related outcomes (e.g., user productivity and user innovation). Moreover, Chan et al. (2010) found in an empirical study of satisfaction with e-government technology that facilitating conditions had direct effects on user satisfaction. Similarly,

![Fig. 1. Conceptual model.](image-url)
in an empirical study of consumer behavioural intentions to use ICT, Venkatesh et al. (2012) found that facilitating conditions influenced behavioural intentions. Therefore, we hypothesize:

H2. Employee perceptions of the existence of technostress inhibitors in their organizational environments are positively associated with their level of satisfaction with ICT use.

H3. Employee perceptions of the existence of technostress inhibitors in their organizational environments are positively associated with their level of intention to extend their use of ICT.

As shown by the dotted line in Fig. 1, we also expect technostress inhibitors to moderate the relationship between technostress creators and employee satisfaction with use of ICT. Both the work stress literature (Cooper, Dewe, & O’Driscoll, 2001) and the IS literature (Ragu-Nathan et al., 2008) assert that technostress inhibitors reduce the effect of technostress creators on strain outcomes. Studies within organizational behaviour have confirmed that stressors (i.e. technostress inhibitors) may have a moderating influence on the relationship between situational factors (i.e. technostress creators) and strain (e.g. Van der Doef & Maes, 1999). However, empirical findings are conflicting (Cooper, Dewe, & O’Driscoll, 2001). Ragu-Nathan et al. (2008) found no support for the moderator effect of technostress inhibitors. On the other hand, Koo and Wati (2011) found that the influence of task complexity on technostress was moderated by literacy facilitation. Therefore, there are good reasons to investigate this relationship further, especially since the presence of this interaction effect is a natural element in the transaction-based model of stress (Cooper, Dewe, & O’Driscoll, 2001), and we present the following hypothesis:

H4. Employee perceptions of the existence of technostress inhibitors in their organizational environments moderate the relationship between technostress creators and satisfaction with the use of ICT.

As shown in Fig. 1, employee intentions to extend the use of ICT are the main outcome variable in the present study. The phrase “intention to extend the use” emphasizes our focus on employee willingness to extend the use of available ICT solutions, and employee willingness to adopt new ICT solutions in the future. Both the IS success model (DeLone & McLean, 2003), and the IS continuance theory (Bhattacherjee, 2001) assert that the intention to utilize ICT is mainly determined by satisfaction with prior IS use. The basis for hypothesizing this relationship is our conceptualization of satisfaction as synonymous with an affect (a positive, indifferent, or negative feeling; Bhattacherjee, 2001: 355), and furthermore, that affects in general (i.e. as attitudes toward something or satisfaction with something) in prior IS studies have been found to be an important predictor of intentions concerning the use of IS (Liu, Liao, & Pratt, 2009). This leads to the following hypothesis:

H5. Employee satisfaction with the use of ICT in connection with their job tasks is positively associated with their intentions to extend their use of available and new ICT.

4. Methods

One medium-sized local government administration in Norway was chosen as our setting. Since the entire government administration sector in Norway has been subject to comprehensive and continuous ICT-based change processes during the last decade, we expected the phenomenon of technostress to be present in this context. The employees in the actual government administration utilized a wide variety of computerized tools, from traditional office systems to more specialized task-specific systems, such as financial management and applications processing tools. The data used to test the research model were obtained using an electronic questionnaire distributed by email to approximately 400 employees. One reminder was sent to the respondents who did not answer within one week. The items used to operationalize the variables in Fig. 1 were adapted from prior studies, with a few changes in wording reflecting the specific context of our respondents.

Instruments on technostress creators and inhibitors were adapted from Ragu-Nathan et al. (2008), and employee satisfaction with ICT use and the intention instruments were adapted from Bhattacherjee (2001). All items, except the satisfaction items, were measured using a seven-point Likert-type scale, ranging from “strongly disagree” to “strongly agree”. Satisfaction items were based on seven-point semantic differential scales.

