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Technostress Research: A Nurturing Ground for Measurement Pluralism?

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Abstract:

Because technostress research is multidisciplinary in nature and, therefore, benefits from insights gained from various research disciplines, we expected a high degree of measurement pluralism in technostress studies published in the information systems (IS) literature. However, because IS research mostly relies on self-report measures in general, reasons exist to also assume that technostress research has largely neglected multi-method research designs. To assess the status quo of technostress research with respect to the application of multi-method approaches, we analyzed 103 empirical studies. Specifically, we analyzed the types of data-collection methods used and the investigated components of the technostress process (person, environment, stressors, strains, and coping). The results indicate that multi-method research is more prevalent in the IS technostress literature (approximately 37% of reviewed studies) than in the general IS literature (approximately 20% as reported in previous reviews). However, our findings also show that IS technostress studies significantly rely on self-report measures. We argue that technostress research constitutes a nurturing ground for the application of multi-method approaches and multidisciplinary collaboration.

Keywords: Literature Review, Technostress, Measurement Pluralism, Multi-Method, Stress, Stressors, Strains.

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1 Introduction

Technostress (Brod, 1982) refers to stress that results from both the use of information and communication technologies (ICTs) (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008) and the pervasiveness and expectations of ICT use in society in general (Riedl, 2013). Technostress is an increasingly important subject in information systems (IS) research because it negatively impacts many IS outcome variables such as usage intention (Fuglseth & Sørebø, 2014; Maier, Laumer, Eckhardt, & Weitzel, 2014), end-user satisfaction (Fuglseth & Sørebø, 2014; Maier et al., 2014), or technology-supported performance (Tams, Hill, Ortiz de Guinea, Thatcher, & Grover, 2014; Tarafdar, Pullins, & Ragu-Nathan, 2015). Thus, most major IS publication outlets now unsurprisingly publish technostress studies[1].

Because ICTs are likely to become more pervasive in the future and because IS scholars' work involves researching relevant IS phenomena, it is worthwhile to examine the state of the art in technostress research. Specifically, in this work, we examine the types of constructs that technostress research examines and the types of methods it uses to examine them. By doing so, we help technostress researchers to identify the constructs and methods that are underrepresented in our understanding of the technostress phenomena.

An important aspect of stress as a phenomenon and, hence, of technostress is the inherent need for multidisciplinary investigation. Cummings and Cooper (1998) highlight that investigations of stress phenomena (e.g., in the context of organizational stress research) require the combined efforts of researchers from medicine, psychology, management, and sociology to advance our understanding of stress in this domain. Hence, researchers have unsurprisingly advocated for multi-method designs, which combine the research traditions of various disciplines, in related disciplines, including technostress research (e.g., Riedl, Davis, & Hevner, 2014; Riedl, 2013).

Tams et al. (2014) demonstrate the strengths of a multi-method approach in technostress research. In the authors' experiment, participants performed a computer-based task (a memory game) while instant messages frequently interrupted them. Measuring the resulting stress on both a psychological level (using self-report measures) and a physiological level (using measures of stress hormone excretion), the authors explained a higher degree of the variance in task performance than with each method alone.

Mingers (2001a) argues that IS researchers can draw on a wide range of related disciplines (e.g., psychology, sociology, economics, and mathematics) and should accordingly also embrace their respective research traditions. By adopting different measurement approaches, researchers in a multidisciplinary discipline, such as IS in general or technostress in particular, can often overcome the limitations of each single approach and its inherent, limited world view (Mingers & Brocklesby, 1997). To bring these differing views together and create a more holistic representation of reality, combining data-collection methods is advantageous (Mingers, 2001a; Mingers & Brocklesby, 1997; Pinsonneault & Kraemer, 1993), as demonstrated by Tams et al. (2014) who combined self-report and physiological measures to explain more variance in individual performance.

However, despite their inherent strengths, multi-method studies remain rare in the IS discipline. For example, Mingers (2001a) shows that IS research published since the 1990s has used few methods (mainly self-report based methods such as surveys and interviews) as its data-collection instrument (sample: empirical papers in *MIS Quarterly*, *Information Systems Research*, *Communications of the ACM*, *Information Systems Journal*, *European Journal of Information Systems*, and *Information and Organization* over the 1993 to 1998 period). Specifically, Mingers shows that only 13 percent of the investigated studies applied more than one type of measurement. In a similar study, based on a larger sample, the same author found a multi-method research rate of approximately 20 percent (Mingers, 2001b). Still, although these rates seem low, they are high compared to mixed-methods research in IS (i.e., a subtype of multi-method research that requires one to not only apply multiple data-collection methods but also mix different paradigms, such as qualitative and quantitative). Orlikowski and Baroudi (1991) found that approximately 3 percent of IS studies had applied such a paradigm-spanning approach to collect data, which has not changed much over time as Venkatesh, Brown, and Bala (2013) show in their more recent review (they still found a mixed-methods research rate of less than 5 percent).

[1] Examples: *EJIS*: Maier et al. (2014); *ISJ*: Maier, Laumer, Weinert, and Weitzel (2015b); Srivastava, Chandra, and Shirish (2015); Tarafdar, Pullins, and Ragu-Nathan (2015); *ISR*: Ragu-Nathan et al. (2008); *JAIS*: Galluch, Grover, and Thatcher (2015); Tams et al. (2014); *JMIS*: D'Arcy, Herath, and Shoss (2014); Moody and Galletta (2015); Tarafdar, Tu, Ragu-Nathan, and Ragu-Nathan (2007); *MISQ*: Ayyagari, Grover, and Purvis (2011).

Against the background of these findings, we have reason to assume that multi-method designs are also rare in IS technostress research. Hence, to assess the status quo of multi-method research in the context of technostress, we reviewed technostress research (N = 103) and first analyzed the used measurement methods. Additionally, given that we hope to foster future multi-method technostress research, we also examined the technostress components (e.g., stressors or strains) that technostress research investigated with these methods. We based this investigation on a subsample of the reviewed studies (N = 93). Finally, we discuss major motivations that have driven multi-method technostress research.

In Section 2, we present the methodology of our literature review and provide details on the corresponding analyses. In Section 3, we present our main results about 1) the share of multi-method research in the IS technostress literature and its development over time, 2) the data-collection methods that the IS technostress literature has applied, and 3) the components in the technostress process that the IS technostress has investigated. In Section 4, we close this paper with reflections on our findings and the potential future of multi-method research in the technostress discipline.

2 Literature Review and Analysis

We used Google Scholar[2] and SCImago[3] to identify relevant studies. We used "technostress" as a keyword in Google Scholar (3 February to 7 February, 2016) while excluding citations and patents from our results; this search led to an initial 3,300 hits, which constituted the basis for further analyses. Next, we selected only journal and conference publications and also introduced a quality criterion (namely, that a paper must have at least five citations; see, e.g., Riedl, 2013, for a comparable procedure). To minimize the possibility of missing recent high-quality IS publications (which do not yet have five citations), we additionally searched for recent technostress publications in major AIS journals (i.e., journals in the Senior Scholars' basket[4]) and in the proceedings of its flagship conference (i.e., ICIS)[5]. In the search process, we identified many studies that cited the pioneering publications by Brod (1982, 1984) but did not actually focus on technostress (but on related topics). Hence, we also excluded the following types of publications:

1. Studies that focused on individual traits, such as computer attitudes or dependence tendencies, that may be predictors of technology-related stress but that do not actually involve stress and its effects (e.g., we excluded Brock and Sulsky (1994) due to this criterion).
2. Studies that focus on the adoption of technology in organizations and related outcomes on the individual and/or organizational level (e.g., resistance to change) but that do not relate directly to individual-level stress perceptions (e.g., we excluded Helliwell and Fowler (1994) due to this criterion).
3. Studies that focus on phenomena related to modern technology but not necessarily focus on ICTs, such as examinations of perceived electronic hypersensitivity or effects of magnetic fields in general (e.g., we excluded Oftedal, Vistnes, and Rygge (1995) due to this criterion).

