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Measuring digital stress in the workplace context

Short version of the Digital Stressors Scale (DSS)

René Riedl[1,2] · Thomas Fischer[3] · Martin Reuter[4]

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Abstract
Digital stress is a form of stress caused by the use and ubiquity of digital technologies. More and more scientists and practitioners are interested in the phenomenon of digital stress, its causes (e.g., constant smartphone accessibility, unreliable and unstable systems, information overload), and its consequences (e.g., negative health effects, dissatisfaction, or reduced performance and productivity). In an article published in *Frontiers in Psychology* (12:607598), we introduced the English version of the Digital Stressors Scale (DSS). This is a psychometrically evaluated self-report questionnaire for measuring digital stress in the workplace. In the current paper, we present a short version of this original questionnaire. The original questionnaire consists of 50 questions (items), whereas the short version presented here contains 30 questions. In accordance with the original questionnaire, the entire digital stress experienced by an individual in the workplace is based on 10 stress categories, with each category being assessed with three questions in the short version. Academics can use the questionnaire to quantify digital stress and its 10 dimensions for reliable and valid measurement within the context of scientific research. Practitioners benefit from using this assessment tool to measure the digital stress perceived by employees in the organizational environment. This is a precondition for implementing effective coping strategies.

According to the International Telecommunication Union (ITU), approximately 5.3 billion people used the internet in 2022 (www.itu.int), which constitutes a majority of the global population. Furthermore, today information and communication technologies (ICT) are an essential backbone of a functioning economy, public administration, and society in general. The use of ICT brings significant benefits to individuals, organizations, and society. Examples include improved access to information, more and faster communication possibilities, as well as increased efficiency and productivity [1–3].

Despite these positive effects, the use and ubiquity of ICT can also have significant negative consequences. One major negative impact is digital stress. Both scientific research and anecdotal evidence indicate that human interaction with ICT, both in private (e.g., social media usage like Facebook or Instagram) and organizational (e.g., email, business application systems, social collaboration platforms like Jira or Teams) contexts, can lead to considerable stress perceptions among users [4, 5].

In the present article, we focus on the digital stress that users perceive in the workplace context due to the use and ubiquity of ICT. The phenomenon of digital stress was already discussed several decades ago, primarily as a result of the introduction of personal computers (PC) in companies. This discussion was predominantly based on the terms "technostress" [6] and "computer stress" [7]. However, in

Terms of use: The questionnaire instrument presented here can be freely used for scientific research purposes. Information on the instrument's use in an organizational context and in a consulting context can be obtained from the first author of this article.

✉ René Riedl
rene.riedl@fh-steyr.at

[1] Digital Business Institute, University of Applied Sciences Upper Austria, School of Business and Management, Campus Steyr, Steyr, Austria

[2] Institute of Business Informatics—Information Engineering, Johannes Kepler University Linz, Linz, Austria

[3] University of Applied Sciences Upper Austria, School of Business and Management, Campus Steyr, Steyr, Austria

[4] Department of Differential and Biological Psychology, University of Bonn, Bonn, Germany

the past 15 years numerous scientific studies on ICT's stress potential have been published [8]. Given the ongoing increase in digitalization in business, public administration, and society, it is expected that the phenomenon of digital stress will continue to be highly relevant in both science and practice.

Both in science and practice it is important to be able to reliably measure the phenomenon of digital stress. In addition to objective neurophysiological stress measurements [9–11], the use of questionnaire-based measurement instruments is often recommended in the academic literature, which can systematically capture subjective stress perceptions based on Likert scales [12]. In science, this type of stress assessment is essential because it allows the latent construct of "digital stress" to be measured empirically in theory-driven research. Furthermore, it is known that the detrimental effects of stress often also relate to negative subjective states that are objectively difficult to quantify [13]. In practice, the availability of a reliable and valid questionnaire-based measurement instrument is equally important so that organizations can assess the stress perceived by their employees. Based on such measurement in companies, effective measures for reducing or avoiding digital stress can be implemented. We observe that an increasing number of decision-makers in practice are beginning to address digital stress, as well as its causes and consequences. While traditionally managers from human resource (HR) departments were more concerned with this phenomenon, more and more top-level managers are now also paying attention to the topic. This is partly because this group is also affected by digital stress and partly because digital stress can adversely affect the performance and productivity of organizations, thus having direct business relevance [14].