The data collection period was 30 days, and 216 responses out of approximately 400 were registered, which gave a response rate of 54%. Our sample included 71% women and 29% men, and the average respondent was 46 years old (19% below 35, 58% between 35 and 55, 23% above 55). In addition, 71% of the respondents held a university and/or a college degree, 26% had a high school education, and 3% had a primary school/junior high education.

5. Data analysis

We employed covariance Structural Equation Modelling (SEM) as our analysis approach and utilized the tool Mplus (version 6.11). We utilized the tool Mplus since it is suitable for testing formative measurement scales, second order concepts and also moderator effects (see e.g. the web forum Mplus Discussion).

Before the data was analyzed with Mplus we tested all the measured variables for common method bias. The extent of common method bias was assessed with Harman’s one-factor test, which was performed by including all items in a principal components factor analysis (Podsakoff et al., 2003). Evidence for common method bias exists when one factor accounts for most of the variance (i.e. explained variance >50%). The specified “one factor” explained 15% variance, and hence, the data do not indicate evidence of common method bias.

5.1. Formative or reflective variables?

As a first step in the evaluation of the measurement instruments, it is important to consider whether the observed variables can be characterized as reflective or formative (Bollen & Lennox, 1991). Jarvis, MacKenzie, and Podsakoff (2003) pointed out that latent variables should be treated as formative if the following rules hold: the nomological net of indicators differs, they are not expected to correlate and the direction of causality is from indicators to the latent variable. Constructs should be modelled as reflective if the opposite conditions apply. Accordingly, these decision rules suggest that the variables “user satisfaction”, “usage intention” and “uncertainty” should be modelled as latent constructs with reflective indicators. The variables technostress creators and inhibitors should, however, be modelled as composite latent constructs with formative indicators.

Literacy facilitation provides a good example of how we have uncovered the formative item-logic in a measurement instrument. One of the items states that “Our organization encourages ICT knowledge sharing to help others deal with new ICT solutions”, while another item in the same pool states that “Our organization fosters a good relationship between the IT department and end-users”. The core
question is: Do these items operate conceptually independently of each other, or are they expected to correlate? Our answer is that they basically operate independently and are not expected to correlate. They have, however, conceptual unity in the concept of literacy facilitation. Therefore, these items should be viewed as a particular form of formative indicators, namely causal indicators, and not as composite indicators (Bollen, 2011).

The only exception from this formative logic is the items belonging to the first order concept uncertainty, where the items operate independently of each other, and hence, are expected to correlate. The items belonging to the concept uncertainty should therefore be treated as reflective/impact indicators.

In addition to being formative variables, technostress creators and inhibitors are hierarchical constructs, or so-called second order constructs, since they are composed of sub-dimensions or so-called first order constructs (Fig. 1).

Modelling technostress creators and inhibitors as formative constructs means that the indicators determine the first order constructs; and further, that first order constructs determine the second order constructs. Two different creators, i.e. techno-invasion and techno-insecurity, provide a good example of how we have uncovered the formative logic of the first order constructs. Employees' perceived levels of the techno-invasion of their leisure time are not conceptually related to employees' perceived levels of the techno-insecurity in their job. Therefore, we should perceive these two constructs to operate as independent causes of technostress creators, and they are formative by definition. Day, Paquet, Scott, and Hambley (2012) support our formative modelling approach when they classify ICT demands (information overload, expectations to be available 24/7, etc.) as formative indicators of an ICT demand construct in their study of technostress.

It follows from the above discussion, that the seven formative out of eight technostress creator and inhibitor instruments cannot rigidly be tested for internal consistency and reliability (Bollen & Lennox, 1991).

5.2. Measurement model results

The literature suggests that formative constructs can be investigated for validity by evaluating three different conditions. First, Jarvis et al. (2003) argued that formative constructs require a census of all of the indicators that form the entire construct. Second, both measures and dimensions should be tested for measurement quality, by assessing the multicollinearity and path weights (Gotz & Liehr-Gobbers, 2004). Third, Bollen and Lennox stated: “...to assess validity we need to examine other variables that are effects of the latent construct” (Bollen & Lennox, 1991: 312). The second condition is analyzed in the next section, while adhering to the first and third conditions means paying attention to (1) a census of the included items and (2) nomological and/or criterion-related validity (Jarvis et al., 2003). The criterion of census was addressed in the questionnaire pre-test procedures, where ten employees were invited to evaluate the two formative instruments and asked to suggest other relevant issues that could create or inhibit the level of perceived technostress. It turned out that the items in our instruments seem to cover actual creators and inhibitors. Criterion-related validity is addressed in the Structural Equation Modeling (SEM) analysis when testing the explanatory power of the creators and inhibitors within the proposed research model.

