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Digital Transformation Stress at the workplace: Measurement and Intervention

PhD Thesis

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Abstract

Digital transformation (DT) is a continuous and one of the most dynamic processes taking place in nowadays world, including organizations. Despite the value of information and communication technology (ICT) solutions and the benefits of digital transformation for people (including employees) and organizations, it is also important to recognize the negative consequences of DT processes. DT challenges, such as tight DT schedules, increased workload, and high time pressure, negatively affect the well-being of employees by increasing job stress, which in turn can lead to burnout. This stress is not just a reaction connected to the need to adapt to working with new technologies. It is rather more a reaction to the digital transformation process itself, including ICT job demands, mode of ICT project management, digital changes introduced in workplace. Therefore, in my research, I introduced a concept of digital transformation stress (DTS) as an approach to job stress in relation to digital transformation process regarding organizations. According to my assumptions, I define DTS as an emotional response of an employee to the specific digital transformation process itself. Accordingly, DTS is a complex concept. This concept includes project management, attitudes to digital changes and to the increasing role of ICT in digital transformation process as well as consequences of specific, ICT job demands related to DT process. Thus, in my research, I began by distinguishing the DTS concept along with proposing tools to measure DTS. Then, using an interdisciplinary approach, I developed a self-report scale to measure DTS and applied sentiment analysis to detect DTS markers in written communication. Simultaneously, based on the Job Demands - Resources model, adapted to DT context, I identified the main predictors of DTS and self-efficacy as a personal resource that mitigates DTS. Finally, I designed and tested a prototype of online psychological intervention that aimed to strengthen job related self-efficacy to cope with digital transformation stress. In my research**, I propose a complete set for measurement of DTS, identification of job ICT demands and resources related to DTS and prototyping the online intervention, which might help to cope with DTS**. My research might provide a basis for creating an application for automatically identifying employees with a high level of DTS, as well as identifying the most common stress triggers, such as specific ICT job demands related to DT process. Furthermore, I confirmed that self-efficacy is a personal resource whose enhancement is important for decreasing stress. Consequently, my research can contribute to the creation of a tailored online intervention for coping with stress. My contributions may help to make the digital transformation process and IT projects less stressful and more effective for employees and organizations.

Streszczenie

Transformacja cyfrowa (DT) to ciągły i jeden z najbardziej dynamicznych procesów zachodzących w dzisiejszym świecie, w tym w organizacjach. Pomimo wartości rozwiązań z zakresu technologii informacyjnych i komunikacyjnych (ICT) oraz korzyści, jakie transformacja cyfrowa przynosi ludziom (w tym pracownikom) i organizacjom, ważne jest również dostrzeżenie negatywnych konsekwencji procesu DT. Wyzwania związane z DT, takie jak napięte harmonogramy DT, zwiększone obciążenie pracą i wysoka presja czasu, negatywnie wpływają na samopoczucie pracowników poprzez zwiększenie stresu zawodowego, który z kolei może prowadzić do wypalenia zawodowego. Ten stres nie jest tylko reakcją związaną z koniecznością dostosowania się do pracy z nowymi technologiami. Jest raczej reakcją na sam proces transformacji cyfrowej, w tym na wymagania dotyczące pracy z ICT, sposób zarządzania projektami ICT, wprowadzanymi zmianami cyfrowymi w miejscu pracy. Dlatego w moich badaniach wprowadziłam pojęcie stresu transformacji cyfrowej (DTS) jako podejście do stresu w pracy, w związku z procesem transformacji cyfrowej w organizacjach. Zgodnie z moimi założeniami, definiuję DTS jako emocjonalną reakcję pracownika na określony proces transformacji cyfrowej. W związku z tym DTS jest pojęciem złożonym. Pojęcie to obejmuje zarządzanie projektem, postawy wobec zmian cyfrowych i rosnącej roli ICT w procesie transformacji cyfrowej, jak również konsekwencje specyficznych, wymagań zawodowych związanych z ICT i procesem DT. Dlatego też w swoich badaniach zaczęłam od wyróżnienia koncepcji DTS wraz z zaproponowaniem narzędzi do pomiaru DTS. Następnie, stosując podejście interdyscyplinarne, opracowałam skalę samoopisową do pomiaru DTS i zastosowałam analizę sentymentu do wykrywania znaczników DTS w komunikacji pisemnej. Jednocześnie, na podstawie modelu "Wymagania pracy - zasoby", dostosowanego do kontekstu DT, zidentyfikowałam główne predyktory DTS oraz poczucie własnej skuteczności jako osobisty zasób łagodzący DTS. Wreszcie, zaprojektowałam i przetestowałam prototyp interwencji psychologicznej online, której celem było wzmocnienie poczucia własnej skuteczności związanej z pracą, aby poradzić sobie ze stresem związanym z transformacją cyfrową. W moich badaniach **proponuję kompletny zestaw do pomiaru DTS, identyfikacji wymagań ICT w pracy i zasobów związanych z DTS oraz prototypu interwencji online, która może pomóc w radzeniu sobie z DTS**. Moje badania mogą stanowić podstawę do stworzenia aplikacji do automatycznej identyfikacji pracowników o wysokim poziomie DTS, jak również do identyfikacji najczęstszych czynników wywołujących stres, takich jak specyficzne wymagania ICT związane z procesem DT. Ponadto potwierdziłam, że poczucie własnej skuteczności jest zasobem osobistym, którego wzmocnienie jest ważne dla zmniejszenia stresu. W związku z tym moje badania mogą przyczynić się do stworzenia dostosowanej interwencji online w zakresie radzenia sobie

ze stresem. Mój wkład może pomóc w uczynieniu procesu transformacji cyfrowej i projektów IT mniej stresującymi i bardziej efektywnymi dla pracowników i organizacji.

Papers included in the series of articles:

1. Makowska-Tlomak, E., Nielek, R., Skorupska, K., Paluch, J., & Kopec, W. (2021, December). Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress. In *IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology* (pp. 103-111).

    - **IF:** - **MNISW**: 70 **My contribution**: 75%

    - My contribution to this article consisted in designing and conducting the studies, creation of algorithm and analyzing and interpreting the data, writing the manuscript (literature review, describing and presenting the results, creating the entire text), submitting the article for publication, responding to reviews, introducing corrections as suggested by reviewers.

2. Makowska-Tłomak, E., Bedyńska, S., Skorupska, K., & Paluch, J. (2022). Blended Online Intervention to Reduce Digital Transformation Stress by Enhancing Employees' Resources in COVID-19. *Frontiers in psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.732301

    - **IF:** 2.99 **MNISW**: 70 **My contribution**: 78%
    - My contribution to this article consisted in research concept, project preparation, organization and planning, scales development and methodology, writing the manuscript (literature review, describing and presenting the results, creating the entire text), editing, and revision, intervention content development, and design of figures, intervention diagram preparation as well as in submitting the article for publication, responding to reviewers, introducing corrections as suggested by reviewers. In relation to data analyzing, my contribution consisted in data curation, formal analysis, interpretation of results.
3. Makowska-Tłomak, E., Bedyńska, S., Skorupska, K., Kopeć, W., Nielek, R., Kornacka M. (submitted). Measuring Digital Transformation Stress at the Workplace – development and validation of the Digital Transformation Stress Scale. *Plos One*, number of manuscript: PONE-D-22-03821R2
    - **IF**: 3.75 **MNISW**: 100 **My contribution**: 65%
    - My contribution to this article consisted in research concept, conceptualization of DTSS, project preparation, organization and planning, scales development and methodology, data collections, conducting statistical analysis writing the manuscript (literature review, describing and presenting the results, creating the entire text), editing, and revision, submitting the article for publication, responding to reviewers, introducing corrections as suggested by reviewers. In relation to data analyzing, my contribution consisted in data curation, formal analysis, interpretation of results.
4. Makowska-Tłomak, E. and Bedyńska, S. (submitted). Negative consequences of ICT job demands in the workplace: Digital Transformation Stress and Burnout. *Human–Computer Interaction,* Submission id: 235662210,
    - **IF**: 6.45 **MNISW**: 140 **My contribution**: 65%
    - My contribution to this article consisted in research concept, translation of ICT Demands, project preparation, organization and planning, data collections, conducting statistical analysis writing the manuscript (literature review, describing and presenting the results, creating the entire text), editing, and revision, submitting the article for publication. In relation to data analyzing, my contribution consisted in data curation, formal analysis, interpretation of results.
5. Makowska-Tłomak, E., Skorupska, S., Kornacka, & Kopeć, W., *Insights from Co-designing an Online Intervention System to Address Digital Transformation Stress in the Workplace* (in process of submission).
    - **My contribution**: 60%
    - My contribution to this article consisted in research concept, project preparation, organization and planning, workshops, preparation of material, data collection, writing the manuscript (literature review, describing and presenting the results, creating the entire text), editing, and revision, workshops content development, and design of figures, exercises preparation as well as in submitting the article for publication.

Introduction

Digital transformation (DT) is a widespread and dynamic process of global informatization (Kling, 2000, 2000; Legner et al., 2017). DT is a natural consequence of the continuous development of information technology and Internet access (since 1990) (Kling et al., 2000). Since 2014, The European Commission has monitored Member States' progress on digital transition and published the annual Digital Economy and Society Index (DESI) reports (European Commission, 2020, 2022;

2030 Digital Compass: The European Way for the Digital Decade, 2021). DESI report summarizes relevant indicators of the performance of the European Union (UE) in the digital transition and monitors the progress of individual EU Member States. For organizations, the DT is defined as a broad process of implementation of information and communication technologies (ICT), which may require organizational changes (Hanelt et al., 2021; Lewis, 2011; Verina & Titko, 2019; Zeike et al., 2019) (sometimes fundamental ones) and /or instilling a culture that supports change and enables the company's overarching strategy (Lewis, 2011; Mergel et al., 2019; Verina & Titko, 2019). Consequently, DT is changing the landscape of work (Hu et al., 2021; Legner et al., 2017; Meske & Junglas, 2020; Tilson et al., 2010) and job demands (Day et al., 2019; Hu et al., 2021; Medzo-M'engone, 2021). The expected effects of DT are improvements in the work efficiency and effectiveness of organizations (Legner et al., 2017; Schallmo et al., 2017; Teichert, 2019).

As I have been working on IT projects for over 20 years, I have observed changes in employees' behavior and attitudes during implementations of digital solutions. This prompted me to investigate the impact of digital transformation on the well-being of employees and investigate the phenomenon of stress related to digital transformation process.

In my research, I focus on job stress (Parker & DeCotiis, 1983) related to DT processes in organizations, and I introduce the concept of digital transformation stress (DTS). For measurement of this phenomenon I propose an interdisciplinary approach, combining previous advancements in psychology and computer science. Accordingly, I propose a complex DTS measurement methodology, using two psychometric, self-reported scales, i.e. Digital Transformation Stress Scale (DTSS) and Digital Transformation Attitudes Scales (DTAS). I also propose an algorithm of automatic identification of employees with a high level of DTS, based on Machine Learning (ML) (Kessler et al., 2016; Ma et al., 2014; Subhani et al., 2017) and sentiment analysis (Elbagir & Yang, 2019; Makowska-Tlomak et al., 2021; Sarma et al., 2013). These tools may be used by Human Resources departments and project managers during the DT projects for monitoring and preventing negative outcomes of DTS. Additionally, I explore predictors of DTS, its consequences for employees and potential indirect effects linking DTS and its consequences. Furthermore, based on my research, I propose an efficient prototype of internet intervention created using best practices in application development, such as participatory design workshops (Demirbas & Timur Ogut, 2020; Kopeć et al., 2018) based on end-users' consultations and user experience (UX) practices (Feather et al., 2016; Knijnenburg et al., 2012).

Below, I present the research problem and study objectives in detail, as well as the results obtained. I refer to a wider theoretical context, pointing to the importance of these results for the development of theoretical concepts concerning the phenomenon of digital transformation stress and the integration of psychological knowledge from various fields.

Stress is a ubiquitous phenomenon and over the years a lot of research has been conducted to better investigate the role of stress (Cohen et al., 1997; Fink, 2016; Harris, 2020), including professional life, i.e. at work (Parker & DeCotiis, 1983; Spector & Jex, 1998). According to Lazarus and Folkman (1984) stress lies person's appraisal of the relationship between that input and its demands and the person's agendas (e.g., beliefs, commitments, goals) and capabilities to meet, mitigate or alter these demands in the interests of well-being (Lazarus, 1990; Lazarus & Folkman, 1984). Complementing the understanding of job stress mechanisms is the Conversation of Resources (COR) theory (Hobfoll et al., 1990), opposite to the stress-appraisal one (Lazarus & Folkman, 1984). The COR theory highlights that stressful events are the wrong unit of analysis and indeed may confuse understanding of stressors (Hobfoll et al., 2018), because stressful conditions are seldom events, rather, they are complicated sequences that occur over time (Dudek et al., 2007; Hobfoll et al., 2018). The COR theory has been important for developing and understanding stress in organizations. In the context of job stress, one of the types of approach, based on the COR theory, is the Job Demands - Resources (JD-R) model (Bakker & Demerouti, 2007; Demerouti et al., 2001), which has indicated job demands as main stressors of employees and resources as employees' capacities to mitigate input of job stressors (Bakker, 2007).

Nowadays, job demands and resources are closely related to rapid development of ICT and digital solutions (Carlson et al., 2017; Day et al., 2012) and dynamically changing technological progress (European Commission, 2020; Legner et al., 2017; Teichert, 2019). Despite the unquestionable advantages of digital transformation (Casalino et al., 2019; European Commission, 2020; Nambisan et al., 2019), in the workplace, the DT process itself may cause distress among employees. This kind of stress may be a reaction of the dynamic increase in ICT demands (Carlson et al., 2017; Day et al., 2012), such as high pressure (Dawson et al., 2016; Lewis, 2011; Mullan & Wajcman, 2019; Zeike et al., 2019), work overload (Dawson et al., 2016; Day et al., 2012; Schwarzmüller et al., 2018), and adaptation to communication challenges (Lewis, 2011). Furthermore, the style of implementation of digital solutions and changes might also increase stress (Dawson et al., 2016; Lewis, 2011; Schwarzmüller et al., 2018) as well as employees' resistance to changes - digital or/and organizational (Dubois et al., 2014; Lewis, 2011; Verina & Titko, 2019). Thus, long-term stress of employees might result in a paradoxical effect of a DT project such as decreased productivity and commitment (Kijek & Kijek, 2019; Watanabe et al., 2018).

In literature, there are concepts of stress related to the increasing role of information and communication technologies (ICTs) such as technostress (Ragu-Nathan et al., 2008) and digital stress (Hefner & Vorderer, 2016). Both phenomena are related to the growth of end-user computing, networking technologies (Ragu-Nathan et al., 2008), triggered by permanent access to an

inconceivable amount and diversity of (social) content (Hefner & Vorderer, 2016). According to Brod (1984), the technostress is caused by an inability to cope with new computer technologies in a healthy manner (Ragu-Nathan et al., 2008; Shu et al., 2011), especially related to demands of organizational computer usage (Reinecke et al., 2017). In comparison, digital stress results from overwhelm caused by the need for intensive or even near-constant use of ICTs (Hefner & Vorderer, 2016) and digital social media (Hefner & Vorderer, 2016; Reinecke et al., 2017; Tarafdar et al., 2019). The digital stress is more related to communication overload by the number of sent and received e-mails and social media messages as well as to Internet multitasking (Hefner & Vorderer, 2016), such as concurrent use of ICTs and other activities (Li et al., 2010; Reinecke et al., 2017). Although both concepts are very important for the research on job stress, they are concentrated on the responses to the results of increasing the role of ICTs in human life, not on the process itself, which is directly related to digital transformation. Therefore, I introduce the concept of perceived digital transformation stress (DTS) as the employee's emotional response related directly to the specific digital transformation process itself, the mode of management, the workload, and other job demands related to the DT process (Day et al., 2012; Makowska-Tlomak et al., 2021; Medzo-M'engone, 2021). The DTS concept is an approach to stress in relation to digital transformation process, introduced in organizations. Although DTS is connected to technostress and digital stress, DTS is not directly dependent on digital competencies. I assumed that it applies to employees with both high and low ICT competencies, as well as those with both positive and negative attitudes towards digital transformation. Thus, DTS is more stress related to digital and organizational changes as well as stress related to ICT implementation process and project management.

Research problem:

Introducing the concept of digital transformation stress related to workplace with measurement tools for monitoring and preventing negative outcomes of digital transformation process.

The problem of stress related to ICTs and digitalization has been studied since the 1980s (Hanelt et al., 2021; Kling et al., 2000). However, the research is more focused on the stress caused by ICTs and their increasing impact on people's lives (Blazejewski & Walker, 2018; Kling, 2000; Ragu-Nathan et al., 2008) than on the process of implementing new ICT solutions in organizations. Although DTS is conceptually appealing, there has been little systematic examination of the stress related to digital transformation process itself (Day et al., 2017; Meske & Junglas, 2020). Hence, there is a need to create dedicated psychometric tools for measuring attitudes and stress due to DT as well as for identification of main stressors appearing in DT process. Only careful measurement and observation of these phenomena will enable to address their root causes and alleviate this type of stress for the benefit of employees who suffer from it. **Therefore, in my interdisciplinary research, I propose dedicated tools for DTS measurement for screening the level of DTS periodically, using the self-development scales as well as sentiment analysis. Moreover, I identified DTS predictors and a resource which may mitigate DTS. Finally, I designed an internet intervention addressed to cope with this kind of stress and evaluated its effectiveness. The design, development and evaluation of DTS measurement tools and the formulation of an actionable and relevant internet intervention design framework would constitute a contribution to the domain of psychology, especially in the job stress, with using best practices from the area of Human-Computer Interaction (HCI). This approach of joining both fields: computer science and psychology results in an interdisciplinary and innovative model to help monitor and cope with DTS as well as foster the well-being of employees.**

Research Objectives

I have formulated three main research objectives:

1) **The construction of the self-descriptive measure of the digital transformation stress and digital transformation attitudes**. I developed two scales: Digital Transformation Stress Scale and Digital Transformation Attitudes Scales and I prepared the Polish version of ICT Demands and Support scales (Day et al., 2012). The full psychometric evaluation was prepared for Digital Transformation Stress Scale. The psychometric evaluation was conducted in two streams: 1) traditional psychometric methodology of scale evaluation, i.e., from scale items assessment by competent judges to factorial analysis (EFA and CFA), item-response evaluation (IRT) (Andrich, 2011; Boone, 2016; Dimitrov, 2017) and construct, criterion, and validity analysis, presented in submitted manuscript: "Measuring Digital Transformation Stress at the Workplace – development and validation of the Digital Transformation Stress Scale"; 2) using the computer science approach, sentiment analysis of help desk tickets of employees (Makowska-Tlomak et al., 2021). Evaluation of psychological self-descriptive scale by using Machine Learning (ML) (Subhani et al., 2017) and sentiment analysis (Capuano et al., 2021; Elbagir & Yang, 2019) of emotional markers would constitute a marked novelty. The results of this evaluation were presented in two works: "Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress" (Makowska-Tlomak et al., 2021), in *IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology* (pp. 103-111) and submitted manuscript "Measuring Digital Transformation Stress at the Workplace – development and validation of the Digital Transformation Stress Scale".(Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022)

2) **The identification of predictors of DTS and resources mitigating DTS, in adapting Job Demands-Resources (JD-R) model** (Bakker & Demerouti, 2007, 2014) to the context of digital transformation and **its consequences for employees**. I set the JD-R model in the DT context and modelled in structural equation modeling the indirect effects between ICT demands, digital transformation stress and burnout through occupational self-efficacy (Rigotti et al., 2008). The results of this study

were presented in submitted manuscript "Negative consequences of ICT job demands in the workplace: Digital Transformation Stress and Burnout" (Makowska-Tłomak & Bedyńska, 2022)

3) **The development of an online psychological intervention aimed to reduce digital transformation stress and evaluation of its effectiveness**. Therefore, an innovative approach would be to design a psychological intervention combining the best practices of psychology and HCI. This interdisciplinary approach combined outcomes of Cognitive-Behavioral (Beck, 1993) as well as Social Cognitive (Bandura, 1989, 1990; Rogala, Smoktunowicz, et al., 2016) therapies (psychology) and participatory design workshops (Demirbas & Timur Ogut, 2020; Cabrero, 2014; Kopeć et al., 2018) and UX, i.e., user experience (Feather et al., 2016; Knijnenburg et al., 2012), to develop an effective and attractive online psychological intervention for coping with DTS. I set two main goals in this area: the first was to test the prototype's performance in terms of its effectiveness and impact on DTS, and its significant decrease after the intervention. The second aim was to reduce quite high dropdown often observed in similar online psychological interventions (Feather et al., 2016; Rogala, Smoktunowicz, et al., 2016; Smoktunowicz et al., 2021). The prototype of internet intervention was initially tested, and both aims have been accomplished. The detailed description of the results is presented in Makowska-Tłomak, E., Bedyńska, S., Skorupska, K., & Paluch, J. (2022). Blended Online Intervention to Reduce Digital Transformation Stress by Enhancing Employees' Resources in COVID-19. *Frontiers in psychology*, *13,* https://doi.org/10.3389/fpsyg.2022.732301.

Overview of the State-of-the-art

Stress definitions

The concept of stress was introduced by Hans Selye in 1936 in the field of physiology (in: Fink, 2016; Harris, 2020). Selye's general adaptation syndrome (GAS) is a framework for stress concepts (Cunanan et al., 2018; Fink, 2010). the GAS has three steps as alarm, resistance; exhaustion (Fink, 2010). Prolonged exposure to the stressor may result in exhaustion (Demerouti & Bakker, 2008; Fink, 2010), which may have serious consequences for human health and even life (Fink, 2010; Hammen, 2005). However, stress is part of people's daily experience, although it is associated with many different, fundamentally different issues, e.g. work under pressure (Fink, 2010, 2016; Heszen, 2013). According to the literature, stress is a reaction, a (nonspecific) response of a person to a specific stressor or stressors individually assessed (Fink, 2016; Spector & Jex, 1998). Stress is also defined as a perception of threat, with resulting anxiety, discomfort, emotional tension, and difficulty in adjustment (Fink, 2016; Parker & DeCotiis, 1983). Lazarus has highlighted individual appraisal of situation as stressful (Lazarus & Folkman, 1984; Robinson, 2018), and has introduced cognition and subsequent emotion as important determinants of behavioral responses to a stimulus (Robinson, 2018).

Stress at work

With reference to workplace, stress at work is named as job stress (Liu et al., 2008; Parker & DeCotiis, 1983; Spector & Jex, 1998) which is a particular individual's awareness or feeling of personal dysfunction as a result of perceived conditions or events, situations in the work settings (Parker & DeCotiis, 1983). The job stress is an emotional response to stimuli that may have dysfunctional psychological or physiological consequences and is associated with negative feelings of individual related to those stimuli (Lazarus, 1990; Parker & DeCotiis, 1983). It is a transaction-based approach regarding stress as a combination of stimulating conditions and the individual's response to it (Lazarus & Folkman, 1984; Ragu-Nathan et al., 2008). Stress occurs when environmental demands exceed one's perception of the ability to cope (Fink, 2016). Progressively, over the past few decades, the job stress has become a major source of distress for adults and serious risks for human health (Dawson et al., 2016; Fink, 2016; Parker & DeCotiis, 1983; Spector & Jex, 1998).

Job stress consequences

In the organizational context, prolonged stress may lead to many consequences, such as job dissatisfaction, lack of commitment to work and low productivity. (Demerouti et al., 2010; Krekel et al., 2019; La Torre et al., 2020; Ragu-Nathan et al., 2008; Tarafdar et al., 2007). Job stress is significantly related to work motivation and stressed employees become chronically exhausted and demotivated (Demerouti et al., 2010; Lazarus, 1990; Ragu-Nathan et al., 2008). The long-term stress may even lead to such negative consequences as depression (Grant et al., 2013; Hammen, 2005) and/or burnout (Demerouti et al., 2010; Maslach et al., 2001; Maslach & Leiter, 2008; Rubino et al., 2009). Burnout is defined as a result of depletion of emotional resources, due to prolonged effort to adapt or endure demands or difficulties, mainly interpersonal in nature (Bedyńska & Żołnierczyk-Zreda, 2015; Demerouti & Bakker, 2008; Legner et al., 2017). Consequently, employees feel they are no longer able to give of themselves on a psychological level (Bakker et al., 2005; Bedyńska & Żołnierczyk-Zreda, 2015; Maslach & Leiter, 2008). Thus, the burnout is defined as a psychological syndrome that can occur when employees are exposed to stressful work environment, with high job demands and low resources (Bakker & Demerouti, 2007; Demerouti & Bakker, 2008). Two main components of burnout are identified, i.e., disengagement (Baka & Basińska, 2016; Demerouti et al., 2010) and exhaustion (Demerouti & Bakker, 2008; Reis et al., 2015). Exhaustion is the feeling of draining mental and physical resources, and energy depletion (Bakker et al., 2005). This component of burnout is a consequence of prolonged exposure to certain job demands (Demerouti et al., 2001, 2010). Appropriately, disengagement is defined as distancing oneself from one's work in general, work object, and work content, which might be taken as, for instance, uninteresting, no longer challenging, or even without willingness to continue the work (Demerouti et al., 2010).

From Lazarus and Folkman to Conservation of Resources theory and Job Demands and Resources model

Following the Lazarus and Folman (1984) approach, stress is a particular relationship between an individual and the environment that is self-assessed as burdening or exceeding the individual's resources and threatening well-being (Lazarus & Folkman, 1984). Consequently, the stressors are assessed subjectively by individuals and the source of stress might be misattributed (Cohen et al., 1983; Lazarus, 1990). Therefore, capturing objective stressors was difficult. Thus, the global measurement of stress (Cohen et al., 1983) was concentrated on perceived stress measured in short periods of time, e.g. 4 weeks (Cohen et al., 1997). The main focus in this concept was on the feelings of a respondent regarding the perception of the specific situation, e.g., at work as stressful or not. However, being able to identify and then analyze the sources of stress would allow countermeasures to be taken. Therefore, although the identification of specific stressors is associated with many difficulties, because people often misattribute their feelings of stress to a particular source when that stress is actually due to another source (Bakker & Demerouti, 2014; Cohen et al., 1983; Shaw et al., 2020), various concepts and studies have emerged on identification of the job stressors (Lazarus, 1990; Lazarus et al., 1985; Liu et al., 2008). Job stressors are events, demands, stimuli, or conditions encountered by individuals in the work or organizational environment as stress triggers (Dawson et al., 2016; Ragu-Nathan et al., 2008; Spector & Jex, 1998; Zięba, 2012).

One of the concepts to identify sources of stress was the Conservation of Resources (COR) theory (Hobfoll, 2001), which concentrates more on resources and defines psychological stress as a response to the environment, in which there is a risk of losing resources (Hobfoll et al., 2018). The basic tenet of COR theory is that people have both an innate and learned desire to preserve the quality and quantity of their resources, both tangible and intangible (Hobfoll, 2001). Hence, they try to limit any condition that may threaten the security of those resources. Consequently, in this approach, stress is defined as a reaction to the environment, in which there is risk of losing said resources (Hobfoll et al., 1990; Hobfoll & Freedy, 1990). In the context of DT at work, the resources may be the position in the company, job security, influence, sense of competence (here, regarding the new IT solutions), or perceived control over the technological changes taking place in the organization. The feeling of a loss of resources may determine the employee's reactions in the situation of changes taking place in the organization during the implementation of IT solutions and new technologies (Carlson et al., 2017; Day et al., 2017; Trenerry et al., 2021). According to COR theory, when people rate stress as low, they are more likely to rely on their own personal resources, while as they rate stress as high, they tend to rely more on social support (Hobfoll & Freedy, 1990). However, a new stream of research has shown that high job-related self-efficacy is not only beneficial to the individual, but also influences the individual's partners through cross-over processes (Hobfoll et al., 2018; Neff et al., 2013). Therefore, in my research, in terms of resources, I focus on examining the impact of self-efficacy on DTS (Makowska-Tłomak & Bedyńska, 2022). Thereafter, in designing an intervention, I focus on strengthening self-efficacy as one of the main resources in coping with stress (Rogala, Shoji, et al., 2016; Smoktunowicz et al., 2021), here with the digital transformation stress (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022).

In numerous research on job stress and stressors, there are two well established psychological models, i.e., Job Demands-Control (JD-C) model (Karasek et al., 1998), and Job Demands-Resources (J-DR) model (Bakker & Demerouti, 2007, 2014; Demerouti et al., 2001). They comprehensively explain the mechanisms underlying job stress. According to Job Demands-Resources model, employees' stress in the workplace increases with the demands' growth and with limited resources (Bakker & Demerouti, 2007, 2014). Job demands can be identified as high work pressure, workload (Bakker et al., 2007; Bakker & Demerouti, 2014), hassles (Day et al., 2012) and lack of control (Day et al., 2012; R. Karasek et al., 1998; Landsbergis, 1988). These job demands are likely to be associated with employee's attitudes such as increased job tension, compromised satisfaction, and commitment (Carlson et al., 2017; Elacio et al., 2020). In contrast, job resources are necessary to deal with job demands as well as being important in stress coping (Bakker & Demerouti, 2007; Hobfoll et al., 2018). Moreover, job resources may buffer the impact of job demands on job strain, including burnout (Bakker & Demerouti, 2007), especially exhaustion and disengagement (Demerouti et al., 2001, 2010; Rhee et al., 2017). The key components of individual adaptive capacity are personal resources (Hobfoll et al., 2018; Xanthopoulou et al., 2007), namely self-efficacy (Bandura, 1989), organizational-based self-esteem (Pierce et al., 1989) and optimism (Scheier & Carver, 1985). According to JD-R's research, employees with high level of personal resources deal more effectively with the job demands (Hobfoll et al., 2018; Xanthopoulou et al., 2007). Consequently, personal resources prevent negative outcomes like exhaustion (Xanthopoulou et al., 2007). As a main component of personal resources, in my research I focus on individuals' job-related self-efficacy (Neff et al., 2013; Rhee et al., 2017), that is, the belief in one's competence and ability to manage with job demands (Bandura, 1989; Demerouti et al., 2001; Rhee et al., 2017). The self-efficacy as a personal resource is likely to alleviate the level of emotional exhaustion and then disagreement (Hobfoll et al., 2018; Neff et al., 2013; Rhee et al., 2017). Therefore, I decided to apply the JD-R model in the context of stress related to the digital transformation process. Accordingly, I assumed that identified ICT demands have been used appropriately in the model as job demands, while self-efficacy treated as an employees' personal resource (Hobfoll et al., 2018).

Digital transformation process

Digital transformation is not only an important and dynamic process affecting every area of human life (Kling, 2000). Over the past few decades, DT has become a constant topic of conversation among researchers and practitioners (Hanelt et al., 2021). For organizations, DT is defined as a broad process of implementation of ICTs, which may require organizational

changes (Hanelt et al., 2021; Lewis, 2011; Verina & Titko, 2019; Zeike et al., 2019), sometimes fundamental ones, and /or instilling a culture that supports change and enables the company's overarching strategy (Lewis, 2011; Mergel et al., 2019; Verina & Titko, 2019). The expected effects of DT are improvements in the work efficiency and effectiveness of organizations (Legner et al., 2017; Schallmo et al., 2017; Teichert, 2019). The COVID-19 pandemic has accelerated the digital transformation in majorities of organizations (Iivari et al., 2020; Priyono et al., 2020), in both sectors – public (Agostino et al., 2021; Iivari et al., 2020) and private (Brynjolfsson et al., 2020; Dwivedi et al., 2020; Iivari et al., 2020; Wang et al., 2021). The pandemic has radically changed the role and perception of digitalization in our societies and economies and accelerated its pace (Agostino et al., 2021; Dwivedi et al., 2020). Digital technologies became imperative for working, learning, entertaining, socializing, shopping and accessing everything from health services to culture (2030 Digital Compass: The European Way for the Digital Decade, 2021). Many employees, for the first time, were strongly dependent on ICT solutions (Leonardi, 2020; Park and Inocencio, 2020) and their current workplace was replaced by a remote one, saturated with ICT solutions to the maximum (Brynjolfsson et al., 2020; Shaw et al., 2020; Wang et al., 2021). Moreover, DT process touches and challenges managers in all industries and contexts (Cortellazzo et al., 2019; Hanelt et al., 2021; Sainger, 2018; Wang et al., 2021). Consequently, DT is changing the landscape of work (Hu et al., 2021; Legner et al., 2017; Meske & Junglas, 2020; Meyer et al., 2021) and job demands (Hu et al., 2021; Medzo-M'engone, 2021; Meyer et al., 2021).

Organizational changes

Although the DT phenomenon seems to create an opportunity or sometimes necessity for organizational changes e.g., in structure (Lewis, 2011), recent observation and research suggest that DT deviates from these past organizational changes for at least several reasons (Hanelt et al., 2021). Among others, they are: 1) Nowadays technology and IT solutions are different to earlier IT solutions which are seen as generative, malleable and combinatorial in comparison to traditional ones (Emory University et al., 2013; Kallinikos et al., 2013; Meyer et al., 2021); 2) End-users, here employees, are familiar with using ICT solutions such as social media (Emory University et al., 2013; Kallinikos et al., 2013; Meske & Junglas, 2020; Meyer et al., 2021); 3) Many digital technologies are becoming ubiquitous and not confined to the boundaries of specific companies or industries (Casalino et al., 2019; Schallmo et al., 2017; Schwarzmüller et al., 2018), and therefore encompass a wider ecosystem and the demand side (Hanelt et al., 2021; Tilson et al., 2010). Furthermore, ICT has become deeply socially embedded (Legner et al., 2017; Meyer et al., 2021; Tilson et al., 2010); 4) Recent decade shows that DT is related to the emergence of new digital business models (Priyono et al., 2020; Schallmo et al., 2017) even in non-IT industries (Casalino et al., 2019; Hanelt et al., 2021; Legner et al., 2017). In addition, it seems to extend beyond those of previous phases of digital technology enabled changes, which were usually related to the practice level and rather incremental changes within organizations (Casalino et al., 2019; Hanelt et al., 2021; Meyer et al., 2021).

