Is the Technostress Creators Inventory Still an Up-To-Date Measurement Instrument? Results of a Large-Scale Interview Study

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Abstract. Self-report measures are of great importance for technostress research and particularly the Technostress Creators Inventory has been amongst the most frequently applied measurement instruments since its inception in 2008. As the technological environment has progressed since then, we investigated whether this inventory still completely represents the phenomenon of technostress today. We conducted interviews with 75 individuals in four companies on their technostress experiences. We asked them about their personal experiences with eight stressor categories in the workplace, the original five dimensions of the Technostress Creators Inventory (techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty) and additional three categories (techno-unreliability, IT-based monitoring, and cyberbullying). We found that techno-insecurity was the least prevalent stressor category throughout all companies, while techno-unreliability, one of our new categories, was the most prevalent stressor. Based on this evidence, we argue that a revised inventory is urgently needed to guarantee content validity of technostress measurement in future studies.

Keywords: Technostress, Stressors, Measurement, Self-Report, Interviews

1 Introduction

Technostress is a phenomenon that arises from the individual use of information and communication technologies (ICT) [1]. The body of knowledge concerning this dark aspect of IS use has grown rapidly in recent years (e.g., [2–4]) and its investigation relies strongly on the use of self-report instruments [5]. The main self-report instrument used for technostress measurement is the Technostress Creators Inventory (TCI) introduced by Ragu-Nathan et al. [1]. This instrument conceptualizes technostress as a superordinate construct with five first order constructs each having three to five reflective indicators. Specifically, the instrument conceptualizes technostress as being manifested in the five dimensions techno-overload (*too much*),

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techno-invasion (*always connected*), techno-complexity (*difficult*), techno-insecurity (*uncomfortable*), and techno-uncertainty (*too often and unfamiliar*) [6].

As this instrument celebrated its tenth anniversary recently, we wanted to know whether it still offers the necessary content validity to capture technostress in a rapidly evolving technological environment. More specifically, we focus on the instrument's first-order constructs, and in line with MacKenzie et al. [7] (p. 304) pose the question: *Are the [first-order constructs] as a set collectively representative of the entire content domain of the construct*? Answering this question is important as it may reveal the need for a revision of the instrument. Such a revision could further improve the diagnostic abilities of the Technostress Inventory, which are crucial to investigate the phenomenon and its detrimental effects efficiently (e.g., to avoid missing important facets that may have emerged during the last ten years).

An initial indication for the need to revise the instrument can be found in previous technostress research. In a number of studies, only a subset of the original five technostress creators were used. For example, Tarafdar et al. [8] used only four of five creators (i.e., overload, invasion, complexity, insecurity) or D'Arcy et al. [9] used only three of five (i.e., overload, complexity, uncertainty). Importantly, it is also critical to assess whether further dimensions are necessary to completely represent the technostress phenomenon. Hence, in addition to the five existing technostress creators we added three additional dimensions (i.e., unreliability, monitoring, cyberbullying). Based on a series of interview studies in four companies in Austria, we investigated whether the original five Technostress Creators are sufficiently representative of the entire content domain. Regularly checking this property is critical as the technological environment that causes technostress evolves constantly. While technostress was originally caused by automation in the workplace, it evolved into a computer-related problem later [10], and may again manifest differently nowadays.

In Section 2, we introduce the TCI in more detail and why we expect that a measurement instrument so tightly connected to the technological domain would benefit from an update. In Section 3, we present an overview of our research methods including the interview guide that was used for all 75 interviews, a characterization of the companies that were used as the sample for our investigation, and a description of the data analysis process (including the coding process and interrater agreement computation). In Section 4, we present the results of our investigation. Finally, in Section 5, we close with conclusions, including the implications of our findings.

2 Theoretical Background

The Technostress Creators are not the first inventory that was developed to measure stressors related to ICT. Another noteworthy, but far earlier inventory was developed by Richard Hudiburg, called the Computer Hassles Scale [11], [12]. This self-report inventory serves as a good example for the necessity to regularly update measurement scales related to technology as Hudiburg himself emphasized the need to make an update of his original instrument within only a few years. This was necessary as the original instrument included items that were related to specific

technologies that were somewhat new and stress-inducing at the time (e.g., automatic bank tellers or library computer scanners) [12], but became common technologies fast and were therefore removed as potential sources of stress in a later version of the inventory [11].