The adequacy of the reflective variables (cf. uncertainty, satisfaction, intention and usage) in the proposed research model can be determined by looking at: (1) the individual item reliabilities, (2) the convergent validities of measures associated with individual variables, and (3) the discriminant validity between variables and items (Hulland, 1999) (see Section 5.2.2).

5.2.1. Measurement quality of formative instruments

The indicators for the seven formative creator and inhibitor variables were assessed for measurement quality using the variance inflation factor (i.e. a test of multicollinearity), path weight and significance of indicators. Multicollinearity was first assessed using SPSS to generate the variance inflation factor (VIF) by regressing indicators on their respective creator and inhibitor variables. The VIF ranged from 1.15 to 3.22, the latter being slightly below the 3.33 threshold recommended by Diamantopoulos and Sigauw (2006). There were, however, only three indicators out of 32 that had a VIF value above 3.0; therefore, we concluded that multicollinearity does not seem to be a problem at the indicator level. With regard to the seven first order dimensions, the VIF ranged from 1.25 to 2.27, which is well below the 3.33 threshold.

After assessing multicollinearity, we examined the path weights and significance level. Table 1 shows the weights for the indicators that belong to the seven formative first order latent composites. As we can see from Table 1, 19 out of 25 first order formative indicators have significant weights. In addition, all first order composites have at least two significant indicators. As opposed to reflective indicators, formative indicators should not necessarily be eliminated because of an insignificant contribution (Diamantopoulos, 2011). There are two viewpoints on this issue in the literature, one recommending that indicators should never be eliminated, and one suggesting that indicators could be removed when they are found to be inadequate (Bollen, 2011). We have chosen the latter approach and utilized the model modification indices in Mplus to identify inadequate indicators. This is a more valid approach when formative indicators are classified as causal rather than composite, since causal indicators (in some sense) are more interchangeable than composite indicators (Bollen, 2011).

Eleven out of 25 formative indicators were dropped based on the reported model modification indices in Mplus (cf. items marked with an asterisk in Table 1). This means that the dropped formative items showed a significant degree of shared non-specified variance among the measurement items. In addition, six out of the eleven dropped formative items were non-significant.

5.2.2. Measurement quality of reflective instruments

As Table 1 shows, all reflective constructs have reliability values that exceed the threshold value of 0.70 recommended by Nunnally (1978). For four out of the 12 indicators, the loadings were below 0.7. In practice, it is common to find several measurement items in an estimated model having loadings below the 0.7 threshold, especially when relatively new indicators are employed, as is the case here (e.g. the technostress-uncertainty instrument) where a more suitable lower cut-off value is considered sufficient in SEM analyses (Hulland, 1999). We chose to apply a cut-off value of 0.65 on the factor loadings to retain items. The result was that two indicators had to be dropped, one from techno-uncertainty and one from intentions to extend the use of ICT (cf. items marked with an asterisk in Table 1). In addition, one item was dropped from the satisfaction instrument based on reported model modification indices in Mplus. All retained measures had significant loadings. Accordingly, the reflective measurement instruments show acceptable psychometric qualities and, therefore, indicate a satisfactory level of convergent validity or internal consistency.

The discriminant validity of the reflective indicators and variables was examined using both factor (cf. Table 2) and correlation (cf. Table 3) analyses.