Technostress, digital stress and digital transformation stress

Dynamic development and increasing role of ICTs in work environment forced the redefinition of the work scope and responsibilities, job demands, new tasks, competences and work mode as well as changes in team management (Atanasoff & Venable, 2017; Day et al., 2012, 2017; Hefner & Vorderer, 2016; Meyer et al., 2021; Ragu-Nathan et al., 2008). Consequently, the ICTs can be a source of professional stress (Day et al., 2019; Legner et al., 2017; Tarafdar et al., 2015). It is directly associated with rapidly emerging new technologies and ICT solutions that are increasingly used at work (Hu et al., 2021; Ragu-Nathan et al., 2008; Zahlquist et al., 2019).

Technostress is defined as stress experienced by an individual due to usage of software or/and hardware that is designed not in a user-friendly way (Ragu-Nathan et al., 2008; Tarafdar et al., 2007). These unhealthy characteristics of modern Information Systems (IS) (Tarafdar et al., 2015) cause additional strain in the workplace and create inability to adapt to a specific work mode with ICTs while exercising appropriate health-related care (Tarafdar et al., 2007, 2015).

The digital stress is another example of stress related to the growing role of ICT and the use of technology, especially the Internet (Hefner & Vorderer, 2016; Reinecke et al., 2017). This type of stress is evoked by permanent online communication demand, emails overloading with perceived self-obligation to respond quickly to messages and using the internet simultaneously with doing other things and switching tasks (Hefner & Vorderer, 2016). Digital stress affects both aspects of an individual's life - private and professional (Hefner & Vorderer, 2016; Reinecke et al., 2017). However, in job area, digital stress is associated to an expectation to be online responsive with ability to absorb and process large amount of information available in the Internet and social media (Hefner & Vorderer, 2016; LaRose & Tsai, 2014).

Both above types of stress, related to the growing role of ICTs in people's lives (Kling et al., 2000; Plekhanov & Netland, 2019), focus on the effects of the growing importance of ICTs, i.e., the consequences resulting from the digital transformation. Whereas in my approach, I focus on the stress resulting from the way of implementation of digital transformation itself rather than its final outcomes. Therefore, I introduce the concept of digital transformation stress (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022), along with the digital transformation attitudes (Makowska-Tlomak et al., 2021) related to ICT solutions implementations or widely understood DT process. Digital transformation stress can affect all types of employees: from these with very low ICT competencies to those with high ICT skills, appreciating new technologies and benefiting from digital progress. DTS is related to situations where all workers, with IT specialists and IT managers among others, are uncertain about how to cope with the challenges of

digitalization (Cortellazzo et al., 2019; Legner et al., 2017; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Sainger, 2018) and workload connected to the DT process (Day et al., 2012, 2017, 2019; Makowska-Tlomak et al., 2021).

Generally, employees nowadays understand that ICT solutions and digitization are very important for organizations' competitiveness and effectiveness (Horváth & Szabó, 2019; Medzo-M'engone, 2021; Meske & Junglas, 2020). Thus, frequently, employees' general attitudes towards digital transformation in their organization are initially very positive (Anthony, 2015; Casalino et al., 2019; Meske & Junglas, 2020). Furthermore, digital transformation and ICT solutions implementations in organizations may activate some employees (Bateman & Crant, 1993; Tims et al., 2012), evoke curiosity, refreshment and motivation to act (Hu et al., 2021; Meske & Junglas, 2020; Verina & Titko, 2019). However, the sharply increasing digital transformation (DT) demands placed on employees, may change these initial viewpoints (Schlachter et al., 2018), even in those employees that are highly competent in ICT. Therefore, digital transformation projects and processes are also strongly related to the well-being of employees (Day et al., 2019; Felstead & Henseke, 2017; Zeike et al., 2019). The consequences of the dramatic increase of ICT demands, the uncertainty regarding digital changes might also increase stress in the workplace (Carlson et al., 2017; Marsh et al., 2022; Schwarzmüller et al., 2018). The manner of implementing digital solutions can change the initial attitude towards DT as well (Dubois et al., 2014; Gordon & Tarafdar, 2007; Henriette et al., 2016; Pfaffinger et al., 2020), especially when, in ICT project implementation process, the main focus is limited to communication of decisions, procedures and instructions (Kazim, 2019; Więcek-Janka, 2006) in place of dedicated trainings and careful management (Legner et al., 2017).

Consequently, I assume that the digital transformation stress (DTS) appears not only because of negative attitudes to DT and ICT per se, or the lack of ICT skills or digital competencies, but also because of the occurrence of a set of factors such as: 1) an improper way of implementing the digital solutions and changes in workplaces (Krishnan, 2017; Lewis, 2011; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022), 2) unfit DT project management (Dursun & Goker, 2022; Richmond & Skitmore, 2006), 3) increasing the ICT job demands (Adler & Koch, 2017; Day et al., 2012, 2019) and finally 4) incertitude of professional future (Lewis, 2011; Pfaffinger et al., 2020), even for IT specialists and IT companies (Gordon & Tarafdar, 2007; Legner et al., 2017). Although the DTS may also be related to the stress resulting from organizational changes due to digital transformation, it is a broader concept due to the factors that may cause it (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Meske & Junglas, 2020).

In short, I defined the perceived digital transformation stress as an emotional response of an employee to the specific digital transformation process itself, the mode of management, the rapid change of the workload related to DT and other job demands related to the DT process. Summarizing, DTS is a complex concept including project management, ICT demands as well as attitudes to digital changes and to the increasing role of ICT in process of digital transformation.

MEASUREMENT OF DIGITAL TRANSFORMATION STRESS – TOOLS DESIGN AND EVALUATION

The COVID-19 pandemic has increased interest in stress related to the implementation of DT, due to its dynamic shift to remote work and reliance on technology i.e., ICTs and digital solutions of communication and meetings (Agostino et al., 2021; Dwivedi et al., 2020; Makowska-Tlomak et al., 2021). DT has accelerated rapidly due to the need for immediate implementation of ICT solutions (Agostino et al., 2021; Iivari et al., 2020). Thus, being able to measure and monitor digital transformation stress became important (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022). I started my research just before the COVID-19 pandemic, and to my knowledge, at this time there were no dedicated scales to assess the perceived digital transformation stress or digital transformation attitudes (Makowska-Tlomak et al., 2021; Meske & Junglas, 2020).

The first objective of the research, presented here (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022), was to develop and validate two scales that measure employees' attitudes towards digital transformation and then perceived digital transformation stress, i.e.,: Digital Transformation Attitude Scale (DTAS), and the Digital Transformation Stress Scale (DTSS). The DTAS evaluates the general attitude towards digital transformation, and the DTSS evaluates perceived transformation stress as employees' response to the process of digital transformation itself. Both tools would aim to monitor the fluctuation in DTS during digital transformation process (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022) in a specific organization.

One of two scales is the **Digital Transformation Attitudes Scale (DTAS),** which aims to measure the general attitude to digital transformation in organizations in three dimensions: affective, behavioral, and cognitive. DTAS is theoretically grounded in relevant general work stress models such as Conservation of Resources (Hobfoll, 2001) theory and the Job Demands-Resources model (Bakker & Demerouti, 2014; Bakker Arnold B., 2007; Demerouti & Bakker, 2011). For this reason, DTAS has initially consisted of three subscales concerning three key areas (Breckler, 1985; Makowska-Tlomak et al., 2021; Ward & Szabó, 2019): (1) Affective (emotional) (Lazarus et al., 1985), related to both negative and positive feelings which potentially accompany digital transformation in the workplace like fear, apprehension, anger as well as joy, interest, and satisfaction (Reinecke et al., 2017); (2) Behavioral (Reinecke et al., 2017; Tims et al., 2012), connected to personal activities appearing in response to the changes occurring in the organization as new ICT solutions are implemented (Blazejewski & Walker, 2018; Day et al., 2017; Meske & Junglas, 2020); and (3) Cognitive – a subscale exploring the cognitive area related to thoughts and individual, cognitive assessment of ongoing or planned digital changes during the process of digital transformation (Agarwal & Karahanna, 2000; Meske & Junglas, 2020). This subscale aims to explore the

attitude towards new technologies. The main aim for DTAS is to measure general readiness to the digital transformation in the workplace (Makowska-Tlomak et al., 2021).

Since the DTAS is a more complex construct, the psychometric validation of DTAS is still in progress. A series of analyses have been performed. Firstly, exploratory factor analysis in structural equation modeling approach was conducted. However, the DTAS structure was showing three or four factors, which had to be carefully verified in the following studies. The fit of the four-factor model was significantly better for DTAS than the initially proposed three-factor model consisting of affect, behavior and cognition ($\Delta\chi 2$ (19) = 63.55, $p < 0.001$). Secondly, confirmatory factor analysis confirmed the four-dimensional DTAS structure, where beside negative affective and positive behavioral dimensions, two cognitive dimensions were drawn out, i.e., negative cognitive and positive cognitive dimensions. Although both factor analyses confirmed assumed ABC structure (van Harreveld et al., 2015; Ward & Szabó, 2019), further analyses are needed using a more numerous sample.

The second scale is the **Digital Transformation Stress Scale (DTSS),** which is designed to measure perceived stress related directly to the specific digital transformation process during the previous month or four weeks. It was inspired by the classic stress measure of the Perceived Stress Scale (Cohen et al., 1983), adapted to workplace conditions (Chirkowska-Smolak, 2016; Lesage et al., 2012). Based on person - environment transaction approach (Lazarus & Launier, 1978) and stress-appraisal theory (Lazarus & Folkman, 1984), the DTSS items were contextually related to the situation of DT. Thus, the DTSS has targeted to measure perceived stress as an emotional response related to the style and manner of implementations and management, time pressure, high workload, and expectations of high efficiency in the context of DT (Day et al., 2012, 2019; Dubois et al., 2014; Hu et al., 2021). From the beginning, the assumption of the DTS measurement was the possibility of quick screening of employee stress, which, together with the sentiment analysis tool (Makowska-Tlomak et al., 2021), would create a comprehensive tool for stress monitoring during DT projects, in short time intervals, like 4-6 weeks (Cohen et al., 1983; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Vallejo et al., 2018). Thus, DTSS was to be a short one-dimensional tool, optimally with a small number of items (from 3 to 8 maximum), with possibly high reliability.

First of all, initial items were generated for both scales: 45 items for DTAS and 20 for DTSS. Next, both scales' items were examined by a group of six competent judges (psychologists and experts in the field of work and stress psychology), who individually assessed the adequacy of each item (Asahara et al., 2013; Jeon et al., 2020). The intraclass correlation coefficient (ICC) was used to measure inter-rater agreement between judges (Barsuk et al., 2019; Joussain et al., 2017; Premelč et al., 2019) for both scales (DTAS and DTSS). The main aim was to identify the most appropriate items for further psychometric evaluation. The items selected for the study have received ICC = 0.86, p <.001 (DTSS) and ICC = 0.802, p< .001. Details of DTSS psychometric evaluation are described in the manuscript "*Measuring Digital Transformation Stress at the Workplace – development and validation of the Digital Transformation Stress Scale*", which has been submitted into *PLOS ONE* journals.

In this manuscript, two studies were described with series of analyses conducted. They aimed to examine the structure of the DTSS scale using Confirmatory Factor Analysis, difficulty and discrimination of the items using Item-Response Theory (Boone, 2016) approach. The theoretical and criterion validity was also tested by examining the associations of the digital transformation stress measured by DTSS with general stress at work as assessed with Perceived Stress Scale (Cohen et al., 1983). Moreover, it was confirmed by using the sentiment analysis (Buitelaar et al., 2013; Elbagir & Yang, 2019; Makowska-Tlomak et al., 2021) of employees' written communication (Makowska-Tlomak et al., 2021) via help-desk (HD) ticketing system (IT supporting system for ICT issues solving).

The theoretical validity of DTSS was evaluated using a sentiment analysis method (Elbagir & Yang, 2019; Makowska-Tlomak et al., 2021). This was an innovative approach to scale evaluation, which may exemplify the synergy between the fields of psychology and computer science. It was presented in the publication "Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress" (Makowska-Tlomak et al., 2021). Firstly, based on research on affective markers in words (K. K. Imbir, 2015; K. Imbir & Rutniewska, 2015; Kędzia et al., 2015), the algorithm was created , aimed to detect emotional (negative) markers in written communication, using sentiment analysis (Buitelaar et al., 2013; Carrillo-de-Albornoz et al., 2018) and Machine Learning (Balcerzak & Jaworski, 2015; Kessler et al., 2016; Subhani et al., 2017). Next, a random sample of registered help desk ticketing system was processed in Clarin System (*Clarin PL | Polska część infrastruktury naukowej CLARIN ERIC*, n.d.; Kędzia et al., 2015). In this way, the sentiment analysis algorithm was tested with an independent open-source solution. Next, a target sentiment analysis study was conducted. The sample consisted of 6,400 recorded HD tickets (short texts) of 223 HD system users, i.e., employees of the financial organization where the DT project was in progress. Among HD users there were also participants of the DTS study, therefore it was possible to carry out a comparative and correlation analysis of the DTS measurement results, collected using two different tools (Makowska-Tlomak et al., 2021).

Secondly, two hypotheses about the employees' activity in help desk system regarding DTS were empirically tested in a correlation study that included a group of employees of the same organization. Despite the fact that the sample for the analysis was small (Makowska-Tlomak et al., 2021), there was a significant correlation between the variables, i.e., the number of HD tickets and DTS level as well as score of negative emotional markers (Makowska-Tlomak et al., 2021) and DTS score (Makowska-Tlomak et al., 2021). The criterion validity of DTSS was independently confirmed using a tool from the field of computer science as sentiment analysis (Makowska-Tlomak et al., 2021).

Thirdly, I also performed analyses confirming the high reliability of the DTS scale as well as DTAS (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022), determined by the internal consistency method using Cronbach's alpha statistics. In the same study, the exploratory factor analysis was conducted and presented a predicted one-factor structure for DTSS.

Finally, in the following study, with the use of confirmatory factor analysis (Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022), the assumed one-factor structure of the DTS scale was confirmed (Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022). In a submitted manuscript (Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022) item discrimination and difficulty parameters in Item Response Theory approach were also presented (Boone, 2016; Edelen & Reeve, 2007). All items obtained satisfying parameters and the scale presented good reliability.

Summarizing, in the performed analyses it has been shown that the DTS scale, namely DTSS, is a reliable self-report tool measuring the perceived DTS during the DT process with the assumed factor structure and it is appropriate for reliability and theoretical validity. DTSS advantage, allowing e.g., repeated assessment of DTS in short periods is also its limited number of items, which helps to avoid a high dropdown in survey completion. In addition, presented studies showed that monitoring the level of perceived DTS using an independent text data processing tool, based on sentiment analysis of official written communication, may be an efficient way of assessing stress without requiring employees to fill out additional surveys. The latter tool opens a venue to propose automatic detection of those employees who suffer the most severe consequences of rapid digital transformation. All research outcomes, described in brief above, are detailed in a series of published or submitted papers, i.e., “Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress” (Makowska-Tlomak et al., 2021), Measuring Digital Transformation Stress at the Workplace – development and validation of the Digital Transformation Stress Scale“ (Makowska-Tłomak et al., 2022a) as well as in “Blended Online Intervention to Reduce Digital Transformation Stress by Enhancing Employees’ Resources in COVID-19” (Makowska-Tłomak et al., 2022b).

JOB DEMANDS-RESOURCES MODEL IN CONTEXT OF DIGITAL TRANSFORMATION – RELATION OF ICT DEMANDS OCCUPATIONAL SELF-EFFICACY TO DTS AND JOB BURNOUT

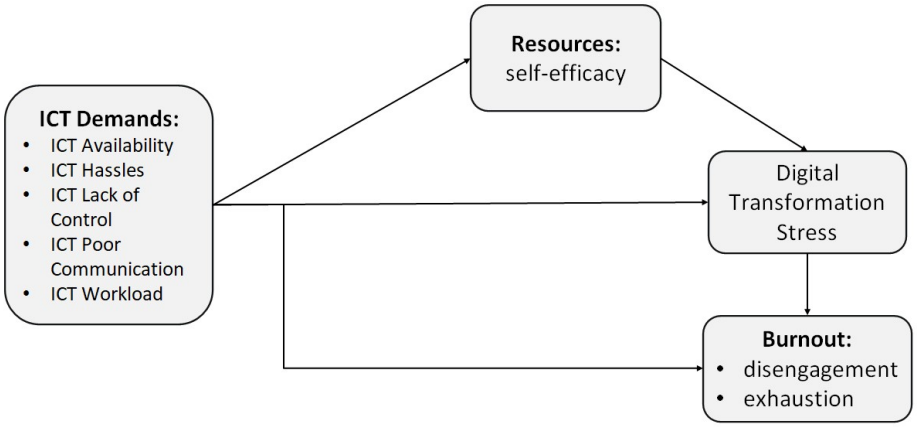
The theoretical assumptions presented above indicate that the growing job demands related to DT may increase in DTS (Makowska-Tlomak et al., 2021). On basis of Karasek's (1988) job demand-control (JDC) model (Adler & Koch, 2017; Karasek et al., 1998; Karasek, 1979) and the Job Demands – Resources (JD-R) model (Bakker & Demerouti, 2014), the model of associations between ICT job demands and resources in digital transformation process was examined. According to these theoretical models, increasing job demands are predictors of rising and sustained stress and, consequently, job burnout manifested in exhaustion and disengagement (Bakker & Demerouti, 2014; Bakker, 2007). In contrast, job resources are a counterweight to job demands and are related with increased work engagement, organizational commitment (Bakker Arnold B., 2007; Demerouti et al., 2001) and motivation (Bakker Arnold B., 2007). Accordingly, in my research, which I present in a submitted manuscript “Negative consequences of ICT job demands in the workplace: Digital Transformation Stress and Burnout” (Makowska-Tłomak & Bedyńska, 2022), I applied the JD-R model to the context of DT, where the demands could be specific job demands related to ICT (Day et al., 2012, 2017) and occupational self-efficacy (Hobfoll et al., 2018; Neff et al., 2013) seen as employees’ personal resource (Hobfoll et al., 2018; Shoji et al., 2016).

The first step was a preparation of a Polish version of ICT Demands and Support scales (Day et al., 2012). The ICT Demands and Support Scales consist appropriately of eight and two subscales (Day et al., 2012). Scales were translated using the back translation method (Chen & Boore, 2010; Kornacka et al., 2016). Similarly, a short version of occupational self-efficacy scale (Rigotti et al., 2008) was translated into Polish. This procedure was necessary to apply the JD-R (Demerouti & Bakker, 2011) model in the context of DT. Then, two studies were conducted which are described in a submitted manuscript (Makowska-Tłomak & Bedyńska, 2022).

In the first study (Makowska-Tłomak & Bedyńska, 2022), I examined associations between DTS and ICT demands to identify which ICT demands may be significant predictors of DTS and subsequently be selected for a second, in-depth study. The analysis found that five of the eight ICT job demands were significant predictors of DTS. The ICT Workload has emerged as the strongest predictor, with the second one, i.e., ICT Hassles. Next, three ICT Demands, i.e., ICT Availability, Lack of control and Poor communication have proved to be DTS predictors as well. Interestingly, neither ICT Learn (expectation to be up to date with new technologies) nor ICT Response expectation were related to DTS.

In the second study, according to the previous study’s outcomes (Makowska-Tłomak & Bedyńska, 2022), I have hypothesized that five identified ICT job demands may be the main predictors of DTS and burnout, in the context of digital transformation. Additionally, I have hypothesized that the main DT resource, which might decrease the DTS, has been occupational self-efficacy (Bandura, 1989; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Rigotti et al., 2008; Shoji et al., 2016). In the proposed model (see Figure 1), based on JD-R (Bakker & Demerouti, 2007, 2014) model, the job demands have been five ICT job demands (DT demands) and the resource has been the occupational self-efficacy. I also tested three indirect effects linking different aspects of ICT job demands and two dependent variables: burnout-disengagement and burnout - exhaustion through self-efficacy and DTS. Results, which I present in the submitted article “Negative Consequences of ICT Job Demands in the Workplace: Digital Transformation Stress and Burnout” (Makowska-Tłomak & Bedyńska, 2022), are succulent.

Figure 1. ICT Job Demands - Resources model in DT context (Study 2).



In line with predictions, both components of burnout, i.e., exhaustion and disengagement, have correlated negatively and significantly with occupational self-efficacy. Similar correlations were observed between ICT demands and self-efficacy with the exception of ICT availability, which did not correlate either with occupational self-efficacy or with exhaustion and disengagement. Additionally, although the ICT Lack of control was positively related to DTS, it was quite a weak predictor of DTS. The ICT Lack of control was poorly related to occupational self-efficacy as well. This output was thought-provoking because this demand is related to computer self-efficacy in dealing with technology (Day et al., 2012, 2019). However, ICT lack of control proved to be a predictor of both burnout components (Makowska-Tłomak & Bedyńska, 2022). The indirect effects of occupational self-efficacy to DTS and burnout's components have occurred as well as the indirect effect of ICT demands on burnout. These results have shown that strengthening the occupational self-efficacy might be the main assumption in internet intervention designing and development.

The obtained results seem to be very important for several reasons. First, my research shows that there are two main ICT demands, i.e., ICT workload and ICT hassles, which have the highest impact on DTS and burnout. Secondly, ICT poor communication and ICT availability have been shown as important predictors of DTS as well as burnout components, i.e., exhaustion and disengagement. Both ICT demands correlate positively and significantly with each other. These outputs might be connected with email overloading (Day et al., 2019) and the necessity of continuous communication during DT projects. Thirdly, occupational self-efficacy has been proved to be the important personal resource in decreasing DTS and burnout.

While the analysis shows that selected ICT job demands are predictors of DTS, it seems to overlook the fact that at the same time as the digital transformation process, other ICT job demands are emerging, such as the need for ICT multitasking (Hefner & Vorderer, 2016; Reinecke et al., 2017; Wang et al., 2020) in ICT projects. Another such ICT job demand may be expectation of the ability to switch between different ICT tools, understood as an ICT flexibility demand (Osmani et al., 2019) as well as an ability to work under pressure (Osmani et al., 2019; Vehko et al., 2019). Reviewing ICT demands (Day et al., 2012; Hu et al., 2021) has become important, and the identification of the new ones may expand the current scale or develop a new scale of ICT job demands. Perhaps this new scale should be defined as a DT job demands scale, to measure the level of intensity of the burden of job demands, specific to work in the DT process. It seems that important for further research would be to measure the impact of the various ICT job demands between the two main groups of participants in the digital transformation process - those who implement the ICT solutions and those where the implementations are carried out. This approach would better identify stressors and resources that help overcome stress. Finally, in further research, I plan to analyse other employee resources, such as ICT skills (Carretero et al., 2017; Eurostat, 2015; Makowska-Tłomak, Bedyńska, Skorupska, Kopeć, et al., 2022) and ICT support (Day et al., 2012; Meske & Junglas, 2020), along with self-efficacy (Neff et al., 2013; Shu et al., 2011) and ICT demands (Adler & Koch, 2017; Day et al., 2012; Makowska-Tłomak & Bedyńska, 2022) based on the JD-R (Demerouti et al., 2001) model in the context of DTS.

PROTOTYPING INTERNET INTERVENTION ADDRESSING DIGITAL TRANSFORMATION STRESS

Internet interventions, known also as online or web-based interventions (Cieślak et al., 2018; Heber et al., 2017) have existed for at least 20 years (Andersson, Titov, et al., 2019; Cieslak et al., 2016) and play a more and more important role in public health (Bennett-Levy et al., 2010; Cieślak et al., 2018; Tate et al., 2009). Internet interventions are also an example of

product of digital transformation (Heber et al., 2017; Tate et al., 2009; Van Gordon et al., 2015; Walsh & Groarke, 2019). Psychological internet interventions are aimed at a wide range of disorders and psychological health problems, (Andersson, 2018; Andersson, Titov, et al., 2019) including depression (Christensen et al., 2009; Hawley et al., 2017), anxiety (Andersson, Carlbring, et al., 2019), post-traumatic stress disorder (Andersson, Titov, et al., 2019; Cieslak et al., 2016) and stress including job stress (Heber et al., 2017; Persson Asplund et al., 2018; Smoktunowicz et al., 2019, 2021). Psychological internet interventions often use cognitive behavior therapy (CBT) (Beck, 1993; Rachman, 2015) as an easily adaptive to self-guide training, based on building participants' engagement into context and then using techniques and exercises impact on attention and cognitive changes (Andersson, Titov, et al., 2019; Eilert et al., 2022).

Although effectiveness of internet interventions was confirmed (Cieślak et al., 2018; Rogala, Smoktunowicz, et al., 2016; Rozental et al., 2014; Smoktunowicz et al., 2019), the problem of high dropout has been observed (Christensen et al., 2009; Rogala, Smoktunowicz, et al., 2016; Smoktunowicz et al., 2021). To eliminate some potential reasons of high dropout (Christensen et al., 2009; Rogala, Smoktunowicz, et al., 2016; Rozental et al., 2014; Smoktunowicz et al., 2021), I decided to involve potential participants (Cavanagh, 2010; Mitchell et al., 2009; Ritterband et al., 2009; Rozental et al., 2014) in the process of prototyping the planned intervention reducing DTS. In the process of prototyping the internet intervention for DTS, I have taken into consideration the previous research using internet interventions addressing coping with stress (Rogala, Smoktunowicz, et al., 2016; Smoktunowicz et al., 2019, 2021). Additionally, seeing that the internet intervention in response to the stress of digital transformation may evoke a kind of cognitive dissonance (Harmon-Jones & Mills, 2019) related to ICT hassles (Day et al., 2012; Makowska-Tlomak et al., 2021; Stich et al., 2018), I decided to consult the potential users of such an intervention. Regarding best practices in application development i.e., participatory design workshops (Feather et al., 2016; G. Cabrero, 2014; Kopeć et al., 2018), with my colleagues from multidisciplinary science group - KOBO (https://kobo.org.pl/), we organized workshops in two modes – online and offline, for participants who had a high level of DTS. Using the persona method (Cabrero, 2014), participants prepared a dedicated addressee for future internet intervention, and they have evaluated future intervention's proposed exercises. Detailed procedure is described in the submitted manuscript "Co-designing an e-Health Intervention to Address Digital Transformation Stress in the Workplace" (Makowska-Tłomak, Skorupska, Kornacka, & Kopeć, 2022).

According to the expectations of participants of co-design workshops, the prototype of my intervention was designed in 4 modules to which participants have unlimited access and they could choose each of the proposed activities. Among the activities, there were some psychoeducational materials in different forms: movies, instructions, visualizations and more interactive exercises aimed to strengthen self-efficacy as well as relaxation exercises in a dedicated module (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022). The designed internet intervention was a prototype to be examined via both ways i.e., 1) through standalone completion of the internet intervention exercises and 2) during online interactive workshops.

The main aim of this study was to verify the effect of the prototype of psychological intervention addressed to decrease digital transformation stress. Accordingly, a series of analyses was conducted for testing the change in several outcome variables, i.e.: digital transformation stress, digital transformation attitudes, stress in the workplace, burnout and employees' self-efficacy. All these variables were measured at two specific time points: before and after the prototype of the intervention.

The results, presented in the published article "Blended Online Intervention to Reduce Digital Transformation Stress by Enhancing Employees' Resources in COVID-19" (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022), were very interesting. Firstly, results showed that there were significant interactions of condition and measurement points in DTS, at the tendency level in one dimension of DTAS, i.e., negative affect, as well as in one of the dimensions of burnout, i.e., disengagement. As predicted, participants actively involved in the intervention had a lower level of DTS in the second measurement point (T2) than in the first one (T1). Secondly, the DTS level was higher in T2 than in T1, in both groups of participants, who had declared not to take part either in the intervention or in workshops. The results of this longitudinal study of the internet intervention prototype are promising and encourage further research on the internet interventions addressing the DTS.

Discussion

The main objectives of my research were: first, to verify how the digital transformation process might be associated with a specific type of employee stress associated with the process in an organization, and then call it digital transformation stress; second, to propose a measurement of DTS, if possible, using the benefits of digital transformation as a sentiment analysis (Buitelaar et al., 2013; Elbagir & Yang, 2019) method; and finally, to design and test the effectiveness of a prototype of online intervention that could be helpful in dealing with DTS and other negative effects of digital transformation process. During the research, I drew on a wide range of research and literature on job stress and DT. According to the Job Demands-Resources (Bakker & Demerouti, 2007; Demerouti et al., 2001) model and approach by Arla Day (2012, 2017), I set the JD-R model (Demerouti et al., 2001) in the context of digital transformation and identified the main DT demands, which might be predictors of DTS, as well as identifying the main resource which might mitigate DTS.

My research on DTS represents an innovative example for an interdisciplinary approach to research problems. Firstly, in my research, I distinguished and explored the concept of stress in relation to the DT process in organizations. According to my assumptions, DTS may encompass other concepts of stress related to ICT role development, such as

technostress, digital stress as well as stress related to digital and organizational changes, including ICT introduced process and project management (Richmond & Skitmore, 2006). This concept seems to apply to employees with both high and low ICT competencies (Carretero et al., 2017; Nosalska & Gracel, 2019; Papagiannidis et al., 2020), as well as those with both positive and negative attitudes towards digital transformation (Dubois et al., 2014; Meske & Junglas, 2020). Therefore, my research on DTS is an innovative approach and the concept of DTS supplements the job stress concept in relation to the organization's digital transformation process.

Secondly, I developed new scales for measuring stress, but I have also proposed an alternative approach to measuring stress without having to complete surveys, thereby avoiding dropouts and without involving participants in the measurement. This is another example of an interdisciplinary approach, combining the fields of psychology and computer science in job stress research.

Thirdly, my research has shown that the JD-R (Bakker & Demerouti, 2007) model can be applied in the context of the digital transformation process. In this approach, ICT-related job demands relate to professional demands, and self-efficacy (Bandura, 1989; Shoji et al., 2016) is an important resource that may mitigate stress and risk of burnout. This represents an important element for psychology of job stress, as evidence of the replicability of the JR-D model's assumptions and its applicability to a new perspective as digital transformation and DTS.

Finally, I propose an interdisciplinary approach to developing online psychological interventions. Creating web-based interventions (Heber et al., 2017) can combine the best practices of app development, such as participatory design workshops, (Kopeć et al., 2018; Rose & Björling, 2017), UX (G. Cabrero, 2014; Knijnenburg et al., 2012) and psychology, like behavioral-cognitive (Curwen et al., 2018; Hawley et al., 2017) or social-cognitive (Bandura, 1989) therapy.

However, despite the benefits of interdisciplinarity in research, one should be aware that an interdisciplinary approach to research presents certain challenges. It is still a pioneering path and using the example of my research combining computer science and psychology, it may be too psychological for the field of computer science and, conversely, too computer scientific for the field of psychology. As a result, publication of research results may face difficulties, as it is still a fairly novel approach to science.

Contributions

With regard to the theory of psychology of job stress (Lesener et al., 2019; Parker & DeCotiis, 1983), my main contribution has confirmed the concept of digital transformation stress in the general assumptions about the role of job demands and resources (Bakker & Demerouti, 2014; Day et al., 2012; Demerouti et al., 2001; Dudek et al., 2007; Hobfoll et al., 2018) . Consequently, I have identified job demands, i.e., specific ICT job demands in context of DTS. Accordingly, I replicated one of the recognized theoretical models for research on stress, which is Job Demands - Resources model (Bakker & Demerouti, 2007; Demerouti et al., 2001), in relation to the DTS. Furthermore, my contributions are composed of several outputs, like the development of two scales of measurement in both aspects related to the DT process issues like digital transformation attitudes, measured by DTAS and digital transformation stress measured by DTSS. Furthermore, I proposed and developed a tool based on Machine Learning (Ma et al., 2014; Subhani et al., 2017) methodology, using sentiment analysis (Buitelaar et al., 2013; Elbagir & Yang, 2019) to investigate if employees suffered from DTS, without completing any questionnaire. Using machine learning in the automatic screening of employees' written communication, with a focus on stressors markers (through sentiment analysis) might allow the automatic identification of the most common issues regarding e.g., ICT demands and help solve them. In addition, I translated ICT Demands and Support scales (Day et al., 2012), then identified ICT Demands as predictors for DTS and burnout (Makowska-Tłomak & Bedyńska, 2022) and applied the selected ICT job demands in Job Demands-Resources (Bakker & Demerouti, 2007; Demerouti et al., 2001) model. Finally, I proposed an efficient online intervention prototype which might be used as a dedicated internet intervention (Cieślak et al., 2018) to deal with DTS using self-efficacy strengthening exercises (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Rogala, Smoktunowicz, et al., 2016; Smoktunowicz et al., 2019). My interdisciplinary approach shows that in the research it is worth to join two different areas of science, here psychology and computer science.

Practical implications

DTS scale may become a substantial part of an automated system consisting of three hierarchical elements: a) preliminary screening, based on a qualitative analysis of e.g. employees' requests in help desk systems (Makowska-Tlomak et al., 2021), b) cross-checking the level of DTS among employees by periodical measurements using DTSS (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022) c) DTS prevention through dedicated psychological intervention, strengthening personal resources, such as job-related self-efficacy, to cope with ICT job demands (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Makowska-Tłomak & Bedyńska, 2022). Moreover, outcomes of DTS research could be used in project management area. Measurement of the perceived digital transformation stress is a key concept in two project management methodologies. It allows to compare the level of digital transformation stress in different project phases and identify the phases in which the employees should be actively assisted. Therefore, using a set of DTS measurement and preventing tools might be an effective way to manage and streamline the digital transformation process in organizations. This applies to both the implementation teams that are responsible for implementing solutions and the teams where changes

are implemented. Research testing the associations between DTS and psychological well-being, burnout, disengagement is of great importance in understanding and evaluating the value of these costs.

Limitations and further research directions

My research had several limitations: 1) limited ability to objectively classify employees of organizations with ongoing digital transformation and those outside the DT process, 2) the COVID-19 pandemic, which was a DT accelerator and redefined the approach to ICT solutions implementation, 3) differentiation of research samples in terms of employees experiencing digital transformation stress into those implementing the change and those in which the transformation process is contained. It would be very interesting to select organizations just as they start the process of digital implementation and evaluate changes in the level of digital transformation stress of their employees longitudinally. Such research design would enable to provide more reliable information about its causal relationship between employees' demands, resources, and stress. Further work should also examine how strongly DT stress impacts different work outcomes such as work commitment, job satisfaction, and burnout of employees. Additionally, more research is needed to examine the variables that allow to predict the level of DTS, for instance attitudes toward digital solutions implementation, perceived job demands. This research should also be conducted after the COVID-19 pandemic, when DT processes will be simpler to plan and properly implemented in organizations.