Developments of this kind have also been acknowledged by Ragu-Nathan et al. [1] who stated that "…modern ICTs have changed the work environment and culture." (p. 418). We endorse this statement and see no reason why this development would have stopped in the last decade. Additional evidence for the need for such an update was provided by Fischer and Riedl [5], who argued that the current conceptualization of technostress in the inventory may not fully encompass common types of technologies found in the workplace (e.g., as evidenced by the need to adapt techno-overload for the context of social media).

For our investigation, in addition to the original five technostress domains, we selected three potential technology-related stressors that have received significant interest by both researchers and practitioners, namely unreliability of technology (e.g., unexpectedly long system response times), monitoring via technology (e.g., electronic performance monitoring), and cyberbullying (e.g., impolite remarks made through electronic communication media). It has to be noted, that although important, these categories reflect a convenience sample of technology-related stressors which could be added to the Technostress Creators Inventory. In addition to this explorative investigation, therefore, a more systematic quantitative investigation is needed to further assess whether these categories, or other eventually also other categories, can strengthen the factorial structure of the inventory.

Unreliability. Reliability is an important feature of information systems that may never be completely achievable as stated by Butler and Gray [13] who expected that "…many important systems are not (and perhaps cannot be) inherently reliable." (p. 212). It has also been shown that system reliability is an important stress-related feature of ICT. For example, Ayyagari et al. [2] showed that system reliability is negatively related to perceived work overload, and Riedl et al. [14] demonstrated the detrimental effect of the malfunction of a webshop on individual stress physiology (i.e., a significant increase in the levels of the stress hormone cortisol).

Monitoring. Employee dissatisfaction related to electronic performance monitoring has been an early topic in technostress research. For example, in a nation-wide survey study amongst 762 employees in the USA, Smith et al. [15] found that monitored individuals report higher levels of job-related stress and physical strains independent of profession (e.g., sales representatives, but also clerks). In more recent years, workplace monitoring has also received considerable public interest, particularly as the threat for individual data privacy has become a more important focus [16], [17].

Cyberbullying. A more recent phenomenon in the workplace is related to the use of electronic communication media for negative behaviors (e.g., offensive comments and insults). Thus far, cyberbullying has mostly been focused on in the context of school children and young adults[1]. Using a sample of white-collar workers, Snyman

[1] https://www.nytimes.com/topic/subject/cyberbullying [07/17/2018].

and Loh [18] more recently confirmed the positive relationship between cyberbullying experiences at work and perceived daily stress in a survey study.

3 Methods

We investigated the prevalence of technological stressors through 75 interviews in four companies. Specifically, we constructed an interview guide, collected data, extracted relevant data in the transcripts (i.e., experiences related to technology-induced stress), coded the interview material, and summarized the data [19], [20]. We chose qualitative interviews because they allow us to grasp a wide area of individual experiences and give us the opportunity to make clarifications wherever needed (e.g., related to the definition of "stress", which can have different meaning across individuals).

Interview Guide. We first constructed an overall interview guide (originally in German) that was then slightly adapted for each company context (i.e., using a pre-test with 2 to 3 employees and adaptations in wording to increase comprehension by our interview partners). Keywords and descriptions for the original Technostress Creators were taken from Tarafdar et al. [6] and the remaining category descriptions were constructed in a comparable fashion:

- Unreliability (*Too unstable*): IS users are confronted with system malfunctions and unexpected system behaviors.
- Monitoring (*Controlled*): IS users feel constant levels of pressure as their behaviors can be tracked by technology and hence evaluated by other individuals.
- Cyberbullying (*Vulnerable*): IS users feel threatened by social misconduct facilitated by communication technologies and social media.