The described search and elimination routines resulted in 121 publications plus an additional 10 studies from our search in AIS outlets. To further check that the criterion of five citations was not too restrictive, we chose high-impact journals in other research disciplines that had published at least one of the publications we had selected thus far and searched for recent technostress publications. This step resulted in our identifying no additional publications (see Appendix A for a list of included journals). Next, we excluded another 25 papers because they were not empirical in nature, and we excluded three other studies due to their low quality of presentation[6]. Thus, 103 technostress publications comprised the empirical basis of our review (see Appendix B for a full list).

2.1 Categories for Classification

To analyze the 103 studies, we used two dimensions: 1) applied data-collection methods and 2) investigated components in the technostress process.

[2] https://scholar.google.com
[3] https://www.scimagojr.com
[4] http://aisnet.org/?SeniorScholarBasket
[5] 10 February to 14 February, 2016: "Technostress" and "Techno*Stress" in the journal archives of the outlets included in the Senior Scholars' basket with the exception of *Journal of MIS* where we selected "online stress" and "technostress" from available keywords. 15 February to 16 February, 2016: Selection of papers from the ICIS proceedings of the last ten years based on title and abstract.
[6] Lee, Jin, and Choi (2012), Popoola and Olalude (2013), Yu et al. (2009).

2.1.1 Data-collection Methods

Based on initially reviewing the identified 103 publications, we devised several categories to classify these studies according to their applied data-collection methods. In total, we developed seven categories: self-reports, interviews, logs, observations, objective performance measures, biological measures, and miscellaneous measures (see Table 1).

Table 1. Types of Data-collection Methods in Technostress Research

Category	Description
Self-reports	In this category, we included all questionnaire-based measures independent of their medium (e.g., paper-based or electronic), structure (e.g., select choice or open-ended questions), or format (e.g., types of rating scales).
Interviews	In this category, we included all types of direct self-reports by individuals although again independent of the interview's structure (e.g., structured, semi-structured, or completely open-ended).
Logs	We used the term "log" to classify all types of self-report measures where individuals themselves took the initiative to write down impressions or take notes on certain events, such as critical incidents (e.g., Salo, Makkonen, & Hekkala, 2015) or communication activities (e.g., Schellhammer, Haines, & Klein, 2013).
Observations	In this category, we included researchers' observations and other forms of monitoring activities that subjects did not initiate. For example, Brooks (2015) recorded the use of a variety of Internet technologies while subjects were supposed to watch an informational video on which they would later have to answer questions.
Objective performance measures	In this category, we included data on the performance of individuals that researchers collected independently of subjective perceptions—predominantly performance in experimental tasks (e.g., time taken to complete tasks and/or error rates; Moody & Galletta, 2015; Tams et al., 2014).
Biological measures	In this category, we included measures that reflect the many biological systems involved in the stress process (e.g., Joels & Baram, 2009). The main types of measures we included concerned hormone excretion (e.g., cortisol, Dickerson & Kemeny, 2004) or psychophysiological processes (e.g., increases in cardiovascular activity, Hjortskov et al., 2004).
Miscellaneous measures	In the case one or at most two studies exclusively used a data-collection method, we combined them in this overall category. For example, Arnetz (1996) employed several environmental sensors to capture contextual aspects inside a building such as office lighting.

2.1.2 Components of Technostress

To frame our classification, we used Lazarus's (1966) and Lazarus and Folkman's (1984) transactional model of stress. This theory constitutes the conceptual foundation of many studies in technostress research, especially in recent years (e.g., Galluch et al., 2015; Neben & Schneider, 2015; Srivastava et al., 2015; Tarafdar et al., 2015). This transactional model posits that stress is not one component of a process (e.g., a stimulus or a response) but the process itself that can lead to detrimental effects in individuals.

This process involves environmental conditions (e.g., demands of the job, such as a certain workload) that the individuals perceive, and, if situational circumstances do not correspond to internal conditions (e.g., task demands that exceed an individual's resources, such as skills and abilities, or desires regarding the situation in general, such as the wish for a lower workload), then they appraise them as a threat to their wellbeing (i.e., a result of so-called primary appraisal). To cope with the detrimental effects of such demands (i.e., strains, such as reduced physical and mental wellbeing), the individuals evaluate the alternatives that could help attenuate the negative effects of these demands based on their available resources and then enact the most promising stress-reducing behaviors (i.e., coping, a result of so-called secondary appraisal).

Based on this basic description of the transactional model (for detailed descriptions, please see Folkman & Lazarus, 1985; Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986), we focus on five main components: person, environment, stressors, strains, and coping (see Table 2). For stressors and coping measures, note that, at least theoretically, most, if not all, elements in the environment could enact demands on the individual or be resources for coping. For example, Nastjuk and Kolbe (2015) demonstrated that the same IS artifact (in their case an in-car navigation system) could even be a source of stress and a coping measure at the same time depending on the given context (e.g., while the navigation system lowered the threat of not arriving at a certain destination at a specific time based on the remaining fuel, individuals perceived constant interaction with the navigation system as a technological stressor). We classified a construct as a stressor if its original study described it as increasing strain; likewise, we classified a construct as a coping measure if its study described it as decreasing strain.

To adapt the classification scheme to the context of technostress, we further subdivided "environment" into task environment, organizational environment, technological environment, and social environment. Researchers have frequently used task, organizational, and social environment in the context of stress research (Cooper & Marshall, 1976; McGrath, 1976; Sonnentag & Frese, 2013), and we added the technological environment as another domain due to its relevance in the technostress context.

Table 2. Components in the Technostress Process

	Component	**Description and Exemplary Constructs**
Person		In the presented stress process, the individual perceives and appraises external demands before enacting regulatory behaviors. Hence, in the "person" component, we include all the constructs that can influence the perception and appraisal processes. Exemplary constructs include individual characteristics, such as personality variables (e.g., Ayyagari et al., 2011; D'Arcy et al., 2014; Emurian, 1993; Maier et al., 2015b; Srivastava et al., 2015; Yan, Guo, Lee, & Vogel, 2013) or attitudes toward technology or one's own ability to handle technology (e.g., Ragu-Nathan et al., 2008; Shu, Tu, & Wang, 2011; Tarafdar, Pullins, & Ragu-Nathan, 2014, 2015).
Environment	Task	The "task environment" includes demands on the individual that originate from the individual's formal and informal roles in an organization (e.g., tasks that are part of one's formal job description but also those tasks that arise from other roles in an organization, such as being a source of support for less experienced colleagues), which previous technostress research has frequently found interest in (e.g., Barley et al., 2011; D'Arcy et al., 2014; Galluch et al., 2015; Sellberg & Susi, 2014; Srivastava et al., 2015). Additionally, task environment includes constructs that represent characteristics of these roles, such as traits of the job, including job autonomy or dependence on technology (e.g., Bailey & Konstan, 2006; Galluch et al., 2015; Shu et al., 2011; Wang, Ye, & Teo, 2014).
	Organization	The "organizational environment" is mostly an encompassing unit for task-related variables and forms that result from the social interactions of an organization's current or former members. Hence, organization environment includes constructs such as organizational culture (e.g., Barley et al., 2011; Wang, Shu, & Tu, 2008) or availability of organizational resources, including the provision of technical support (e.g., Fuglseth & Sørebø, 2014; Ragu-Nathan et al., 2008; Tarafdar et al., 2015). It also includes physical characteristics of the organizational environment, such as office ergonomics or lighting conditions, because they can be potential stressors (e.g., Arnetz, 1997; Berg & Arnetz, 1996).
	Social	The "social environment" encompasses stressors and coping resources that arise from interpersonal relationships. Although one could include organizational roles here (e.g., as in McGrath (1976) who, in his classification, depicted roles as a combination of tasks that arise from social interaction), we apply a more narrow distinction: we focus mostly on social interaction that is not related to the work environment but rather to the private domain. Exemplary constructs in social environment include perceived non-work demands (e.g., Chen & Karahanna, 2011; Voakes, Beam, & Ogan, 2003) or social support from family or friends (e.g., Al-Fudail & Mellar, 2008; Thomée, Härenstam, & Hagberg, 2012; Yan et al., 2013).