One of the directions I am interested in for my future research on DTS is, among others, to examine DTS in the context of gender. I want to explore whether gender is a moderator of the concept of DT, and I also would like to explore the impact of gender on employees' assessment of their own digital competences (especially women's assessment of ICT skills) and whether this has an impact on the level of DTS. This is an interesting aspect regarding DTS and stereotype threat, so this will be a further direction of my research. Seniority and age of employees also seem to be very interesting to study in context to DTS and stereotyping. Another area for further research is the investigation of the consequences of DTS, both positive and negative, such as resignation, retraining, satisfaction and job crafting (Blazejewski & Walker, 2018; Tims et al., 2012). This is a broad and diverse area that is worth exploring.

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Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress

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ABSTRACT

Digital transformation (DT) is the process of transformation of the business world with the use of information and communication technology (ICT) solutions. It not only has a large impact on organizations – their competitiveness and performance, but also on employee well-being and their stress levels. To measure the stress associated with such digital changes we used the concept of Digital Transformation Stress (DTS), and its verified psychometric survey-based tools. In this study we proposed and verified an alternative, automatic tool to measure DTS based on sentiment analysis of help desk ticket data set. First, we conducted sentiment analysis (SA) of help desk tickets of an international financial company to estimate how employees' stress could manifest in official written communication. We identified negative emotions markers and analysed the relationships between the ticket registration frequency and negative emotion markers. Our interdisciplinary research confirmed that there is high and positive correlation between the stress measurement results based on the established psychometric survey and sentiment analysis results of help desk ticket data set. We conclude that the novel tool we proposed allows for continuous monitoring of DTS among employees in any organization, without psychometric surveys. It is an attractive alternative to lengthy questionnaires, as it makes better use of employees' time while continuously monitoring stress levels to evaluate at any time if an intervention, such as training, tool upgrade or any other support is needed to safeguard employee's job satisfaction and their well-being.

CCS CONCEPTS

• **Information systems** → **Sentiment analysis**; • **Social and professional topics** → *Implementation management*; *Project and people management*.

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KEYWORDS

Sentiment analysis, Digital transformation, Stress Measurement, Wellbeing, Data Science

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1 INTRODUCTION

Despite the many advantages of Digital Transformation (DT) [13, 58], there are many issues related to it, technological progress, the impact of ICT solutions on productivity and efficiency, enterprises [69] and the whole economy [1, 61]. The DT process may result in high pressure, work overload, challenges related to the adaptation and communication and finally the employees' resistance to change [50, 72, 78]. Employees' stress related to DT might result in a decrease of productivity and commitment [37]. Moreover, the high stress (DTS and general stress at work as well), in the long term, may result in the employees' health problems and even in burnout [8, 20, 79].

Therefore, stress control and dedicated monitoring tools are needed to respond promptly when digital transformation stress is increasing [51, 68]. Quick response to stress may aid in addressing the risks of lower productivity and employee turnover [40, 71].

The COVID-19 pandemic increased the need for continuous monitoring of digital stress levels [42, 51] because the global lockdown has been, for many people, a new and difficult experience. In a very short time they had to change their manner of working, and switch to remote and online work mode [3, 42]. This situation highlighted the importance of research in the field of stress associated with digital transformation - especially how to quickly measure the level of stress, and how to effectively counteract it [55, 64]. Therefore, developing dedicated digital transformation stress (DTS) [47] measuring tools which do not contribute to work overload is a research problem which may have important implications for the business world.

The main objective of our study is to create a technological solution that will monitor stress levels independently of completing

psychometric questionnaires. We hope that it could be an alternative to time-consuming surveys [26] whose results may not be robust [74] and which need repeated measurements in fixed and specific time intervals to provide reliable results. The developed tool should not demand additional effort from the employees. It should also adhere to the need of using it continuously in short time intervals, simultaneously avoiding not-response bias [32, 41] as well as the risk of perceiving it as spam [32, 41].

Therefore, in our study we present a new tool to measure Digital Transformation Stress (DTS) based on the established practice of sentiment analysis [21, 63]. For this purpose, we analyse the sentiment of the content of real help desk tickets and test the results of this analysis against the baseline results obtained from a study done on the same sample of people in a similar time frame [1] with a previously developed and verified psychometric scale [47].

2 RELATED WORK

2.1 Digital Transformation in Organizations

The process of digital transformation in organizations is connected with a wide range of social changes [38] related to the redefinition of the work scope and responsibilities, number of employees, requirements, new tasks, competences and work mode, as well as changes in human team management [18, 22, 39].

Organisational changes give rise to resistance due to their unpredictability, as well as to the interference with the existing order and structures of the company [49, 70]. This resistance among employees can be expressed in terms of passive fears, severe stress, in some cases aggression, as well as professional burnout [8, 22]. The transformation of rooted patterns of behaviour and value systems requires targeted and lengthy training measures to be carried out by managers, psychologists and educators [18]. As the main focus of the DT work is on project implementation, change in training programs is limited to communication of changes, procedures and instructions [35]. Professional development of employees is often neglected in this area when changes are introduced [22, 68] which leaves them without the tools to manage these changes.

2.2 Employees and Stress Related to Digital Transformation (DT)

Employees' reactions to changes associated with DT depend on several factors, e.g., their sense of control, other resources such as skills, self-efficacy and in opposite job demands towards employees [19, 20]. According to the job demand-control model (J-DC)[28, 34], employees who are faced with high demands, e.g. related to working with new IT tools, may experience more or less tension – in this case, in the context of the digital transformation – depending on the skills they have (resources), and how much control they have over the situation to meet its demands [22, 57, 68], (see Fig 1). Employer expectations regarding the implementation of IT solutions constitute an additional stress factor [57]. Uncertainty related to changes in the organization and the fear of being made redundant are the most frequent initial reactions of people informed about such changes [18].

[1] HD tickets for sentiment analysis were collected over a longer period to provide a larger and richer data set

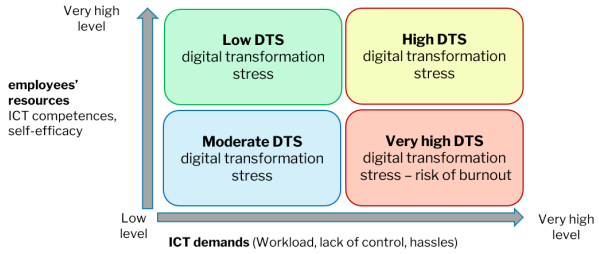

Figure 1: The ICT J-DR model diagram in the context of digital transformation

Based on the European Working Conditions Survey, carried out every 5 years, in 2020 [25, 27, 56] it is possible to identify areas that can be analyzed in the context of employees' stress in combination with digital transformation. These include job satisfaction surveys, the so-called work-home balance – i.e. for example the number of hours spent at work, but also indicators like digital skills, ICT usage in enterprises and use of computers, mobile devices and the Internet by the employees.

Starting with the job demand-control-support model (JDCS) [2, 17, 33] and the Job-Demands-Resources model (J-DR) E. Demerouti and A.B. Bakker [6] factors influencing professional stress in the digital transformation are:

(1) ICT Demands [19], competences and skills in the field of ICT (on the one hand, these are the requirements – employer expectations, and on the other hand, the employee resources),
(2) the sense of control at work, i.e. the influence on decisions concerning performed work [33],
(3) social support [30] – here we can distinguish supervisor support and support from colleagues at work, closely related to relations with colleagues.

Thus, DTS is emotional response of an employee to a specific situation, which is the digital transformation process. In this case, how employee perceives the situation of digital change or the IT implementation process as a potential threat to the current, familiar work style, but also e.g. to the current position. The DTS may even apply to employees who initially presented openness and positive attitude towards the DT process and ICT implementations [47].

To measure employee stress related to digital transformation in our prior research we developed and evaluated the digital transformation stress scale (DTSS) [47]. Based on the Job Demand-Control-Support model (JDCS) [2], [34] and Job-Demands Resources model (J-DR) [7, 20] we identified main factors which impact the level of digital transformation stress which are reflected in our psychometric measurement tool[47].

2.3 Machine Learning and Sentiment Analysis

Nowadays ICT solutions in machine learning (ML) and data mining are more and more often used to examine possibilities to identify human emotions [52, 77], cognitive functions [73] or disorders [36, 65]. Machine learning methods are being increasingly tested to identify specific features of stress [62, 73]. Such studies include the

examinations of the effects of e.g cognitive or physical stress, e.g. on specific writing [73], smartphone using patterns [59] or patterns of activity of the brain [65]. Sentiment analysis (SA) permits to analyze people's opinions, sentiments, appraisals, attitudes, and emotions towards many entities such as products, services, organizations, phenomenons, issues, subject, and their attributes [43]. Subjective expressions may contain explicit sentiment markers [53], which can be identified by sentiment analysis of on-line texts in applications, opinion forums and service help desk for customers [4, 11, 12]. Using these platforms, people express their subjective opinions and ratings, often with strong emotional load (especially when they are dissatisfied) [9, 16, 44]. The main issue for sentiment analysis is to establish adequate lexicon and lexical clues, which are characterized for the specific domain [23]. It is also very important for ML and sentiment analysis approach to identify correct classification methods [10, 23, 36, 65]. One of the ways to verify the correctness of algorithms is to compare them with psychometric tools, such as established surveys [15, 59]. Data clustering can also help in identifying natural groupings that exist in a given data-set, such as the patterns in the same cluster being more similar and the patterns in different clusters – less similar [60]. The aim of data clustering [76] is to identify the natural grouping of sentiment (limited collection) occurrence that exist in the given data-set [5, 66].

3 METHODS

3.1 Study Goals

Based on existing knowledge and results in this field [18, 19, 59], in our study we are investigating the use of ML and sentiment analysis to identify DT stress factors. The main aim of the study is to evaluate the effectiveness of using help desk ticket contents as source data to measure DTS among employees. This will be done through verifying if there is a correlation between: (1) the stress levels measured through sentiment analysis of employee HD tickets and (2) the stress levels measured with the use of the previously validated psychometric survey. The correlation between two different stress measurement tools will confirm the feasibility of using written communication among employees as an efficient solution for monitoring their stress without the need to complete tedious questionnaires.

3.2 Study Assumptions

In order to develop and evaluate the tool for automatic DT stress measurement we worked with the following assumptions:

(1) the process of digital transformation had to be in progress in the organization where the research takes place;
(2) employees have to be affected by DTS;
(3) employee stress is expressed in their written communication, including help desk tickets and project e-mails;
(4) the research has to be done simultaneously, and the results of two independent measurement tools (the new sentiment analysis tool and the previously validated psychometric survey [47]) have to be compared.

If simultaneous occurrence of above conditions is confirmed, it will be the basis for the development of a language corpus of stress in DT processes [24, 54]. This corpus in turn can serve as training data for an automatic stress detection tool based on Machine Learning.

3.2.1 Hypothesis 1. We predict to obtain a positive correlation between the results of digital transformation stress measurements conducted with the psychometric scale and the sentiment analysis in written communication, in our case, help desk tickets.

3.2.2 Hypothesis 2. We also expect to discover the relationships between the number of help desk tickets and the occurrence of negative emotions as well as between help desk tickets and the levels of digital transformation stress, measured with the help of DTSS psychometric tool.

Therefore, in this study we focused on the relationships between DTS and sentiment analysis in help desk communication, during the intense period of digital transformation in a selected company.

3.3 Baseline Tool: Digital Transformation Stress Scales

As baseline we used two psychometric scales which were validated in our previous research [47]:

- Digital Transformation Attitudes Scale (DTAS) is one of self-developed scales for measuring employees' attitudes toward the digital transformation. It measures Digital Transformation Attitudes (DTA) which are employee reactions to technological and IT changes introduced in the organization, which include, for example, the implementation of new software, Document Management System (DMS) or work automation. Its psychometric evaluation was conducted in a series of two studies, in December 2019 and June 2020, Cronbach's Alpha was equal ALPHA = .86, $p < .001$ [47].
- Digital Transformation Stress Scale (DTSS) the second self-developed scale. It measures DTS, which is the emotional response of an employee to the digital transformation processes. It was psychometrically evaluated in the series of two studies as mentioned above. The reliability was high in both studies, Cronbach's Alpha was equal ALPHA = .91, $p < .001$ [47].

In short, both scales proved to be consistent with Demands-Resources Model [20] – the relationship between DT stress levels and IT skills (employee resources). The lower the IT skills, the higher the level of stress associated with digital transformation. The correlation was negative and high. Accordingly, IT skills and DTSS R=-.582 and IT skills and DTSS R=-.599. Similar result was noticed for lack of control (ICT component [19]) and DTAS and DTSS, in sequence R= -.335 and R=-.485. The content validity, predictive validity have been pre-confirmed and therefore the stress measurement tools (DTAS and DTSS) could be used for the main study - verification of the digital transformation stress level in the sentiment analysis based on DTSS results.

3.4 Our New Proposed Tool: Sentiment Analysis of Help Desk Tickets

The help desk platform, containing messages exchanged between workers and tickets directed to the internal technical support team,

was a promising source of behavioural data within the company that may help to measure DTS. In our study we use sentiment analysis to extract polarity and strength of emotions present in these short messages [23].

3.4.1 Help Desks. The main goal of HD applications is to provide employees with support related to IT projects, software, computers, electronic equipment etc. Help desks allow to track and sort employee tickets with the help of a unique number, and can frequently classify problems by user, computer program, or into similar categories (see Fig 2). Help desk (HD) communication, as it is aimed at solving issues should be brief and specific. In each ticket registration the user should choose the category of issue, e.g. the name of an application affected (e.g. Egeria[2] or Webcon[3], Simplified programs[4]). The HD ticket description should be short but contain all necessary details like screenshots or system alerts, that is all of the information which could be helpful in solving the issue. The employees register tickets mainly in case of technical issues, usually related to new systems implemented. This can happen as employees want to prioritize their issue, get it solved faster, identify the person responsible for solving their problem or simply to avoid starting email threads.

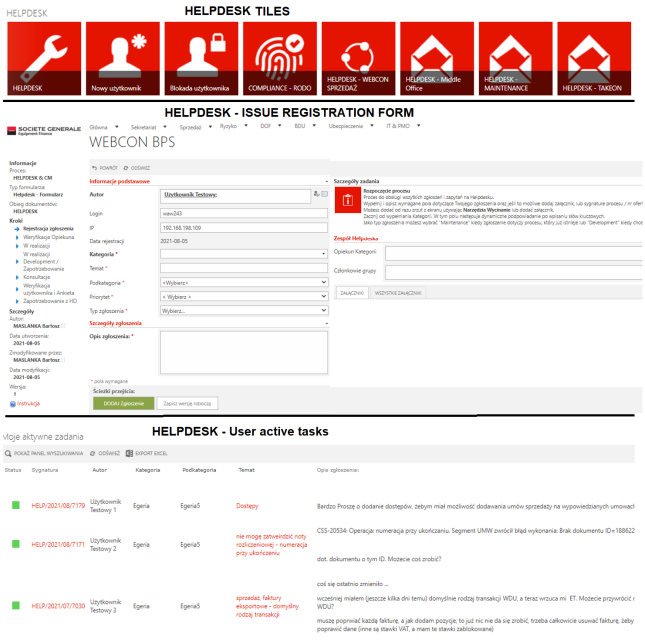

Figure 2: Screenshots of the help desk application used in the company where the research took place.

[2]Egeria is the name of main accounting and financial system, built on Oracle database
[3]Webcon is the name of company which is the supplier of the Webcon BPS solution, but in this case by *Webcon* employees understood the name of system used in company as digital business processing platform
[4]Sales programs with automatised risk estimation which provide the user to simplified path of sales contract processing or to full risk processing conducted by risk officer.

3.4.2 Help Desk Communication. As illustrated in the examples below, for help desk communication to be effective, it should be based on short, fact-based descriptions of the specific issue submitted by the end-users. This communication should be emotion-free and without subjective assessments. Yet, this is not always the case, as in Example 1. Hence the idea of analyzing whether in texts submitted to HD occur semantic elements with emotional markers, indicating stress, dissatisfaction, frustration or irritation.

- Ticket Example 1: *When I applied the button START the application Egeria I obtained the alert "your certificate is not valid - contact the administrator"*
- Ticket Example 2: *I CANNOT SEND THE SUPPLIER KYC FOR VERIFICATION !!!!! KYCDOST / 2020/12/00066; INFO appears ATTENTION! Please register the KRD process after the registration of the process, info will appear ATTENTION! A check in KRD is already registered for the given Contractor !!!!! it blocks work !!!!! .*

3.5 Procedure and participants

3.5.1 Company and Participants. There were 37 participants, who provided valid responses to the survey, that is who completed the survey in full, 30 were female and 7 were male. All participants (mean age = 40.5, SD = 8.76) were employed in the same international financial organization (hiring 200 employees in their office in Poland) and took part in the survey with the consent of the company's Management Board. The selected multinational company, has been in the process of digital transformation related to the digitization of business processes and the implementation of a dedicated business process management platform [45] for over a year.

3.5.2 Ethics. The research protocol was approved by the Ethical Committee of the SWPS University of Social Sciences and Humanities. The present study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA, 2010). Prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the questionnaire was activated. Participation was voluntary, and participants did not receive compensation for their participation in the study.

3.5.3 Recruitment. The information about the objective of the study and involved researchers was featured in the company's newsletter. At the same time an email to employees was sent with the same information and a kind request to participate in the study. The study was conducted in Polish, so the survey results and the help desk data were gathered in Polish.

3.5.4 Gathering Survey Responses. Participants could start the questionnaire by clicking on a respective link in the newsletter or in the e-mail. All data was collected online on the Qualtrics platform [5]. The survey was composed of seven sections, i.e. sociodemographic, DTAS, DTS, ICT Demands, ICT skills part; perceived stress at work and general self-efficacy scale. The survey contained 82 questions in total. The average duration of the survey completion

[5]https://www.qualtrics.com

was predicted 25 minutes. The number of employees who started the survey was 70 but only 53% (37 people) completed the survey.

3.5.5 Gathering Data for Sentiment Analysis. Simultaneously, written communication data from help desk system was collected for sentiment analysis (see Fig 3 and Fig 4).

For initial analysis, we collected all tickets registered between June 2017 (launch of the new HD system) and April 2021. Overall, we collected 27944 ticket records. We started with an analysis of the increase in the tendency of HD requests (named as HD tickets) during the last four years. While the average number of tasks between 2017 and 2019 was slightly above 3200, in 2020 we observed a dramatic increase of the number of thickets, which reached the level of 13648 records. 6617 out of these records accumulated in the first half of 2020. It was the period when employees completely switched to remote work. We focused on data collected between January and June 2020 for two reasons:

(1) it was a period of intense digital transformation in the company, as a consequence of COVID-19 pandemic,
(2) DTS research time - the survey on digital transformation stress was conducted during this period of intensive Digital Transformation.

All data was analysed to acquire a number of logins for each record, i.e. *waw080, waw079*, in order to map the association between survey's participants and HD users and run a correlation analysis between DTS survey results and their HD sentiment analysis.

We filtered out tickets related to software issues, i.e., all problems regarding the category related to the ERP system[6], business process management platform[7], company's application and programs necessary to complete daily work. We obtained 6323 items, which comprised 95% of all HD tickets registered between January and June 2020.

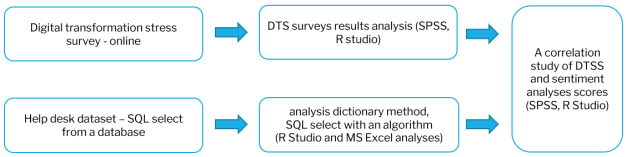

Figure 3: An overview of the data acquisition and data analysis procedure.

4 RESULTS

4.1 Baseline: Digital Transformation Stress Among Employees

In the first part of study we measured the level of the digital transformation stress (DTS) among employees as total and by gender. The average DTS score of participants was M=2.77, SD = 0.73, the mean of DTS among women (M=2.94, SD = .71) was higher the among men (M=2.19, SD = .43). The average employees' DTS was moderate high. Regarding the digital transformation attitudes, although employees' positive cognitive attitude subscale[8] toward digital transformation was high (M = 4.42 SD = .86), as well as the proactive behaviour subscale[9] (M = 3.56 SD = .54), the mean of negative cognitive attitudes (anxiety) toward digital transformation was moderate high too (M = 2.94, SD = 1.00.

4.2 Sentiment Analysis

We started the initial analysis with limited, basic words phrases and syntax collection with emotional markers like:

- imperative forms,
- exclamation marks mixed with question marks,
- generalizations ("always", "never", "nobody", "again"),
- irritations ("it annoys me", "I'm sick of", "why")
- and curses or swearword expressions [9, 31].

Next, we analysed the frequency of occurrence of basic keywords in HD tickets, the average number of characters in the ticket per user and the number of HD requests per user over two periods: first one between January 2019 and June 2019 (6 months – 2036 requests and 208 users) and second one between January 2020 and June 2020 (6400 HD requests and 223 users). Compared to the period of last year (first six months of 2019 and first six months of 2020), the number of HD requests increased by over 200%.

In same period in 2019 there were in average 10 HD requests per user and in 2020 nearly three times more (29 HD requests per user).

In second period of analysis, 79% of users have registered HD tickets with negative emotions markers in the HD ticket text. Only in tickets submitted by 22 users there were no negative emotion markers. Sentiment correlation between the number of requests and frequency of negative emotions markers in HD requests text was high, in both cases R=.78 p<.001. Women registered more HD tickets (in average 36% tickets more) and more HD tickets with negative emotion markers (64% in average) then men (61% in average). We verified the negative emotions markers occurrence in HD tickets and we carried out cluster analysis.

Cluster analysis was carried out using the grouping methods by k-means method [14] preceded by making a scree plot (see Fig 5). Based on the scree plot, 3-5 possible clusters were identified. The choice of 4 clusters seemed to be optimal. Cluster analysis was based on the number of negative emotions markers in HD tickets (sentiment frequency) compared to the number of tickets per user. 4 clusters group users patterns in sentiment frequency in their HD tickets. There were 2 groups of users who, in a similar number of tickets, have used highly emotional verbal expression. One (first) cluster group are users with a small number of HD tickets and low occurrence of negative emotions markers in HD tickets. That may indicate low stress levels. The last identified cluster (4) contained extreme values – both with a large and medium number of requests (between 100 and 200) with a large and very large, but very diverse, occurrence of negative emotions markers in HD tickets (see Fig 5).

[6]ERP - Enterprise Resource Planning system, in this case Egeria system on Oracle
[7]Webcon bps https://webcon.com/platform/, https://www.youtube.com/watch?v=nIrVXkbtIFk
[8]reversed scale
[9]reversed subscale

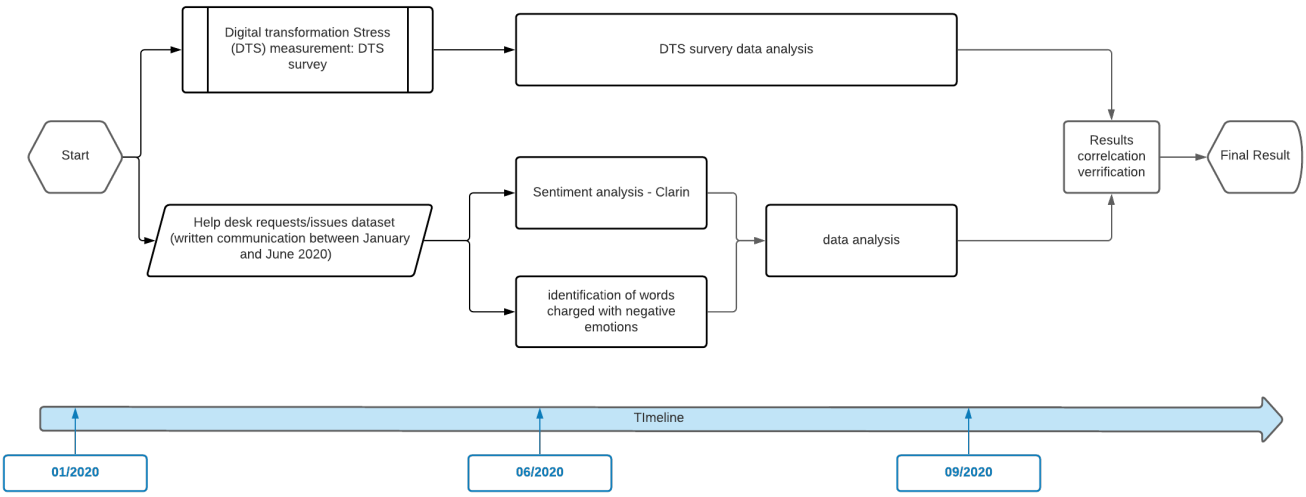

Figure 4: The whole study flow diagram with a timeline

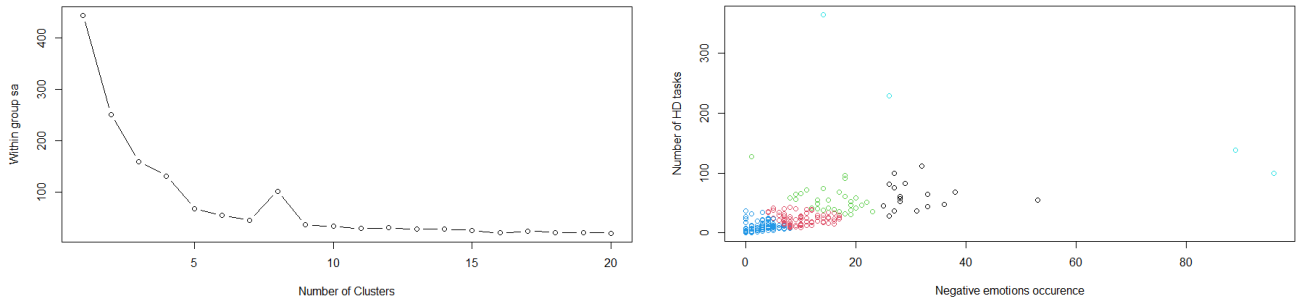

Figure 5: Sentiment occurrence in help desk ticket items per user

4.3 Tools' Comparison: DTS survey and sentiment analysis approach

After conducting separate analyzes (psychometric and sentiment analysis), we tested whether DTS scale was associated with help desk sentiment analysis results (see Fig 4). For this purpose, the logins of the survey participants were mapped to the reporters' logins of the help desk requests, extracted between January and June 2020. HD requests were limited to the first half of the year due to the intensity of the digital transformation process caused by the COVID-19 pandemic [3].

We observed a significant and positive correlation between digital transformation stress score (DTSS) and sentiment analysis results, (R = .46 p < .05). Significant and positive correlation was observed also between the number of registered HD tasks and DTSS score, (R = .44 p < .05). We also confirmed the high and positive correlation between number of HD tasks and negative emotions occured in HD tasks, among employees who completed the DTS survey. The correlation was (R = .52 p < .05).

5 DISCUSSION

The digital transformation process in companies is associated with the process of change [49, 58, 70]. Both of these processes are likely to cause stress among employees, with varying degrees of severity [51, 67]. Employee stress can reduce company efficiency [18, 22]. It may lead to a commitment decrease [64] [29, 75] and, in extreme cases, to professional burnout [18], thus reducing the effectiveness of the organisation [37, 48]. Therefore, for mature organizations which value their employee well-being, monitoring the level of stress among employees can be of crucial importance, especially if no time-consuming surveys are required.

In this study we proposed and verified an automatic sentiment analysis tool for detecting digital transformation stress based on the contents of help desk tickets. This solution will enable continuous monitoring of stress levels among employees without additional costs associated with ordering external stress measurement evaluations and wasting employee's time on repetitive surveys. Monitoring like this can:

- guide the pace of the processes of digital transformation in companies, to allow employees to keep up with the changes

- help evaluate the existing ICT tools used in companies and make decisions about implementing more people-oriented software tools, which were built with employees emotional needs in mind
- allow HR departments to promptly react to the needs of specific teams and employees by offering appropriate training or support, e.g. psychological, online, self-guided interventions [46]
- preemptively react to potential decrease in job satisfaction among employees affected by DTS

Hence, tools for automatic detection of stress associated with digital transformation (DTS), which can be introduced to the existing business processes (help desk ticketing) with the use of relatively few resources can have great value for many companies. This is especially important as the pace of digital transformation is accelerating and employees have trouble keeping up with the changes and demands of our increasingly digitized and data-oriented society. Not only this solution can help to increase their well-being, by evaluating and reacting to their needs, but also it can improve the performance of businesses.

5.1 Limitations

The present study has several limitations. First, organizational changes, especially the the change in management board in the company at the time could interfere with perceived stress scores. Second, only 70 employees out of 230 started the survey. Third, there was a 47% dropout rate among respondents. Therefore in future research, a shorter version of the DTS survey should be used to increase participation.

6 CONCLUSIONS

Digital transformation is one of the most important processes at the level of the economy as well as individual companies. But this process may have a negative impact on employees well-being and, in consequence, their efficiency at work, as it increases their levels of Digital Transformation Stress (DTS). For this reason, continuous monitoring of DTS levels is advisable to quickly react to the emergence of this type of stress, which may not only lower company effectiveness but also increase turnover among employees. Thus, in this paper we proposed and verified the feasibility of a novel tool to evaluate the sentiment of help desk tickets.

First, we conducted sentiment analysis of help desk request text to estimate how employees' stress could manifest in official written communication. We identified negative emotions markers in help desk ticket text, analysed the relationship between the frequency of ticket registration and negative emotion markers in help desk ticket text. In June 2020, we conducted a psychometric measurement of DTS stress on the same group of employees. Next we collated results both analysis, i.e., sentiment analysis of HD ticket text and DTS measurement. Our interdisciplinary research confirmed that there is high and positive correlation between the psychometric stress measurement results, based on an established survey and sentiment analysis results of help desk ticket data set.

The novel tool we propose will allow for the continuous monitoring of digital transformation stress among employees in any organization, without using psychometric surveys. This will allow companies to make better use of their employees' time and to react quicker when an intervention, such as training, tool upgrade or any other support is needed to safeguard employee's job satisfaction and their well-being.'

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Niniejszym oświadczam, że w pracy Makowska-Tłomak, E., Nielek, R., Skorupska, K., Paluch, J. & Kopeć, W. Evaluating a Sentiment Analysis Tool to Detect Digital Transformation Stress. WI-IAT '21: IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology December 2021 Pages 103–111, https://doi.org/10.1145/3486622.3494024, mój udział polegał na pomocy w opracowaniu koncepcji, edycji i korekcie manuskryptu. Mój udział w powstaniu pracy wynosi 10%.

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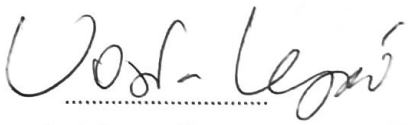

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Blended Online Intervention to Reduce Digital Transformation Stress by Enhancing Employees' Resources in COVID-19

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Generally, the solutions based on information and communication technologies (ICT) provide positive outcomes for both companies and employees. However, the process of digital transformation (DT) can be the cause of digital transformation stress (DTS), when the work demands caused by fast implementation of ICT are elevated and employees' resources are limited. Based on the Job Demand-Resources (JD-R) Model we claim that DT, rapidly accelerating in the COVID-19 pandemic, can increase the level of DTS and general stress at work. To reduce these negative effects of DTS, we propose the online intervention aimed to strengthen employees' resources, such as self-efficacy. In this article we evaluate the effectiveness of the blended intervention, based on cognitive behavioral therapy (CBT) and social cognitive therapy, composed of a prototyped online training (e-stressless) and series of interactive online workshops. In a longitudinal study, we examined the change in DTS, perceived stress at work, attitudes toward DT, self-efficacy and burnout in two time points, before and after the intervention. We compared five groups of participants (558 in total), three groups not qualified ($n = 417$), and two groups qualified to intervention ($n = 141$). Our results revealed that the designed blended intervention decreased DTS and one of the dimensions of burnout, namely disengagement. More specifically, the results showed that in the group of active participants of the blended intervention DTS significantly decreased [$M_{T1} = 3.23$, $M_{T2} = 3.00$, $t(432) = 1.96$, $p = 0.051$], and in the group of ineligible participants DTS significantly increased [$M_{T1} = 1.76$, $M_{T2} = 2.02$, $t(432) = 4.17$, $p < 0.001$]. This research paves way for the creation of blended online intervention which could help in addressing employee digital transformation stress before it starts having adverse effects on employee performance and well-being.

Keywords: digital transformation stress, digital transformation, online intervention, self-efficacy, burnout, COVID-19

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INTRODUCTION

Digital transformation (DT) is a continuous process which is changing the economy and the society in fundamental ways (Meske and Junglas, 2020). In organizations, the DT often takes the form of a rapid and ongoing implementation of new information and communication technologies (ICT) solutions. It requires an organizational change (Verina and Titko, 2019) and instilling a culture that

supports the change while enabling the company's overarching strategy (Mergel et al., 2019; Verina and Titko, 2019). Digital transformation also modifies employees' overall workplace experience: tasks processing, the workload, the sense of control, and social relations within the organization (Dubois et al., 2014; Cortellazzo et al., 2019).

The COVID-19 pandemic leading to national lockdowns forced a transition to new working conditions almost overnight (Dwivedi et al., 2020; Iivari et al., 2020). The digital transformation has accelerated (Iivari et al., 2020; Priyono et al., 2020). Many employees, for the first time, were strongly dependent on ICT solutions (Leonardi, 2020; Park and Inocencio, 2020) and their current workplace was replaced by a remote one, saturated with ICT solutions to the maximum (Shaw et al., 2020). Consequently, the COVID-19 pandemic necessitated the employees' adaptation to new working conditions and increased job demands. Therefore, DT in these conditions can be a substantial source of stress in the workplace (Day et al., 2012, 2017; Tarafdar et al., 2015; Legner et al., 2017) for some employees (Tims et al., 2012).

Based on the Job Demand-Resources (JD-R) Model (Demerouti and Bakker, 2011), we claim that digital transformation demands (Day et al., 2012) are rapidly growing in the COVID-19 pandemic and they increase the level of digital transformation stress (DTS) (Makowska-Tłomak et al., 2022) and general stress at work (Day et al., 2012; Berg-Beckhoff et al., 2017). In the long term, the elevated level of stress might result in the employees' burnout (Bedyńska and Żołnierczyk-Zreda, 2015; Berg-Beckhoff et al., 2017). Therefore, to reduce these negative effects of DTS, we propose a psychological intervention aimed to strengthen employees' resources in order to facilitate healthy coping strategies with digital transformation stress. Due to the limited possibilities of direct contact in the COVID-19 pandemic, we proposed self-help online training supported by online group workshops as a blended intervention to help employees in dealing with digital transformation stress.