Sample and Data Collection. The sample included two small family-owned businesses and two medium to large sized organizations in Austria with up to several thousands of employees. In each organization, we aimed for a sample of individuals that was representative of the departments of the local branch of the organization or the organization as a whole (e.g., focusing on the largest departments). Participation in the 75 face-to-face interviews was voluntary. All interviews were recorded based on written consent given by the interview partners. An overview of the sample characteristics and the collection periods can be found in Table 1.

Each interview started with the interviewer first explaining the general topic of technostress, then asking the participant to sign a written consent form, and afterwards the technostress categories were briefly explained before the interviewee was asked to tell the interviewer about personal experiences with each technostress category they had at work. For the technostress categories, we used the same order every time (i.e., overload, invasion, complexity, insecurity, uncertainty, unreliability, cyberbullying, monitoring, other stressors); it has to be noted though that at each point interviewees were able to talk about their experiences related to each category. Interview lengths ranged from 9 to 78 minutes with a slight variance between organizations (company A: 18 to 70 minutes; company B: 14 to 78 minutes; company C: 9 to 26 minutes; company D: 13 to 53 minutes). The particularly short length of

interviews in company C could be attributed to efficient coping with technostress, facilitated by a high level of decision latitude in the organization (e.g., individuals can switch easily between activities and are not mandated to be available for further tasks as soon as they leave the workplace).

Table 1. Sample characteristics and overview of collection periods

ID	*Type of business*	*N*	*Age Median*	*Collection Period*
A	Software development	15 (2 f)	42	03/16/2017-05/04/2017
B	Passenger transportation	21 (8 f)	50	12/06/2017-03/12/2018
C	Publishing	24 (20 f)	38.5	12/14/2017-03/21/2018
D	Petrochemical production	15 (2 f)	43	11/20/2017-03/28/2018

Content Analysis and Interrater Agreement. The interviews were transcribed by the interviewers and potential experiences of technostress (e.g., instances were individuals showed annoyance or anger related to technology) were highlighted in each transcript using MAXQDA (version 11).

A total of 380 text passages related to technostress were then coded by the first and second author independently, using the stressor categories. Cohen's Kappa was used as a measure of interrater agreement [21]. Overall, a Cohen's Kappa of .84 was achieved, which indicates a strong agreement between the coders [22], with a range of .83 (company C) to .87 (company B). The remaining text passages, for which no initial agreement was achieved, were then discussed by the first and second author until a consensus was reached.

4 Results

In the following sections, we present insights for the original TCI and our additional stress categories, including concrete quotations from the interviews (literally translated from German). In addition, for each stressor we report on the share of individuals (rather than the absolute number, because of differences in samples sizes) who have had experiences with it before as well as an average (AVG) across all organizations (please note that this average is not weighted based on the sample size per company).

4.1 Technostress Creators Inventory (TCI)

From our investigation, we can conclude that there is a large variance in the share of individuals who had stressful experiences with techno-overload and techno-invasion across companies, while that share is widely consistent for techno-complexity, techno-insecurity, and techno-uncertainty.

Techno-Overload (A: 93%; B: 52%; C: 42%; D: 80%; AVG: 67%). In this category, we found a large discrepancy between companies, with the software developer (A) having the highest share of individuals who had experienced techno-overload before, while individuals in the transportation company (B) and the

publishing company (C) had far less experience with this kind of stressor. In company A, most of the interviewed employees have short-term problem solving as part of their job responsibilities, which could explain the high prevalence of overload in this context. Particularly the dependence on communication technologies in some cases leads to a strong need to keep a focus on inboxes, with one software developer (A01, male, 44 years old) stating that: "*My main medium is e-mail. Within that medium, it is absolutely massive. Practically speaking, I spend about 80% of my time with e-mails*."