It can be seen in Table 2 that no items have higher cross loadings than factor loading on their respectively assigned latent variables. In addition, all items have cross loadings that are at least 0.10 lower than the factor loading on their respectively assigned latent variables, suggesting that discriminant validity at the item level is met for all three reflective first order constructs.
The inspection of discriminant validity among variables is based on the squared correlation between the variables and their respective average variance extracted. As Table 3 shows, the average variance extracted value for the variables is consistently larger than the off-diagonal squared correlations, suggesting satisfactory discriminant validity among reflective first-order variables.
5.3. Results

5.3.1. Structural model
To model the formative indicators and second order constructs, we followed the guidelines provided by Muthen and Muthen on the Mplus discussion web page. This implies that each formative composite was established through the use of one reflective and a minimum of two formative indicators.

Fig. 2 summarizes the structural model results from the SEM analysis. Standardized regression coefficients are shown in connection with each path, and the $R^2$ is shown in conjunction with endogenous variables. All path coefficients show significant associations with endogenous variables; therefore, we conclude that hypotheses H1, H2 and H5 are supported, while H3 and H4 are not supported. As Fig. 2 shows, the Mplus analysis documents relatively moderate levels of explained variance. We assert, however, that the levels of explained variance (22% and 10%) are sufficiently high to indicate that the proposed theory has explanatory power.

The fit indices from the SEM analysis are shown in Table 4. We applied the following threshold values to assess the reported model fit indices: the $\chi^2$ statistic should be insignificant with a $p$-value above .05, the ratio of $\chi^2$ to degrees of freedom should be smaller than 3:1, the root mean square error of approximation (RMSEA) should be lower than 0.06, the comparative fit index (CFI) should be greater than 0.90, the Tucker–Lewis index (TLI) should be greater than 0.90 and the standardized root mean square residual (SRMR) should be lower than 0.08. As shown in Table 4, three out of six fit indices were within the acceptable range for the initial measurement model, while five out of six were within the acceptable range for the final structural model. Based on these results, we conclude that the proposed structural model (cf. Fig. 2) shows a reasonably good fit.

5.3.2. Results mediation effects
The Sobel test of mediation was utilized to test the mediation effects of technostress creators and inhibitors on employee intentions to extend the use of ICT. Both of the effects turned out to be significant; i.e. the mediation effect of the creators was $-0.37$ ($p < 0.001$), and the mediation effect of the inhibitors was $0.06$ ($p < 0.05$).

5.3.3. Results moderating effect
To test for a moderating effect of technostress inhibitors on the relationship between technostress creators and user satisfaction, we utilized the interaction command in Mplus (cf. XWITH) and the procedure recommended by Fürst and Ghisletta (2009). The results did not support a moderating effect, therefore H3 is rejected.

5.3.4. Control variables
As a test of the robustness of our findings, five control variables (i.e. age in years, gender, educational level, average hours per workday with ICT-use, and number of ICT-courses) were included as supplementary predictors of technostress inhibitors and creators in addition to user satisfaction and employee intentions to extend the use of ICT. Particularly, the variable gender is of interest in this connection, since gender is shown by previous research to

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Table 2
Discriminant validity: Cross-loadings reflective items.

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Uncertainty</th>
<th>Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sat2</td>
<td>0.90</td>
<td>0.03</td>
</tr>
<tr>
<td>Sat3</td>
<td>0.86</td>
<td>0.09</td>
</tr>
<tr>
<td>Sat4</td>
<td>0.85</td>
<td>0.06</td>
</tr>
<tr>
<td>Unc1</td>
<td>0.07</td>
<td>0.84</td>
</tr>
<tr>
<td>Unc2</td>
<td>0.12</td>
<td>0.88</td>
</tr>
<tr>
<td>Unc4</td>
<td>0.12</td>
<td>0.84</td>
</tr>
<tr>
<td>Int1</td>
<td>0.23</td>
<td>0.12</td>
</tr>
<tr>
<td>Int2</td>
<td>0.25</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Table 3
Discriminant validity: First order reflective constructs.

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Uncertainty</th>
<th>Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Uncertainty</td>
<td>0.07</td>
<td>0.60</td>
</tr>
<tr>
<td>Intention</td>
<td>0.26</td>
<td>0.13</td>
</tr>
</tbody>
</table>

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Table 4
Mplus reported model fit indices.