The psychological Internet-based interventions have been shown to deliver effective treatment for a variety of mental health problems, such as depression or anxiety (Cieslak et al., 2016; Andersson et al., 2019). Internet-delivered cognitive behavior therapy (CBT) has been used for more than 20 years and hundreds of studies have presented its effectiveness (Andersson et al., 2019). In contrast, interventions conceptualized in the stress and cognitive appraisal model (Lazarus and Folkman, 1984), or job demands-resources (JD-R) model (Bakker and Demerouti, 2007) are still relatively uncommon (Smoktunowicz et al., 2021). Hence, we decided to design an online intervention to address the digital transformation stress in the occupational health and well-being context within the dominating theoretical framework based on the CBT (Bond and Hayes, 2002) and Social Cognitive Therapy (SCT) (Bandura, 1989).

In this study, we tested the effectiveness of the blended intervention approach, composed of online training and online workshops. We predicted that this intervention would reduce perceived stress in the workplace (Lesage et al., 2012; Chirkowska-Smolak, 2016), digital transformation stress (Makowska-Tłomak et al., 2021), and job burnout (Dubois et al., 2014; Berg-Beckhoff et al., 2017). Moreover, our aim was to verify the role of self-efficacy, one of the most important employees' resources (Aesaert et al., 2017; Lloyd et al., 2017) as a possible mediator of the reduction in stress and digital transformation stress. Following previous studies on the online interventions, we focused here not on a general self-efficacy, but on contextual self-efficacy related to coping with digital transformation stress (Smoktunowicz et al., 2021).

To summarize, the main aim of the study was to verify if the online blended intervention is an effective tool in decreasing stress and digital transformation stress, reducing negative attitudes toward digital transformation and burnout. Firstly, we designed a prototype of the online intervention in form of an online training on the Moodle platform, with different activities strengthening self-efficacy and reducing DTS. Secondly, to evaluate the effectiveness of this intervention, we measured general stress at work, DTS, attitudes toward DT, burnout (Smoktunowicz et al., 2019) and self-efficacy (Gam et al., 2016) in two time points: before and after a blended online intervention. Thirdly, we collected the evaluation about our online training in terms of usability (Kopeć et al., 2018; Makowska-Tłomak et al., 2021), effectiveness and attractiveness.

MATERIALS AND METHODS

Study Design

The presented study was prepared as a longitudinal study, with two time points, i.e., with baseline assessment (T1), and follow-up assessment (T2)—see flow diagram in **Figure 1**. The study consisted of two surveys measuring the outcome variables and a blended online intervention, which in turn was composed of online training and workshops (both interactive), as well as support in form of video material. The study was approved by the Ethical Review Board at SWPS University of Social Sciences and Humanities (opinion 8/2021 issued in February 2021).

Participants

The participants were recruited between March and April 2021, from professionally active adults or students who used ICT technologies at work or studies. The participants represented a large range of occupations: teachers, IT specialists, corporate employees, managers, engineers, from 21 different business sectors (according to the Polish Classification of Business Activities, i.e., PKD). From the convenient sample (n = 558) of adults (245 women, 313 men), the following inclusion criteria were applied: (1) Adults, at least 20 years old, (2) using ICT technology at work or studies (3) perceived digital stress level above average (i.e., 2.5 of DTS scale), 4) indicated willingness to participate in workshops and/or a course online (internet intervention). 55% of all respondents (309) declared to participate in the online psychological intervention, but 54% (168) among them qualified to the program because of the higher DTS score. 279 of all survey respondents (50%) represented a

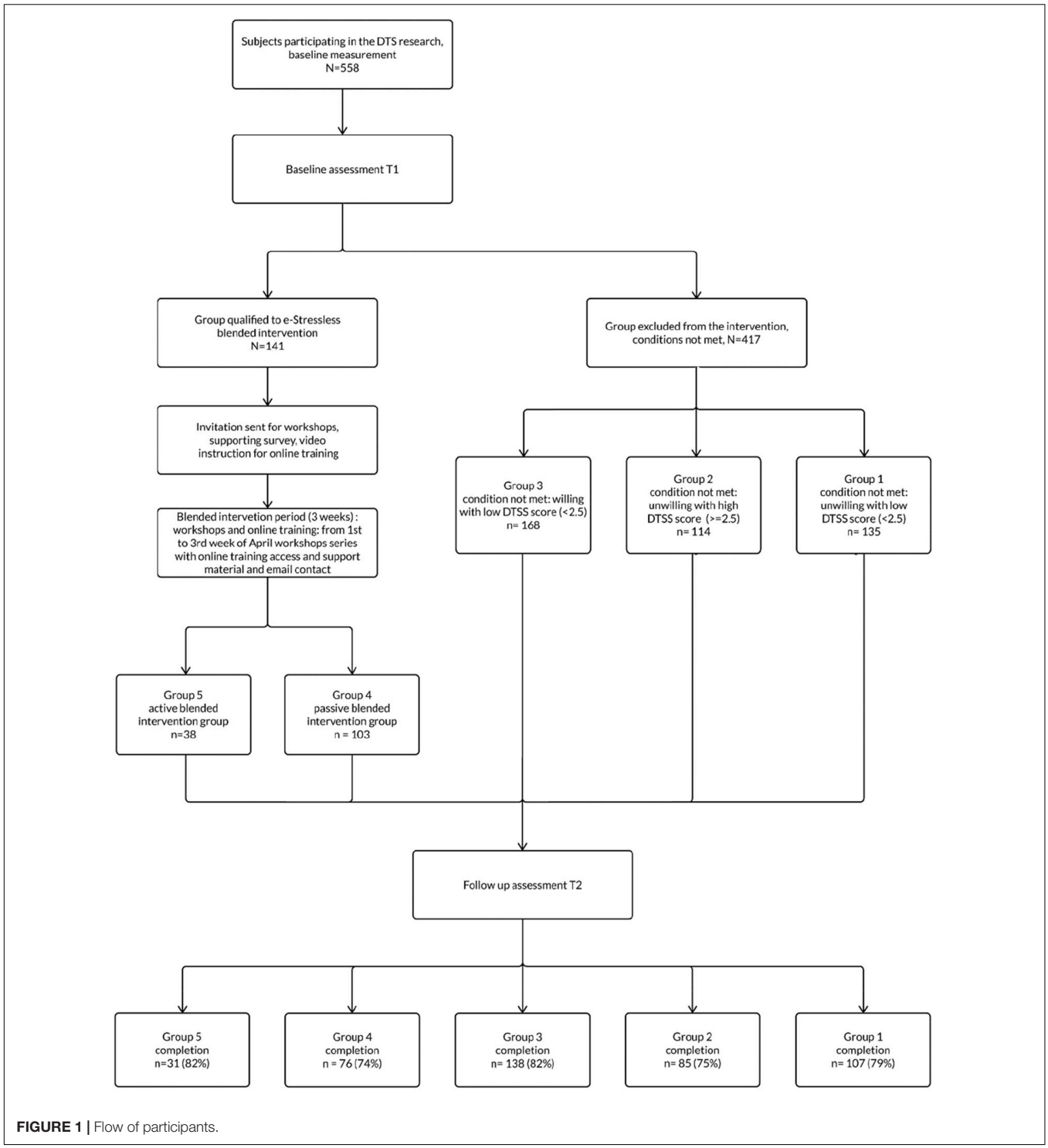

FIGURE 1 | Flow of participants.

higher score of DTS (greater or equal to 2.5) and 60% of them declared their readiness to the intervention program and entered their e-mail.

The invitation to the blended intervention was sent to 141 participants (81 women and 60 men), the average age of 39 (*SD* = 9.8). Although men comprised the majority of the whole study sample, i.e., 56%, this proportion was reversed in the group qualified to the intervention, where women constituted 57% of participants. The demographic characteristics of participants qualified (141) and not qualified to the intervention (417) are presented in **Table 1**.

TABLE 1 | Demographic characteristics of the participants qualified and not qualified to the blended intervention.

Variable	Total ineligible participants (*N* = 417)	Respondents qualified to blended intervention (*N* = 141)	Comparison of respondents qualified and not qualified to the blended intervention—tests statistics
Gender N (%)			$\chi^2(1, N = 558) = 14.05, p < 0.001$
Females	164 (39.3)	81 (57.4)	
Males	253 (60.7)	60 (42.6)	
Age in years M (SD)	43.43 (10.81)	39.52 (9.88)	$t(556) = 3.799, p < 0.001$
Seniority in years M (SD)	19.84 (10.91)	16.09 (9.01)	$t(556) = 3.680, p < 0.001$
Remote work N (%)	232 (55.6)	103 (73.0)	$\chi^2(1, N = 558) = 13.32, p < 0.001$
Education level N (%)			$\chi^2(4, N = 558) = 28.64, p < 0.001$
Primary	3 (0.7)	0 (0)	
Vocational	31 (7.4)	2 (1.4)	
Secondary	170 (40.8)	34 (24.1)	
Studying	6 (1.4)	7 (5.0)	
University degree	207 (49.6)	98 (69.5)	
Self-assessment ICT Skills M (SD)	3.37 (0.91)	3.67 (0.75)	$t(556) = 3.511, p < 0.001$
Digital transformation stress—time 1, M (SD)	2.16 (0.76)	3.08 (0.39)	$t(556) = 13.660, p < 0.001$

The blended intervention group consists of 38 participants (active group). Participants who did not decide to take part in workshops and further did not declare the preferred type of intervention have received a notification with educational video material containing information about the online training and access to it. The demographic characteristics of participants are presented in **Tables 2**, **3**.

Power Calculation

Although the blended intervention composed of online training and online workshops had a limited number of participants, we conducted an *a priori* sample size estimation using G*Power 3.1 3.1 (Faul et al., 2009), to ensure a statistical power of 0.95 to detect the post-test effect of comparisons between study conditions (Smoktunowicz et al., 2021). According to the approach in similar intervention research, we aimed to detect the minimum effect sizes of $d = 0.30$ for the comparisons between conditions at 2 measurement points (T1, T2), while controlling for baseline scores at an alpha error level of 0.05. A power analysis showed that a sample of 38 was needed as minimum. With regard to other online interventions studies (Rogala et al., 2016; Smoktunowicz et al., 2019), we expected a high dropout rate, therefore we decided to qualify a sample of 141 participants, according to baseline conditions. Because of expected high dropout rate as well as approach of prototyping the blended intervention, willingness of participants, and testing in real-life, we decided to use pragmatic trial (Patsopoulos, 2011; Ford and Norrie, 2016; Säfsten et al., 2019; Zvonareva, 2021).

Procedure

The study flow is presented in **Figure 1**. The conditions for blended interventions were as follows in the baseline assessment (T1): (1) Willingness, declaration to participate in the blended intervention; (2) Digital Transformation Stress Scale (DTSS) score >= 2.5 (equal or greater mean of DTSS), (3) participants are adult and active professionally, (4) participants have entered their email address. If participants met these conditions, an additional survey was sent where they could choose the type of intervention - blended (workshops with the online course) or only the online course. The participants who have chosen the blended intervention could then choose an available date for online workshops meetings. We sent the invitation to online workshops with proposed slots of online meetings. Before each online workshop, we sent email notifications about the meeting and information about the training online together with the link to our e-stressless online training.

The workshops series (5 online workshops in MS Teams) were conducted from the beginning of April 2021. During each workshop the participants identified the digital transformation stress factors on sticky-cards on Google Jamboard. Participants could add new DTS factors or add to those already mentioned. Afterward, we sent the invitation e-mail with a link to the course online with the key code to the training and the audio-video instruction for logging in (a short movie).

We replicated the approach from the first study (June/August 2020), where we surveyed adult and professionally active people and then selected, from the intervention volunteers, those with high stress indicators (Makowska-Tłomak et al., 2021).

TABLE 2 | Demographic characteristics of the participants eligible to the blended intervention.

Variable	Respondents who actively participated in the blended intervention (*N* = 38)	Respondents who received educational materials (*N* = 103)	Means comparison of respondents—blended intervention vs. educational materials—tests statistics
Gender N (%)			$\chi^2(1, N = 141) = 2.56, p = 0.109$
Females	26 (68.4)	55 (53.4)	
Males	12 (31.6)	48 (46.6)	
Age in years M (SD)	38.11 (9.80)	40.04 (9.89)	$t(139) = 1.032, p = 0.30$
Seniority in years M (SD)	14.53 (8.69)	16.67 (9.09)	$t(139) = 1.257, p = 0.21$
Remote work N (%)	30 (78.9)	73 (70.9)	$\chi^2(1, N = 141) = 0.92, p = 0.338$
Education level N (%)			$\chi^2(3, N = 141) = 2.91, p = 0.406$
Primary	0 (0)	0 (0)	
Vocational	0 (0)	2 (1.9)	
Secondary	6 (15.8)	28 (27.2)	
Studying	2 (5.3)	5 (4.9)	
University degree	30 (78.9)	68 (66.0)	
Self-Assessment ICT Skills M (SD)	3.52 (0.74)	3.72 (0.75)	$t(139) = 1.48, p = 0.14$
Digital transformation Stress—time 1, M (SD)	3.18 (0.43)	3.04 (0.36)	$t(139) = 1.835, p = 0.07$

TABLE 3 | Demographic characteristics of the participants ineligible to the blended intervention.

Variable	Wiling but Ineligible participants (*N* = 168)	Reluctant ineligible participants (*N* = 249)	Means comparison of ineligible participants wiling vs. reluctant - tests statistics
Gender N (%)			$\chi^2(1, N = 417) = 0.65, p = 0.422$
Females	70 (41.7)	94 (37.8)	
Males	98 (58.3)	155 (62.2)	
Age in years M (SD)	42.13 (10.89)	44.32 (10.68)	$t(415) = 2.04, p < 0.05$
Seniority in years M (SD)	18.48 (10.45)	20.77 (11.14)	$t(415) = 2.11, p < 0.05$
Remote work N (%)	112 (66.7)	120 (48.2)	$\chi^2(1, N = 417) = 13.87, p < 0.001$
Education level N (%)			$\chi^2(4, N = 417) = 9.18, p = 0.057$
Primary	0 (0)	3 (1.2)	
Vocational	15 (8.9)	16 (6.4)	
Secondary	56 (33.3)	114 (45.8)	
Studying	3 (1.8)	3 (1.2)	
University degree	94 (56.0)	113 (45.4)	
Self-assessment ICT skills M (SD)	3.69(0.83)	3.16 (0.89)	$t(415) = 2.04, p < 0.05$
Digital transformation stress—time 1, M (SD)	1.97 (0.70)	2.30 (0.77)	$t(415) = -6.17, p < 0.001$

After about a month from finishing the blended intervention period, the same group of respondents was tested using the same questions to enable the measurement and comparison of variables. Modification of the questionnaire concerned the removal of questions about the preferred scope of intervention, which were replaced by questions about the participation in

the intervention program and preferable module(s) from the training. The list of modules also included those that were not in the online training. We aimed to verify if respondents actually participated in this specific intervention.

We registered the online training users' activity using standard Moodle functionality (logins, exercises completion, frequency). Additionally, we identified the most active participants during workshops, individual meetings and emails and rated their engagement. We created a supporting variable with the rating of participants' activity from 0 to 5, where 0 meant *no activity* and 5-*very high activity* at workshops and online training.

All data was collected in online mode only, via a survey. The majority of measured data (T1, T2) was collected by a research agency and, according to prior consent. Simultaneously, data was collected on the Qualtrics platform, under the license of the university. The research application was approved by the Ethical Committee of the University. The present study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the questionnaire was activated. Participation was voluntary, and participants did not receive compensation for their participation in the study.

Participatory Workshops

In the study conducted between June and August 2020 we surveyed 150 employees of different sectors to evaluate the level of the digital transformation stress and identify crucial resources protecting from the high level of DT stress (Makowska-Tłomak et al., 2021). Based on the DTS survey results, we distinguished variables that were associated with the DT stress level, i.e., the ICT workload, the ICT hassles. We also identified the self-efficacy, self-assessed ICT competences and ICT Support as significant resources protecting employees from the high level of digital transformation stress. During two series of participatory workshops, we worked with previously selected exercises, which were aimed at strengthening self-efficacy and coping with stressful situations in the workplace during the digital transformation process. The workshops resulted in a list of exercises and materials that were assessed by the participants as most useful for online interventions addressing stress in the workplace (Makowska-Tłomak et al., 2021).

Qualitative assessment of the first series of workshops as well as educational materials and exercise evaluation indicated that co-design workshops can work as psychological interventions themselves. The majority of participants of the first series of workshops admitted that their stress coping knowledge increased and that intervention exercises were useful and helpful to manage DTS and to increase their self-efficacy. During workshops, participants were working with selected exercises, and in the post-workshops survey they indicated the most useful and helpful exercises as well as language and intervention design preferences.

Consequently, we decided to organize the blended intervention as a prototype of an unguided online intervention with educational materials and practical, interactive exercises with social, informative support in the form of interactive workshops. This approach allowed us to collect the feedback of the online intervention prototype focused on dealing with the stress of digital transformation.

Blended Intervention

Because of the prototype of further unguided online intervention, in the study we opted for the blended online intervention concept, i.e., a mix of social support in form of workshops, consultation meetings and online training (e-stressless), mainly addressing digital transformation stress and perceived stress at the workplace.

E-stressless is a prototype of self-guided online intervention in the form of online training on the Moodle platform (Moodle, 2021). Moodle is a software package designed to help educators create effective online trainings, with a possibility to log users' activities, self-authorization registration, and privacy policy. The platform is tailored to create exercises in a flexible and effective way. Therefore, we decided to adopt the Moodle platform's large range of functionalities to the intervention needs.

The e-stressless online training contains 4 modules with psychoeducational materials and interactive exercises. We adapted the online training intervention to available Moodle functionalities like lessons, quizzes, surveys, essays, with Moodle's feedback features. These were made available to participants in different variants depending on participants' needs and preferences. Every module started with a one-page guide for navigation in the module. Each consisted of psychoeducational animated clips and interactive tasks proposing both web-based and offline activities (Smoktunowicz et al., 2021), tips and short TED movies that were made available to participants sequentially (one module a week). We identified two main modules. The first module (1) concentrated on general stress and stress in the workplace. The second module (2) was intended to strengthen the sense of self-efficacy and the ability to cope with difficult situations (see **Figure 2**). The next two modules were supporting the previous ones—the third module covered relaxation as an efficient method of addressing stress (**Figure 3**) and the fourth module contained tips and additional materials supporting participants with stress coping. A detailed description of the modules' content is presented in **Table 4**. None of the modules were treated as obligatory. All the modules were available for participants for 3 weeks, with full support of the team available. To complete all the tasks within each exercise, participants needed up to 1.5 h. All exercises were available to be retaken depending on individual needs and preferences.

The exercises were selected through Cognitive Behavior Therapy (CBT) handbooks such as *Brief cognitive behavior therapy* (Curwen et al., 2018) and *Mind over mood: Change how you feel by changing the way you think* (Greenberger and Padesky, 2015). The selection of exercises was a process started in July 2020 by psychologists before the first series of participatory workshops. Based on workshops participants' feedback, we selected exercises based on CBT (Beck, 1993) and Cognitive Social Therapy (CST) (Bandura, 1989), empowering self-efficacy and coping with stressful and/or difficult situations. We chose specific exercises for the blended intervention based on the opinions of the participants (from the 2020 workshops and surveys), which have

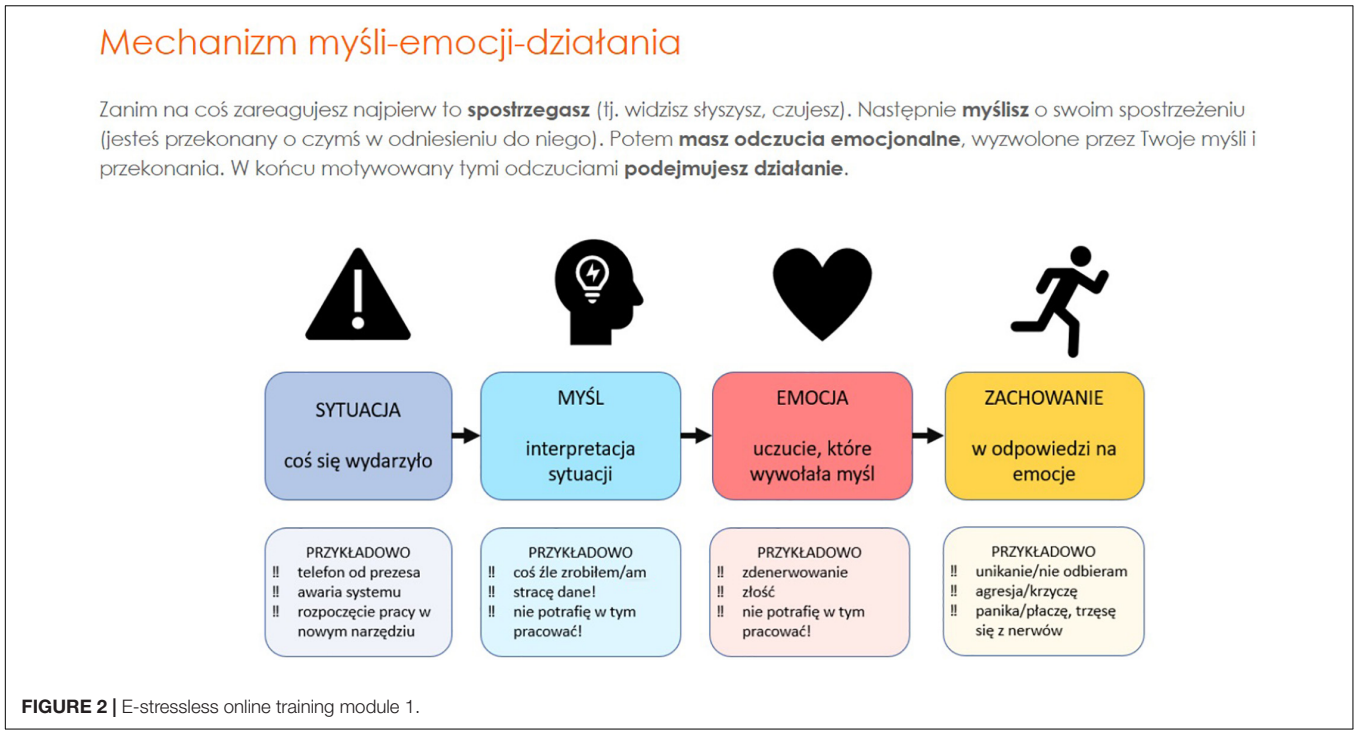

FIGURE 2 | E-stressless online training module 1.

FIGURE 3 | E-stressless online training module 4. Vector image reproduced with permission from vectorstock.com.

defined the most interesting areas for them regarding coping with stress, especially digital transformation stress.

Before starting with online training, we have organized a series of online workshops which served as a training introduction. Participants were identifying the main digital transformation stress sources and sharing opinions with others using Google Jamboard sticky notes (see **Figure 4**). Afterward, together with participants we were looking for ways to deal with (digital transformation) stress using a different board. The main aim of these workshops was the introduction to the self-online training, using the digital solution for digital transformation stress. We helped to login to the e-stressless training. We discussed the scope and functionality, strengths and weaknesses of the solution.

TABLE 4 | DTS online training—overview of the online intervention on Moodle Platform.

Module	Educational material	Exercises and practical materials
1. Stress in human life	**"**What is stress?"—educational materials as a Moodle lesson, regarding the definitions, causes and consequences of stress, stress at workplace. Materials supported by short TED movies "How stress affects our body and mind."	- Survey: How much does the stress of digital transformation impact me? - Exercise: "drag and drop"- identification of stressors of digital transformation. - Survey—Does procrastination bother you at work? - Exercise: "Do it Now! How to overcome procrastination." Exercise with tips and step by step instructions.
2. Overcome difficulties and strengthen yourself	"Different situations: our thoughts, emotions and beliefs"—educational material regarding the thought-emotion-action mechanisms, based on the cognitive–behavioral therapy (CBT). "Self-efficacy belief"—educational material regarding the social cognitive theory (SCT).	- Exercise: "Identifying stressful situations," quiz form, with instructions to a step-by-step analysis of a chosen situation, with tips. - Exercise: "Get ready for a difficult situation," quiz form, with instructions to a step-by-step analysis of a chosen situation. - Exercise: "Plan how to deal with difficulties." - Exercise: "Should I send this?" A list of tips and instructions as a to-do checklist before making a decision. - Exercise: "Goal I want to achieve"—an exercise type to-do task with instructions in form of a checklist.
3. Relaxation and activity	"Exercise's introduction"—educational material regarding relaxation and activities (like sport, leisure) addressing stress.	- Relaxation exercise 1: "Jacobson training," progressive muscle relaxation - an audio-visual material with exercise narration. - Relaxation exercise 2: Relaxation according to Benson. - Relaxation diary - an exercise with instruction, describing feelings and emotions during relaxation. - Diary: "Planning leisure activities," an exercise with instructions, supporting identification and planning of leisure time as a way of coping with stress.
4. Tips and additional materials	"The power of words"—educational material on how the words impact people. Healthy words can improve our mental and physical health. Unhealthy words can be toxic and cause negative thoughts and emotions.	- Exercise: "time management" - an audio-visual material. - Survey: "What factors may cause stress of digital transformation for you"?

FIGURE 4 | What is digital transformation stress for you—Google Jamboard screenshot.

Participants have been assured that in case of any difficulties, concerns or needs they could always contact us directly, and participate in the next workshops to share their online training opinions.

Measures

Perceived Stress Scale

Perceived Stress Scale (PSS-4), and in the workplace (Cohen et al., 1983; Lesage et al., 2012; Smoktunowicz and Cieślak, 2017). Consisted of four items such as e.g., "How often have you felt difficulties were piling up so high that you could not overcome them?" All items were rated on a 5-point Likert-like scale where 1 meant *Never* and 5 meant *Almost always*.

Digital Transformation Attitudes Scale

Digital Transformation Attitudes Scale (DTAS) is a self-descriptive tool for measuring digital transformation stress (Makowska-Tłomak et al., 2021), composed of 12 items. DTAS consists of four subscales concerning three different symptoms of digital transformation stress: (1) Affective (emotional) accompanied by digital transformation in the workplace (3 items, Cronbach's Alpha = 0.67, e.g., "I am worried that my responsibilities may change and I may not be able to meet them"). (2) Proactive behavior—reactions to the occurring changes in the organization as a result of new ICT solutions implementation (3 items, Cronbach's Alpha = 0.80, e.g., "I am excited because the changes related to the implementation of new IT solutions will allow me to improve my skills and professional development"). (3) Positive cognitive attitudes, i.e., thoughts and beliefs of ongoing or planned digital, technological or IT changes in the work environment (3 items, Cronbach's Alpha = 0.88, e.g., "New technologies and ICT solutions are necessary for the efficient functioning of an organization") 4) Negative cognitive attitudes (3 items, Cronbach's Alpha = 0.79, an example of the item: "IT implementations of e.g., new systems and programs most often cause chaos in the organization and the growing frustration of its employees"). All items were rated on a 5-point Likert-like scale where 1 = *Not applicable* and 5 = *Applicable* in the first block of statements and 1 = *Disagree* and 5 = *Agree* in the second block of statements.

Digital Transformation Stress Scale

Digital Transformation Stress Scale (DTSS) measures the perceived stress of employees during the digital transformation process, in the last month with 6 items (Makowska-Tłomak et al., 2021). An example of item is "How often have you felt irritated in connection to new ICT solutions implementation which have affected your professional duties/tasks?." All items were rated on a 5-point Likert-like scale where 1 meant Never and 5 meant *Almost always*. Reliability was high with Cronbach's Alpha = 0.90.

Short Occupational Self-Efficacy Scale

Short Occupational Self-Efficacy Scale (Rigotti et al., 2008) was adapted to Polish conditions; it consists of 6 statements measuring self-efficacy related to work with a 5-level response scale ranging from 1 = *Disagree* to 5 = *Agree*. An exemplary item is "I feel prepared for most of the demands in my job." The reliability of the scale was high with Cronbach's Alpha = 0.89.

Oldenburg Burnout Inventory

Oldenburg Burnout Inventory (OLBI) (Demerouti and Bakker, 2008). The Polish version of OLBI (Baka and Basinska, 2016) measures two dimensions of burnout: exhaustion and disengagement. We used 6 items, 3 from each dimension. Examples of the items are "After work, I tend to need more time than in the past in order to relax and feel better," and "During my work, I often feel emotionally drained" (both reversed). Participants indicated their answers on a 4-point Likert-like scale where 1 meant *strongly disagree*, and 4 meant *strongly agree*. Reliability of the OLBI was high with Cronbach's Alpha = 0.79.

Self-Assessment Information and Communication Technologies Skills Scale

To assess specific ICT skills, we developed the ICT skills self-assessment scale, based on The Digital Competence Framework for Citizens (Carretero et al., 2017). At the beginning, participants were asked to estimate their general ICT skills in the context of work ("Please evaluate your computer skills in the workplace"), by using 5-point scale where 1 meant *Basic level—limited to elementary functionality* and 5 meant *Very advanced level—programming, graphic processing, computer operation of machines*. There was also a possibility to mark the answer "*I'm not using a computer at work.*" Afterward, respondents were asked to describe their skills in the listed areas, such as using keyboard shortcuts, or working in different programs commonly used in the workplace. They were also questioned about their activity on the Internet. Examples of items are: "I can prepare a presentation in a dedicated program," "I can choose the layout, background, template, charts, tables." "I can pay my bills using online bank transfer." The responses evaluated their skills on a 5-point scale, where 1 means very low skill level and 5 means very high skill level. The reliability of the Self-assessment ICT scale was high (Cronbach's alpha = 0.88).

Digital Transformation Processing at the Workplace

We asked a question: "Are there any implementation projects (IT) currently being carried out in the organization where you work or study, which affect your work or your activities?". Respondents indicated their answer by using the following options: *Yes, there are* and *No, there are not, I do not know* and *Not applicable.*

Digital Transformation Stress Intervention Expectations

At the end of the survey in the first measurement time (T1: before the intervention) there were 3 questions regarding the scope of intervention and declaration of participation. We asked participants the following question: "Would you like to take part in the online stress counteract program, in particular the digital transformation?". Participant, who confirmed were asked about their expectation by indicating the areas of interest in the proposal of program for counteracting stress of digital transformation. Respondents who declared to participate in the

intervention online, were asked to enter their e-mail address for further contact.

Digital Transformation Stress Intervention Usability

At the end of the second measurement time (T2, for all study participants) there was a 2-question block about participation in the blended intervention: "Have you participated in workshops or an online training addressing stress?," and when the participant has indicated Yes, the next two questions were as follows: (1) "Was the online workshop or training useful for you in coping with stress?," with a 5-point Likert reverse scale where 1 meant *Definitely helpful* and 5 meant *Definitely unhelpful*; (2) "Which module of online training did you like the most?" with a multiple-choice list with the actual names of online training modules as well as false names of modules.

Socio-Demographic Information

Participants were asked to indicate the appropriate year of birth, seniority in years, gender, education level, occupation, and position in their current job.

Activity Measure

Activity tracking by Moodle logs reports and an online training list from Moodle online training, intervention survey, Teams list of participation were gathered to evidence blended intervention participants' activity. Based on these indicators, participants' activity in the program was evaluated using a 6-point scale where 0 meant *Not applicable* (for DTS study participants who were not selected to the blended intervention program), 1 meant *Lack of activity,* 2—*low activity, 3—moderate activity* (participation in the workshop or/and online training), 4—*high activity* (active participation in the workshop or/and online training) and 5—*very high activity* (many logs in the online training and active participation in the workshops).

RESULTS

The main goal of the present study was to verify the effect of the psychological intervention aimed at reducing digital transformation stress. Thus, we conducted a series of statistical analyses in which we tested change in several outcome variables: digital transformation stress, digital transformation attitudes, and more general work outcomes such as stress in the workplace, burnout, employees' resources (i.e., self-efficacy at the workplace). All these variables were measured at two specific time points: before and after the intervention. We applied a two-way analysis of variance in mixed design with between-person factor differentiated 5 groups of participants: (1) not assigned to an intervention, unwilling, with a low DTSS score, (2) not assigned, unwilling, with a high digital transformation stress score, (3) (wait list) not assigned, willing, with a low digital transformation stress score and (4) assigned, willing (with a high digital transformation stress score), not active and (5) assigned, willing (with a high digital transformation stress score), active.

We also conducted a dropout analysis using a chi-square statistic, Mann-Whitney's *U*-test, and Student's *t*-test for independent samples. To compare those respondents who participated in the intervention with those who resigned, we tested differences in sociodemographic variables (gender, age, seniority, education level, intervention group) and dependent variables (self-efficacy, digital transformation stress and attitudes, self-assessment ICT skills) measured before the intervention (Time 1). We start the presentation of the results from dropout analysis, and then we present descriptive statistics for all dependent variables and a series of mixed design analysis of variance examining the change in the dependent variables in two measurement points across intervention groups.

Dropout Analysis

Comparison of groups of respondents revealed significant differences only in age, seniority, education, self-efficacy at work, and one dimension of digital transformation attitude—positive cognition. Those who resigned from participation in the study were younger (dropout M = 38.45, SD = 9.68, no-dropout M = 43.55, SD = 10.73), with lower seniority (dropout M = 16.71, SD = 10.80, no-dropout M = 19.50, SD = 10.45), lower education level (dropout Mrank = 250.28, no dropout Mrank = 287.59), lower self-efficacy at work (dropout M = 3.67, SD = 0.72, no-dropout M = 3.81, SD = 0.66), and higher positive cognition (dropout M = 2.23, SD = 0.86, no-dropout M = 2.05 SD = 0.81). Detailed statistics are presented in **Table 5**.

The general dropout rate between T1 and T2 equals to 21% (121 respondents). In the 5th group—the active group in the intervention, the dropout rate was 18%—7 participants did not complete the T2 survey, but actively participated in workshops or online training. The highest dropout rate was observed in the 2nd and 4th group—groups with high level of digital transformation stress score before the intervention. The 2nd group was not interested in participating in the blended intervention and the 4th group did not participate actively in interventions and received only video material related to interventions. In the 4th group the dropout rate was equal to 26% (27 participants) and in the 2nd group the dropout was 25% (29 participants).

TABLE 5 | Statistics of tests in dropout analysis.