In the cases of companies B and C, this problem is far less prevalent and decision latitude seems to have an impact on this matter and in particular timing control [23], which is evident in the statement of one member of the management in company B (B01, male, 52 years old): *"On one hand, I think that [ICT] is stress-reducing, because it lets me know what is still to do. Back in the day, I had to wait until the evening until I received a long list of tasks for the next day. Now I know exactly what to do and can schedule ..."*

Techno-Invasion (A: 73%; B: 38%; C: 4%; D: 40%; AVG: 39%). In this category, we find more support for the assumption that timing control may have a strong influence on technostress perceptions. One of the manifestations of this relationship can be found in company A, were individuals have to cope with rigorous customer demands and a large variety of customized systems. A member of the support team (A02, male, 42 years old) addresses this point directly, stating that: "*As soon as I am awake, I basically look into it all the time and react to them [i.e., e-mails]. Because there is an implicit demand and our customers get really angry when they write an e-mail on Sunday and do not get a response."*

This pressure, which takes timing control away from the individual, as quick responses and solutions are needed, is far less of a problem in company C, as indicated by an employee who is responsible for managing online media outlets of the company (C01, female, 30 years old): "*Generally, if somebody is calling me in the office, I am taking the call. If this person then starts to chat away, for which I might not have time at work, I try to reschedule the call towards the evening*."

Techno-Complexity (A: 40%; B: 38%; C: 46%; D: 53%; AVG: 44%). Being overwhelmed by the possibilities and functionalities of ICT was a recurring problem in all companies, mostly caused by large numbers of different systems or a wide variety of different use cases that were not all needed regularly. One member of the research and development department in company D (D01, female, 39 years old) pointed out that there is often a lack of time to get used to operate complex systems, stating that: "*For example SAP, something like that is extremely complex. ... if you find the time to use it and get used to it… then you get able to handle such a system. Yet, that time is often missing.*"

Techno-Insecurity (A: 13%; B: 33%; C: 8%; D: 0%; AVG: 14%). The level of perceived threat to one's job security and potential changes to the job profile was generally low across all organizations. The highest prevalence of this stressor was in company B, with bus drivers fearing that they might get replaced someday. As one bus driver (B02, male, 55 years old) puts it: "*When the bus is controlled by computers someday, then I will not sit in it anymore. This will definitely become a reality, but I*

will not experience that during my time. We do not have to discuss that, this will definitely come to pass!"

Techno-Uncertainty (A: 53%; B: 52%; C: 42%; D: 53%; AVG: 50%). As a stressor, the prospect of unexpected and rapid changes in the used technologies was comparable in its frequency to techno-complexity. There were also no main differences between companies in this domain, with most individuals reporting stress due to the uncertainty whether they would be able to use systems again after some sort of update. What is interesting though, is that the prospect of changes themselves is not that stressful, but what may come after, as expressed by a customer support employee in company A (A03, male, 27 years old): "*In our case, there are constant changes and new additions to programs. In many instances I do not really know if some added part works already or not*."

4.2 Techno-Unreliability

Unreliability of systems turned out as the most frequently cited stressor (A: 80%; B: 76%; C: 75%; D: 67%; AVG: 74%). In some cases, smaller hassles were reported as stress-inducing as they occurred frequently and therefore led to a chronic experience of stress. For example, a software developer in company A (A04, male, 37 years old) reported on his constant problems with a slow Internet connection: "*This is amongst our biggest topics – the stability of the Internet connection. ... There is nothing worse than hitting a button and there is a delay until it loads. Or when you try to scroll down on your monitor and you can watch it go down very slowly*."

In other cases, singular, non-frequent instances of unreliability, sometimes with serious consequences, were reported, such as lost work as reported by a member of the sales department in company C (C02, female, 54 years old): "*When an order gets lost or, in the case of e-mail, when I have written a comprehensive offer, was almost done and then it suddenly gets lost. That does not make you happy…*"

In each case, ICT behaved differently from what individuals expected and therefore caused anger or insecurity. In addition, comparable to techno-uncertainty, there is a spiral of problems that is related to unreliability. While slow response times themselves may not be problematic, these delays may lead to work overload as the current task cannot be handled sufficiently fast. Hence, time pressure is an important contextual factor for unreliability-related stress, just as the job-related dependence on technology [24]. This was indicated by a bus driver in company B (B03, male, 50 years old) who stated: "*Simply, because you are dependent on that stuff and in a crucial moment it often does not work. That is pure stress! When your navigation device does not work and you are not sure where to go*."