Table 2. Components in the Technostress Process

	Technology	The "technological environment" comprises the technologies and their characteristics that the individual uses throughout the day not only in the organizational environment but also in the private domain (e.g., mobile devices, which can easily cross these domains). In particular, we focus on the potential of technology to directly influence individual stress perceptions (as a stressor or coping resource) but do not include mediator effects. For example, we would classify perceived "invasion" of the private life of an individual through technology (e.g., continuous work demands in the form of emails) as pertaining to the "task environment" rather than the "technological environment" because technology (email in this case) is merely the carrier of the demand that is actually causing stress (work tasks). Exemplary constructs relate to technology acceptance, such as usefulness (e.g., Ayyagari et al., 2011; Maier, Laumer, Weinert et al., 2015) and ease of use (e.g., Al-Fudail & Mellar, 2008; Ayyagari et al., 2011; Maier, Laumer, Eckhardt, & Weitzel, 2012; Moody & Galletta, 2015) or to indicators of system performance, such as system reliability (e.g., Al-Fudail & Mellar, 2008; Ayyagari et al., 2011; Moody & Galletta, 2015; Riedl, Kindermann, Auinger, & Javor, 2012, 2013).
Stressors		"Stressors" are demands (or a force in general) that force a variable outside of its range of stability (Cummings & Cooper, 1979, 1998). For example, unusual task demands might force an individual to handle a workload with which the individual is not comfortable, or system malfunctions might create interruptions in an individual's usual workflow. The individual must perceive these demands first and then appraise them as detrimental to their wellbeing (e.g., a higher workload could also be perceived as beneficial if the individual needs higher levels of stimulation) to be stressors. Accordingly, we classified those constructs that the reviewed studies included as antecedents to detrimental effects (i.e., strains) as stressors. In the context of technostress, such constructs include the "technostress creators" (overload, invasion, complexity, insecurity, and uncertainty) that Ragu-Nathan et al. (2008) introduced.
Strains		"Strains" are the detrimental effects of stressors on an individual's wellbeing pertaining to the psychological, physiological, and/or behavioral levels (e.g., Carayon, Smith, & Haims, 1999; Sonnentag & Frese, 2013). Exemplary constructs include exhaustion (e.g., Ayyagari et al., 2011; Galluch et al., 2015; Maier, Laumer, & Eckhardt, 2015), increased stress hormone excretion (e.g., Galluch et al., 2015; Riedl et al., 2012; Tams et al., 2014), or reduced performance (e.g., Brooks, 2015; Moody & Galletta, 2015; Tams et al., 2014).
Coping		Individuals primarily enact "coping" behaviors to reduce the detrimental impact that stressors can have on their wellbeing, although there can also be organizational-level interventions that help one reduce stress (e.g., technical support). These individual behaviors or organizational interventions can focus on diminishing the stressor itself (problem-focused coping, such as resolving a software malfunction) or just the resulting strains (emotion-focused coping, such as taking a break in the case of a malfunction). In the context of technostress, interventions that have received repeated attention include breaks and break schedules (e.g., Boucsein & Thum, 1997; Ye et al., 2007), relaxation (e.g., Arnetz, 1996), and technology literacy facilitation (e.g., Ragu-Nathan et al., 2008).

2.1.3 Classification Procedure

For this literature review, we needed two classification phases. First, we had to select suitable publications for the review, which required our developing several exclusion criteria (see the beginning of Section 2.1) to narrow down our selection to publications that focus on the negative effects of technology from a stress perspective. We jointly developed these criteria in the process of reviewing the abstracts of the initially identified publications, while the first author performed the classification (inclusion or exclusion) based on abstract and full text, which the second author then reviewed. We discussed borderline cases until we reached agreement. This process led to our selecting 103 publications.

Second, the main classification for this review involved our identifying 1) applied data-collection methods and 2) the purpose for which the methods were applied (i.e., measurement of which technostress components). The first author performed the first part of this (straightforward) classification, and the second author reviewed the classification results. The main challenge in this stage involved classifying the measured constructs, which required reviewing each individual publication in depth. As such, this stage involved frequent discussion between the two authors.

In general, we tried to assign measured constructs to as few components as possible based on their role in different research models. For example, consider individual use of technology. In the case of technology-mediated tasks, we assigned technology usage to the task environment because the involved technologies were mainly tools for handling tasks related to one's assigned role (e.g., Schellhammer et al., 2013). In comparison, if technology use was independent of a given task (e.g., Brooks, 2015) or if a global measure of the general exposure to technology was used (e.g., Riedl et al. 2012), then we assigned technology use to the "person" component as a characteristic of individual behaviors. Finally, if technologies were used as a way to cope with given stressors (e.g., Maier et al., 2015), then technology use was classified as a form of coping.

Furthermore, in the case of self-report measures, we analyzed the specific items that the studies used to decide to which component of the stress process we should assign a variable. As an example, consider the "technostress creators" that Ragu-Nathan et al. (2008) introduce. This self-report instrument comprises 25 items arranged along five main factors. Tarafdar, Tu, Ragu-Nathan, and Ragu-Nathan (2011, p. 117) briefly define these factors as:

1. Techno-overload: "IS users face information overload and IS-enabled multitasking".
2. Techno-invasion: "IS users never feel 'free' of IS".
3. Techno-complexity: "IS users find it intimidating to learn and use IS".
4. Techno-insecurity: "IS users feel insecure about their jobs in the face of new IS and others who might know more about these technologies".
5. Techno-uncertainty: "IS users feel unsettled by continual upgrades and accompanying software and hardware changes".

One of these factors, "techno-overload", includes the following five items (Ragu-Nathan et al., 2008, p. 426):

- I am forced by this technology to work much faster.
- I am forced by this technology to do more work than I can handle.
- I am forced by this technology to work with very tight time schedules.
- I am forced to change my work habits to adapt to new technologies.
- I have a higher workload because of increased technology complexity.

While Ragu-Nathan et al. (2008) intended these items to measure stress appraisal regarding work overload caused by technology, based on some of the involved items, we would also assign this construct to the task environment. While working much faster, having a higher workload, or adapting to new technologies may seem stressful to some individuals, those individuals' "hell" may be another individual's "heaven" (Cummings & Cooper, 1998, p. 106). In this case, only the second item actually asks for an individual's perception in the context of the individual's own capabilities (i.e., "more than I can handle" would actually indicate the result of an appraisal process). Analogously, we assigned not only techno-overload to both the task environment and the list of potential stressors but also the other four factors to components outside of potential stressors (i.e., techno-invasion to the task and social environment, techno-complexity to the technological environment and personal characteristics, techno-insecurity to the organizational environment, and techno-uncertainty to the technological environment).