Variable	Test statistics comparing dropout and no-dropout
Age	$t(556) = 4.73$, $p = 0.001$, Cohen's $d = 0.50$
Seniority	$t(556) = 2.58$, $p = 0.010$, Cohen's $d = 0.26$
Gender	$\chi^2(1, N = 558) = 0.64$, $p = 0.423$
Education	$U = 22902.5$, $p = 0.011$
Intervention group	$\chi^2(4, N = 558) = 3.95$, $p = 0.413$
Self-efficacy at work	$t(556) = 2.02$, $p = 0.044$, Cohen's $d = 0.20$
DTS	$t(556) = 0.74$, $p = 0.458$
ICT Skills	$t(556) = 0.51$, $p = 0.609$
Stress at work (PSS)	$t(556) = 0.02$; $p = 0.983$
DTAS Affect	$t(556) = 0.60$, $p = 0.547$
DTAS Negative Cognition	$t(556) = 0.41$, $p = 0.679$
DTAS Positive Cognition	$t(556) = 2.20$, $p = 0.028$, Cohen's $d = 0.22$
DTAS Proactive Behavior	$t(554) = 2.58$, $p = 0.126$

DTS, Digital Transformation Stress; DTAS, Digital Transformation Attitude Scale; ICT Skills, Self-assessment ICT skills scale.

Generally, we can conclude that the dropout level was relatively low compared to others reported in interventions (Rogala et al., 2016; Smoktunowicz et al., 2021).

Descriptive Statistics

Descriptive statistics: means, standard deviations, and Pearson's r coefficients for variables in baseline and post-intervention measurement are presented in **Table 6**. Inspection of the means leads to a conclusion that the level of stress at work, digital transformation stress and burnout is moderate, with values around the middle point of the scale. The level of self-efficacy is rather high. As predicted, self-efficacy is related negatively to stress, digital transformation stress, negative affect, negative cognition toward digital transformation, and both dimensions of burnout. Age and gender were almost non-related to the rest of the variables.

Hypothesis Testing

To test the influence of the blended intervention on the level of digital transformation stress and more general work outcomes, we conducted a series of analyses of variance in mixed design with the intervention condition as a between-group factor and pre- and post-intervention measures of the digital transformation stress and work outcomes. Detailed statistics of all effects of analysis of variance are presented in **Table 7**. Based on theoretical assumptions, we predicted significant interactions of the intervention and time of measurement (pre-post). Therefore, when interaction effect was significant, we present only decomposition of the interaction effect into simple main effects, without further exploration of main effects. Guided by our hypotheses, we also limited description of simple main effects of interaction effect to differences between pre- and post- intervention. The differences between intervention groups in a specific time point and the results of *post hoc* tests for significant main effects of intervention groups are presented in **Supplementary Material**.

The results showed that there were significant interactions of condition and measurement points in DTS, at the tendency level in DTAS—negative affect, and in disengagement—one of the dimensions of burnout. Decomposition of the interaction for DTS showed that there were significant changes in the level of DTS in the following groups: not assigned and not willing to participate in the intervention (1st group), and not assigned but willing with low stress (3rd group). In these groups, the digital stress level was higher in T2 than in T1 [group1: $M_{T1} = 1.76$, $SE = 0.05$, $M_{T2} = 2.02$, $SE = 0.07$, $t(432) = 4.17$, $p < 0.001$; group 3: $M_{T1} = 1.95$, $SE = 0.04$, $M_{T2} = 2.21$, $SE = 0.06$, $t(432) = 4.67$, $p < 0.001$]. Participants who were not assigned to the intervention because they were unwilling to do so (with high stress, 2nd group) had a lower stress level in T2 than in T1 [$M_{T1} = 2.70$, $SE = 0.08$, $M_{T2} = 2.95$, $SE = 0.06$, $t(432) = 3.44$, $p < 0.001$]. As predicted, participants who were actively involved in the intervention (5th group) had a lower level of digital transformation stress in T2 than in T1 [$M_{T1} = 3.23$, $SE = 0.09$, $M_{T2} = 3.00$, $SE = 0.13$, $t(432) = 1.96$, $p = 0.051$].

In the DTAS—negative affect, there were significant differences only among participants who were actively involved in the intervention (5th group). They had a lower level of negative emotions related to digital transformation in T2 than in T1 [$M_{T1} = 3.20$, $SE = 0.14$, $M_{T2} = 2.80$, $SE = 0.14$, $t(432) = 2.71$, $p = 0.007$]. There were no significant differences in the other groups.

Interestingly, the only change observed in general work outcomes was in one of the dimensions of burnout, namely disengagement. Active participation in the intervention (5th group) lowered the level of disengagement [group 5: $M_{T1} = 3.20$, $SE = 0.14$, $M_{T2} = 2.39$, $SE = 0.11$, $t(430) = 2.59$, $p = 0.010$]. Among the participants who wanted to take part in the intervention but were not assigned with low stress (3rd group) the pattern was reversed and their level of disengagement was higher in T2 than in T1 [group3: $M_{T1} = 2.10$, $SE = 0.05$, $M_{T2} = 2.00$, $SE = 0.05$, $t(430) = 2.61$, $p = 0.009$]. There were no significant differences in the other groups.

In the first assessment (T1) we also tested users' expectations toward online training and, in the second assessment (T2), the usability of the intervention (online training). Measures of expectations showed that the most preferred components were exercises enhancing the self-efficacy (70.5%) and relaxation techniques (66.3%). Therefore, in the e-stressless online training we focused on modules related to self-efficacy and relaxation. After the intervention, in T2, participants with high activity in the course rated its usability. The usability of the intervention in coping with stress was assessed as high ($M = 3.84$, $SD = 1.01$).

DISCUSSION

In the presented longitudinal study, the main aim was to test the efficiency of blended psychological intervention in employees' stress reduction, more specifically the stress related to digital transformation. Because of reported high dropout rate of self-guided internet interventions (Hoerger, 2010; Rogala et al., 2016; Smoktunowicz et al., 2021) we decided to use the blended intervention, and combine self-guided online training addressing digital transformation stress with online interactive workshops with participants. The interactive workshops might have had additional social support function, which could increase self-efficacy (Hogan et al., 2002). We assumed that because the increase of self-efficacy raises a person's ability to solve difficult tasks and endeavors and succeed in them for a long time (Gam et al., 2016), it consequently results in improvement in the ability to cope with stress (Cieslak et al., 2016; Gam et al., 2016).

To verify the effects of the intervention on digital transformation stress and more general work outcomes, namely general stress, self-efficacy at work, and burnout, we assessed these measures before (T1) and after (T2) the intervention. We compared five groups of participants depending on their participation in the workshop, willingness to participate, baseline level of stress and activity during the intervention (Zwarenstein et al., 2008; Patsopoulos, 2011; Loudon et al., 2015). The results indicated that in the group of participants who were active in the intervention the levels of digital transformation stress, negative emotions toward digital transformation and disengagement were lower after the intervention in comparison to the baseline level. These results, in our opinion, offered a preliminary confirmation of the positive effect of the blended intervention in reducing

TABLE 6 | Descriptive statistics: means, standard deviations, and Pearson's r coefficients for variables in baseline (T1) and post-intervention (T2) measurement.

Variable	M	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Gender																					
2. Age	42.44	1.708																			
3. DTS -T1	2.39	0.79	−0.15**	−0.04																	
4. DTS -T2	2.45	0.80	−0.07	−0.12*	0.62**																
5. PSS—T1	2.65	0.63	−0.19**	−0.09*	0.45**	0.37**															
6. PSS—T2	2.65	0.66	−0.01	−0.14**	0.35**	0.47**	0.39**														
7. DTAS_B—T1	2.97	0.98	−0.05	−0.00	−0.03	−0.02	0.06	0.07													
8. DTAS_B—T2	2.96	0.97	−0.03	0.07	−0.04	−0.11*	−0.03	0.08	0.54**												
9. DTAS-PC—T1	2.09	0.82	0.00	−0.01	0.21**	0.19**	0.12**	0.20**	0.31**	0.22**											
1. DTAS-PC—T2	2.18	0.85	0.01	−0.01	0.20**	0.20**	0.11*	0.18**	0.22**	0.32**	0.62**										
11. DTAS-AF—T1	2.55	0.83	−0.09*	−0.11*	0.50**	0.42**	0.44**	0.33**	−0.17**	−0.16**	0.11*	0.15**									
12. DTAS-AF—T2	2.55	0.82	−0.10*	−0.11*	0.43**	0.56**	0.28**	0.47**	−0.07	−0.13**	0.17**	0.11*	0.50**								
13. DTAS-NC—T1	3.01	0.85	0.00	0.01	0.40**	0.31**	0.21**	0.17**	0.16**	0.13**	0.13**	0.20**	0.24**	0.26**							
14. DTAS-NC—T2	3.06	0.84	0.01	−0.01	0.35**	0.38**	0.17**	0.26**	0.12*	0.09	0.17**	0.17**	0.20**	0.29**	0.50**						
15. SEW—T1	3.78	0.67	0.04	0.14**	−0.40**	−0.33**	−0.32**	−0.33**	−0.25**	−0.20**	−0.40**	−0.38**	−0.31**	−0.28**	−0.20**	−0.23**					
16. SEW—T2	3.69	0.73	−0.01	0.11*	−0.34**	−0.36**	−0.27**	−0.37**	−0.18**	−0.20**	−0.32**	−0.36**	−0.25**	−0.30**	−0.18**	−0.14**	0.53**				
17. OLBI-E—T1	2.31	0.62	−0.10*	−0.07	0.42**	0.38**	0.39**	0.35**	0.15**	0.12*	0.16**	0.13**	0.32**	0.26**	0.32**	0.29**	−0.31**	−0.25**			
18. OLBI-E—T2	2.39	0.56	−0.08	−0.04	0.36**	0.42**	0.32**	0.39**	0.05	0.08	0.16**	0.17**	0.27**	0.30**	0.30**	0.27**	−0.29**	−0.34**	0.65**		
19. OLBI-D—T1	2.19	0.59	−0.02	−0.20**	0.30**	0.29**	0.31**	0.31**	0.30**	0.24**	0.20**	0.28**	0.27**	0.20**	0.23**	0.23**	−0.46**	−0.36**	0.59**	0.43**	
2. OLBI-D—T2	2.21	0.58	−0.01	−0.15**	0.29**	0.34**	0.23**	0.38**	0.20**	0.21**	0.22**	0.28**	0.25**	0.28**	0.20**	0.19**	−0.33**	−0.45**	0.47**	0.53**	0.66**

$^{**}p < 0.01$; $^{*}p < 0.05$.

PSS, Perceived Stress Scale; DTSS, Digital Transformation Stress Scale; DTAS, Digital Transformation Attitude Scale; DTAS_AF, DTAS Affect; DTAS_PB, Proactive Behavior; DTAS_CN; DTAS Negative Cognition; DTAS_PC, DTAS Positive Cognition; SEW, Self-efficacy; OLBI-E, Burnout—exhaustion, OLBI-D, Burnout –disengagement.

TABLE 7 | Statistics of the mixed design analysis of variance testing the differences between intervention condition and change in time (pre- and post-intervention).

Variable	Main effect of condition	Main effect of T1-T2	Interaction
DTS	$F(4, 432) = 91.85$, $p < 0.001$, $eta^2 = 0.46$	$F(1, 432) = 0.032$, $p = 0.859$, $eta^2 = 0.001$	$F(4, 432) = 12.78$, $p < 0.001$, $eta^2 = 0.11$
DTAS_PC	$F(4, 432) = 8.04$, $p < 0.001$, $eta^2 = 0.07$	$F(1, 432) = 10.29$, $p < 0.001$, $eta^2 = 0.02$	$F(4, 432) = 0.72$, $p = 0.578$, $eta^2 = 0.007$
DTAS_NC	$F(4, 432) = 13.55$, $p < 0.001$, $eta^2 = 0.11$	$F(1, 432) = 0.39$, $p = 0.535$, $eta^2 = 0.001$	$F(4, 432) = 0.91$, $p = 0.460$, $eta^2 = 0.008$
DTAS_PB	$F(4, 432) = 13.01$, $p < 0.001$, $eta^2 = 0.11$	$F(1, 432) = 0.02$, $p = 0.896$, $eta^2 = 0.001$	$F(4, 432) = 0.51$, $p = 0.726$, $eta^2 = 0.005$
DTAS_NAFF	$F(4, 432) = 19.25$, $p < 0.001$, $eta^2 = 0.15$	$F(1, 432) = 1.16$, $p = 0.281$, $eta^2 = 0.003$	$F(4, 432) = 2.16$, $p = 0.073$, $eta^2 = 0.020$
Stress at work (PSS)	$F(4, 432) = 14.59$, $p < 0.001$, $eta^2 = 0.12$	$F(1, 432) = 0.88$, $p = 0.349$, $eta^2 = 0.002$	$F(4, 432) = 1.12$, $p = 0.344$, $eta^2 = 0.010$
Self-efficacy (SEW)	$F(4, 432) = 13.77$, $p < 0.001$, $eta^2 = 0.11$	$F(1, 432) = 6.14$, $p = 0.014$, $eta^2 = 0.014$	$F(4, 432) = 0.98$, $p = 0.420$, $eta^2 = 0.009$
Burnout—exhaustion (OLBI)	$F(4, 430) = 10.88$, $p < 0.001$, $eta^2 = 0.09$	$F(4, 430) = 3.17$, $p = 0.076$, $eta^2 = 0.007$	$F(4, 430) = 1.79$, $p = 0.129$, $eta^2 = 0.016$
Burnout-disengagement (OLBI)	$F(4, 430) = 7.39$, $p < 0.001$, $eta^2 = 0.06$	$F(1, 430) = 0.33$, $p = 0.568$, $eta^2 = 0.001$	$F(4, 430) = 03.75$, $p = 0.005$, $eta^2 = 0.034$

Pillai's trace was reported in all within-group effects. DTS, Digital Transformation Stress; DTAS_PC, Digital Transformation Attitude—Positive Cognition; DTAS_NC, Digital Transformation Attitude –Negative Cognition; DTAS_PB, Digital Transformation Attitude—Proactive Behavior; DTAS_NAFF, Digital Transformation Attitude—Negative Affect.

digital transformation stress. By lowering the level of burnout dimension—exhaustion—these results are also in line with our assumptions that this kind of psychological intervention may influence not only specific stress related to digital transformation but also more general work outcomes. The latter results are of great practical importance because disengagement is associated with the intention to resign from work and may have a tremendous effect on the available workforce (Bakker et al., 2005; Atanasoff and Venable, 2017; Willard-Grace et al., n.d.).

Although we assumed that the intervention should strengthen employees' resources, namely self-efficacy, we did not observe significant increase in this variable. We believe that such changes may appear in some time distance and therefore the third measurement point would be necessary to evaluate such a prolonged change. Furthermore, it can be hypothesized that this type of intervention influences digital transformation stress rather by providing social support (Hogan et al., 2002; Cieślak et al., 2018) or by helping to deal with negative emotions (Hülsheger et al., 2013; Ninaus et al., 2015), than by changing self-efficacy. These alternative mechanisms should be verified in further studies.

Our results also offer very important contribution for practice. Our intervention seems to be "fighting fire with fire," because it significantly reduced the digital transformation stress by using online intervention [i.e., digital (ICT) solution]. Moreover, we successfully tested the concept of internet intervention using an open-source e-learning platform such as Moodle, which enabled users to self-develop an effective open access intervention without sophisticated IT knowledge. This platform offered also quite good user experience (UX) qualities and were positively evaluated by the participants representing a wide range of business sectors; therefore the sample of employees was very heterogeneous. In comparison to other online interventions (Cieslak et al., 2016; Rogala et al., 2016; Smoktunowicz et al., 2019), our blended intervention had similar results in effectiveness within the active group of participants, with a lower dropout rate (18%) vs. (c.a. 80%) in other online interventions (Rogala et al., 2016; Smoktunowicz et al., 2019, 2021). Thus, the effect of blended intervention seems to have the potential to be available for both practitioners and wide range of users.

Additionally, in our study, in the follow-up assessment (T2) we measured the whole group of respondents, not only participants of the blended intervention. This approach allowed us to test the DTS score in ineligible groups. According to this approach, we can cautiously conclude that the lack of blended intervention has increased the level of digital transformation stress in comparison to active participation in interventions, whose DTS significantly decreased.

LIMITATIONS

The present study has several limitations that need to be emphasized. Firstly, because of the COVID-19 pandemic, and the resulting online activities overload, participants may hesitate to engage in the additional Internet initiative, like online meetings, workshops and trainings. As a consequence, this factor could be one of the reasons for the high dropout rate and the low activity of the 4th group. Although the differences between active and control groups are not significant, we consider using a randomized control trial (RCT) approach in the future studies (Rogala et al., 2016; Smoktunowicz et al., 2019, 2021).

Secondly, a related limitation was finding balance in using digital solutions, namely the online intervention, as a digital transformation stress countermeasure, especially in the situation where people spend a lot of time in front of the computer out of necessity. Although participation in the intervention might be demanding due to the lockdown difficulties and tiredness while working online for the whole day before, the activity during workshops was successful. Monitoring of online training frequency of the participants revealed that they completed the majority of proposed exercises. However, using this intervention in a group of employees working in a traditional way might be a good control group in the future research.

The next limitation was lack of a possibility to receive objective measures of the level of digital transformation in a participants' organization and necessity to rely on self-report measures. Possibly, some participants might have overestimated the level of digital transformation in their organization. For future research, we should purposefully select the organizations to invite participants to the study.

Finally, we were not able to observe the prolonged effects of the interventions that would enable us to evaluate

the stability of observed effects in the long term, with 3 measurements of dependent variables (stress in the workplace, digital transformation stress, digital transformation attitudes). Finally, in the further research we should consider examining intervention effect in different cultural contexts, for generalization of results. Although recent meta-analysis on effectiveness of Internet -based CBT interventions confirmed its effectiveness in different cultural context (Andersson et al., 2019) it is important to better understand factors that may limit its usability.

CONCLUSION

This study offers both theoretical and practical contributions. It confirmed the usefulness of ICT demands and employees' resources model in the context of the digital transformation stress and digital transformation attitude. The blended intervention with e-stressless online training is an effective program enhancing the well-being of professionals affected by ICT demands increasing during the accelerated digital transformation in the workplace. Being broadly accessible to employees who currently work under DT demands, the proposed, blended intervention offers substantial psychological and social support, especially in the situation of remote work.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The research protocol was approved by the Ethical Committee of the SWPS University of Social Sciences and Humanities, Warsaw, Poland, number of decisions: 47/2020, 50/2020, 3/2021, 8/2021. The study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA, 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. The patients/participants provided their written informed consent to participate in this study. Participation was voluntary, and the participants did not receive compensation for their participation in the study.

AUTHOR CONTRIBUTIONS

EM-T: research concept, project preparation, organization, planning, scales development methodology, writing the original draft, intervention content development, and design of figures. SB and EM-T: data curation, formal analysis, interpretation of results, writing the manuscript, editing, and revision. EM-T and KS: project administration and first abstract writing. SB and KS: scale English back translation. EM-T and JP: intervention diagram preparation. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.732301/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Oświadczenie o współautorstwie

Niniejszym oświadczam, że w pracy: Makowska-Tłomak, E., Bedyńska, S., Skorupska, K., & Paluch, J. Blended online intervention to reduce digital transformation stress by enhancing employees' resources in COVID-19. Frontiers in Psychology, 804. doi: 10.3389/fpsyg.2022.732301, mój udział polegał na analizie wyników, pisaniu edycji i korekcie manuskryptu. Mój udział w powstaniu pracy wynosi 15%.

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Niniejszym oświadczam, że w pracy Makowska-Tłomak, E., Bedyńska, S., Skorupska, K., & Paluch, J. Blended online intervention to reduce digital transformation stress by enhancing employees' resources in COVID-19. Frontiers in Psychology, 804. doi: 10.3389/fpsyg.2022.732301, mój udział polegał na przygotowaniu diagramu interwencji. Mój udział w powstaniu pracy wynosi 2%.

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PLOS ONE

Measuring Digital Transformation Stress at the Workplace - development and validation of the Digital Transformation Stress Scale

--Manuscript Draft--

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Full Title:	Measuring Digital Transformation Stress at the Workplace - development and validation of the Digital Transformation Stress Scale
Short Title:	Digital Transformation Stress Scale
Corresponding Author:	Ewa Makowska-Tłomak SWPS University of Social Sciences and Humanities: SWPS Uniwersytet Humanistycznospoleczny Warsaw, 1180197245 POLAND
Keywords:	Digital Transformation; digital transformation stress; Workplace Stress
Abstract:	Despite the unquestionable advantages of digital transformation (DT) in organizations, the very process of DT could have an impact on the level of stress of the employees. The negative effects of the digital transformation process can be observed during the implementation of information and communication technologies (ICT) solutions. They are further enhanced by the effects of COVID-19 pandemic, as digital transformation has accelerated to allow for remote work. Herein we distinguish between general stress at the workplace and the very specific type of stress, namely digital transformation stress (DTS). We assumed that this type of stress appears when rapid implementation of ICT solutions is introduced with time pressure and incertitude of further results. To quantify this phenomenon, we developed a new self-report scale - the Digital Transformation Stress Scale (DTSS), measuring employees' stress stemming from the process of digital transformation in organizations. The psychometric validity of the scale was evaluated in two studies: Study1 conducted at the beginning of COVID-19 pandemic in 2020 (N = 229) and Study 2 in 2021 (N = 558), after a year of mostly remote work. The results confirmed the good reliability with Cronbach's Alpha α =.91 in Study 1 and .90 in Study 2 and assumed unidimensional factorial validity of the scale in both studies. All items of the scale had good difficulty and discrimination values evaluated in Item Response Theory, i.e., IRT approach. The scale showed predicted convergent validity as the indicator of the digital transformation stress moderately correlated with general stress at work. Moreover, the assumption that even employees with high ICT skills could be affected by DTS was confirmed. Additionally, the results indicated that digital transformation stress was significantly higher among employees who reported both issues: ongoing digital solutions projects at the workplace and high impact of COVID-19 pandemic on their work. The scale could be used in future work on measuring and counteracting digital transformation stress at the workplace.
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Opposed Reviewers:	
Response to Reviewers:	Dear Associate Chairs and Reviewers, Thank you for your insightful reviews and comments. Your constructive feedback on the topic selection motivated us to continue working on this topic, and the detailed comments allowed us to refine and complete the areas highlighted in our article, so we hope our article will provide a better contribution to the area of digital transformation. Regarding your comments and suggestions, please find our responses to the pointed

issues below, marked in blue in the attached document "PLOS ONE responses to Reviewers 28112022.docx", which is uploaded as a separate file :
Reviewer #3: This paper reports on the development of the Digital Transformation Stress Scale, a timely and potentially useful measure of organizational stress during digital transition. The authors proceed to describe two studies aimed toward evaluating the psychometric properties of the measure, first via an exploratory factor analysis to identify structure, and second via a confirmatory factor analysis to validate the proposed unidimensional structure. Although the authors provide much detail regarding their intentions and procedures there are a few core flaws that prevent me from recommending acceptance.
1)First, this work is not integrated with the very large literature in organizational change. This literature is rich in information describing and predicting employees' responses to multiple types of organizational change. Though the authors describe meticulous prior work intended to define DTS, this construct is not conceptualized as part of the larger body of work to which it belongs. DTS is clearly differentiated as stress associated with the process of technological change rather than toward the technology itself. This suggests a stress and coping response to an organization change that remains hidden. A more thorough grounding in stress and coping theory is also needed to identify needed boundary conditions for the construct. It would useful to consider the stress/coping concept more carefully. See Mukerjee, Montani, and Vandenberghe (2021), A dual model of coping with and commitment to organizational change: the role of appraisals and resources in the Journal of Organizational Change Management.
Thank you very much for your comments. We expanded the context of digital transformation process in organizations and ICT project implementation process – i.e., style of DT introduction, project management etc., which is the most important in the context of stress related to DT. Please find it, in attached corrected article, in lines: 64-86, 93-101 and 192-202
We have also added a dedicated section on the concept of stress, as well as the assumptions we made to prepare the DTS scale. Please find it, in the attached corrected article, in lines: 112-179 and 182-192.
2) Second, possibly because of shallow conceptual grounding, there is no information regarding item origins. Though the authors focus on the need and desirability of brief measures as a response to this issue, it skirts the issue. Moving from conceptual to operational definitions requires understanding of the scope and boundaries of the construct. Typically, scale creators summarize adjacent measures, invent and adapt a large universe of potential items, and rely on data reduction techniques to distill items. In this case there was no theory or information provided to suggest whether a unidimensional or multidimensional structure was expected. Consequently, items are mainly characterized by different words for negative affect (upset, irritated, annoyed, powerless, overwhelmed) rather than a distinct conceptualization of DTS. It isn't surprising that the items grouped in a unidimensional structure as items of similar sentiment often do. Is DTS simply a negative affective reaction to IT related organizational change? Again, the organizational change literature may supply additional information that allows you to tease out what this construct really is.
Thank you for your comments. Please find in line 248-262, 295 4 303 a detailed description regarding the number of DTS items and the approach. Moreover, we added the section describing related work on the scale construction in lines 208 to 229. Detailed procedure of scale development was described in lines 248-284.
There are one-dimension scales with no inverted items e.g., general self -efficacy scale (Schwarzer, 2014; Schwarzer & Jerusalem, 1995), short version of occupational self-efficacy scale (Rigotti et al., 2008), ICT Support scales (Day et al., 2012). We also addressed the issue of unidimensionality more thoroughly in lines: 241-245, 258-263 as well as the number of items, please find in lines: 295- 304

Finally, the described factor analysis and Cronbach alpha are rudimentary evaluations of scale metrics. The general point of factor analysis is to pull those items that vary together out of the item pool. This is why a large number of items is so desirable at the start. Authors should include and report factor structure more carefully, including why they chose oblique rotation, correlations between factors, post rotation (structural) factor loadings and rules for retention in the scale. However, more comprehensive techniques (e.g., Rasch analysis) allow evaluation of item spread in regard to the difficulty, or frequency of extreme response ratings. In this way the analysis can reveal if the collection of items validly represents the construct under study (See Boone WJ.

	(2016) Rasch analysis for instrument development: Why, when, and how?). Following the suggestion of the reviewer we added analysis in IRT approach in the Results section: “Items difficulty and discrimination” (lines 537-586). In sum, digital change is a type of organizational stress that should be contextualized within the broader domain of the organizational change literature. This literature is large and well-established. Please see these for history, summary and linkage to this important research domain: 1.) Lewis, L. (2019). Organizational change. In Origins and Traditions of Organizational Communication (pp. 406-423), 2.) Hanelt, A., Bohnsack, R., Marz, D., & Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. Journal of Management Studies, 58(5), 1159-119, and 3.) Olafsen, A. H., Nilsen, E. R., Smedsrud, S., & Kamaric, D. (2020). Sustainable development through commitment to organizational change: The implications of organizational culture and individual readiness for change. Journal of Workplace Learning) Thank you for this suggestion – we added these works to introduction and discussion to elaborate the theoretical context of the DTS scale construction more broadly, please find references to them in lines: 61-86, 92-111, 633 – 640, 692-698 Overall, thank you again for your valuable feedback, we were happy to provide the additional information to strengthen our contribution. On behalf of all of the Authors, Ewa Makowska-Tłomak
Additional Information:	
Question	**Response**
Financial Disclosure Enter a financial disclosure statement that describes the sources of funding for the work included in this submission. Review the submission guidelines for detailed requirements. View published research articles from *PLOS ONE* for specific examples. This statement is required for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate.	Open access was financed by the European Union resources within the European Social Found no POWR.03.02.00-00-I054/16-00 and supported by doctoral fellowship ICT&Psychology - Interdisciplinary Ph.D. Study from University of Social Sciences and Humanities and Polish Japanese Academy of Information Technology. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

This letter accompanies our submission of an article entitled: "Psychometric Validity of Digital Transformation Stress Scale in the Workplace" that we would like to be considered for publication in PLOS ONE as a research article.

In the presented article, we describe the development of Digital Transformation Stress Scale (DTSS) and its psychometric evaluation in two independent studies. Our work is based on the assumption that digital transformation is a process that touches every area of modern human life. It brings with itself unquestionable advantages, especially in organizations. However, the process of digital transformation, rapidly accelerated in some situations e.g.by COVID-19 pandemic, can have a negative impact on employees' level of stress at the workplace. Therefore, our research concentrates on digital transformation stress in the workplace defined as employees' response to these DT processes.

In contrast to technostress, the digital transformation stress is a border concept and is rather related to the mode of DT introduction and management, to possible changes and employees' resistance as well as to ICT demands overload. Although these two types of job stress are caused by IT solutions, technostress is experienced mostly by individuals due to their inability to adapt to new technologies. The sources of digital transformation stress are more in the properties of the implementation of digital transformation. That is why it is important to differentiate technostress from digital transformation stress.

The proposed Digital Transformation Stress Scale was previously used in our study implementing sentiment analysis for detecting digital transformation stress in written communication among employees (Makowska-Tlomak et al., 2021). In that research, we indicated the relationship between the negative emotional markers in help desk tickets and the level of digital transformation stress, measured by DTSS. Consequently, the validity of our scale was evaluated in two independent ways: psychometrically (described in the submitted article) and using sentiment analysis and machine learning methods. In the present article we evaluated our scale using Exploratory and Confirmatory Factor Analysis (EFA and CFA) to make our results comparable to the previous works on similar tools such as scale of Perceived Stress at Work (PSwP) or Perceived Stress Scale. Following Reviewers 3 suggestions we also added analysis of the item properties in the Item Response Theory (IRT) approach. The results generally confirm good psychometric properties of the scale itself presented in CFA. They also showed that all items have consistently good properties as measured by difficulty and discrimination as well as item curves. That also addresses the comments of the Reviewer 2 about the item 5 and 6. In this submission we also broadened the theoretical context to the organizational change literature as proposed by the Reviewer 3, what may make this paper more interesting to a broader audience of readers.

Taking all the above improvements, we hope that our article will be of interest to your readers, especially that its results may be applied in professional and research settings and that it will point to relevant areas of further research on digital transformation projects and processes in relation to employees' well-being and methods and tools for dealing with the challenges of digital transformation.

This manuscript (or one describing these data) was not under review in PLOS ONE or elsewhere, nor have these results been published previously. We also kindly ask to place the following information about funding in the manuscript: "*Open access was financed by the European Union resources within the European Social Found no POWR.03.02.00-00-I054/16-00 and supported by doctoral fellowship ICT&Psychology - Interdisciplinary Ph.D. Study from University of Social Sciences and Humanities and Polish Japanese Academy of Information Technology.*"

Thank you for receiving our manuscript and considering it for review. We appreciate your time and look forward to your response.

On behalf of the Authors,

Ewa Makowska-Tłomak

Original Manuscript

MEASURING DIGITAL TRANSFORMATION STRESS AT THE WORKPLACE – DEVELOPMENT AND VALIDATION OF THE DIGITAL TRANSFORMATION STRESS SCALE

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Abstract

Despite the unquestionable advantages of digital transformation (DT) in organizations, the very process of DT could have an impact on the level of stress of the employees. The negative effects of the digital transformation process can be observed during the implementation of information and communication technologies (ICT) solutions. They are further enhanced by the effects of COVID-19 pandemic, as digital transformation has accelerated to allow for remote work. Herein we distinguish between general stress at the workplace and the very specific type of stress, namely digital transformation stress (DTS). We assumed that this type of stress appears when rapid implementation of ICT solutions is introduced with time pressure and incertitude of further results. To quantify this phenomenon, we developed a new self-report scale - the Digital Transformation Stress Scale (DTSS), measuring employees' stress stemming from the process of digital transformation in organizations. The psychometric validity of the scale was evaluated in two studies: Study1 conducted at the beginning of COVID-19 pandemic in 2020 (N = 229) and Study 2 in 2021 (N = 558), after a year of mostly remote work. The results confirmed the good reliability with Cronbach's Alpha α =.91 in Study 1 and .90 in Study 2 and assumed unidimensional factorial validity of the scale in both studies. All items of the scale had good difficulty and discrimination values evaluated in Item Response Theory, i.e., IRT approach. The scale showed predicted convergent validity as the indicator of the digital transformation stress moderately correlated with general stress at work. Moreover, the assumption that even employees with high ICT skills could be affected by DTS was confirmed. Additionally, the results indicated that digital transformation stress was significantly higher among employees who reported both issues: ongoing digital solutions projects at the workplace and high impact of COVID-19 pandemic on

50 their work. The scale could be used in future work on measuring and counteracting
51 digital transformation stress at the workplace.

52 Keywords: Digital transformation; digital transformation stress; workplace stress
53

Introduction

The digital transformation (DT) in organizations is defined as the broad process of implementing information technology (IT) and information and communication technology (ICT) solutions (1,2). DT encompasses, for instance, the process of implementing advanced systems for digitalizing business processes and document management (known as Document Management Systems -DMS). The digital transformation of a company might be related with fundamental organizational changes (2–4) and instilling a culture that supports change and enables the company's overarching strategy (3,5).

Although DT evokes organizational changes, recent observations suggest that DT deviates from the past organizational changes. Nowadays changes related to IT are much more generative, malleable and combinatorial in comparison to traditional ones (6,7). Many modern digital technologies are becoming ubiquitous and not confined to the boundaries of specific companies or industries, and therefore encompass a wider ecosystem and the demand side (4,8). Therefore, digital change becomes more multidimensional and requires both technical and social skills . Furthermore, in contrast to traditional organisational changes, DT can cause far more dynamic changes that can be triggered and shaped by episodic (technological/ICT) outbursts (4,9). Digital transformation changes not only the organisations but can also cause the sudden extinction of some business models and the emergence of new digital business models, even in non-IT industries (1,4).. Therefore, digital transformation nowadays seems to be a qualitatively different organisational change than the ones previously observed and examined in the literature (4).

The expected effects of DT are improvements in the work efficiency and effectiveness of organizations (1, 11, 12). Despite the unquestionable advantages of digital transformation (10, 13, 14), the DT process and improper implementation of digital changes and solutions may cause high pressure (2,14), work overload (15), hassles (17, 18) and challenges in adapting communication to many employees (19, 20). These demands in turn may increase stress experienced in the workplace (15,20) and, in consequence, decrease productivity, commitment (21,22) and more broadly decrease the well-being of employees in the workplace (2,23,24).