Methodology

Data collection

For the validation of the instrument, we used an existing data set ($n = 3333$) that was collected in the German-speaking region (Germany, Austria, Switzerland) as part of the development of the original version of the Digital Stressors Scale (DSS). About one third of the data originates in each of the three countries and the participants are representative of the local employed population in terms of age and gender distributions (for details, please refer to [15]).

The questionnaire was provided online and for each question, a 7-point Likert scale was consistently used ranging from 0 "strongly disagree" to 6 "strongly agree." Hence, the value "3" constitutes the neutral position on the scale. For each question, the participants also had the possibility to choose the option "Don't know" and were instructed to do so if they were not sure about the meaning of the question or if they thought that it was not applicable to their situation.

Table 1 Reliability of stressor categories in the 50-item and 30-item version of the Digital Stressors Scale (DSS)

Stressor category	Cronbach's α	
	DSS[50]	DSS[30]
I. Complexity	0.88	0.79
II. Conflicts	0.91	0.85
III. Insecurity	0.92	0.86
IV. Invasion	0.86	0.81
V. Overload	0.85	0.79
VI. Safety	0.85	0.79
VII. Social environment	0.80	0.72
VIII. Usefulness	0.84	0.72
IX. Technical support	0.87	0.78
X. Unreliability	0.84	0.83

Instrument validation

To create a short version of the original DSS, we focused on retaining at most three items per stressor category, in line with recommendations for the minimum number of items that is needed for reliability and factor analyses (e.g., [16]). We retained items that have shown strong loadings with their respective stressor categories in the original instrument and then tested the *reliability* of each of the 10 stressor dimensions with their reduced number of items. As can be seen in Table 1, all stressor categories show sufficient reliability with a Cronbach's alpha of >0.70. In addition, despite the fact that we substantially reduced the number of items for each stressor category (from five to three, and hence the total number of questions in the instrument was reduced from 50 to 30, a reduction of 40%), we can observe that for most categories of the short version instrument (denoted DSS[30]) reliability is comparable to the original version of the DSS and the criterion of Cronbach's alpha >0.70 was always met (denoted DSS[50]).

After this initial inspection of the reliability of our short version instrument, we then used the 30 items and 10 stressor categories as input for a confirmatory factor analysis to also ensure the *validity* of the new factor structure. The overall quality of the model can be inspected using fit indices, which show that the new factor structure works very well: Chi-Square = 2602.68, df = 360, $p \leq 0.0001$; Root Mean Square Error of Approximation (RMSEA) = 0.045; Normed Fit Index (NFI) = 0.99; Comparative Fit Index (CFI) = 0.99; Standardized RMR = 0.034; Goodness of Fit Index (GFI) = 0.95 (see [17] for related cutoff values). In addition, Table 2 shows that each item loads strongly onto its dedicated stressor category, which indicates that the