Even in the case that a specific study used established inventories, such as the described "technostress creators" for data collection, the classification required an in-depth analysis because some studies did not use the full inventory of items (e.g., some studies only used four of the presented factors, such as Sellberg and Susi (2014) and Tarafdar et al. (2015), or only three of them, such as Brooks (2015), D'Arcy et al. (2014), and Maier et al. (2012)) or made adaptations to items for their use in a specific study context. For example, Maier et al. (2012), Maier et al. (2014), and Maier et al. (2015b) adapted the technostress creators for the context of online social networks. Due to the characteristics of involved technologies (ICT in an enterprise context versus ICT in a social networking context), their items focus more intensely on the social environment than on the task environment. For example, Maier et al. (2015b, p. 293) used the construct "social overload" (e.g., "I address my friends' problems too much on Facebook") instead of the original construct "work overload".

Due to the challenges related to recognizing such nuanced differences, we opted to not classify measured components in the technostress process if a study was solely based on qualitative data-collection methods (e.g., only interviews or observations). However, when used as an addition to quantitative methods (e.g., self-reports), we classified them as contributing to the measurement of the same components as their quantitative counterparts. Hence, while we classified the overall data-collection methods applied for each of the 103 publications, we assessed only 93 studies regarding the contributions they have made to the measurement of specific technostress components.

3 Data-collection Methods in Technostress Research

A look at the various components involved in the technostress process (person, environment, stressors, strains, and coping) strongly implies that measuring the ongoing interaction between person and environment necessitates measurement pluralism. Hence, our ex ante expectation before starting the analyses was that technostress research would be a good exemplary domain that embraces multi-method approaches to data collection. More specifically, we expected a rate of multi-method research that was greater than the rate in IS research in general that Mingers has reported (2001a: ~13%; 2001b: ~20%). The results confirmed our expectations. We found a multi-method research rate of 37 percent in technostress research (i.e., 38 of 103 studies). In other words, a bit more than one third of technostress studies applied more than one data-collection method.

To visualize the development of technostress research over time, we looked at the chronological distribution of the 103 reviewed studies. In Figure 1, we indicate the number of publications (y-axis) per year (x-axis) for mono-method studies (one method of data collection) and multi-method studies (more than one method of data collection). Overall, the number of technostress publications has increased substantially over the years; however, we were also interested in potential differences in development for both types of studies. Hence, we also included regression lines (calculated in SPSS 24) for both mono-method studies ($F(1,36) = 55.643$, $p = .000$, with an R^2 of .607) and multi-method studies ($F(1,36) = 4.681$, $p = .037$, with an R^2 of .115), which indicate that, although both types of studies became more popular over time (see the positive slopes of both functions; mono-method: .1303, multi-method: .0497), a gap has opened up between both functions. The difference between mono-method and multi-method research over time was statistically significant (mono-method: average of 1.71 publications per year; multi-method studies: average of 1.00 publications per year; $U = 523.5$; $p = .029$).

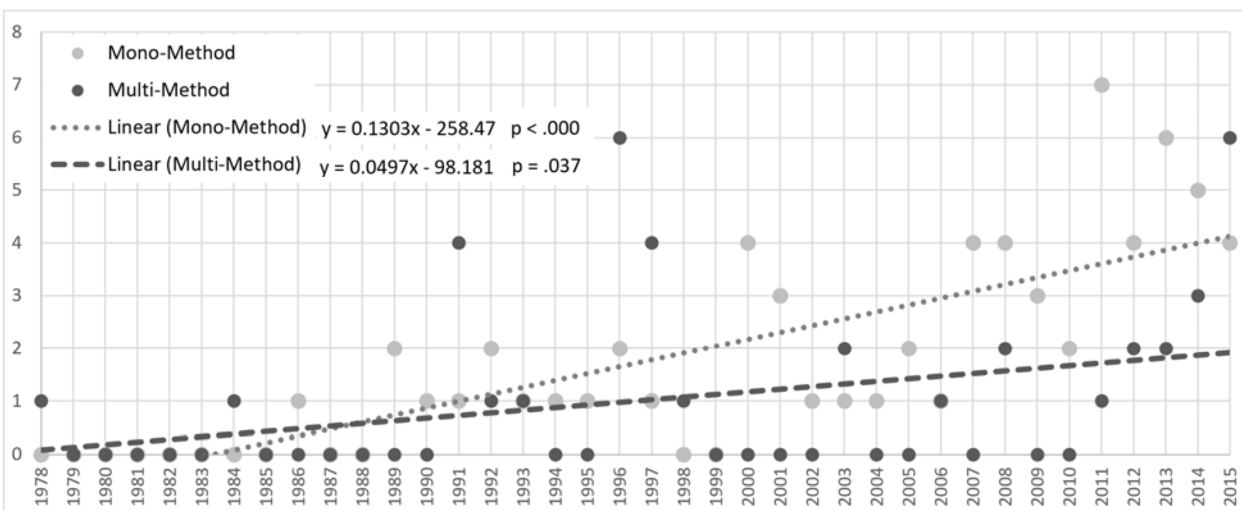

Figure 1. Overview of Reviewed Technostress Studies Based on Publication Year

We surmise that one major reason for this finding is that recent technostress research has not attracted many researchers outside of the IS discipline who typically have sound knowledge on methods that are less established in the IS discipline (e.g., physicians' knowledge on biological measures). Note that non-IS scholars (predominantly psychologists (e.g., Brod, 1982) and physicians (e.g., Arnetz, 1996)) conducted most of the early technostress research that appeared in the 1980s and 1990s.

The change in outlets in which technostress research has appeared further supports this impression. For example, if we cluster the reviewed studies based on their publication year into three blocks of roughly ten years (i.e., 1995 and before, 1996-2005, and 2006-2015), we find that IS outlets now publish most technostress research[7], while non-IS outlets initially published most of it. Specifically, of the 18 studies published before 1995, non-IS outlets published 16 of them, IS and non-IS outlets published an equal number in the 1996-2005 period (14 each), and IS outlets published the large majority of papers (49 of 57) in the most recent period.

As such, this basic overview of technostress research and the distribution of multi-method studies over the years warranted further analysis of the technostress components and corresponding methods. For this purpose, we further analyzed 93 of the original 103 studies. Table 3 presents the results.

Of the 93 studies, 92 applied self-reports to measure various components of the technostress process (note that self-reports may refer to measurements of theoretical constructs and control variables), and, in 58 studies, self-reports were the only means of data collection (of 65 studies that used only one method of data collection). This finding shows that self-report measures are not only the dominant data-collection method but are also frequently used without application of further measurement methods. It is also noteworthy that many studies do not report on survey measurement items in detail. Of the 92 studies that used self-report instruments, 54 did not fully cover the involved items. As we highlight in Section 2.1.3, without knowing the actual items used, it is not possible to classify even established self-report inventories. Therefore, we only classified self-report inventories if all the items were actually available even if they were reported in a different publication due to the possibility of item adaptations for a specific research context.