The recent COVID-19 pandemic has accelerated the digital transformation in a wide range of areas, from business to education (25–27). The national lockdowns have forced public and private sectors to sharply reorganize daily work into remote and online modes practically almost overnight (26,28,29). In consequence, the negative impact of DT on employees' psychological well-being has been recognised along with the increase of stress related to the acceleration in introduction of ICT solutions and digital changes in organizations (19,30–32). This rapid digital transformation process revealed that negative consequences of DT were not only identified in organizations which were forced to implement digital transformation solutions, but also in IT companies which were responsible for introducing IT and ICT solutions in those organisations. It is important to note that, despite the high IT skills of the employees in the latter organisations, the job demands, namely workload, availability, time pressure, stemming from the rapid digital transformation rose to a level beyond manageable and were perceived as stressful for both groups of employees (33,34).

This situation has emphasized the paucity of tools and research evaluating employees stages of adaptation to digital solutions implementation process and

potential factors that can affect this adaptation, with stress among others (35–37). Monitoring the level of stress stemming from digital transformation, namely digital transformation stress (DTS), has grown particularly important. In response to this demand, we propose a new self-report scale, Digital Transformation Stress Scale, designed to identify the early signs of the very type of stress, resulting from digital transformation. It may serve as a monthly screening test to identify employees affected by this type of stress to prevent potential damage the very stress can cause at the personal level, and consequently, to the organisation.

Job stress

According to the literature and research, stress is a reaction, a (nonspecific) response of a person to specific stressors individually assessed (38,39). Following the Lazarus and Folman approach "the stress is a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (40). Stress is defined also as the perception of threat, with resulting anxiety, discomfort, emotional tension, and difficulty in adjustment (38–40). With reference to workplace, job stress is a particular individual's awareness or feeling of personal dysfunction as a result of perceived conditions or happenings in the work settings (41). Job stress is also defined as an emotional response to stimuli that may have dysfunctional psychological or physiological consequences, and is associated with negative feelings of an individual related to that stimuli (41,42). This type of stress occurs when environmental job demands exceed one's perception of the ability to cope (39), because for instance the lack of resources (43). According to Job Demands-Resources (JD-R) model (43,44), employees' stress in the workplace increases with the job demands' growth and with limited resources (Bakker & Demerouti, 2014; Bakker

Arnold B., 2007). Examples of job demands include a high work pressure, workload (Bakker et al., 2007; Bakker & Demerouti, 2014), hassles (Day et al., 2012) and lack of control (Day et al., 2012; Karasek et al., 1998; Landsbergis, 1988). All of those job demands may increase the level of employees' stress if they are not balanced with job resources (43,45). These job demands are likely to be associated with employee attitudes such as increased job tension, compromised satisfaction, and commitment (Carlson et al., 2017; Elacio et al., 2020).

Job stress is significantly related to work motivation and stressed employees become chronically exhausted and demotivated (43). Although the identification of specific stressors is associated with many difficulties because people often misattribute their feelings of stress to a particular source when that stress is actually due to another source (38,46), there is ample research on identification of job stressors (43,47,48). Nowadays, job stress is by far the most significant source of stress for adults and it has been escalating over the past few decades (39,47,49). Therefore, its identification at an early stage is an important aim in the workplace to avoid prolonged and negative consequences for the well-being of employees and prevent potential resignation from work (17,50,51).

A commonly used scale assessing perceived stress is the Perceived Stress Scale (38), known as PSS-4, PSS-10, PSS-14 ((38,52,53). According to stress-appraisal theory (40),PSS evaluates the degree to which an individual (here employee) has experienced distress and negative feelings stemming from perceiving life (of work) and the feeling that they cannot cope with a specific situation or stimulus (38,41,54) .

Whereas stress appraisal theory is limited to the assertion that what is perceived as stressful is stressful (38,40,55), we also relied on the assumptions of

resource conservation (CoR) theory(55,56). According to the CoR theory, psychological stress isindividual's reactions to an environment in which valuable resources are threatened. On the basis of CoR, we assume that the threat of losing resources, evoked by digital transformation in the workplace, determines the employee's reactions to changes taking place in the organization during the implementation of IT solutions and new technologies (16,55,57,58). In the context of digital transformation at the workplace, these resources may be employees' competencies, previously pivotal for effective work but less adequate in a new situation, due to changes in IT solutions. As a result, in the continuous process of digital transformation, individuals could experience decreasing sense of influence or control over technological changes taking place in the organization, threat of losing their position or even their job (30,55,59,60). Therefore, with the idea that personal resources (55,61) loss is the strongest predictor of psychological distress (61) confirmed in multiple studies (58,61–63), the COR theory provides substantial theoretical background to the construction of Digital Transformation Stress Scale

Digital transformation stress (DTS) and its potential consequences

Based on previous research on job stress (16,44,49), we assume that the stress caused by digital transformation should be distinguished from general technostress (31,64,65). Technostress is stress experienced by the individual due to their inability to adapt to new technologies because of the low level of competencies indispensable for taking advantage of modern Information Systems (IS) (5, 23). However, nowadays, many employees understand that ICT solutions and digitization are very important for organizations' competitiveness and effectiveness (1, 9, 24). Thus, frequently, employees' general attitudes towards new technology in their organization

are initially very positive (67,68). However, the sharp and improper implementation mode of new ICT solutions may increase job demands placed on employees and be an additional source of their job stress (68,69), even in those employees who are highly competent in ICT (33,68). We defined this type of stress, stemming from digital transformation, as digital transformation stress (DTS). In contrast to technostress, we assume that the DTS arises not because of negative attitudes to new technology *per se*, or lack of ICT skills, but because of the occurrence of a set of factors such as: 1) an improper way of implementing digital solutions and changes in workplaces (70) 2) unfit DT project management, 3) an increase in ICT demands, 4) incertitude of professional future evoked by the globality of the change. Finally, 5) the DTS may also be related to the stress resulting from organizational changes due to digital transformation (4,59,71). Therefore DTS is a broader and more complex concept in comparison to technostress and stress related to organizational changes, due to the many factors that may cause it (67,68,72).

Therefore, in contrast to technostress, digital transformation stress can also affect employees with high ICT skills, appreciating new technologies, and otherwise benefiting from digital progress (10,67,68,73). Highly skilled IT specialists and IT managers may also face the challenges of digital transformation and suffer from the workload produced by rapid implementation of DT solutions (16,17,70,74).

Although existing measures of technostress have contributed significantly to understanding the antecedents and consequences of stress-related to information technology, they were generally not designed to evaluate stress caused exclusively by digital transformation (16,31,36,64,67). Distinguishing technostress from digital transformation stress is important to allow organizations to address and mitigate the consequences of the introduction of technological stressors in the workplace context

(67). Hence, there is a need to create dedicated psychometric tools to measure stress due to DT, which will enable data scientists and researchers to explore root causes of this type of stress and find ways to alleviate or address it for the benefit of employees who suffer from it, as well as the organizations undergoing digital transformation.

Related work

According to our assumptions above , referring to DTS, in our previous study we were working on developing and evaluating the tool for automatic detection of DT stress, conducted between June and August 2020 (75). In that study, we used two self-developed scales related to digital transformation stress: first is the Digital Transformation Stress Scale we psychometrically evaluate in this article and second: the Digital Transformation Attitudes Scale (DTAS) for measuring employees' attitudes toward the digital transformation (75), such as employee reactions to technological and IT project introduced in the organization, which include, for example, the implementation of new software or work automation. In contrast to DTSS, the DTAS has a tree-dimensional structure, emotional, behavioural and cognitive. The initial psychometric evaluation of DTAS was conducted in a series of two studies, in December 2019 and June 2020, Cronbach's Alpha was equal $\alpha = .86$, (no published yet)

Because the aim of the study was to develop and evaluate the questionnaire-free tool for detecting and monitoring digital transformation stress based on sentiment analysis, we concentrated on examining the relation between results of DTS measurement conducted in two ways (75). Moreover, the relationship between DTAS and DTS exists because of the positive and significant correlation between variables, $R = .63$, $p <= .001$The relation between two scales and scales reliabilities were

confirmed in our previous study on developing internet intervention addressing DTS (72).

Aims of the studies

The central aim of our research is to validate psychometric properties of the Digital Transformation Stress Scale (DTSS), which assesses perceived transformation stress defined in terms of employees' response to the process of digital transformation in the workplace. The DTSS serves as a psychometric tool targeted to measure stress, caused by the style and manner of ICT tools' implementation and management, related to time pressure, high workload, and expectations of high efficiency in the context of DT (16,19,23,30). Since our goal was to create a careening test for stress, which, together with the sentiment analysis tool (68), set a complex instrument for stress monitoring during DT projects, at intervals of short periods (4-6 weeks) (38,52), we assumed a brief (few items), one-dimensional scale from the beginning.

Constructing the DTSS was based on two scales assessing perceived stress, i.e., the Perceived Stress Scale (38) and the Perceived Stress at Work (76). In both scales participants are asked to describe their feelings during the previous month to capture a relatively recent experience in their lives (in PSS) or at the workplace (in PSS-W). Both scales evaluate the degree to which an individual (or employee) has perceived life (of work) as unpredictable, uncontrollable, and overwhelming during the previous month

Based on Parker, DeCotiis (41) we concentrated on measuring the DTS based on the concept of stress limited to an emotional response to stimuli that may have dysfunctional psychological or physiological consequences. Here these stimuli were related to the process of DT. As people often misattribute source of stress (38,41), we decided to construct a scale containing direct inquiries about the perceived stress in

the context of the digital transformation, e.g. the process of implementing ICT projects. In designing DTSS, we also assumed that the scale may be practically used as a tool to monitor the level of stress during DT process, in repeated measures design. Therefore, we decided to refer to PSS (38), to design our scale because it was proved that it can tap perceived stress fluctuation across different measurement points. We ask our participants to describe their DTS in the last months because prior studies on the PSS showed that the predictive validity of the scale is expected to decrease rapidly after four to eight weeks (38). Therefore, the perceived DTS measurement could be retested after that period and any changes could be observed. For the same reason, we wanted to obtain short feeding time (up to a few minutes) and ease to score

Firstly, we prepared the initial list of 20 proposed items, describing symptoms of stress in the context of digital transformation (57,77). Accordingly, in our approach we used similar to PSS phrases referring to the sensations and the frequency of their occurrence, i.e., "*how often have you felt*" (38), similarly referring to previous month (or 4 weeks). However, the content of the items we contextualized to the situation of the digital transformation process, on two theories i.e., Appraisal (40) and CoR (55) Theories. According to Lazarus & Folkman's (1984) stress-appraisal theory and Cohen (1983), we aim to capture whether the employee perceives the situation in the context of work, during the DT and/or ICT implementation, as stressful (38,40). Therefore, some items were designed to evaluate negative emotions, (i.e., upset in the first item, irritated in the second item and annoyed in the fourth), which could appear in DT process at the measurement moment. Whereas stress appraisal theory is limited to the assertion that what is perceived as stressful is what is stressful (38,40,55) therefore we designed some items we based on CoR theory (56,61) Thus, two items refer to sense of control or influence: the third: "*How often have you felt that you had*

no control over ICT changes connected with new procedures and your tasks?" and the fourth: *"How often have you felt annoyed because of new work tasks/rules in connection with system/program changes whose implementation you had no influence on".* Another item (the sixth one) refers to lack of competencies and skills, i.e., specific personal resources (55) used to deal with ICT demands during ICT solution implementation: "*How often have you felt that your competences and skills were insufficient to be proficient in new IT tools implemented at your workplace?"*

Secondly, each proposed item was discussed with experts working in occupational psychology, financial and IT sector employees, and PhD candidates with the aim to optimize the initial list of items for further assessment (77). Thirdly, the items were examined by the group of six competent judges (psychologists, experts in work and stress psychology), who, based on the DTS definition, evaluated the adequacy of each item. The item ratings were given on a five-point scale - from 1 to 5, where 1 meant that the item did not concern any aspect of DTS and 5 meant that the item was well aligned with the different symptoms of DTS. We used the intraclass correlation coefficient (ICC) to measure inter-rater agreement between judges (78–80).

For above mentioned (and practical reasons), from the beginning, our aim was to develop a brief and less time consuming scale (38,52,81,82), possible to use as a screening test at the workplace, which meant it had to be quicker to complete (38,52,82). Following evidence showing that a short form of the Perceived Stress Scale PSS-10 (38,83,84) obtained better psychometric properties than a longer version (52,53,85), we decided to select a very limited number of items, with the highest ratings of competent judges and with the high agreement of these ratings. Based on

these criteria, we selected 6 items to the final DTSS with ratings higher than 4.0 and with ICC = .82, $p < .001$.

To fulfil the general aim of this research – evaluating the psychometric validity of the new measure of digital transformation stress in the workplace – we ran two separate studies. In Study 1, we examined the initial factorial validity of the DTSS scale using the exploratory factor analysis and reliability of the scale. In the second study, we re-evaluated the assumed unifactorial structure of the scale in confirmatory factor analysis. Following the results of Study 1, in Study 2, we evaluated convergent and criterion validity (57,86). In our previous studies, we indicated a significant association between the occurrence of negative emotion markers in sentiment analysis of helpdesk tickets in one specific organization, with digital stress level assessed using DTSS (68). In a similar vein, in Study 2 we examined the association between digital transformation stress and general perceived stress at work, assuming that these two types of stress should be related, although not the same. Moreover, in the second study, based on the assumption that digital transformation stress does not stem from the lack of ICS skills, we also examined the association between digital transformation stress and self-assessed ICT skills. Additionally, we explored notable differences in the level of digital transformation stress experienced in organizations with and without ongoing IT implementation. We predicted that employees working in the latter should experience a lower level of digital transformation stress. In addition, assuming the COVID-19 pandemic caused acceleration in IT implementation in organizations, we compared the level of digital transformation stress in two groups of employees: those who declared that their professional life was affected by COVID-19 pandemic and those who declared that they were not affected.

Study 1

In Study 1, we evaluated the preliminary psychometric properties of DTSS: factorial structure and internal consistency in the sample of employees. We conducted the exploratory factor analysis to study the factorial structure of the scale and we evaluated the scale reliability using Cronbach ‘s Alpha.

Participants and Procedure

The participants constituted a sample of 229 adults (136 women, 75 men, 18 individuals not indicating their gender). The study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA 2010). The research protocol (with all text contents and compliance with the GDPR) was approved by the Ethical Committee of the University (number of decisions: 47/2020, 50/2020). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the questionnaire was activated. Participation was voluntary, and participants did not receive compensation for taking part in the study.

All participants were professionally active, working in a range of diverse occupations (e.g., accountants, business analysts, financial analysts, teachers, IT specialists, and managers). A large majority of the participants (82%) had completed higher education and held a full-time job. Most of the participants were between 36 and 45 years old (36.7%). More than 50% of the participants declared their work experience to be over 10 years and nearly 36% of participants declared work seniority between 20 and 30 years. The majority of the participants used ICT in their daily work. The study was conducted in two slots, between the end of December 2019 and February 2020, and after the end of the national lockdown, between mid-June 2020

and the end of September 2020. A more detailed description of the sample is presented in Table 1.

----------insert Table 1 over here----------

We mainly recruited the participants via social media, in particular LinkedIn and Facebook, as well as Messenger and WhatsApp. We also recruited participants using the snowball technique through contacts in various organizations from educational and business sectors. Because the study was aimed at employees who use ICT solutions at work, we asked a few Human Resources (HR) managers to send employees an email invitation to the study with a link to the survey. Participants accessed the survey by clicking on the link in the newsletter or email. All data was collected online via Google Forms and the organizational version of the Qualtrics platform, under the university license.

Measures

The Digital Transformation Stress Scale (DTSS) consisted of 6 items. The participants were asked to indicate on a five-points scale (1 = Never; 5 = Very often) the frequency of perceived stressful situations concerning the ICT implementation which they experienced during the last four weeks. An example of such an item is "How often have you felt annoyed because of new work tasks/rules involved with the system/program change which you had no influence on?". All items of the DTSS with their translation into English are presented in Table 2. The general indicator of digital transformation stress was prepared by averaging the answers of the participants.

Socio-demographic information: participants were asked to indicate their age range, seniority level, gender, education level, occupation, and position in their current job.

Results

Descriptive statistics

Descriptive statistics for all items and the general indicator of digital transformation stress are presented in Table 2. Inspection of descriptive statistics indicated in Table 2 showed that the general level of digital transformation stress was rather moderate with the mean close to the middle point of the scale. The variability was close to one point of the scale.

Factorial structure and reliability of the DTS scale

We started the psychometric evaluation of the DTSS Scale with an exploratory factor analysis. We used principal component analysis with oblique rotation in IBM SPSS Statistics 27.0 to examine the number of factors which can be identified. We implemented eigenvalues higher than 1 as a criterion to identify the number of factors. Items with factor loadings higher that .40 were evaluated as presenting good factorial validity of the scale (57).

Exploratory factor analysis of the DTSS scale confirmed the one-dimensional structure of the scale. The KMO test was equal to .85 with $p < .001$. The one-dimensional structure explained over 68% of the total variance with six items. All factor loadings of the items of Digital Transformation Stress Scale (DTSS) were high from .86 for item 3 and 1 to .74 for item 6 (see Table 2). The reliability of DTSS was high with Cronbach's Alpha $\alpha = .91$.

----------Insert Table 2 over here----------

Discussion and Conclusions

The main aim of the first study was to conduct an initial psychometric evaluation of Digital Transformation Stress Scale (DTSS). We examined the

preliminary factorial validity and reliability of the tool. The results confirmed the good reliability of the DTSS and assumed unidimensional structure of the scale. The factor loadings of all items developed in the DTSS were moderate or high, therefore there was no need to eliminate any of the items from the Digital Transformation Stress Scale. In conclusion, the results of Study 1 provide support for the assumed structure and internal consistency of the DTSS in the sample of Polish employees. In the next study, we decided to examine the DTSS factorial structure in confirmatory factor analysis and to test theoretical validity of the DTSS by presenting its associations with other variables, e.g., general stress at work.

Study 2

The main goal of Study 2 was to conduct a more advanced psychometric evaluation of the Digital Transformation Stress Scale (DTSS). We decided to conduct confirmatory factor analysis (CFA) for DTSS. Following theoretical assumptions and the results of Study 1, we predicted a unidimensional structure of the scale. Again, as in Study 1, we examined reliability using Cronbach's Alpha statistics. To extend the information about the psychometric properties of the DTS scale we conducted Graded Response Polytomous IFA-IRT models for assessment for the extent to which a single latent trait could predict the pattern of associations among these 6 items. The GR model is often used when response data are ordinal, with Likert-type responses (87). This model is an extension of the dichotomous two parameter logistic IRT model. We also aimed to examine the convergent validity of the scale by presenting the relationships of digital transformation stress with perceived stress at work. We predicted that a higher level of digital transformation stress, measured with DTSS, would be associated with a higher level of general stress. We also tested the relationship between ICT skills and digital transformation stress, and we predicted a

rather weak, if any, correlation between these two variables. To test theoretical validity, we also compared digital transformation stress between two groups of workers: affected and unaffected by COVID-19 pandemic. In the same vein, we analysed the differences between employees working in organizations with and without ongoing digital implementation.

Participants and procedure

The participants of the second study constituted a sample of 558 adults, where 245 were female and 313 male. All participants, except one, were professionally active, most participants have experienced working remotely (n = 335, 60%), whereas 223 participants did not work remotely at all (40%). The structure of participants comprised of a range of diverse occupations like accountants, business analysts, financial analysts, teachers, IT specialists, and managers, but also engineers, receptionists etc. Majority of the participants had a master's degree or above: 305 (54%) and 204 (37%) had a bachelor's degree. Only 36 (6%) participants had the education equal to or lower than middle school and held a full-time job. The average age in the sample group was 43.6. The youngest participants were 20 years old and the oldest and professionally active were 69 years old. Most participants were between 40 and 49 years old (183, i.e., 33%), and between 30 and 39 years old (167, i.e., 30%). We grouped the professional occupation declared by the participants into seven job position categories, similarly to Study 1. A more detailed description of the sample is presented in Table 3.

----------insert Table 3 over here----------

The participants were recruited to the study by a professional research agency. All data was collected in online mode only. The present study was conducted in compliance with ethical standards adopted by the American Psychological

Association (APA 2010). The research protocol (with all text contents and compliance with the GDPR) was approved by the Ethical Committee of the University (number of decisions: 47/2020, 50/2020, 3/2021, 8/2021). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the survey was activated. Participation was voluntary, and employees did not receive compensation for their participation in the study.

Measures

The Digital Transformation Stress Scale (DTSS) is a self-report scale consisting of six items. All items are presented in Table 4. The participants were asked to indicate on a five-points scale (1 = *Never*; 5 = *Very often*) the frequency of perceived stressful situations concerning the ICT implementation which they experienced during their last four weeks in the workplace. The general indicator was prepared by averaging the answers of the participants.

The Perceived Stress Scale (PSS-4) (38,88) comprised four items and was based on the Polish version of PSS (45,89), modified to relate to general stress at work (45). Participants were asked to describe their feelings and thoughts related to their professional work during the last month using a five-point scale where 1 = *Never* and 5 = *Almost always*, e.g., "How often have you felt that you were unable to control the important things in your life at work?".

Self-assessment ICT skills inventory - To assess specific ICT skills in different areas, we developed the 7 items of ICT skills self-assessment inventory based on The Digital Competence Framework for Citizens (90). Firstly, participants were asked to estimate their ICT skills in the workplace in general, ("Please evaluate your computer skills in the workplace"), by indicating the answers on a 5-point scale

where 1 meant *Basic level - limited to elementary functionality* and 5 meant *Very advanced level - programming, graphic processing, computer operation of machines*. There was also a possibility to mark the answer "I'm not using a computer at work". Afterwards, respondents were asked to determine their skills in the listed area and their activity on the Internet as well. It was performed in a matrix of statements applied to different ICT skills, from using keyboard shortcuts and internet transfer to working in different programs commonly used in the workplace. Example statements are: "I can prepare a presentation in a dedicated program, I can choose the layout, background, template, charts, tables.", "I can pay by an online bank transfer". The responses evaluated their skills on a 5-point scale, where 1 means *very low skill level* and 5 means *very high skill level*. The reliability of the Self-assessment ICT inventory was high (Cronbach's alpha = .88).

Digital transformation processes at the workplace – a one-item question: "Are there any implementation projects (IT) currently being carried out in the organization where you work or study, which affect your work or your activities?". Respondents have been asked to indicate an answer among "*Yes, there are"*, "*No, there are not"*, "*I do not know"* and "*Not applicable"*.

COVID – 19 impact assessment. To assess the impact of the COVID-19 pandemic on the participants' professional life, we added a series of questions related to COVID-19, i.e., "Has the COVID-19 pandemic impacted your professional life?" Respondents selected answers between *Yes* and *No*. When they indicated *Yes*, this answer was followed by a few questions to specify this impact. Respondents could select multiple answers from the list like "I used to work more before COVID-19 pandemic", "I started working remotely and it was something new for me", "I lost my job", "I have gained a lot of new ICT skills (Information and Communication

Technologies)". There was also a possibility to enter their own statement describing the COVID-19 pandemic impact on the professional life of the participant.

Socio-demographic information. Participants were asked to indicate their age range, seniority range, gender, education level, occupation, and position in their current job.

Results

Descriptive statistics

We again started our analysis from descriptive statistics, and we present means and standard deviations for all items and the general indicator of Digital Transformation Stress scale in Table 4. As in Study 1, the general level of digital transformation stress was moderate with the value of mean close to the middle point of the scale, with variability close to one point of the scale.

----------Insert Table 4 over here----------

Factorial structure and reliability

In this study we again verified unidimensional structure of the DTSS using confirmatory factor analysis (CFA) in structural equation modelling approach in Mplus, version 8.2 (91). Due to non-normality of the variables, we used Maximum Likelihood Robust (MLR) approach (92–94). First, an exploratory analysis of the data is presented with descriptive statistics and correlations to evaluate the quality of the data. Then, a confirmatory factor analysis (CFA) was conducted. We specified one factor model loaded by all six items of the DTSS scale. We used modification indices to improve the preliminary model. The final model was evaluated using fit indices following Kline's (57) recommendations, therefore we present Root Mean Square Error Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) as well as the

general fit based on χ^2 test of model fit and its significance (*p*). We adopted widely recommended cut-off values indicative of an adequate model fit to the data, respectively: RMSEA and SRMR < .06 and < .08, CFI and TLI >.95 and >.90 (93).

The CFA analysis indicated that the preliminary model was not well fitted to the data χ^2 (9) = 97.72, $p < .001$, CFI = .91, TLI = .85, RMSEA = .133, $p = .001$, 90% CI.[.110, .157], SRMR = .043. Following suggestions based on modification indices, we added covariance between two items with similar wordings – item 5 and item 6. This modified model was well fitted to the data χ^2 (8) = 14.90, $p = .061$, CFI = .99, TLI = .99, RMSEA = .039, $p = .678$, 90% CI.[.001, .070], SRMR = .014. All factor loadings significantly loaded to one factor. Covariance between item 5 and item 6 equals .48. All factor loadings are presented in Table 4. Therefore, it can be concluded that the Confirmatory Factor Analysis confirmed a unidimensional structure of the DTSS scale.

Items difficulty and discrimination

Psychometric assessment of the items discrimination and difficulty was conducted using Item Factor Analysis in Item Response Model approach. The current gold standard of estimation for IFA models is marginal maximum likelihood (MML). However, this estimation method in small samples does not provide information about global and absolute fit. Instead, we conducted assessment of model fit with weighted least squares estimator using mean and variance-corrected χ^2 (WLMSV). Similarly, to CFA we used CFI, TLI, RMSEA, SRMR and χ^2 test as measures of model fit with cut-off values described above to evaluate the goodness of fit. Following the A two parameter model exhibited quite good fit measured by CFI = .963, TLI = .939 and SRMR = .036, but unacceptable fit by χ^2 test of absolute fit χ^2 (9) = 329.722, $p < .001$, and RMSEA = .253 [CI = .230, .276; $p < .001$]. A reduced model in which with one

parameter fit significantly worse DIFFTEST(5) 24.211 $p < .001$. Thus, the original model was retained for further examination using MML estimation instead.

Model parameters obtained using MML and a logit link are shown in Table 5 which includes IFA item parameters (thresholds and loadings) as well as their Item Response Theory (IRT) analogous parameters of item discrimination and difficulty.

----------Insert Table 5 over here----------

It can be seen that all the items have similar discrimination parameters and it can be assumed that they similarly discriminate participants with different level of latent trait. Also, threshold parameters for all items have quite similar values with a similar spread across values of latent variable.

Figure 1 (left panel) displays the test information function. As can be seen in that plot the scale lacks measurement precision with theta falling below -2 but has high precision in moderate and high values of the latent variable. In sum the scale yields precise measurement for individuals with moderate to high DTS levels and relatively imprecise measurement for individuals with low DTS levels. Additionally, in Figure 1 (right panel) we present test information for ease of interpretation converted into a traditional measure of reliability that ranges from 0 to 1. It shows that test reliability is higher than .80 for latent variable values ranging from -1,8Z, which is almost 2 standard deviations below the mean. It means that for almost 95% of population the measurement reliability is higher than .80 and for almost 91% is .90 or higher. Importantly, reliability is high for highest levels of digital transformation stress.

----------Insert Figure 1 over here----------

Figure 1. Test information function and test reliability of the Digital Transformation Stress Scale (DTSS) in Study 2 (N=558).

We also present items information curves in Figure 2. As can be seen in Figure 2, one of the curves is a bit lower than others, namely for item 6. This indicates that overall degrees of measurement precision for this item is also relatively lower than for the rest of items. The highest plots are obtained for items 3 and 4 indicating higher measurement precision. Inspection of the item characteristics curves for all items (see attachment) revealed that the pattern of curves is similar for all items, with a slightly higher curves for category 1 and category 5, and smaller for middle categories of responses. This may suggest that extreme categories of response scale are more informative than the middle ones.

----------Insert Figure 2 over here----------

Figure 2. Figure 2. Items information functions of the Digital Transformation Stress Scale (DTSS) in Study 2 (N=558).

To test the reliability, we calculated Cronbach's Alpha in IBM SPSS Statistics 27.0. The reliability was high (Cronbach's Alpha α =.90) and it was similar to the results obtained in the first study.

Convergent validity

To present the convergent validity, we tested the association between general stress at work, measured with the Perceived Stress Scale (PSS) (38,45) and stress of digital transformation, assessed with Digital Transformation Stress Scale. As predicted, we found moderate and positive correlation between general stress in the workplace and DTSS with Pearson's $r = .45$, $p < .001$. Employees with a higher level of digital transformation stress indicated a higher level of general stress at work. As predicted, indicators of general stress and digital transformation stress shared a rather moderate percentage of common variance ($R^2 = .20$), and, therefore, they can be identified as separate constructs.

Divergent validity

Ongoing IT implementation

We expected that employees working in organizations in which there was ongoing digital transformation process should present higher digital transformation stress than those working in organizations with no digital transformation. Thus, we compared the level of digital transformation stress in these two groups using Student's *t* test for independent samples. The results revealed that the level of DTS in employees working in organizations who implemented IT solutions was higher (M = 2.45, SD = 0.81) than for employees working in organizations without ongoing implementation (M = 2.29, SD = 0.79; $t(426) = 2.14$; $p < .001$, Cohen's d = .21).

COVID-19 impact

The majority of participants (61.8%) stated that COVID-19 affected their professional lives, and we observed a significant difference in the level of DTS between the group of participants who did state that COVID-19 impacted their professional lives (M = 2.49, SD = 0.78) in comparison to participants who did not state that COVID-19 modified their working conditions (M = 2.24, SD = 0.79; $t(556) = 3.72$; $p < .001$, Cohen's d = .32).

ICT skills

We verified if self-assessment of ICT skills is the factor of DTS. Thus, we examined the correlation between the DTSS and self-assessment of ICT skills inventory. For the entire sample (N = 558), we observed no correlation between two indicators: r = -.04, p = .31. Additionally, we calculated the correlation between ICT skills and digital transformation stress only for those participants who declared that there is ongoing IT solutions implementation in their organization (see Table 6). There was significant negative correlation between self-assessment skills and digital

transformation stress in the group of participants who reported that there was ongoing implementation IT process in their organisation. However, this correlation was very weak. Such correlation was not present in the group of employees who declared that there is no such implementation in their organisation.

----------Insert Table 6 over here----------

Discussions and conclusions

The first goal of Study 2 was to examine whether we could confirm the factorial structure of DTSS found in Study 1 in a new sample of professionally active participants. The second goal of the study was to evaluate difficulty of the items and their discrimination, and the third goal was to evaluate the convergent and divergent validity of DTSS. Firstly, the results of Confirmatory Factor Analysis confirmed the unidimensional structure of Digital Transformation Stress Scale, observed in Study 1. Secondly, the level of difficulty and discrimination, evaluated in IRT approach was similar for all items and the whole scale had a good reliability for moderate and high level of measure latent variable. Thirdly, confirming our predictions, the correlations coefficients indicated that the level of DTS was positively but rather moderately related with general, perceived stress in the workplace. As predicted, the correlation between the DTS and self-assessment ICT skills was also weak, confirming that this type of stress, in contrast to technostress, does not stem from lack of IT skills.

We also tested the role of COVID-19 impact, as perceived by the employees. Most of the participants stated that COVID-19 impacted their professional lives and as predicted, we observed significant differences in digital transformation stress level between two groups of participants: those who stated that COVID-19 impacted their professional life had the elevated level of DTS in comparison to those who felt unimpacted by COVID-19. The same pattern of results was observed in the presence

of the factor of ongoing ICT solutions implementation processes. Employees working in organisations with ongoing implementations had a higher level of digital transformation stress in comparison to those employees who worked in the organisation without such implementations. Taken together, these results can be interpreted as prior evidence that acceleration of DT can be the source of DTS.

General discussion

The main aim of our research was to psychometrically evaluate the Digital Transformation Stress Scale. Based on a comprehensive literature review, we defined DTS as employees' stress related directly to the DT process itself, as employees' response to the mode of DT project management. Following this definition, we constructed a six-item Digital Transformation Stress Scale to evaluate the level of digital transformation stress in the workplace. In line with theoretical assumptions, we identified digital transformation stress as one of the sources of general stress at work and we assumed that these two constructs are related, though not the same. Therefore, we predicted that a significant, but rather moderate, correlation on these two constructs of our data would be found. We also distinguished digital transformation stress from technostress, by pointing out the limited role of perceived ICT skills in elevating digital transformation stress. We assumed that the level of ICT skills in employees should not be strongly related to digital transformation stress. We also predicted that digital transformation stress should be higher in employees working in organizations that had been implementing digital solutions. As the COVID-19 pandemic situation strongly impacted the acceleration of DT (19,28,35,95), we also anticipated that those workers who believed to be strongly impacted by the pandemic would present a higher level of digital transformation stress.

The results of our studies generally presented Digital Transformation Stress Scales as a valid tool to evaluate the level of digital transformation stress. The results of our exploratory and confirmatory factor analyses as well as IRT approach confirmed the one-dimensional structure of DTSS and its good reliability in both studies. In line with our predictions, we observed no correlation between DTSS and self-assessed ICT skills in quite a numerous and diverse sample in Study 2, even when we limited participants to those whose organizations were undergoing a digital transformation process.

Although there was a significant difference in DTSS levels between the two groups, it was relatively small. This pattern of results can stem from several processes. Firstly, it is the way of introducing ICT solutions that may have significant impact on the level of perceived stress (18,67,95), stress resulted from digital transformation. However, in our study participants were asked only about the presence of the digital implementation and did not evaluate the quality of their own project and digital transformation management.

Secondly, according to the CoR and the JD-R theories, stress is the psychological response that arises when job demands (availability, workload and lack of control) and resources (organisational, technical support and social support) are imbalanced. Although the DTS scale includes items related to the assessment of personal resources, such as the sense of control or competence, they are of an emotional nature. Therefore, we see the need to compare the measurements of the perceived stress of digital transformation with a scale examining attitudes to digital transformation, consisting of cognitive, emotional, and behavioural dimensions. Similarly, this transactional nature of stress was unfortunately not captured precisely by the measure of ICT implementation used in our study, as we did not evaluate both

job demands and resources in ongoing digital transformation process. In a further study, we would like to address this limitation by exploring the interaction of ICT demands (e.g. ICT hassles, ICT availability, ICT workload and ICT lack of control (16,19)) with employees' resources (e.g. like self-efficacy (96,97) or ICT support (18)).