<table>
<thead>
<tr>
<th>fit indices</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\chi^2$/df</th>
<th>RMSEA</th>
<th>CFI</th>
<th>TLI</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial model</td>
<td>1028.9 ($p &lt; .000$)</td>
<td>637</td>
<td>1.62</td>
<td>0.053</td>
<td>.83</td>
<td>.82</td>
<td>.072</td>
</tr>
<tr>
<td>Final model</td>
<td>487.8 ($p &lt; .000$)</td>
<td>313</td>
<td>1.56</td>
<td>0.051</td>
<td>.91</td>
<td>.90</td>
<td>.077</td>
</tr>
</tbody>
</table>
influence ICT-related variables (Bao, Xiong, Hu, & Kibelloh, 2013; Hong, Chiu, & Huang, 2012; Kay & Lauricella, 2011; Kibelloh & Bao, 2013). The inclusion of these control variables resulted only in a minor increase or decrease in the coefficients that are reported in Fig. 2 (cf. Appendix). This insignificant change in the coefficients supports the internal validity of our findings. Moreover, the control variables age, average hours per workday with ICT-use, and number of ICT-courses had a significant relationship with the latent variables in Fig. 2 (cf. Appendix). This indicates e.g. that age is a significant antecedent of how employees perceive the presence of technostress creators and inhibitors.

6. Discussion

6.1. Contribution of the present study

This paper contributes to an enhanced understanding of the phenomenon of technostress and its effects in the following ways:

We developed and tested a model of how technostress creators and inhibitors influence employee use of ICT in connection with their job tasks. The results of our SEM analysis showed support for a transaction based model of technostress that included employee satisfaction with ICT use and willingness to extend ICT usage. Our study links the effects of technostress creators and inhibitors closely to the employees’ use of ICT at work. We believe such a linkage is important to enhance the understanding of the effects of technostress on user behaviour, and furthermore, how managers should handle technostress.

We investigated the use of formative modelling to identify technostress creators and inhibitors. Our reason for doing this was based on our evaluation of the measurement instruments by Ragu-Nathan et al. (2008) as formative in nature. The result of our formative modelling with Mplus indicated that it is valid to specify both technostress creators and inhibitors (as they were originally specified by Ragu-Nathan et al., 2008) as formative variables, and more specifically, as causal indicators (cf. Bollen, 2011). However, there are two exceptions: The first is the variable “uncertainty”, which we evaluated to be reflective. The second is the formative variable “invasion” that turned out to have an insignificant coefficient with the internal validity of our findings. Moreover, the control variables age, average hours per workday with ICT-use, and number of ICT-courses had a significant relationship with the latent variables in Fig. 2 (cf. Appendix). This indicates e.g. that age is a significant antecedent of how employees perceive the presence of technostress creators and inhibitors.

6.2. Practical implications

A key implication of this research for managers is that they should implement strategies for coping with technostress through the theoretical concept of technostress inhibitors. The present study indicates that traditional measures, such as a help desk, end-user training and user participation, are effective technostress reducing mechanisms. However, the study also indicates that managers should actively encourage employees to try out new ICT, and reward employees for using new ICT (cf. involvement facilitation). In addition, managers should emphasize teamwork and encourage ICT knowledge sharing (cf. literacy facilitation).

The technostress instruments used in the present research could be utilized by managers to identify potential technology-related sources of negative stress among employees in their organizations. For example, high average scores on items such as: “I cannot find enough time to study and upgrade my ICT skills,” and “I feel there is less sharing of ICT knowledge among co-workers in fear of being replaced” indicate that actions should be taken to help employees upgrade their ICT skills and to encourage ICT knowledge sharing. Actual measures may be to provide personal training, relieve employees of some of their work when introducing new systems, and organize user experience seminars.