4.3 Monitoring

Comparable to techno-overload, there was also a large variance of the prevalence of experiences with monitoring between companies (A: 53%; B: 43%; C: 0%; D: 27%; AVG: 31%). While none of the individuals in company C had any stressful experiences with monitoring, more than half of the individuals in company A had

made such experiences before. A potential connection here can be drawn between these observations and the level of control that is exerted in each company, for varying reasons. For example, regulatory demands (e.g., documentation of working hours) were often quoted as potential reasons for monitoring, which although often acknowledged as reasonable, nonetheless led to substantial stress. In company B, one of the bus drivers (B04, male, 58 years old) argued: "*I do not find it distracting, but not right, as we are completely supervised. It does not matter who it is … they know at all times exactly where I am."*

In the same vein, a customer support employee in company A (A05, female, 23 years old) stated: "*What I fear is that everything can be checked. What I do, what I say … internal support can check everything. … That leads to … pressure*."

Monitoring and data collection are also often accompanied by a lack of transparency on what types of data are collected and why they are collected. Even if being monitored was not directly stress-inducing, the lack of transparency itself led to concern in individuals, which was particularly expressed by individuals in company A and D, who are knowledge workers handling extensive amounts of data. For example, a software developer in company A (A01, male, 50 years old) expressed particular concern stating: "*You do not feel threatened … it is more of a concern due to the uncertainty of what will happen with the data and for how long it is kept*." An employee in the innovation and process management department in company D (D02, male, 52 years old) extended this thought and told us of a case that justified that type of concern: "*We had the case, where e-mails from the last 15 years were opened. I was also often involved. [It creates] fear that you are completely transparent.*"

4.4 Cyberbullying

Experiences with mobbing or bullying via ICT were the least prevalent type of stressor, comparable to techno-insecurity (A: 13%; B: 38%; C: 0%; D: 0%; AVG: 13%). In two companies, none of the interviewed individuals reported about any own experiences with stressors of this category, though they were mostly aware of the possibility of this type of behavior.

In those few cases were individuals reported on related experiences, they mostly traced rude or unsocial behavior back to the type of impersonal communication that ICT allow for. For example, a member of the management of company B (B05, female, 49 years old) felt that communication amongst employees was more confrontational if it was done via ICT: "*In our WhatsApp group we are often confronted with subservient messages by our drivers. What really annoys me is when pictures of a dirty vehicle get posted, just because there are some crumbs in it … They make a mountain out of a molehill … and everybody can see it*."

A potential explanation for the low prevalence of this type of stressor are coping mechanisms that individuals employ to avoid such issues related to ICT-mediated communication. One internal support employee in company A (A06, male, 23 years old) even stated that he now detests online communication and he explained that he tries to avoid it: "*I personally prefer to not write via ICT … because something always comes back. In that moment I feel like [telling that person] that I am also not*

the perfect human being and also cannot deliver a 100% perfect answer. I am not interested in getting rebuked ten times in ten e-mails …."

4.5 Additional Technostressors

In addition to our eight stress categories that were defined and presented to the interviewed individuals, we also gave them the chance to talk about additional instances were ICT may lead to stressful experiences. With the exception of company B, individuals in every company told us about such instances (i.e., 13% of individuals in company A, 21% in company C, 20% in company D). We clustered these instances in two broader categories, with the first one being related to ambiguity in communication via ICT and the second one being related to information system security.

In company A and company C, some individuals expressed that they were sometimes confronted with confusion and misunderstandings when they communicated via ICT, about issues that could otherwise be resolved quickly when they interacted personally. For example, a customer support employee in company A (A07, male, 26 years old) reported about a case were a program misbehaved: *"[The function of the system] does not work and [another employee] shows it to me today and tells me that it does not work. I try all the necessary steps and it works. … None of the software developers were able to [solve it]. They had exchanged 20 e-mails amongst each other, sometimes with 10 people in carbon copy … and we solved the problem quickly in a casual interaction.*"

Relatedly, previous research has found that communicating the way we would usually do (e.g., using gestures and voice tonality) is mostly not possible using communication channels such as e-mail, which can lead to messages being interpreted in a different way [25].