Table 2 Stressor categories, items, and standardized factor loadings

Stressors and items	Factor loadings
I—Complexity	
I.1 I often find it too complicated to accomplish a task using the ICT that are available to me at work	0.77
I.2 I feel that the ICT that are available to me at work are too confusing	0.77
I.3 I often do not find enough time to keep up with new functionalities of ICT at work	0.76
II—Conflicts	
II.1 I feel that my private life suffers due to ICT enabling work-related problems to reach me everywhere	0.82
II.2 It is too hard for me to keep my private life and work life separated due to ICT	0.85
II.3 ICT make it harder to create clear boundaries between my private life and work life	0.82
III—Insecurity	
III.1 I fear that I could be replaced at work due to the increasing standardization of work processes, which is enabled by ICT	0.80
III.2 I fear that I could be replaced by machines	0.82
III.3 I fear that digitalization will cost me my job	0.85
IV—Invasion	
IV.1 I fear that my use of ICT is less confidential than I would like it to be	0.81
IV.2 I fear that the information that I exchange using ICT is not as protected as I would like it to be	0.80
IV.3 I fear that malevolent outsiders (e.g., hackers) can easily copy my identity due to ICT	0.75
V—Overload	
V.1 Due to ICT I have too much to do	0.77
V.2 Due to ICT I have a too large variety of different things to do at work	0.77
V.3 I never have any spare time because my schedule is too tightly organized by ICT	0.77
VI—Safety	
VI.1 I have to worry too often whether I might receive malicious e-mails	0.75
VI.2 I feel anxious when I get an e-mail from somebody that I do not know as it could be a malevolent attack	0.82
VI.3 E-mails whose sender I do not know make me nervous	0.76
VII—Social environment	
VII.1 Due to ICT I have too much to do with the problems of others	0.72
VII.2 I think that ICT generate too much of an expectation that I have to be reachable everywhere and at any time	0.71
VII.3 I feel that ICT create unwanted social norms (e.g., the expectation that e-mails should be answered right away)	0.65
VIII—Usefulness	
VIII.1 I think that I do not gain enough benefits from using the ICT that I am provided with at work for my tasks	0.72
VIII.2 The ICT I use at work are full of too many functionalities that I never need	0.69
VIII.3 I think that most of the ICT I am supplied with at work is not useful enough and I could work without it	0.67
IX—Technical support	
IX.1 In the case of ICT-related problems, it happens too often that there is not enough support available at work	0.77
IX.2 I think that it happens too often that technical support is not available when I need it	0.75
IX.3 I often have to wait for a long time because technical problems cannot be adequately solved in our organization	0.74
X—Unreliability	
X.1 I think that I lose too much time due to technical malfunctions	0.79
X.2 I think that I spend too much time trying to fix technical malfunctions	0.81
X.3 There is just too much of my time at work wasted coping with the unreliability of ICT	0.82

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expected association between items and latent factors are supported.

Applying the instrument

Recommendations for using the questionnaire can be made to help apply it effectively. For *designing the questionnaire*, it is recommended to make it available online, as it was during the instrument's development, thereby facilitating the presentation of the items in random order. Additionally, there should be an introductory statement at the beginning, describing the types of technologies respondents should consider when answering the questionnaire. Based

Table 3 Recommended introductory statement

The penetration of society with Information and Communication Technologies (hereinafter referred to as ICT) continues unabated, and there is no doubt that ICT has become a pivotal factor in the lives of many people. A modern society without the use of ICT is not imaginable today. Individuals, organizations, and society in general benefit from the use of ICT in various ways, including improved access to information and increased productivity. Despite these positive effects, human-computer interaction in both personal and organizational contexts can lead to significant stress reactions in users. We now want to explore your perceptions regarding digitalization in the professional environment
Explanation of ICT: Please note that the abbreviation "ICT" stands for "Information and Communication Technologies," encompassing a range of technologies commonly associated with office work. Typically, ICT includes: – Mobile technologies (e.g., mobile phones, laptops, pagers, PDAs) – Network technologies (e.g., the internet, intranet, VPN) – Communication technologies (e.g., email, voicemail) – Enterprise software (e.g., SAP) – Generic applications (e.g., word processing, spreadsheet programs, or presentation software) – Collaborative technologies (e.g., chat or videoconferencing tools) – Other workplace-specific technologies
The questions pertain to your perceptions of ICT in your professional environment and your personal well-being. If you are ready, please click 'Next.' Note: If you are unsure about a question, find it unclear, or believe it does not apply to your situation, please select the 'Don't know' option in the questionnaire. Thank you for your participation

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on Riedl et al. [15], we recommend the statement as summarized in Table 3.