6.3. Limitations

The present research has limitations. The response rate was 54% and this may have produced a “non-response bias”, i.e. due to possibility that the answers of respondents differ from the potential answers of those who did not answer. The average response rates for surveys studies published in the highest ranked information systems journals is 35% (King & He, 2005) and we will therefore categorize 54% as a moderate response. There may be several reasons to the relatively moderate response rate in the present study. One may be that electronic surveys in general give lower response rates than e.g. postal surveys (Kaplowitz, Hadlock, & Levine, 2004). Another may be that a 52 item questionnaire (i.e. 38 technostress, 4 intention, 4 satisfaction and 6 demographic) is demanding to answer. Research demonstrates that a general “rule of thumb” is that the response rate is likely to decrease with the increasing number of questionnaires items (Edwards et al., 2002). The population of this study is coworkers using ICT at work and the sample is 216 administrative employees in one organization. Generalization from such a sample to the population is a very complex issue since it involves at least three circumstances: (a) how the sample was generated (i.e. drawn randomly versus non-randomly), (b) the response rate and (c) the actual sample size. The sample was not drawn randomly from the population and the response rate (i.e. 54%) is moderate. Both these conditions are, however, prevalent in IS-survey research and a well-known threat
to statistical generalization (King & He, 2005). The sample size of 216 is well above the required minimal sample size in SEM (i.e. 100–150 cases) and only marginally below the average sample size of 259 in comparable IS-research (Gefen et al., 2000). Future research is needed to support the generalizability of our findings.

Our effort to model technostress creators and inhibitors as a multidimensional formative construct should be seen as a first step in the development of a formative instrument suitable for covariance based SEM. Our contribution is to model and analyse the instrument as consistent with its true nature as possible, despite the fact that the instrument was not initially developed for formative modelling with covariance-based SEM. Accordingly, there is one important task to deal with for future research before the present instrument could attend adequately to recent developments of formative measurement models within covariance based SEM. For each formative construct with its corresponding measurement instrument, at least two reflective measures should be developed (a so-called MIMIC model). The purpose of these measures is to achieve adequate model identification in accordance with recent developments of validation procedures for formative measurement models within covariance based SEMs (Diamantopoulos, 2011). In addition, further research is needed to identify and test other possible dimensions of technostress and items within each dimension. For example, the current technostress creators do not include ICT hassles, such as crashes, breakdowns and freezes. Recent research has indicated that technology malfunctions may increase employee strain (e.g. Day et al., 2012).

7. Concluding remarks

The purpose of this paper has been to investigate how technostress may influence employee use of ICT in connection with their work tasks, and the motivation has been to learn more about the effects of technostress in organizations.

The empirical study is based on the transaction theory of technostress, which distinguishes between technostress creators and inhibitors (e.g. Al-Fudail & Mellar, 2008; Raghu-Nathan et al., 2008). These two second order technostress variables were hypothesized to influence two strain variables, namely, employee satisfaction with the use of ICT and employee willingness to extend the use of ICT. In addition, we showed that technostress creators and inhibitors should be modelled in agreement with their true nature, as formative multidimensional constructs. Our findings indicate that both technostress creators and inhibitors influence employee use of ICT. We believe that these findings and the implications of our research can be used as a basis for future studies in this area.

Appendix A

The direct influence of control variables on latent variables in Fig. 2.

<table>
<thead>
<tr>
<th>Control variable</th>
<th>Creators to satisfaction</th>
<th>Inhibitors to satisfaction</th>
<th>Inhibitors to intention</th>
<th>Satisfaction to intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.42*</td>
<td>.18</td>
<td>.03</td>
<td>.31</td>
</tr>
<tr>
<td>Age</td>
<td>+.02</td>
<td>-.02</td>
<td>+.02</td>
<td>.00</td>
</tr>
<tr>
<td>Education</td>
<td>-.01</td>
<td>-.06</td>
<td>-.02</td>
<td>+.01</td>
</tr>
<tr>
<td>Daily ICT-use</td>
<td>-.03</td>
<td>-.03</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>ICT-courses</td>
<td>.00</td>
<td>-.01</td>
<td>.00</td>
<td>.00</td>
</tr>
</tbody>
</table>

* Original standardized regression coefficient (cf. Fig. 2).
* Change in original standardized regression coefficient due to inclusion of control variable.

References