Table 3. Data-collection Methods along the Technostress Process

	Data-collection methods (N = 103)								Technostress components (N = 93)							
	Mono-method (N = 65)	Self-reports	Interviews	Logs	Observations	Objective performance	Biological measures	Miscellaneous	Person	Task	Organization	Social	Technology	Stressors	Strains	Coping
										Environment						
Totals	**-**	**92**	**16**	**7**	**10**	**14**	**22**	**4**	**85**	**50**	**32**	**24**	**35**	**40**	**50**	**14**
Self-reports	**58**	-	.07	.04	.10	.15	.23	.04	85 (37)	45 (24)	26 (16)	22 (19)	31 (21)	37 (26)	37 (24)	10 (8)
Interviews	**6**	.38	-	.31	.13	.06	.19	.06	2	2	3	2	3	2	1	3
Logs	**0**	.57	.71	-	.14	.00	.14	.00	0	2	1	0	2	1	0	2
Observations	**0**	.90	.20	.10	-	.30	.50	.20	3	5	0	1	3	2	2	1
Objective performance	**0**	1	.07	.00	.21	-	.64	.00	1	Not applicable (N/A)					13	N/A
Biological measures	**1**	.95	.14	.05	.23	.41	-	.09	1						22	
Miscellaneous	**0**	1	.25	.00	.50	.00	.50	-	0	2	3	0	0	1	3	0

In Table 3, we present the result of this classification (right side) for self-report measures in two ways: outside of parentheses, we list the number of studies that reported all the items for at least one construct involved in the measurement of the specific component, and in parentheses, we include the number of studies that reported all items used, with at least one variable being related to the specific component. For example, in the case of "person" variables, studies often presented sample demographics in detail, including the used items and rating scales, whereas most did not fully report items involved in measuring

[7] To classify outlets as "IS" or "non-IS", we looked up the "subject areas" of a publication outlet in SCImago. Because "computer science" was the only subject area that all the journals in the Senior Scholars' basket shared, we classified a venue as "IS" if it was categorized as a "computer science" outlet. As an alternative, we considered but rejected the subject category "information systems" because, for example, it did not include the *Journal of MIS*. In the case of venues' not being listed (e.g., in the case of conferences), we classified them according to the main topics that their respective outlines presented.

self-perceptions (e.g., attitudes or personality characteristics), which led to a large discrepancy between the numbers reported for this component.

In total, 56 potential combinations of methods and components are principally possible (seven methods × eight components; note that we divided environment into four subcomponents), although the nature of the involved methods restricted their potential in some ways. We indicate this restriction for biological measures and objective performance measures in Table 3, where an application independent of the individual is not possible. This fact limits their application potential to current individual states and strains (e.g., current academic performance via GPA; Galluch et al., 2015; or chronically high blood pressure; Korunka, Huemer, Litschauer, Karetta, & Kafka-Lützow, 1996).

In addition to self-report measures, many studies in the reviewed sample frequently applied biological measures (22 of 103 studies). This finding is, at least from an IS perspective, surprising due to the practical challenges related to collecting and analyzing the involved measures (e.g., high data-collection costs or required expertise to analyze data; Dimoka et al., 2012; Riedl et al., 2010; Riedl et al., 2014). Ten of these studies collected biological samples from blood (4 studies), urine (4 studies), and/or saliva (4 studies) to detect the excretion of stress hormones, such as cortisol (e.g., Arnetz, 1996; Riedl et al., 2013) or alpha-amylase (e.g., Galluch et al., 2015; Tams et al., 2014). Another 10 studies measured data related to cardiovascular activity of participants (e.g., heart rate or blood pressure), eight measured electro-dermal activity, four measured muscular tension (e.g., activity of jaw or neck muscles), and two used other means of data collection (i.e., respiration and bodily motion; Boucsein & Thum, 1997; eye tracking; Eckhardt, Maier, & Buettner, 2012).

Studies used interviews, logs, and observations throughout the entire spectrum of technostress components and, due to the small number of applications, we did not find any specific trends regarding their application. In “miscellaneous measures”, we included more exotic data-collection methods, such as a dermatological investigation that Berg, Arnetz, Lidén, Eneroth, and Kallner (1992) employed, expert ratings of office ergonomics that Arnetz, Berg, and Arnetz (1997) employed, or the use of environmental sensors to measure variables such as office lighting that Berg and Arnetz (1996) employed.

We also indicate the relative frequency of combinations of measures in Table 3 on the left side. For example, of the 92 studies that used self-report measures, 23 percent also used biological measures. Other interesting findings are that studies often combined interviews and logs (31% of the 16 studies that used interviews or even 71% of 7 studies that used logs), combined observations in addition to biological measures (50% of 10 studies that used observations), and combined biological measures with objective performance measures (64% of 14 studies that used objective performance measures also used biological measures or 41% of 22 studies that used biological measures also used objective performance measures), mostly in laboratory experiments. Furthermore, in each study that used objective performance measures, the study also used self-report measures. [8]

Another finding of our study is that studies most frequently investigated strains based on multiple measures. The multi-faceted nature of strains, including a variety of psychological, physiological, and behavioral outcomes, can explain this finding (e.g., Carayon et al., 1999; Sonnentag & Frese, 2013). Of 93 studies, 50 measured some type of strain (again adjusted for those studies that did not fully report the items of their self-report measures). Of those 50, 11 used more than one type of data-collection method to measure this specific component of the stress process alone.

At this point, however, the question arises whether measurement pluralism (in our case, the use of multi-method designs) actually has an impact on technostress research. As previous studies have shown (e.g., Korunka et al., 1996; Tams et al., 2014), one needs to apply multiple methods in the context of strains because single measures (e.g., self-reports) alone do not explain as much variance in a dependent variable as multiple methods typically do. Tams et al. (2014) even used different types of measures for each main type of strain (i.e., self-reports for psychological strains, biological measures for physiological strains, and objective performance measures for behavioral strains). Hence, achieving better explanatory power is a major motivation for researchers to apply multi-method designs.

[8] It is not surprising that authors never combined objective performance measures and logs because they mainly used objective performance measures in the context of laboratory studies based on a cross-sectional design, whereas authors mainly used logs to gather information on individual perceptions outside of controlled research situations.

However, when reviewing the 38 studies that applied multiple methods, we found only a few in which the authors attributed higher levels of explained variance to the variety of applied data-collection methods. For example, Birdi and Zapf (1997) used observations in addition to self-reports to collect data on user behavior and the effects of age in the context of computer trouble (i.e., errors). They found converging evidence from self-reported and observed data that age is an important predictor of negative emotions in response to computer errors. In several further studies, data collected without using self-reports also helped explain additional variance. For example, in Wiholm and Arnetz (1997), hormone levels helped to account for the occurrence of musculoskeletal disorders; in Eckhardt et al. (2012), objective performance in computer-based tasks helped to illuminate user satisfaction; and, in Moody and Galletta (2015), indicators of physiological stress (e.g., galvanic skin response, heat flux, near body temperature, skin temperature) helped to explain the variance in individual task performance.

Although Tams et al. (2014) have clearly demonstrated that multi-method designs can be useful to achieve complementary insight, motivations other than the potential complementarity of methods have often guided previous technostress research. According to Venkatesh et al. (2013), major arguments for mixing methods include achieving completeness and, thus, creating a more holistic representation of the technostress phenomenon (Tams et al., 2014) and compensating for the weaknesses of other methods (e.g., common method bias in the context of self-report measures; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

For example, Wastell and Newman's (1996a, 1996b) studies used self-report measures, observations, physiological measures (cardiovascular indicators), and measures of objective performance to investigate the influence of a new system on an ambulance service's performance and working environment. As a strength of their multi-method approach, they highlighted that "[i]t is important to emphasize the holistic nature of this approach…[with which one can gain] a much richer understanding of complex psychosocial processes...[than with] a one-dimensional analysis" (Wastell & Newman, 1996b, p. 285). In a similar vein, Gallivan (2003) combined self-reports and interviews to investigate the implementation of a new technology and highlighted that "[w]hile multi-method studies pose special challenges to researchers, they may also provide unique insights that are not revealed by qualitative or quantitative methods alone" (p. 14). Finally, Barley et al. (2011) examined the stress potential of common means of communication in organizations (e.g., meetings, encounters, e-mail) using a combination of self-reports, interviews, and logs. They justified their using a multi-method approach by stating that (p. 891):

> *Because we sought to deepen our understanding of the mechanisms that might underlie [the] relationship, we collected both quantitative and qualitative data…. Combining both types of data is valuable because it not only allows one to confirm common findings across methods…, but just as importantly, one can identify dynamics obscured by one data source or another.*

Another common reason why studies used more than one method to collect data was to overcome the weaknesses of single methods. For example, Galluch et al. (2015) investigated the influence of ICT-enabled interruptions on individual stress perceptions and physiological strain indicated through hormone excretion. With respect to their choice of data-collection methods, they highlighted that "Our design was particularly effective because, in each hypothesis, we captured the two constructs being tested with a unique technique…. [Doing so] significantly reduced method bias" (p. 27). Moody and Galletta (2015), who investigated the effect of information scent, time constraints, and physiological stress on performance and website attitude, made a similar argument; they state that "[u]sing objective measures such as GSR, latent semantic analysis, and task performance helps to avoid common method bias" (p. 214).