Each item can be answered on a 7-point Likert scale, ranging from "strongly disagree" (value "0") to "strongly agree" (value "6"). As a result, "neutral" corresponds to a value of "3" and represents the middle of the scale. The "Don't know" option is also provided. Before beginning the data analysis following the survey, it is necessary to check for potential missing values. If respondents selected the "Don't know" option or left an item unanswered, the missing value can be replaced with the median of the remaining values for that item. However, if the proportion of these cases is very high (e.g., >10%), consideration should be given to excluding the respective item from further analysis.

To calculate *values for the 10 stress categories and the overall digital stress score*, the average of values per stress category (i.e., the average across the three items in each category) or the average across all items in the questionnaire (i.e., across the 30 items) is to be calculated. This procedure is possible because the DSS is a reflective questionnaire instrument. This means that the stress categories represent the perception of digital stress, and the items, in turn, represent their respective stress category. Consequently, the 10 stressor categories can also be used independently of each other. Therefore, for a specific scientific investigation or in a particular company, if not all stress categories are relevant or, in an extreme case, only one category is of interest, the relevant categories can be used independently. However, it is recommended to use the five-item version [18], especially when prioritizing a specific stress category or a few categories, to better mitigate the disruptive effects of missing values.

When *interpreting the obtained stress values*, the following should be considered. When calculating the total digital stress experienced by an individual (i.e., the average across all 30 questions), every value greater than zero already represents stress perceptions—the higher the value, the more pronounced the perceived stress. Moreover, our experiences of using the measurement instrument in corporate practice show considerable variations in values across the 10 stressor categories. The average value of the total perceived digital stress lies roughly in the middle of the scale and slightly below it for a majority of respondents. It is less common for many employees in a company to be far above the scale's midpoint. However, this does *not* mean that such a situation is only associated with low to moderate strain levels among respondents. Rather, reports from corporate projects in German-speaking areas indicate that, at least currently, some stressor categories may have a rather low manifestation (e.g., stressor category III—Insecurity), while other categories can exhibit very high manifestations (e.g., stressor categories II—Conflicts and VII—Social environment). Such a constellation can be associated with high perceived strain, even with a moderate overall score for digital stress. In extreme cases, as per our experience from corporate projects, nine of the 10 categories may have a rather low manifestation, while one category has the maximum manifestation, leading to significant strain and burnout tendencies.

Furthermore, it should be noted that the interpretation of (digital) stress is ideally carried out using neurobiological methods and survey methods (such as the short or long version of the DSS). The main reason for this fact is that conscious stress perceptions in individuals that can be measured using survey methods often do *not* correlate with the typically unconscious increases in stress hormones and other stress parameters, such as increased blood pressure and reduced heart rate variability. This finding is reported in both the general stress literature and in the literature on digital stress (selected studies can be found in [10]). Therefore, in questionnaires, individuals may exhibit low values (i.e., they subjectively believe they have little stress) when asked about their perceived (digital) stress, even though neurobiological stress parameters already show increased or significantly changed values compared to baseline measurements. Despite this fact, psychometrically evaluated survey instruments for measuring digital stress, such as the DSS, are currently the central tool for stress assessment in a cor-

porate context, particularly from the perspective of management and HR departments, even though wearables like smartwatches increasingly allow for a relatively straightforward physiological determination of stress parameters such as heart rate and heart rate variability [19].

Conclusion

Digital stress is a form of stress that is gaining increasing importance worldwide due to the widespread use of ICT. In this article, an English-language short version of the DSS was introduced based on the original English-language [18] and German-language [15] instruments, each of which conceptualizes digital stress along 50 questions across 10 stressor categories. The instrument presented in the current paper consists of 30 questions, and each stressor category is measured based on three questions. The psychometric evaluation presented here demonstrates the instrument's reliability and validity, both regarding the total digital stress perceived by an individual in the workplace and for each of the 10 stressor categories. The instrument introduced here contributes to future research and the assessment of digital stress in businesses, providing a foundation for the development of effective coping strategies.

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Note A German version of the measurement instrument presented in this article is published in a paper entitled "Digitalen Stress im Arbeitskontext messen: Kurzversion der Digital Stressors Scale (DSS)" in Wirtschaftsinformatik & Management (2023).