The second area that was prevalent in companies C and D was stress from security threats, either directly (e.g., hacking attacks) or indirectly (e.g., stress from security measures to avoid security threats). A member of the sales department in company C (C04, female, 48 years old) reported on her concerns regarding the possibility of threats from outside the company: "*My brother-in-law told me that it is enough to open an e-mail. That can be enough for hackers to cause some damage … and that is why you have to be really careful. For example, when an e-mail only with an attachment and nothing else comes in, then I am instantly nervous, because I do not know what it is. I immediately delete it then!*"

The steps that are then taken to avoid such threats should be planned carefully. If security measures are too rigorous, they might create stress on their own as indicated by a member of the marketing department in company D (D03, male, 48 years old): "*It becomes a problem when I want to load a website of one of our customers or potential customers and they include some words that are usually under embargo for us and … the pop-up-blocker stops me … that can be annoying right then*."

5 Conclusion and Future Research

Recently, Tarafdar et al. [26] presented updated definitions of their original constructs (see [1]), which now envelop some of our proposed stress categories. For example, aspects of unreliability are now included in techno-complexity as "interruptions, complications, hassles", monitoring is included as part of techno-invasion and security-related stress is spread out across techno-overload (adhere to security requirements), techno-invasion (surveillance and monitoring), techno-uncertainty (no control over IS use policies), and techno-complexity (hard to understand IS use policies). Yet, although the authors have acknowledged through this update that their original conceptualization of technostress was out-of-date to some degree ten years after its inception, or eventually lacking in completeness at all, we are not aware of an updated technostress measurement instrument that reflects this extended conceptualization on the item level.

In addition, it is questionable whether new aspects of technostress can simply be assigned to dimensions in the existing framework of Ragu-Nathan et al. [1] or whether additional dimensions are needed. For example, Ayyagari et al. [2] made a clear distinction between complexity and reliability as technology features. In our investigation, unreliability was the most prevalent technostress creator, but only occurred together with complexity to a limited extent (i.e., 48% of individuals who reported experiences with unreliability also had stressful experiences with complexity, which is less than uncertainty with 50% or overload with 63%).

Based on this evidence, we therefore make a call for additional quantitative investigations into the dimensionality of technostress, which acknowledges the current status of affairs. Based on the usage of a new set of items, it would be possible to demonstrate whether the same dimensions of technostress creators emerge again and therefore uphold the test of time or whether extending their definitions has led to a bloating of these first-order constructs beyond their conceptual usefulness.

Our research study also has limitations. First, though we used a sampling procedure that was comparable to Ragu-Nathan et al. [1] (i.e., firm-specific samples, selection of organizations based on contacts, self-selection of respondents), this naturally leads to a sample that is not generalizable to a wider population and results should therefore only be interpreted in the context of the specific companies and individuals involved. We also used a conservative approach in our coding procedure, only focusing on own accounts of previous stressful experiences. This may have led to an underestimation of certain stressor categories, for example indicated by the account of an employee in the research and development department of company D (D04, male, 30 years old): *"...when somebody is sitting next to you and receives a WhatsApp message or an SMS every 10 seconds and it rings all the time with some weird noise. That is not only stressful for them ... but it also stresses me if it rings all the time*." In addition, personal interviews may have led to some individuals not wanting to talk about their previous experiences in detail, as was sometimes the case for cyberbullying, where individuals hinted on some type of experience, but did not go into detail on their own (a form of social desirability bias). To minimize the influence of this bias, interviews were always conducted by a person that the

individual was familiar with (to ensure a level of trust) using a standardized interview guide. We avoided conducting interviews ourselves as outsiders might be perceived as "agents" of the company management.

In summary, we argue that a systematic investigation of the factorial structure of technostress is needed. Further, we recommend the use of data triangulation in order to elicit stressor categories that were not considered before (e.g., bullying), but may be more important than self-report data alone could reveal initially.

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