We also checked whether publications of both groups (mono-method and multi-method studies) received different average numbers of citations per year. At first glance, mono-method studies ($N = 65$) received distinctively more citations on average per year ($M = 7.31$; $SD = 10.63$) than multi-method studies ($M = 5.92$; $SD = 8.47$). Hence, we statistically tested for a significant difference in citations per year between both groups. Due to a number of remarkable outliers, we first tested for normality of the distribution using the Shapiro-Wilk test (SPSS 24) and found that neither of the samples was normally distributed ($p = .000$ for both groups). Hence, we applied the Mann-Whitney test (SPSS 24) for non-parametric values and found no significant difference between the groups ($U = 1,125$; $p = .452$). These findings indicate that the number of applied data-collection methods has no impact on the number of citations that technostress publications receive over time.

4 Conclusion, Limitations, Future Research

Initially, we expected that we would find technostress research to constitute a nurturing ground for multi-method research. To some extent, our findings met our expectations because the overall rate of multi-method research was higher in the technostress domain than in IS in general (if one uses Mingers (2001a, 2001b) as a benchmark). We also found a positive development in the overall number of technostress studies published per year, which is a good indicator of the growing research interest in this domain. Considering the developmental pattern of multi-method research (see Figure 1), one could argue that an increasing number of studies have applied multi-method designs each year; however, these types of study designs still seem to evolve into a niche practice compared to the number of mono-method studies.

In particular, we found that, much as in IS research generally (e.g., Riedl & Rueckel, 2011), many technostress studies have used self-report measures as their sole method to collect data. For example, Podsakoff (1986) highlighted that self-reports can offer a variety of applications that are also relevant to technostress research (e.g., to collect demographic data, personality data, or data on psychological states and perceptions). However, Podsakoff et al. (2003) later argued that using the same measurement methods to collect data on related variables could lead to a tremendous share of explained variance being attributable to inflation or deflation caused by common method variance (with up to 40% in some of the exemplary studies on attitudes they mentioned). While the general threat of common method variance for single-method studies has been challenged by, for example, Spector (2006), Spector also highlighted that common method variance could pose a threat especially for such cases where the involved variables are actually related to each other as is definitely the case in the stress process.

Although researchers have proposed statistical methods to attenuate the effects of common method variance (e.g., Podsakoff et al., 2003), some have also suggested that the most straightforward way to minimize this threat is to use more than one source of data (e.g., Donaldson & Grant-Vallone, 2002; Podsakoff et al., 2003). Accordingly, in recent technostress research (e.g., Galluch et al., 2015; Moody & Galletta, 2015), overcoming weaknesses of single-method studies was a legitimate motivation for applying multi-method designs. Still, researchers such as Ahmed and Sil (2012) have contested this justification for multi-method research. They argue that overcoming the weaknesses of single methods should not be the main argument for multi-method research because this argument would require researchers in multidisciplinary academic fields such as IS to assimilate a variety of research traditions. In turn, doing so would lead to a loss in actual knowledge that researchers could create because the specific perspectives and world views that are unique to each research domain would be weakened due to researchers' no longer being able to focus on their own discipline and having to consider many others at the same time. Hence, instead, they suggest that one should see multi-method research as a means of uniting researchers from different disciplines and enabling "cross-cultural communication" (p. 948) and, ultimately, collaboration among researchers who specialize in their respective disciplines.

In addition to the potential practical uses of multi-method designs (e.g., convergent validation and more holistic representation), multi-method research could, therefore, support IS researchers in their collaborative efforts and help them fulfill their role "as builders and creators that piece together many pieces of a complex puzzle into a coherent whole" (Tams et al., 2014, p. 739). In this paper, we further emphasize this notion and call for more frequent collaboration of IS researchers with researchers from other, related disciplines. For this purpose, we use technostress as an exemplary, multidisciplinary topic, which is already a domain for frequent collaboration among researchers from varying disciplines but could also still benefit from additional efforts in this regard. In favor of such collaborations, we also highlight that they can lead to the establishment of new, thriving domains, such as neuroIS (Dimoka, Pavlou, & Davis, 2007), a research discipline that applies methods and knowledge from neuroscience in IS research (e.g., Dimoka et al., 2012; Riedl et al., 2010; Riedl & Léger, 2016).

Notably, although we focus here on applying multiple data-collection methods because previous technostress research has frequently called for more diversity in this context (e.g., Ayyagari et al., 2011; Moody & Galletta, 2015; Srivastava et al., 2015; Tarafdar et al., 2015), other interesting methodological avenues for future technostress research exist. Researchers have highlighted that stress research in general and organizational stress research in particular still need more studies that apply longitudinal designs (e.g., Kahn & Byosiere, 1992; Kasl, 1978; Sonnentag & Frese, 2013), a call that researchers have also made for technostress research specifically (e.g., Fischer & Riedl, 2015; Ragu-nathan et al., 2008; Tarafdar et al., 2015). Additionally, researchers have called for a greater variety in the samples and contexts that such research uses, to reduce the reliance on student samples (e.g., Galluch et al., 2015;

Srivastava et al., 2015; Tarafdar et al., 2015), and to increase the use of field studies (e.g., Moody & Galletta 2015; Tarafdar et al., 2015).

For our own research, we seek to analyze the measurement instruments (particularly the survey instruments) that previous technostress research have used in detail. Doing so will help us identify those related disciplines and their theories and methods that have informed technostress research the most and might offer still more directions for future research in this regard. We plan to base this analysis on the details of the used measurement instruments, which remained absent in many publications (e.g., the concrete survey items) of our present sample. This analysis can also serve as the basis for the construction of future survey-based measurement tools in the technostress domain. Notably, a limitation of our review is the focus on previous technostress research alone to guide the development of future measurement approaches. However, by studying approaches in related domains (e.g., stress research in general rather than technostress), the measurement toolset from which IS scholars could benefit would become even larger. Despite this current limitation, we hope that the present paper helps advance technostress research in particular and informs IS researchers interested in multi-method research in general.

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Riedl, R., & Rueckel, D. (2011). Historical development of research methods in the information systems discipline. In *Proceedings of the Americas Conference on Information Systems.*

Salo, M., Makkonen, M., & Hekkala, R. (2015). "I just cursed and opened a beer": Explaining mobile users' non-complaining behavior through coping. In *Proceedings of the International Conference on Information Systems.*

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Srivastava, S. C., Chandra, S., & Shirish, A. (2015). Technostress creators and job outcomes: Theorising the moderating influence of personality traits. *Information Systems Journal*, *25*(4), 355-401.

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Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly*, *37*(1), 21-54.

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Yan, Z., Guo, X., Lee, M. K., & Vogel, D. R. (2013). A conceptual model of technology features and technostress in telemedicine communication. *Information Technology & People*, *26*(3), 283-297.

Ye, Z., Abe, Y., Kusano, Y., Takamura, N., Eida, K., Takemoto, T.-i., & Aoyagi, K. (2007). The Influence of visual display terminal use on the physical and mental conditions of administrative staff in Japan. *Journal of Physiological Anthropology*, *26*(2), 69–73.

Yu, J.-C., Kuo, L.-H., Chen, L.-M., Yang, H.-J., Yang, H.-H., & Hu, W.-C. (2009). Assessing and managing mobile technostress. *WSEAS Transactions on Communications*, *8*(4), 416-425.