Finally, we believe that the COVID-19 pandemic, being the global factor, had forced rapid digital transformation and changes in almost all organisations. Although switching to the remote work arrangement and technical adaptations processes as well as adaptation of the IT infrastructure could not be perceived as the ongoing implementation project per se, these processes could impact employees in the same way as IT solution projects and digital changes. Consequently, all the above may increase the digital transformation stress level. Because of that, observed differences between workers in organisations with ongoing implementations and those without implementations did not differ strongly in terms of DTS. All of these processes may explain why differences in DTS between these two groups of employees were not more noticeable.

Summarizing, our studies showed that DTSS may serve as a reliable instrument in measuring employees' perceived DT stress in response to the specific process of DT in organizations.

Limitations and future research directions

The present study has several limitations which need to be discussed. Firstly, respondents, especially in the first study, were invited mainly via social media, particularly through LinkedIn, and this may seriously limit the generalizability of our findings.

Secondly, the online way of conducting the study might have reduced the number of participants who were very strongly affected by DTS. Therefore, further research on the role of different modes of survey administration are necessary to assess the influence of this factor on the level of DT stress observed at the workplace.

Thirdly, as stated above, some limitation of our research includes the measure used to identify organizations with ongoing digital transformation process. As it was based only on self-reports provided by employees, it might not precisely capture the higher level of DTS demands related to implementations. It would be very interesting to select organizations just as they start the process of digital implementation and evaluate changes in the level of digital transformation stress of their employees longitudinally. Such research design would enable us to provide more reliable information about its causal relationship between employees' demands, resources and stress.

Finally, phenomenon of DTS is conceptually larger than only emotional dimension therefore further research on digital transformation stress should be expected. We assess that deeper analysis on digital transformation stress and digital transformation attitudes should be conducted, taking into account the multidimensional construct of stress i.e., cognitive, behavioural and emotional.

Further work should also examine how strongly DT stress impacts different work outcomes such as work commitment, job satisfaction, and burnout of employees. Additionally, more research is needed to examine the variables that allow to predict the level of DTS e.g., attitudes toward digital implementation, perceived work demands. This research should also be conducted after the COVID-19 pandemic, when DT processes will be simpler to plan and properly implemented in organizations.

Theoretical and practical implications

The general aim of our studies is to propose a self-descriptive and easy-to-administer measurement tool aimed to identify highly stressed employees who would benefit from specific psychological interventions reducing DT stress. The DTSS possesses satisfactory psychometric properties but is also attractive for reasons of cost and time effectiveness, especially in automated screening systems that might be constructed using this scale. Being a rather brief scale, DTSS is more user-friendly and may have a higher response rate in comparison to more elaborated measures.

In the future, DTS scale may become a substantial part of an automated system consisting of three hierarchical elements: a) preliminary screening, based on a qualitative analysis of help-desk tickets sent by employees (68), b) evaluation of the level of DT stress based on the DTSS (72) to identify highly stressed employees, c) invitation to take part in a psychological intervention, the effectiveness of which we presented in our previous study (72). Designing and testing such systems may play a crucial role for preserving psychological well-being of the employees, especially when situation demands a rapid DT implementation at the workplace.

Moreover, in project management area (98,99), the Digital Transformation Stress Scale may be used to compare different project management methodologies, typically used in implementing digital transformations, e.g., the waterfall technique with more modern agile techniques (99–102). The waterfall, being more traditional, includes a set of techniques used for planning, estimating, and controlling activities (94,98). Using a simplification, it strictly separates implementation phases: the analysis phase, the implementation, and the testing phase. Often, final users – namely employees, are not involved in the initial stages but instead they start working with

new solutions in the testing phase, very often under time pressure (102). Agile technique is a more flexible (98,100,102,103), iterative approach in which end-users are more actively taking part in the whole process and can gradually learn about and test new solutions (13,98,100). Measurement of the perceived digital stress in key in these two project management methodologies. It allows to compare the level of digital transformation stress in different project phases and identify the phases in which the employees should be actively assisted. Therefore, using DTSS could be an efficient way to manage and improve the digital transformation process in organizations.

From the theoretical standpoint, DTSS can be used to further elaborate psychological antecedents (e.g., DT demands), and new sources of stress in various contexts e.g., at the workplace, in education, in the health-care systems - wherever the digital implementations are introduced in the hope of improving the effectiveness of the system. Research testing the associations between DTS and psychological well-being, burnout, disengagement is of great importance in understanding and evaluating the value of these costs.

Conclusions

The COVID-19 pandemic has highlighted the importance of digitalization in many areas of business, accelerating the digital transformation process. Although the digital maturity of organizations and employees is increasing overall, there are considerable consequences of DT. The negative effects of DT on employees appear due to the process of introducing changes under time pressure, without proper planning, and gradual implementation (36,104). In consequence, we observe a strong impact on employees' comfort of work and their stress related to the acceleration of digital changes in organizations (17,30,31). In our studies we present a psychometric evaluation of Digital Transformation Stress Scale designed to assess the level of

digital transformation stress at the workplace. Our results confirmed good psychometric properties of the DTSS, and this may enable researchers to address the root causes of DTS with proper guidelines and interventions. Evaluation of the DTS level may also help alleviate this type of stress by helping employees deal with DTS. As we presented in our previous studies, DTSS can be successfully applied as s screening tool to identify employees who suffer from this type of stress, and also to assess the effectiveness of the psychological intervention offered to reduce DTS (105). This may also be beneficial at the organizational level by supporting businesses which would benefit from improved efficiency, satisfaction, and well-being of their employees.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethics statement

The research protocol was approved by the Ethical Committee of the SWPS University of Social Sciences and Humanities, Warsaw, Poland, number of decisions: 47/2020, 50/2020, 3/2021, 8/2021. The study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA, 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. The questionnaire was activated only after the participants declared their informed consent to the study. Participation was voluntary, and the participants did not receive compensation for their participation in the study.

Author contributions

EMT: conceptualization of DTSS, research design and management, data collection, writing and revising the manuscript. EMT and SB: conducted statistical analyses, formal analysis, and interpretation of results. EMT and SB: investigating, writing, and reviewing the manuscript. EMT, KS: project administration. EMT, SB, KS: translation of the scale into English, EMT SB, KS, RN, MK, WK: review and editing. All authors contributed to the article and approved the submitted version.

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Tables

Table 1. Sociodemographic information on the participants in Study 1 (n=229)

Sociodemographic information about the sample (Study 1)						
Statistics	**N**	**%**	**Female (N)**	**Female (%)**	**Male (N)**	**Male (%)**
Total sample	229		136	57%	75	39%
Age						
18-25	5	2.2%	4	2.9%	1	1.3%
26-35	47	20.5%	30	22.1%	17	22.7%
36-45	84	36.7%	52	38.2%	30	40%
46-55	65	28.4%	43	31.6%	22	29.3%
56-65	10	4.4%	7	5.1%	3	4%
over 65	2	0.9%	0	0%	2	2.7%
Degree						
Middle school or lower	24	11.3%	11	8.1%	13	17.3%
University degree	189	82.5%	125	91.9%	62	82.7%
Job seniority						
up to 1 year						
1-3 years	11	5.1%	1	0,7%	1	1.3%
3-10 years	29	12.7%	9	6,6%	10	13.3%
10-15 years	36	15.7%	19	14%	16	21.3%
15-20 years	42	18.3%	27	19,9%	15	20%
20-30 years	82	35.8%	52	38,2%	27	36%
over 30 years	15	6.6%	9	6,6%	6	8%
Job position						
Independent, self-employed	3	1.3%	3	2.2%	0	0%
IT Specialist	3	1.3%	0	0	3	4%
Manager	76	33.2%	40	29%	36	48%
Operational position	32	14%	27	19.9%	4	5.3%
Specialist, analyst, accountant	32	14%	24	17.6%	7	9.3%
Teacher	16	7%	11	8.1%	5	6.7%
Other	51	22%	30	22%	20	26.7%

Table 2. Descriptive statistics and factor loadings of the Digital Transformation Stress Scale (DTSS) in Study 1 (N = 220)

	Item – English version	Item – Polish version	M	SD	Factor loadings
DTSS	General indicator (average)		2.71	0.85	-
Item 1	How often have you felt upset in connection with new ICT programs/systems?	Jak często czułeś/czułaś się wyprowadzony/a z równowagi, w związku z wdrażanym nowym oprogramowaniem/systemem?	2.90	1.03	.87
Item 2	How often have you felt irritated in connection with new ICT solutions which have affected your professional duties/tasks?	Jak często czułeś/czułaś się zdenerwowany/a w związku wdrażanymi rozwiązaniami informatycznymi (np. nowy system, oprogramowanie), które wpływają na obowiązki służbowe?	2.93	1.06	.86
Item 3	How often have you felt that you had no control over ICT changes connected with new procedures and your tasks?	Jak często miałeś/aś uczucie, że nie ma kontroli nad wprowadzanymi zmianami informatycznymi lub technologicznymi w pracy, powiązanymi z nowymi procedurami i zakresem zadań?	2.84	1.04	.84
Item 4	How often have you felt annoyed because of new work tasks/rules in connection with system/program changes whose implementation you had no influence on?	Jak często denerwowałeś/aś się z powodu nowych zadań/zasad w pracy, w związku ze zmianą systemu/programu, na których wdrożenie nie miałeś/aś żadnego wpływu?	2.90	1.00	.83
Item 5	How often have you felt that what was expected of you due to technological or IT changes was too much for you, to the point where you couldn't cope with it?	Jak często miałeś/aś uczucie, że postawione przed Tobą wymagania, w związku ze zmianami technologicznymi lub informatycznymi, przerastają Cię i że sobie z nimi nie radzisz?	2.35	1.01	.82
Item 6	How often have you felt that your competences and skills were insufficient to be proficient in new IT tools implemented at your workplace?	Jak często miałeś/aś uczucie, że Twoje kompetencje lub umiejętności są niewystarczające do obsługi nowych narzędzi IT, wdrożonych w organizacji, w której pracujesz?	2.34	1.05	.74

Note: DTSS = Digital Transformation Stress Scale

1280 **Table 3. Sociodemographic information on the participants in Study 2 (N=558)**

	N	**%**	**Female (N)**	**Female (%)**	**Male (N)**	**Male (%)**
Sample size	558	-	245	43.9%	313 (56.1%)	56.1%
Age (in years)	*M* = 43.44 (*SD* = 10.71)		*M* = 41.52 (*SD* =10.99)		*M* = 43.17 (*SD* = 10.45)	
Seniority (in years)	*M* = 18.90 (*SD* = 10.60)		*M* = 17.55 (*SD* = 10.43)		*M* = 19.95 (*SD* = 10.60)	
Remote Work N(%)	335	60%	153	62.4%	182	58.1%
Education (N (%)):						
Primary	3	0.5%	1	0.4%	2	0.6%
Vocational	33	5.9%	8	3.3%	25	8.0%
Secondary	204	36.6%	90	36.7%	114	36.4%
Studying	13	2.3%	7	2.9%	6	1.9%
University degree	305	54.7%	139	56.7%	166	53.0%
Job position (N (%))						
Independent, self-employed	23	4.1%	15	6%	8	3%
ICT specialist	18	3.2%	4	2%	20	8%
Manager	75	13.4%	27	11%	48	20%
Operational position	156	28.0%	102	42%	133	54%
Specialist, analyst, accountant	104	18.6%	55	22%	46	19%
Teacher	33	6.0%	16	7%	15	6%
Others	143	26%	26	11%	43	18%
Self-Assessment ICT Skills M (SD)	*M = 3.44 (SD = 0.88)*		*M* =3.35 (*SD*=.90)		*M*= 3.52 (*SD*=.86)	

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Table 4. Descriptive statistics and factor loadings in the Confirmatory Factor Analysis of the Digital Transformation Stress Scale (DTSS) in Study 2 (N = 558)

	Item	M	SD	Factor loadings	SE	95% CI
DTSS	General indicator (average)	2.71	0.95	-	-	
Item 1	How often have you felt upset in connection with new ICT programs/systems?	2.86	0.93	.77*	.03	[.72, .83]
Item 2	How often have you felt irritated in connection with new ICT solutions which have affected your professional duties/tasks?	2.96	0.97	.77*	.03	[.72, .83]
Item 3	How often have you felt that you had no control over ICT changes connected with new procedures and your tasks?	2.83	0.96	.83*	.02	[.79, .88]
Item 4	How often have you felt annoyed because of new work tasks/rules in connection with system/program changes whose implementation you had no influence on?	2.86	0.91	.82*	.03	[.78, .87]
Item 5	How often have you felt that what was expected of you due to technological or IT changes was too much for you, to the point where you couldn't cope with it?	2.37	0.96	.72*	.03	[.66, .77]
Item 6	How often have you felt that your competences and skills were insufficient to be proficient in new IT tools implemented at your workplace?	2.32	1.10	.65*	.03	[.59, .72]

Note: DTSS = Digital Transformation Stress Scale, SE = Standard Error, CI = Confidence Intervals
*$p < .001$

Table 5. Item loadings, thresholds, discrimination, and difficulty parameters for all items of the Digital Transformation Stress Scale (DTSS) in Study 2 (N=558).

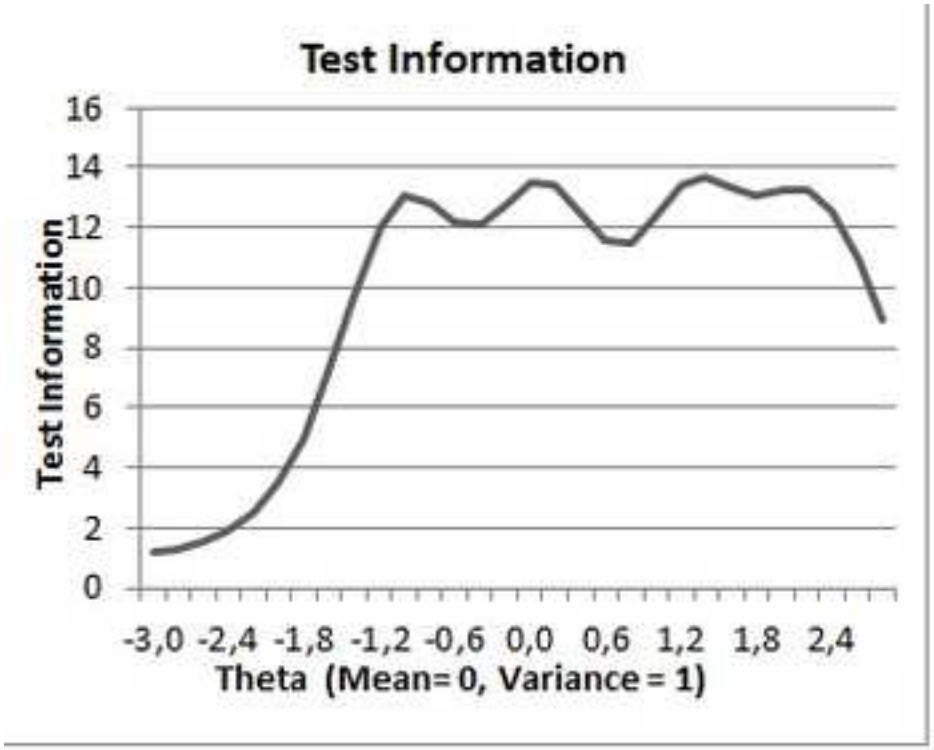
	IRT Parameters									
	Discrimination (a)		Difficulty (b_1)		Difficulty (b_2)		Difficulty (b_3)		Difficulty (b_4)	
Item:	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
item 1	2.679	0.201	-1.052	0.083	0.089	0.062	1.381	0.091	2.595	0.205
item 2	2.640	0.193	-1.098	0.085	0.070	0.062	1.223	0.083	2.108	0.140
item 3	3.236	0.253	-1.114	0.080	-0.014	0.059	1.290	0.082	2.309	0.163
item 4	3.340	0.262	-1.008	0.077	0.148	0.058	1.231	0.079	2.138	0.141
item 5	2.681	0.209	-0.739	0.074	0.322	0.062	1.579	0.102	2.536	0.196
item 6	2.237	0.175	-0.826	0.082	0.375	0.067	1.649	0.114	2.837	0.242
	IFA Parameters									
	Loading		Threshold (y > 1)		Threshold (y > 2)		Threshold (y > 3)		Threshold (y > 4)	
Item:	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
item 1	2.679	0.201	-2.820	0.229	0.239	0.166	3.701	0.257	6.952	0.519
item 2	2.640	0.193	-2.899	0.229	0.185	0.164	3.229	0.233	5.565	0.357
item 3	3.236	0.253	-3.604	0.296	-0.045	0.191	4.175	0.311	7.472	0.549
item 4	3.340	0.262	-3.366	0.290	0.494	0.197	4.112	0.311	7.141	0.511
item 5	2.681	0.209	-1.980	0.198	0.862	0.172	4.232	0.289	6.800	0.508
item 6	2.237	0.175	-1.847	0.175	0.838	0.152	3.688	0.243	6.347	0.489

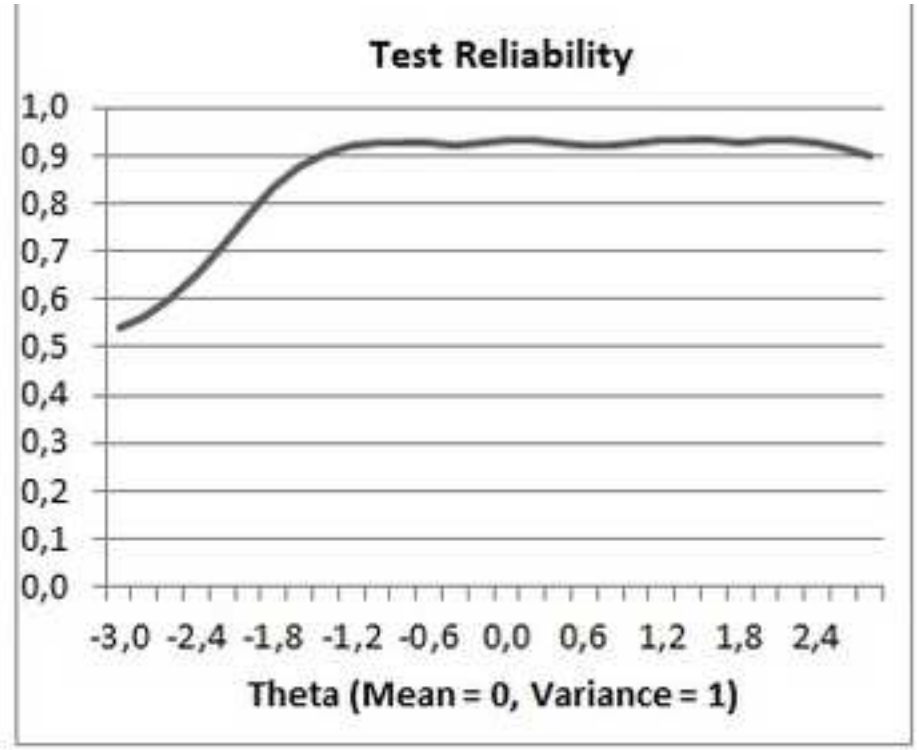
Table 6. Correlations among general stress, digital transformation stress and ICT skills in groups of employees working in organizations with and without ongoing digital solution implementation in Study 2 (N=558).

Group		**Pearson's *r* coefficients (N = 558)**	**1.**	**2.**
Ongoing implementation = *Yes*	1.	Digital Transformation Stress (DTSS)	-	
	2.	General Stress (PSS-4)	.43**	-
	3.	Self-assessment ICT skills	-.16*	-.17**
Ongoing implementation = *No*	1.	Digital Transformation Stress (DTSS)	-	
	2.	General Stress (PSS-4)	.48**	-
	3.	Self-assessment ICT skills	.03	-.15*

Note: ** $p < 0.01$, * $p < 0.05$. ICT = information and communication technologies

Figure





Figure

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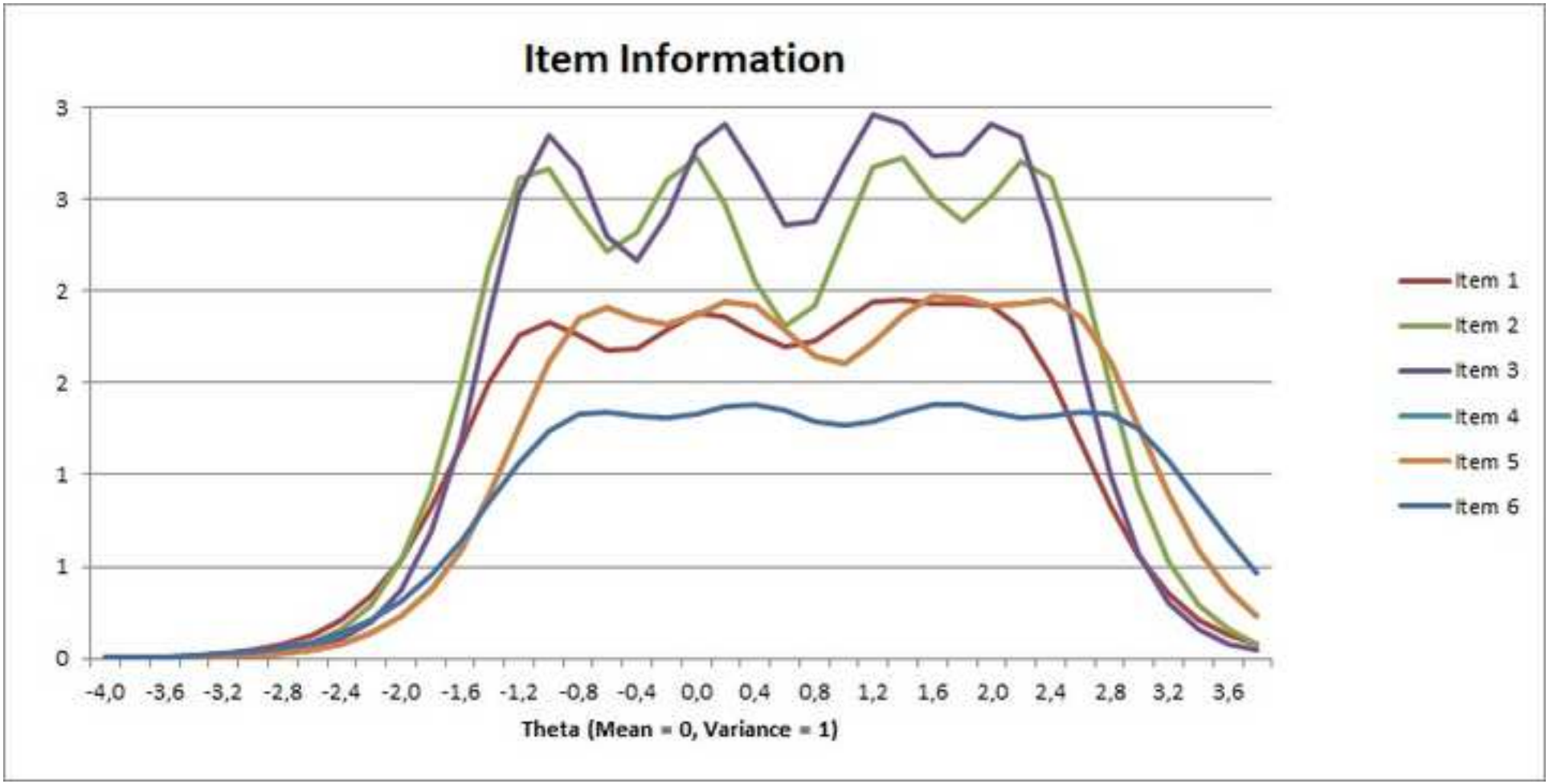

Figure

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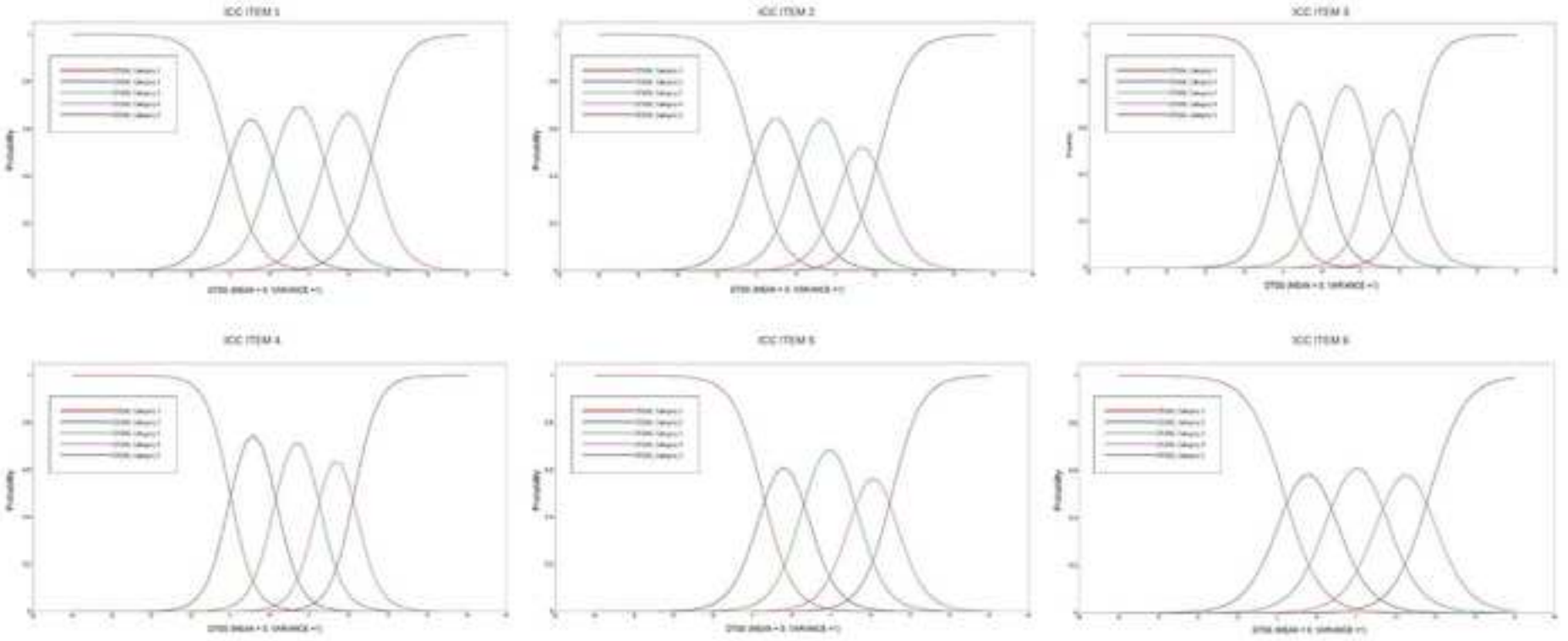

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Negative consequences of ICT job demands in the workplace: digital transformation stress and burnout

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outcomes (work satisfaction and intention to work in women and older employees). She is an author and co-author of books, papers and chapters on the role of negative stereotypes in education and at work.

Authors' contributions

Author1: conceptualization of DTS, research design and management, data collection, writing and revising the manuscript. Both authors: conducted statistical analyses, formal analysis, and interpretation of results. Investigating, writing, and reviewing the manuscript. Both authors contributed to the article and approved the submitted version.

Availability statement

The data that support the findings of this study are openly available in Open Science Foundation (OSF) at DOI 10.17605/OSF.IO/WU8RX.

Negative consequences of ICT job demands in the workplace: Digital Transformation Stress and burnout

The importance of Information and Communication Technologies (ICT) solutions is growing because of the acceleration in the global digital transformation (DT) process. Despite the unquestionable advantages of digital transformation for organizations, the increase of job demands related to ICT could be a source of employees 'stress, named digital transformation stress (DTS), which may result in burnout. Based on the Job Demands – Resource model, we assumed that burnout may be a response to the increasing and prolonged DT stress, caused by increasing ICT job demands. Therefore, we present two studies where we investigated those relations. In the first study, we examined the relationships among ICT job demands and DTS (study 1, N=165) to select ICT demands, which might be the main predictors of DTS. In the second study (N=568), we examined the relationship among ICT job demands, employees' self-efficacy, DTS and burnout, focusing on the indirect effects from ICT Demands through self-efficacy to DTS and burnout. Generally, our findings showed that ICT job demands are related to the decrease in employees' self-efficacy and predicted the increase in DTS, and burnout. Further research should explore these mechanisms longitudinally to propose interventions that strengthen employees' elf-efficacy as a protective resource.

Keywords: digital transformation stress; ICT Demands, burnout, self-efficacy

Introduction

Digital transformation (DT) is one of the most important processes of human life nowadays (Kling et al., 2000), in both areas: professional (Hanelt et al., 2021; Nambisan et al., 2019; Schwarzmüller et al., 2018) and private (Hanelt et al., 2021; Iivari et al., 2020; Solberg et al., 2020). Could we imagine living and working during pandemic times, like these of COVID - 19, without digital transformation benefits? Imagine ourselves in 2000, or even in 2010, when we should start to work from home, totally remotely, be in connection with others and be effective. Can we imagine how we could switch to remote work and meetings without the wide range of information and communication technology (ICT) solutions accessible today?

All these unquestionable advantages lift productivity and growth in organizations (Hanelt et al., 2021; Nambisan et al., 2019). However, the digital maturity in some organizations was not enough for the fast introduction of digital changes (Nosalska & Gracel, 2019; Ochoa-Urrego & Peña-Reyes, 2021; Teichert, 2019). Organizations, regardless of their type and size, need to be prepared and ready to align or even replace their current business processes with new ones (Andreeva & Yolova, 2019; Horváth & Szabó, 2019; Kraus et al., 2022; Lewis, 2011) that they might not necessarily be comfortable with.

Generally, employees understand that ICT solutions and digitization are very important for organizations' competitiveness and effectiveness (Nambisan et al., 2019; Solberg et al., 2020; Teichert, 2019). Thus, employees' general attitudes towards digital transformation in their workplace are initially very positive (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022; Meske & Junglas, 2020). However, the sharply increasing digital transformation (DT) job demands (Hu et al., 2021, 2021) placed on employees may change these preliminary viewpoints (Schlachter et al., 2018), even in those employees who are highly competent at ICT (Makowska-Tłomak et al., 2022).

Digital transformation stress

Digital transformation increases the role of ICT solutions and leads to a change in strategies and business models for many organizations (Arifiani et al., 2021; Schwertner, 2017). Implementations of ICT solutions may create a more flexible, reactive and agile organization to respond to the new and constantly evolving challenges (Harteis et al., 2020; Medzo-M'engone, 2021). However, DT is not only changing organizations (Hanelt et al., 2021; Lewis, 2011; Schwarzmüller et al., 2018) but it is also modifying the landscape of work (Brussevich et al., 2018; Meyer et al., 2021) and job demands (Day et al., 2017; Hu et al., 2021). Implementation of the digital systems frequently requires new competencies from employees (Horváth & Szabó, 2019), as well as readiness for IT changes and corresponding

effort (Day et al., 2017; Harteis et al., 2020). Therefore, DT projects and processes may negatively affect the well-being of employees in the workplace (Atanasoff & Venable, 2017; Medzo-M'engone, 2021; Zeike et al., 2019). Moreover, when digital maturity of an organization (Ochoa-Urrego & Peña-Reyes, 2021; Teichert, 2019) is low, digital transformation may additionally increase uncertainty about the professional future of the organization and its employees (Fischer et al., 2021; Hanelt et al., 2021) .

Therefore, despite all these indisputable benefits of digital transformation, the own process of digital transformation may be a source of employees' stress as a response to DT process as well as digital, social and organizational changes in the workplace (Fischer et al., 2021; Harteis et al., 2020; Lewis, 2011; Makowska-Tlomak et al., 2021). This stress we named as digital transformation stress (DTS) (Makowska-Tłomak et al., 2022). We assumed that the source of DTS is not the lack of ICT skills of employees, but rather an improper way of implementing the digital solutions or changes in workplaces that rapidly increase job demands (especially ICT job demands).

ICT job demands

According to Karasek (1998), job demands are "psychological stressors involved in accomplishing the workload" (Dawson et al., 2016). However, some challenging demands are needed as motivators, because otherwise work engagement may be thwarted and job performance undermined (Bakker & Demerouti, 2014). The Job Demands-Resources (JD-R) model (Bakker & Demerouti, 2007; Demerouti et al., 2001) indicates and explains significant aspects of the working environment and employees' characteristics that may have positive and negative effects on work outcomes and employees' health (Bakker & Demerouti, 2014; Dawson et al., 2016; Ninaus et al., 2015). The premise of the model is that, regardless of the type of occupation, these critical determinants of work outcomes can be divided into job demands and job resources (Bakker & Demerouti, 2007, 2014). A number of studies have

supported the dual pathways to employees' well-being proposed by the JD-R theory (Bakker & Demerouti, 2014), and have shown that they can also predict important organizational outcomes (Bakker & Demerouti, 2014; Dawson et al., 2016; Day et al., 2012; Ninaus et al., 2015). Therefore, the JD-R model is often used to predict the relationship between working conditions, employees' characteristics, burnout, and other ratings of performance (Adler & Koch, 2017; Carlson et al., 2017; Demerouti, Nachreiner, et al., 2001).

The most common aspects of the DT process are: high pressure evoked by rapid changes in tasks demanding high availability (Hu et al., 2021; Mullan & Wajcman, 2019; Zeike et al., 2019), work overload (Bondanini et al., 2020; Salanova et al., 2013; Schwarzmüller et al., 2018), ICT hassles such as technical IT problems (Day et al., 2012, 2017; Hu et al., 2021), lack of control (Baillien et al., 2011; Day et al., 2017; Stich et al., 2018), and challenges in adapting communication to many employees (Hu et al., 2021; Reinecke et al., 2017). During the digital transformation process, the main job demands became the ICT job demands (Day et al., 2012; Stich et al., 2015). ICT workload (Day et al., 2012) is related to overload as a result of e.g., time pressure (Bondanini et al., 2020; Van Laethem et al., 2019) or exigency of reconciling current tasks with new ones in ICT implementation. Other ICT job demands are related to computer issues (hassles) (Day et al., 2019), emotional demands (lack of control, poor communication), and changes in tasks (e.g., availability, response expectation) as well as the necessity of continuous learning and developing ICT competencies (Day et al., 2012) . All these job demands were documented to be predictors of general stress level at the workplace and health problems reported by the employees (Bakker & Demerouti, 2014; Bondanini et al., 2020; Day et al., 2012; Ninaus et al., 2015; Salanova et al., 2013; Van Laethem et al., 2019). It was also showed that the increase in ICT demands (Day et al., 2012; König et al., 2020) is related to the increase in

stress experienced in the workplace during the digital transformation (Makowska-Tlomak et al., 2021; Schwarzmüller et al., 2018).