Appendix A: List of Additional Journals Checked

We searched the following list of journals (Table A1 below) for additional publications on 15 and 16 April 2016 using the term "technostress".

Table A1. Overview of Journals Checked for Additional Publications

(ISSN) Journal title	Journal website
(1554-3528) *Behavior Research Methods*	http://www.springer.com/psychology/cognitive+psychology/journal/13428
(1362-3001) *Behaviour and Information Technology*	http://www.tandfonline.com/toc/tbit20/current
(0301-0511) *Biological Psychology*	http://www.journals.elsevier.com/biological-psychology
(1471-244X) *BMC Psychiatry*	http://bmcpsychiatry.biomedcentral.com/
(1471-2458) *BMC Public Health*	https://bmcpublichealth.biomedcentral.com/
(1867-0202) *Business and Information Systems Engineering*	http://www.bise-journal.com/
(1435-5566) Cognition, *Technology and Work*	http://www.springer.com/computer/hci/journal/10111
(1479-5759) *Communication Education*	http://www.tandfonline.com/toc/rced20/current
(1552-3810) *Communication Research*	http://crx.sagepub.com/
(1557-7317) *Communications of the ACM*	http://cacm.acm.org/
(1529-3181) *Communications of the AIS*	http://aisel.aisnet.org/cais/
(0360-1315) *Computers and Education*	http://www.journals.elsevier.com/computers-and-education
(0747-5632) *Computers in Human Behavior*	http://www.journals.elsevier.com/computers-in-human-behavior
(1600-0536) *Contact Dermatitis*	http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1600-0536
(2152-2715) *Cyberpsychology, Behavior, and Social Networking*	http://www.liebertpub.com/overview/cyberpsychology-behavior-brand-social-networking/10/
(0095-0033) *DATA BASE for Advances in Information Systems*	http://sigmis.org/the-data-base/
(0040-0912) *Education and Training*	http://www.emeraldgrouppublishing.com/products/journals/journals.htm?id=et
(0091-6765) *Environmental Health Perspectives*	http://ehp.niehs.nih.gov/
(1366-5847) *Ergonomics*	http://www.tandfonline.com/toc/terg20/current
(1748-8583) *Human Resource Management*	http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1748-8583
(0378-7206) *Information and Management*	http://www.journals.elsevier.com/information-and-management/
(1471-7727) *Information and Organization*	http://www.journals.elsevier.com/information-and-organization/
(0020-0255) *Information Sciences*	http://www.journals.elsevier.com/information-sciences
(0959-3845) *Information Technology and People*	http://www.emeraldgrouppublishing.com/products/journals/journals.htm?id=itp
(2329-4884) *International Journal of Business Communication*	http://job.sagepub.com/
(0167-8760) *International Journal of Psychophysiology*	http://www.journals.elsevier.com/international-journal-of-psychophysiology
(1573-3424) *International Journal of Stress Management*	http://www.apa.org/pubs/journals/str/

Table A1. Overview of Journals Checked for Additional Publications

(1741-5276) *International Journal of Technology Management*	http://www.inderscience.com/jhome.php?jcode=ijtm
(1365-2729) *Journal of Computer Assisted Learning*	http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365-2729
(1541-4140) *Journal of Educational Computing Research*	https://uk.sagepub.com/en-gb/eur/journal-of-educational-computing-research/journal202399
(1552-6550) *Journal of Marketing Education*	http://jmd.sagepub.com/
(1536-5948) *Journal of Occupational and Environmental Medicine*	http://journals.lww.com/joem/pages/default.aspx
(1099-1379) *Journal of Organizational Behavior*	http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1379
(0022-3999) *Journal of Psychosomatic Research*	http://www.journals.elsevier.com/journal-of-psychosomatic-research/
(1741-2978) *Journal of Sociology*	http://jos.sagepub.com/
(0092-0703) *Journal of the Academy of Marketing Science*	http://www.springer.com/business+%26+management/journal/11747
(1533-4406) *New England Journal of Medicine*	http://www.nejm.org/
(1526-5455) *Organization Science*	http://pubsonline.informs.org/journal/orsc
(0018-9219) *Proceedings of the IEEE*	http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5
(1094-9054) *Reference and User Services Quarterly*	https://journals.ala.org/rusq
(0090-7324) *Reference Services Review*	http://www.emeraldgrouppublishing.com/rsr.htm
(1795-990X) *Scandinavian Journal of Work, Environment and Health*	https://www.jstor.org/journal/scanjworkenvihea
(1533-8525) *Sociological Quarterly*	http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1533-8525
(1532-2998) *Stress and Health*	http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1532-2998
(0040-1625) *Technological Forecasting and Social Change*	http://www.journals.elsevier.com/technological-forecasting-and-social-change
(0736-5853) *Telematics and Informatics*	http://www.journals.elsevier.com/telematics-and-informatics
(1464-5335) *Work and Stress*	http://www.tandfonline.com/toc/twst20/current

Appendix B: List of Studies in Review (Chronological Order)

Below, we list of all 103 publications that constituted the empirical basis of this review (in chronological order). We highlight publications that were not part of the in-depth analysis (10) with an asterisk (*) before the authors' names:

Johansson, G., Aronsson, G., & Lindstrom, B. O. (1978). Social psychological and neuroendocrine stress reactions in highly mechanised work. *Ergonomics*, *21*(8), 583-599.

Johansson, G., & Aronsson, G. (1984). Stress reactions in computerized administrative work. *Journal of Organizational Behavior*, *5*(3), 159-181.

*Bichteler, J. (1986). Human aspects of high tech in special libraries. *Special Libraries*, *77*(3), 121-128.

Hudiburg, R. A. (1989). Psychology of computer use. XVII. The computer technology hassles scale: Revision, reliability, and some correlates. *Psychological Reports*, *65*(3f), 1387-1394.

Hudiburg, R. A. (1989). Psychology of Computer Use: VII. Measuring Technostress: Computer-related Stress. Psychological Reports, 64(3), 767–772.

Hudiburg, R. A. (1990). Relating computer-associated stress to computerphobia. *Psychological Reports*, *67*(1), 311-314.

Ballance, C. T., & Rogers, S. U. (1991). Psychology of computer use: XXIV. Computer-related stress among technical college students. *Psychological Reports*, *69*(2), 539-542.

*Compton, D. C., White, K., & DeWine, S. (1991). Techno-sense: Making sense of computer-mediated communication systems. *Journal of Business Communication*, *28*(1), 23-43.

Emurian, H. H. (1991). Physiological responses during data retrieval: Comparison of constant and variable system response times. *Computers in Human Behavior*, *7*(4), 291-310.

Hudiburg, R. A. (1991). Relationship of computer hassles, somatic complaints, and daily hassles. *Psychological Reports*, *69*(3 Pt 2), 1119-1122.

Hudiburg, R. A., & Jones, T. M. (1991). Psychology of computer use. XXIII. Validating a measure of computer-related stress. *Psychological Reports*, *69*(1), 179-182.

Ballance, C. T., & Ballance, V. V. (1992). Psychology of computer use: XXVI. Computer-related stress and in-class computer usage. *Psychological Reports*, *71*(1), 172-174.

Berg, M., Arnetz, B. B., Lidén, S., Eneroth, P., & Kallner, A. (1992). Techno-stress: A psychophysiological study of employees with VDU-associated skin complaints. *Journal of Occupational Medicine*, *34*(7), 698-701.

Hudiburg, R. A. (1992). Factor analysis of the computer technology hassles scale. *Psychological Reports*, *71*(3), 739-744.

Emurian, H. H. (1993). Cardiovascular and electromyograph effects of low and high density work on an interactive information system. *Computers in Human Behavior*, 9(4), 353-370.

Hudiburg, R. A., Brown, S. R., & Jones, T. M. (1993). Psychology of computer use: XXIX. Measuring computer users' stress: The computer hassles scale. *Psychological Reports*, *73*(3 Pt 1), 923-929.

Fujigaki, Y., Asakura, T., & Haratani, T. (1994). Work stress and depressive symptoms among Japanese information systems managers. Industrial Health, 32(4), 231-238.

Hudiburg, R. A. (1995). Psychology of computer use. XXXIV. The computer hassles scale: Subscales, norms, and reliability. *Psychological Reports*, *77*(3), 779-782.

Arnetz, B. B. (1996). Techno-stress: A prospective psychophysiological study of the impact of a controlled stress-reduction program in advanced telecommunication systems design work. *Journal of Occupational & Environmental Medicine*, *38*(1), 53-65.

Arnetz, B. B., & Berg, M. (1996). Melatonin and adrenocorticotropic hormone levels in video display unit workers during work and leisure. *Journal of Occupational & Environmental Medicine*, *38*(11), 1108-1110.

Ballance, C. T., & Ballance, V. V. (1996). Psychology of computer use: XXXVII. Computer-related stress and amount of computer experience. *Psychological Reports*, *78*(3 Pt 1), 968-970.

Berg, M., & Arnetz, B. B. (1996). An occupational study of employees with VDU-associated symptoms: The importance of stress. *Stress Medicine*, *12*(1), 51-54.

Hudiburg, R. A., & Necessary, J. R. (1996). Psychology of computer use: XXXV. Differences in computer users' stress and self-concept in college personnel and students. *Psychological Reports*, *78*(3 Pt 1), 931-937.

Korunka, C., Huemer, K., Litschauer, B., Karetta, B., & Kafka-Lützow, A. (1996). Working with new technologies: Hormone excretion as an indicator for sustained arousal. A pilot study. *Biological Psychology*, *42*(3), 439-452.

Wastell, D., & Newman, M. (1996). Information system design, stress and organisational change in the ambulance services: A tale of two cities. *Accounting, Management and Information Technologies*, *6*(4), 283-300.

Wastell, D. G., & Newman, M. (1996). Stress, control and computer system design: A psychophysiological field study. *Behaviour & Information Technology*, *15*(3), 183-192.

Arnetz, B. B., Berg, M., & Arnetz, J. (1997). Mental strain and physical symptoms among employees in modern offices. *Archives of Environmental Health*, *52*(1), 63-67.

*Benamati, J., & Lederer, A. L., & Singh, M. (1997). Changing information technology and information technology management. *Information & Management*, *31*(5), 275–288.

Birdi, K. S., & Zapf, D. (1997). Age differences in reactions to errors in computer-based work. *Behaviour & Information Technology*, *16*(6), 309-319.

Boucsein, W., & Thum, M. (1997). Design of work/rest schedules for computer work based on psychophysiological recovery measures. *International Journal of Industrial Ergonomics*, *20*, 51-57.

Wiholm, C., & Arnetz, B. B. (1997). Musculoskeletal symptoms and headaches in VDU users—a psychophysiological study. *Work & Stress*, *11*(3), 239-250.

*Rose, P. M., Stoklosa, K., & Gray, S. A. (1998). A focus group approach to assessing technostress at the reference desk. *Reference & User Services Quarterly*, *37*(4), 311-317.

Joshi, K., & Rai, A. (2000). Impact of the quality of information products on information system users' job satisfaction: An empirical investigation. *Information Systems Journal*, *10*(4), 323–345.

Kaluzniacky, E. (2000). Work stress among information systems professionals in Manitoba. In *Proceedings of the Information Resources Management Association International Conference.*

Rozell, E., & Gardner, W. I. (2000). Cognitive, motivation, and affective processes associated with computer-related performance: A path analysis. *Computers in Human Behavior*, *16*(2), 199–222.

Salanova, M., Grau, R., Cifre, E., & Llorens, S. (2000). Computer training, frequency of usage and burnout: The moderating role of computer self-efficacy. *Computers in Human Behavior*, *16*(6), 575–590.

Benamati, J., & Lederer, A. L. (2001). Coping with rapid changes in IT. *Communications of the ACM*, *44*(8), 83-88.

Poole, C. E., & Denny, E. (2001). Technological change in the workplace: A statewide survey of community college library and learning resources personnel. *College & Research Libraries*, *62*(6), 503-515.

Towell, E. R., & Lauer, J. (2001). Personality differences and computer related stress in business students. *American Journal of Business*, *16*(1), 69-76.

Ogan, C., & Chung, D. (2002). Stressed out! A national study of women and men journalism and mass communication faculty, their uses of technology, and levels of professional and personal stress. *Journalism & Mass Communication Educator*, *57*(4), 352-369.

*Allan, J., & Lawless, N. (2003). Stress caused by on-line collaboration in e-learning: A developing model. *Education and Training*, *45*(8/9), 564-572.

Gallivan, M. (2003). Examining gender differences in IT professionals' perceptions of job stress in response to technological change. In M. Mandviwalla & E. Trauth (Eds.), *Proceedings of the SIGMIS Conference on Computer Personnel Research* (pp. 10-23).

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Iwanaga, K., Liu, X. X., Shimomura, Y., & Katsuura, T. (2005). Approach to human adaptability to stresses of city life. *Journal of Physiological Anthropology and Applied Human Science*, *24*(4), 357-361.

Tu, Q., Wang, K., & Shu, Q. (2005). Computer-related technostress in China. *Communications of the ACM*, *48*(4), 77-81.

Bailey, B. P., & Konstan, J. A. (2006). On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior*, *22*(4), 685-708.

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*Thomée, S., Dellve, L., Härenstam, A., & Hagberg, M. (2010). Perceived connections between information and communication technology use and mental symptoms among young adults—a qualitative study. *BMC Public Health*, *10*, 1-14.

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological antecedents and implications. *MIS Quarterly*, *35*(4), 831-858.

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Chen, A. J., & Karahanna, E. (2011). Personal life interrupted: Understanding the effects of technology-mediated interruptions from work to personal life. In *Proceedings of the International Conference on Information Systems.*

Hung, W.-H., Chang, L.-M., & Lin, C.-H. (2011). Managing the risk of overusing mobile phones in the working environment: A study of ubiquitous technostress. In *Proceedings of the Pacific-Asia Conference on Information Systems.*

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Maier, C., Laumer, S., Eckhardt, A., & Weitzel, T. (2012). When social networking turns to social overload: Explaining the stress, emotional exhaustion, and quitting behavior from social network sites' users. In *Proceedings of the European Conference on Information Systems.*

Riedl, R., Kindermann, H., Auinger, A., & Javor, A. (2012). Technostress from a neurobiological perspective—system breakdown increases the stress hormone cortisol in computer users. *Business & Information Systems Engineering*, *4*(2), 61-69.

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Maier, C., Laumer, S., & Weitzel, T. (2013). Although I am stressed, I still use IT! Theorizing the decisive impact of strain and addiction of social network site users in post-acceptance theory. In *Proceedings of the International Conference on Information Systems.*

*Niehaves, B., Köffer, S., & Ortbach, K. (2013). The effect of private IT use on work performance—towards an it consumerization theory. In R. Alt & B. Franczyk (Eds.), *Proceedings of the 11th International Conference on Wirtschaftsinformatik.*

*Niehaves, B., Köffer, S., Ortbach, K., & Reimler, S. (2013). Boon and bane of IT consumerization: The burnout-engagement-continuum. In J. P. Shim, Y. Hwang, & S. Petter (Eds.), *Proceedings of the Americas Conference on Information Systems.*

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