Consequently, the digital transformation stress may be the employees' response to redefinition of the work scope and responsibilities, a growing number of requirements, new tasks, required new competences and work mode, as well as changes in human team management and time pressure in digital technology implementation (Makowska-Tłomak et al., 2021; Makowska-Tłomak et al., 2022).

Regarding the JD-R model in context of DTS, we selected five ICT Demands from ICT Demands scales (Day et al., 2012), such as ICT availability, ICT hassles, ICT lack of control, ICT poor communication and ICT workload. Based on previous research, these selected ICT demands are predictors of distress (Day et al., 2017; Hu et al., 2021; Makowska-Tlomak et al., 2021; Ninaus et al., 2015; Stadin et al., 2019).

Some of ICT job demands, potentially related to DTS and burnout, are social demands (Day et al., 2019), namely ICT availability, poor communication and response expectations (Day et al., 2012). The ICT availability demand, during the network and remote time, refers to the extent to which an employee is expected to be available and respond to work-related emails and chats (Day et al., 2012; Hu et al., 2021) during and after working hours (Becker et al., 2021; Hu et al., 2021). That is, the mere expectation of constant availability means that one's cognitive resources are always in the "on" mode during nonwork hours (Becker et al., 2021). In effect, on one hand, digital transformation provides considerable resources, like workplace flexibility, but on the other hand, many organizations, by ICT solutions (e.g., mobile applications), create pressure on individuals to be constantly accessible and responsive. In consequence, it may blur boundaries between work and personal life, and then lead to burnout (Day et al., 2019; Hu et al., 2021; Ninaus et al., 2021).

Next ICT job demand, important in the context of DTS, is miscommunication, named ICT poor communication (Day et al., 2012). Because of increased frequency of email and multi-ICT channels of exchanging information among employees, the traditional communication (i.e., face-to-face or by phone) is replaced by its remote equivalent (Felstead & Henseke, 2017; Wang et al., 2021). However, the ICT poor communication has the greatest margin of errors resulting from limited verbal and nonverbal cues that assist the receiver in inferring tone and intonation of the message (Day et al., 2012). The increasing amount of communication by emails and chats leads to information overload (Bawden & Robinson, 2020). Such information overload was observed very often, especially in COVID-19 pandemic, during digital transformation process (Bawden & Robinson, 2020; Day et al., 2019).

ICT hassles (Day et al., 2012, 2019) demand is related to technological malfunctions, software incompatibility, issues of security, problems with internet connection or file losses (Day et al., 2012, 2019; Hu et al., 2021). With the digital transformation process, rapid development, implementation of new ICT solutions, and working remotely, ICT hassles affect employees daily (Day et al., 2012; Makowska-Tlomak et al., 2021). In consequence, employees' attentional and energy resources are directed from work-related tasks to resolving the technical issues, resulting in digital transformation stress and exhaustion (Day et al., 2012; Hu et al., 2021; Leonardi et al., 2010; Makowska-Tlomak et al., 2021).

ICT lack of control (Day et al., 2012) belongs to cognitive ICT demands (Day et al., 2019) and is defined as employees' control over ICT solutions and their level of ability to perceive technology as helpful in improving work efficiency and flexibility (Day et al., 2012, 2019). When employees have a sense of control over the digital transformation process (e.g., ICT solutions implementation project), they tend to experience less stress in comparison to employees who lack control over the process (Day et al., 2012, 2019). Therefore, this type of

ICT demand is related to self-efficacy (Bandura, 1989; Day et al., 2017), which refers to individuals' confidence in their capability to exercise control over challenging demands (Shoji et al., 2016) and that may protect employees from negative outcomes of stress (Day et al., 2012, 2019), here: DTS.

Another ICT job demand is ICT learn (Day et al., 2012) , which is directly connected to the overload from necessity to learn new technologies, systems or processes (Day et al., 2019) . The expectation of continuous improvement of ICT competences (Day et al., 2019) may cause uncertainty about individual ICT skills and thus lead to stress (Day et al., 2012, 2019) .

Lastly, ICT workload (Day et al., 2012), which is a response to the overload, generated by necessity of combining everyday work tasks and duties with tasks resulting from DT, like testing new systems or using ICT implemented solutions. All of the above is often preceded under time pressure (Bondanini et al., 2020; Day et al., 2012, 2019; Fischer et al., 2021; Parent-Rocheleau & Parker, 2022; Zeike et al., 2019). Employees who frequently use ICT are more likely to report feeling overworked (Day et al., 2012; Stich et al., 2018; Van Laethem et al., 2019) and thus the increased workload emerged as a major stressor of work-related DT process (Ninaus et al., 2015; Parent-Rocheleau & Parker, 2022; Van Laethem et al., 2019).

Therefore, the ICT job demands are potential stressors during the digital transformation at the workplace, thus they may lead to a higher level of DTS and by decreasing self-efficacy of the employees, provide to exhaustion (Day et al., 2019; Seidler et al., 2014) and disengagement (Basinska & Gruszczynska, 2020). This potential indirect effect is going to be tested in our model.

Digital transformation stress and burnout

It has been well established in the literature that stressors in the workplace may lead to negative outcomes such as distress (Dawson et al., 2016; Fischer et al., 2021) and burnout

(Day et al., 2017; Demerouti & Bakker, 2008a; Maslach & Leiter, 2008). Burnout is defined as physical, emotional, and mental exhaustion that is perceived by an employee in relation to work (Demerouti & Bakker, 2008a; Ninaus et al., 2015). It is a negative reaction to prolonged work situations (Demerouti & Bakker, 2008a; Ninaus et al., 2021), and to workplace stress that has not been managed (Basinska & Gruszczynska, 2020), resulting in reduced professional efficacy. Here, we focused on two core dimensions of burnout i.e., exhaustion and disengagement from work (Baka & Basińska, 2016; Demerouti & Bakker, 2008a).

Exhaustion is defined as distance from work, expressed by loss of enthusiasm (Basinska & Gruszczynska, 2020). The second component of burnout is disengagement (Demerouti & Bakker, 2008a). Disengagement refers to distancing oneself from one's work in general, work object, and work content – perceiving work as uninteresting, no longer challenging, but also, in extreme cases, it may even lead to "disgust" towards work (Demerouti et al., 2010; Demerouti & Bakker, 2008a). Disengaged employees, in context of digital transformation, endorse negative attitudes towards ICT job demands but also ICT innovations (De Spiegelaere et al., 2015; Nambisan et al., 2019), the possibility of self-development as well as general work content and overall work engagement (Demerouti & Bakker, 2008a). As some research revealed, prolonged and repeated experiences of stress (here, DTS) and demanding working conditions (here, ICT job demands) may lead to exhaustion (Ninaus et al., 2021) – a component of burnout (Demerouti et al., 2010; Demerouti & Bakker, 2008a). Therefore, we predicted that Digital Transformation Stress at the workplace may be significantly associated with burnout experienced by employees.

Occupational self-efficacy of employees

The Job Demands-Resource model (JD-R) (Bakker., 2007) not only describes the negative consequences of job demands but also posits that job resources may buffer the negative effects of demands and can be positively related to health and work outcomes (Bakker &

Demerouti, 2014; Dawson et al., 2016; Ninaus et al., 2015). One of the well-documented resources is occupational self-efficacy (Bandura, 1989; Lloyd et al., 2017; Rigotti et al., 2008). According to the social cognitive theory (Bandura, 1989), perceived self-efficacy is defined as individuals' beliefs in their capability to exercise control over challenging demands. More specifically, the employees' self-efficacy is defined as the individual self-confidence or ability to cope with difficult tasks or problems (Bandura, 1986; Rigotti et al., 2008). In the digital transformation context, self-efficacy represents the confidence that one can employ the skills necessary to deal with DT job-specific tasks and cope with challenges caused by digital transformation and related to ICT job demands (Hu et al., 2021; Shoji et al., 2016).

Previous research on stress at the workplace showed that self-efficacy may operate as a resource preventing negative consequences of strain (Blecharz et al., 2014; Cieslak et al., 2016; Shoji et al., 2016; Smoktunowicz et al., 2019). Therefore, employees' self-efficacy may prompt recovery (Shoji et al., 2016) from digital transformation stress. Additionally, perceived self-efficacy facilitates employees' adaptation to digital transformation challenges as well as changes in the organization.

Because of the unquestionable qualities of occupational self-efficacy as an employee's resource, we decided to examine the associations among self-efficacy, ICT Demands, digital transformation stress level and burnout. According to the recent meta-analysis of research on the relation between burnout and self-efficacy, significant links between self-efficacy and burnout are observed across different countries and in different professions (Shoji et al., 2016). Therefore, based on Job Demand - Resources Model (Bakker, 2007), in our study we examined if there is an indirect effect linking ICT Demands, DTS and burnout through self-efficacy.

Aims of the studies

The main aims of our research are to examine the association of ICT demands in digital transformation with two outcome variables: digital transformation stress and burnout. In the first study, according to our assumption, based on literature review, we aimed at identifying the strongest predictors of DTS. In the second study, we used these ICT demands as predictors in a more complex model, with the aim to examine the ICT demands with the highest relationship with DTS and if they might be predictors of DTS. Then, selected ICT Demands which proved to be predictors, would be examined in the aspect of the relationship between ICT demands and occupational self-efficacy and how this relationship is associated with DTS and burnout. We assumed that the appropriate ICT job demands management as well as strengthening self-efficacy could be important for minimalizing the employees' digital transformation stress and benefit employees who suffer from DTS and consequently from burnout (exhaustion and disengagement), (see Figure 1).

==========INSERT FIGURE 1 HERE==========

Implementing the JD-R model (Bakker & Demerouti, 2007; Demerouti, Nachreiner, et al., 2001) to the context of digital transformation in our study, we identified five ICT Demands as job demands and occupational self-efficacy as the main resource. We predicted significant relations among ICT demands and self-efficacy, DTS, burnout. We predicted a high and positive correlation between ICT demands and DTS, and a negative relation between ICT demands and the self-efficacy which should be, in turn, negatively associated to DTS and positively to burnout. Self-efficacy should be involved in the indirect effects between ICT Demands and DTS, as well as between ICT Demands and two components of burnout: disengagement and exhaustion.

Study 1

The main objective of the first study was to identify which ICT demands are related to the stress of digital transformation. Regarding the literature and previous research in the job demands area (Bondanini et al., 2020; Day et al., 2012, 2017, 2019; Hu et al., 2021; Stadin et al., 2019; Stich et al., 2018) , the ICT demands construct belongs to one of the five ICT categories related to employees' well-being and health (Hu et al., 2021). Therefore, in this research we investigate which of ICT demands might be responsible for digital transformation stress growth and, consequently, negatively affect employees' well-being (Day et al., 2012; Hu et al., 2021; Ninaus et al., 2015). The ICT Demands scales are one of the most the complex constructs, because it includes social, behavioural and emotional stressors (Day et al., 2012, 2019; Hu et al., 2021). Our aims were to identify the most important ICT demands stressors and investigate if the ICT Demands (Day et al., 2012) construct which had been developed ten years ago has been corresponding to our assumptions in context to digital transformation stress. Therefore, according to Job Demands-Resources model assumptions, we translated the ICT Demands scales (Day et al., 2012) for examining the relationship using the digital transformation stress scale.

Participants and procedure

The participants constituted a convenient sample of 162 adults (95 women, 35 men, 30 of participants did not indicate their gender). All participants were professionally active, working in a random sample of diverse occupations (e.g., accountants, business analysts, financial analysts, teachers, IT specialists, managers). The vast majority of participants had higher education and a full-time job. The largest group of participants was between 36 and 45 years old, see Table 1. More than 50% of the participants declared their work experience was over 10 years. The majority of participants used ICT in their daily work. The study was conducted after the end of national lockdown, from the middle of June 2020 to the end of

September 2020, and over 50% of participants indicated that their work was mainly remote due to the COVID pandemic. We collected data mostly in social media, mainly by Linked-in as a publication on the authors profiles and by Facebook as a post. We also recruited participants through a snowball technique through contacts in various organizations from educational and business sectors. We asked if these individuals agreed to complete the questionnaire and, if possible, to distribute the information to their colleague and coworkers. Because the study was aimed at employees who use ICT solutions at daily work, we asked a few companies' Human Resource (HR) managers to send employees an email invitation to the research with a link to the survey.

==========INSERT TABLE 1 HERE==========

All data was collected in online mode only, by the link to a survey on the Qualtrics platform, under the license of the university. The research protocol was approved by the Ethical Committee of the University. The present study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the questionnaire was activated. Participation was voluntary, and participants did not receive compensation for their participation in the study.

Measures

The ICT Demands Scales (Day et al., 2012) consist of 27 items representing eight formative subscales, i.e., response expectations (2 items), availability expectations (4 items), ICT hassles (5 items), ICT workload (3 items), lack of control over ICT (3 items), continuous learning expectations (3 items), ICT poor communication (3 items), and a 4-item subscale of ICT-monitoring of employees. In the adapted ICT Demands Scales, we have used a five-point scale where 1 has meant *Never* and 5 has meant *Almost Always*. Participants indicated

the frequency to which they experienced each ICT demand. An example question related to common ICT hassles when employees were dealing with ICT and remote work: "I experience problems with my internet connection (e.g., speed, access, downloads)". The average Cronbach's Alpha of whole ICT Demands scales, $\alpha = .82$

The Digital Transformation Stress Scale (DTSS) is a self-report scale consisting of six items (Makowska-Tłomak et al., 2022). The participants were asked to indicate on a five-point scale (1 = *Never*; 5 = *Very often*) the frequency of perceived stressful situations, concerning DT and/or the ICT implementation which they experienced during the last four weeks in the workplace. The general indicator was prepared by averaging the answers of the participants. The Cronbach's Alpha, $\alpha = .91$.

Socio-demographic information. Participants were asked to indicate the appropriate age range, seniority range, gender, education level, occupation, position in their current job.

Results and Discussion

Inspection of descriptive statistics, presented in Table 2, indicated that the level of DTS is rather high or moderate. Some ICT Demands scales (Day et al., 2012) scores are higher than the DTSS score. We observed the highest and significant correlations between DTSS and ICT Workload. The correlation between DTSS and ICT Hassles was high and significant as well. In two cases, there are no correlations, i.e., between DTSS and ICT Learn and similarly between DTSS and ICT Response Expectation. Descriptive statistics with correlations are included in Table 2.

==========INSERT TABLE 2 HERE==========

Subsequently, we conducted a series of linear regressions to identify which of ICT Demands may be the DTS predictors. The ICT Workload has emerged as the strongest predictor, with ICT Hassles. Next three ICT Demands, i.e., ICT Availability, Lack of control and Poor communication have proved to be DTS predictors as well. (See Table 3).

==========INSERT TABLE 3 HERE==========

Discussion

The main aim of the first study was to select the ICT demands which have the highest relationship with digital transformation stress measured by DTSS. Based on the results of Study 1 as well as our analysis, we decided to select the following ICT demands (Day et al., 2012) to the further study: ICT Workload, ICT Hassles, ICT Poor communication, ICT Availability and ICT Lack of control.

Study 2

The main aim of the second study is to verify the model based on JD-R (Bakker & Demerouti, 2007; Demerouti et al., 2001) in context of digital transformation. Thus, we examined the association of previously selected ICT job demands with two outcome variables: digital transformation stress (Makowska-Tlomak et al., 2021) and burnout (Demerouti, Bakker, et al., 2001; Demerouti & Bakker, 2008a). According to our assumption and the model presented in Figure 1, we aimed to verify the hypothesis that there are significant relationships among the appropriate ICT job demands, occupational self-efficacy (Rigotti et al., 2008), employees' digital transformation stress (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022) and as well burnout (exhaustion and disengagement) (Demerouti & Bakker, 2008a).

Participants and procedure

The participants of the study constituted a sample of 558 adults: 245 female and 313 male. All participants, except one, were professionally active; most participants have experienced working remotely (N = 335, 60%) and 223 participants did not work remotely at all (40%). 231 participants (41%) admitted that in their organization there were ongoing digital

solutions projects. In the opinion of 197 (35%) participants, there was no ongoing digital solutions project in their workplace and 106 (19%) participants did not know if there were any ongoing digital solutions projects. The professional structure of participants comprised of a range of diverse occupations like accountants, business analysts, financial analysts, teachers, IT specialists, and managers, but also engineers, receptionists etc. The majority of the participants had a master's degree or above: 305 (54%), whereas 204 (37%) had a bachelor's degree. Only 36 (6%) participants had the education equal or lower than middle school and held a full-time job. The average age in the sample group was 43.6. The youngest participants were 20 years old and the oldest and professionally active were 69 years old. Most participants were between 40 and 49 years old (183, i.e., 33%), and between 30 and 39 years old (167, i.e., 30%). We grouped the professional occupations declared by the participants into seven job position categories. A more detailed description of the sample is presented in Table 4.

==========INSERT TABLE 4 HERE==========

The participants were recruited to the study by a professional research agency. All data was collected in online mode only. The present study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the survey was activated. Participation was voluntary, and employees did not receive compensation for their participation in the study.

Measures

ICT Demands: The selected five subscales from ICT Demands Scales (Day et al., 2012). For the study, we decided to use three items of five distinguished ICT Demands: ICT Availability (3 items; e .g ., "Technology enables the people I work with to contact me at any time"); ICT

Hassles (3 items, e.g., I experience problems with my internet connection); ICT Lack of control (3 items; e .g ., "Technology allows me the flexibility to do my job when and where I want"); ICT Poor Communication (3 items, e.g. "People misinterpret my e-mail messages") and ICT Workload (3 items; e. g., "Technology creates more work for me"). Reliabilities of ICT Demands selected to the study were: ICT Availability Cronbach's Alpha, α = .74, ICT Hassles Cronbach's Alpha, α =. 80, ICT Lack of Control Cronbach's Alpha, α = .73, ICT Poor Communication Cronbach's Alpha, α = .85 and ICT Workload Cronbach's Alpha, α = .85

Short Occupational Self-Efficacy Scale (Rigotti et al., 2008), translated into Polish, consists of 6 statements measuring self-efficacy related to work with a five-level response scale ranging from 1 (*Disagree)* to 5 (*Agree)*. An exemplary item is "I feel prepared for most of the demands in my job". The reliability of the scale was high with Cronbach's Alpha, α =.89

The Digital Transformation Stress Scale (DTSS) (Makowska-Tłomak et al., 2022), the same scale which we used in Study 1. The Cronbach's Alpha, α = .90.

Oldenburg Burnout Inventory (OLBI, Demerouti & Bakker, 2008). The Polish version of OLBI (Baka & Bazińska, 2016) measures two dimensions of burnout: exhaustion and disengagement. The original construct of OLBI includes, in both subscales, four items that are positively worded and four items that are negatively worded. We used 6 items, 3 from each dimension. We used two negatively worded items in the exhaustion component and one in the disengagement dimension. An example of the item from the exhaustion component is "After work, I tend to need more time than in the past in order to relax and feel better", and the example of the item from the disengagement component is "It happens more and more often that I talk about my work in a negative way" (both negatively worded). Participants indicated their answers on a 4-point Likert-like scale where 1 meant *Strongly disagree*, and 4

meant *Strongly agree*. Reliabilities of the OLBI components were for OLBI Disengagement Cronbach's Alpha α = .67, and for OLBI Exhaustion Cronbach's Alpha α = .65.

Socio-demographic information. Participants were asked to indicate their age range, seniority range, gender, education level, occupation, and position in their current job.

Data preparation and analytical approach

All analyses were conducted using Mplus 8.2 (Muthén & Muthén, 2015). We used structural equation modelling and the Maximum Likelihood Robust (MLR) approach implemented in Mplus to model the relations between continuous non-normally distributed variables and three indirect effects linking different aspects of ICT demand and two dependent variables: burnout-disengagement and burnout-exhaustion. The proposed indirect paths from ICT demands to burnout were through: 1.) occupational self-efficacy 2.) digital transformation stress. We used a 95% confidence intervals (C.I.) method to determine the significance of these indirect effects. This approach is considered less conservative and lacking in power when compared to the Sobel test (MacKinnon et al., 2002). According to this approach, the indirect effect is significant if the C.I. does not include zero.

All structural models were evaluated using fit indices following Kline's (2011) recommendations: mean square error approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) and the general fit based on the χ^2 test. We used the most widely recommended cut-off values indicative of an adequate model fit to the data, respectively: RMSEA and SRMR < .06 and < .08, CFI and TLI > .95 and > .90 (Lance et al., 2006). All initial models, based on our hypothesis, were modified to eliminate insignificant paths and add some paths suggested on the basis of modification indices. All statistics are presented for the final models.

Results

Descriptive statistics

Inspection of descriptive statistics presented in Table 5 indicated that the level of DTS, burnout-exhaustion, and burnout-disengagement was rather moderate in our sample. Participants also had a slightly elevated level of occupational self-efficacy. Regarding the ICT demands indicator, we observed that the highest indicator among ICT demands was the ICT availability.

==========INSERT TABLE 5 HERE==========

In line with our predictions, there were significant and positive correlations between DTS and ICT Demands (see Table 5). We observed the highest relationship between DTS and ICT workload; a high correlation between DTS and ICT poor communication and ICT hassles was observed as well. We also examined the correlation among Occupational Self-Efficacy Scale, ICT Demands Scales, DTS, and two components of burnout. Except the ICT availability, we observed negative and significant correlations among occupational self-efficacy, ICT demands, DTS, exhaustion and disengagement. The highest and negative correlation was indicated between the Occupational Self-Efficacy Scale (OSES) and Burnout-Exhaustion. Only ICT availability did not correlate with OSES and burnout components.

Path models with ICT demands as predictors of DTS and burnout with indirect effects through self-efficacy

ICT availability

Results indicated that the model for ICT availability as a predictor of burnout with indirect effects through occupational self-efficacy and DTS achieved quite a good fit to the data (see Table 6). The model explained 24% of burnout-exhaustion, 20% of burnout-disengagement, 23% of DTS, and 2% of occupational self-efficacy.

==========INSERT TABLE 6 HERE==========

The results indicate that the majority of the relationships between the variables is consistent with the hypotheses (see Table 7).

==========INSERT TABLE 7 HERE==========

ICT availability was positively and moderately related to DTS but was not related to occupational self-efficacy. DTS was related negatively to occupational self-efficacy and participants with a higher level of self-efficacy reported lower DTS. As predicted, DTS was a significant predictor of both dimensions of burnout – the magnitude of its relation to disengagement was higher than for exhaustion. Self-efficacy was also related negatively with both burnout dimensions: more strongly with exhaustion than disengagement. The statistics of indirect effects indicated two indirect effects from the ICT availability: through DTS to both burnout-exhaustion and burnout-disengagement (see Table 8).

==========INSERT TABLE 8 HERE==========

ICT hassles

Results indicated that the model for ICT hassles as a predictor of burnout with indirect effects through occupational self-efficacy and DTS achieved a good fit to the data (see Table 7). The model explained 25% of burnout-exhaustion, 21% of burnout-disengagement, 29% of DTS and 7% of occupational self-efficacy. Path estimates are generally consistent with the hypotheses (see Table 6). The ICT hassles demand was positively and moderately related to DTS but was not related to occupational self-efficacy. DTS was related negatively to occupational self-efficacy and participants with a higher level of self-efficacy reported lower DTS. As predicted, DTS was a significant predictor of both dimensions of burnout – the magnitude of its relation to disengagement was higher than for exhaustion. Self-efficacy was also related negatively with both burnout dimensions: more strongly to exhaustion than to disengagement. The statistics of indirect effects (see Table 7) indicated significant effects

from the ICT hassles through self-efficacy to DTS through self-efficacy to burnout-exhaustion, and from an ICT hassles through self-efficacy to burnout-disengagement. There was also a significant indirect effect from ICT hassles, through occupational self-efficacy and DTS to burnout-disengagement.

ICT lack of control

The model with ICT lack of control as a predictor of burnout also obtained a good fit (see Table 6), and it explained 33% of burnout-exhaustion, 25% of burnout-disengagement, 16% of DTS and 11% of occupational self-efficacy. Consistent with the hypotheses, ICT lack of control was positively related to DTS but poorly related to occupational self-efficacy (see Table 7). DTS was related negatively to occupational self-efficacy and participants with a higher level of OSES reported lower DTS. As predicted, DTS was a significant predictor of both dimensions of burnout – the magnitude of its relation to disengagement was higher than for exhaustion. OSES was also related negatively to both burnout dimensions: more strongly to exhaustion than disengagement. The statistics revealed significant indirect effects from ICT lack of control to DTS through occupational self-efficacy to burnout-disengagement through OSES and DTS, from ICT lack of control through OSES to burnout-exhaustion, and from ICT lack of control, through OSES and DTS to burnout-exhaustion (see Table 8).

ICT poor communication

The model for ICT poor communication as a predictor of burnout with indirect effects through occupational self-efficacy and DTS achieved quite a good fit to the data (see Table 6) and it explained 24% of burnout-exhaustion, 20% of burnout-disengagement, 30% of DTS and 8% of OSES. Inspection of path coefficients displayed in Table 7 indicates that the majority of the relationships between the variables is consistent with the hypotheses. ICT poor communication was positively and moderately related to DTS and to OSES. DTS was

related negatively to occupational self-efficacy and participants with a higher level of self-efficacy reported lower DTS. As predicted, DTS was a significant predictor of both dimensions of burnout – the magnitude of its relation to disengagement was higher than for exhaustion. OSES was also related negatively with both burnout dimensions: more strongly with exhaustion than disengagement. All indirect effects were significant (see Table 8), with the more complex through OSES and DTS to burnout-exhaustion and to burnout-disengagement.

ICT workload

The model with ICT workload as a predictor achieved quite a good fit to the data, and it explained 23% of burnout-exhaustion, 22% of burnout-disengagement, 36% of DTS, and 8% of OSES. As in the previous models, the majority of the relationships between the variables is consistent with the hypotheses (see Table 7). ICT workload was positively and moderately high related to DTS and negatively related to occupational self-efficacy. DTS was associated negatively with OSES and participants with a higher level of OSES reported lower DTS. As predicted, DTS was a significant predictor of both dimensions of burnout –disengagement and exhaustion. Occupational self-efficacy was also related negatively with both burnout dimensions: more strongly with exhaustion than disengagement. All indirect effects were significant (see Table 8), with the more complex through OSES and DTS to both burnout dimensions.

Discussion

The main aims of the second study were to examine the hypothesis if five selected ICT job demands are predictors of DTS and then examine a relationship between those job demands and occupational self-efficacy (Rigotti et al., 2008) in the JD-R model (Demerouti & Bakker, 2011), adapted to digital transformation stress (Makowska-Tlomak et al., 2021) context. The

ICT job demands are predictors of DTS and the employees' self-efficacy is the main resource, mitigating DTS, in this model. All selected ICT job demands fit the model well. Two job demands, i.e., ICT workload and ICT hassles, are most closely related to increased digital transformation stress. This might be related to working under time pressure, having to combine multiple tasks, and using multiple ICT tools. Consequently, this might cause fatigue and lead to job burnout. Perhaps we should take a closer look at the components of these two ICT job demands and separate them from the ICT workload, such as e.g., the ICT time pressure demand, the ICT multitasking demand. Accordingly, it might be justified to separate from the ICT hassles, specific ICT job demands, such as the ICT tool switching ability or the ICT flexibility demand. This would allow for a more accurate grasp of the main predictors inducing an increase of stress and burnout, which in turn would make it easier to identify resources to counter these consequences.

General Discussion

The aim of our studies was to extend the prior research on digital transformation stress (Makowska-Tlomak et al., 2021) by testing the health implications of ICT demands (Day et al., 2012, 2019) and digital transformation stress at the workplace. Thus, we examined the association between ICT demands stemming from the process of digital transformation with digital transformation stress and burnout experienced by the employees. More specifically, we investigated the hypothesis that employees' self-efficacy and DTS are crucial variables linking, through indirect effect, two sets of variables: different dimensions of ICT demands as predictors and two burnout components (Demerouti & Bakker, 2008b), namely disengagement and exhaustion, as outcomes.

The results of our study strongly emphasize the relevance of addressing stress and strain stemming from ICT demands evolving from the digital transformation process in an organization. Our findings demonstrate that higher level of demands related to internet

582 communication are associated to higher digital transformation stress. We also indicated the
583 indirect effects linking ICT through self-efficacy and digital transformation stress with
584 burnout. The latter result demonstrate that the potential impairments resulting from higher
585 ICT demands at work extend to decreased levels of psychological well-being. To the best of
586 our knowledge, our study is the first to demonstrate such negative effects of ICT demands on
587 the stress experienced by the employees when digital transformation is implemented in an
588 organization. Thus, the present study extends prior research by identifying two significant
589 components of ICT demands which have the highest impact on digital transformation stress
590 and burnout, i.e., ICT workload, ICT hassles. Those implications show that in the digital
591 transformation process the ICT demands such as ICT workload and ICT hassles may be
592 burdensome for employees who need to deal non only with digital transformation challenges
593 but simultaneously with current job tasks, DT process additional tasks (workload) and ICT
594 issues (ICT hassles), which might increase as the digitalization accelerates. This in turn could
595 lead to issues regarding ICT poor communication – ICT and project information overload and
596 consequently provide to the ICT lack of control. Nowadays, the ICT availability has become
597 a common demand at work. That is why the demand of being available, as a basic result of
598 global digitalization, has become an acceptable and no-stress generator approach. Therefore,
599 people have become accustomed to being available by email, chats, and mobiles (Ninaus et
600 al., 2021). However, when it is overused (e.g., demand to be available by mails or mobile
601 during holidays), it could be a source of digital transformation stress (Makowska-Tłomak,
602 Bedyńska, Skorupska, & Paluch, 2022; Ninaus et al., 2021), but could not directly related to
603 self-efficacy. According to our model, all ICT Demands selected to the research are
604 predictors of burnout components, i.e., disengagement and exhaustion. We observed a mostly
605 indirect effect of ICT demands on burnout, stronger on disengagement. The self-efficacy has
606 a stronger impact on the exhaustion component of burnout, i.e., when self-efficacy decreases,

607 the exhaustion component of burnout increases. Regarding DTS as a predictor of burnout we
608 observed that the impact was stronger on disengagement, in all combinations with ICT
609 demands. We observed, as well, the impact of DTS on the second burnout component, i.e.,
610 exhaustion, except for the combination with ICT hassles. There are indirect effects on
611 burnout components from self-efficacy through DTS. Therefore, it seems that enhancing self-
612 efficacy could have a positive effect on reducing stress. This should be taken into account
613 when preparing a psychological intervention.

614 While our analysis shows that selected ICT job demands are predictors of DTS, it
615 seems to overlook the fact that at the same time as the digital transformation process, new
616 requirements for ICT positions are emerging, such as the need for ICT multitasking (Hefner
617 & Vorderer, 2016; Reinecke et al., 2017; Wang et al., 2020) in ICT projects or the need for
618 the ability to switch between different ICT tools, understood as a flexibility demand (Osmani
619 et al., 2019) as well as ability to work under pressure (Osmani et al., 2019; Vehko et al.,
620 2019). Arguably consideration should be given to expanding the current scale or developing a
621 new scale of job demands in the ICTs, such as the more specifically named DT job demands
622 scale, to measure the level of intensity of the burden of job demands, specific to work in the
623 digital transformation process. Similarly, in further research, it would seem important to
624 measure the impact of the different demands of work in the ICT industry on the two main
625 groups of participants in the digital transformation process - those who implement ICT
626 solutions and those where implementations take place. Such an approach would better
627 identify the stressors and resources that help overcome stress.

628 **Limitations and future research directions**

629 Although our results provide new insights into the antecedents and potential consequences of
630 digital transformation stress, a number of limitations should be taken into consideration in
631 interpretation of our results.

The first limitation refers to the fact of the cross-sectional nature of our data. Our findings are, by and large, correlational and as such do not provide information about potential causality of the presented links between variables found in our data. This limitation may specifically be a relevant issue with regard to the link between ICT demands and digital transformation stress. In our study, we assume that ICT demands are antecedents of digital transformation stress, but the direction of these links may also be reversed.

The second methodological limitation concerns the use of self-descriptive measures. All measures of the digital transformation stress, self-efficacy, burnout, ICT demands and information about any ongoing digital transformation process were based solely on self-reports provided by employees. Such assessment is not free from social desirability and other biases. Future research should implement a more elaborate assessment of these variables. In case of an ongoing digital transformation, it would be very important to select organizations just as they start significant digital implementation and track changes in the level of digital stress of their employees before, during and after the process of this digital transformation. Such longitudinal design would enable us to evaluate dynamic changes in digital transformation stress and perceived ICT demands across the digitalization process and would provide more reliable information about the relationship among employees' self-efficacy, ICT demands, digital transformation stress and burnout. Using diary studies would also help to control biases related to natural fluctuation of the above-mentioned psychological states. Further work should also examine how DT stress impacts different work outcomes such as work commitment, job satisfaction, and burnout of employees regarding seniority, age, and gender to address the validity issues. A more complex and carefully selected sample would also bring significant benefits in future studies. Besides methodological limitations identified above, the present study opens a possibility for a number of future studies on digital transformation stress. Based on research on gender and age stereotypes, we can further

examine the role of ICT demands for digital transformation stress and burnout depending on the age group and separately for males and females. Studies on stereotype threat suggested that even when the workplace environment is relatively free from ageism and gender stereotyping, negative stereotypes may shape employees' well-being (von Hippel et al., 2011, 2018). It is also interesting what the relation between digital transformation stress and health outcomes is, such as depression and anxiety, and whether these consequences may evoke resignation from work. Prior research on stereotype threat suggests that these phenomena are significantly related, especially in samples of workers who belong to stereotyped groups. Understanding the antecedents of these detrimental effects of stress in the workplace are of great importance in light of the limited number of workforce in organizations (Ostberg et al., 2020; Soelton et al., 2020). We believe that addressing these questions will also be important for human computer interaction to understand main the role of ICT demands for employees in process of digital transformation at their workplace.

Conclusions

Evaluation of the DTS level may also help alleviate this type of stress by helping employees deal with DTS. The DTS Scale (Makowska-Tlomak et al., 2021; Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022) can be successfully applied as a screening tool of employees' DTS. Monitoring DTS among employees is important, in order to take timely action to prevent the effects of stress. The online psychological intervention offered to employees could be one of the ways to reduce this kind of stress, (Makowska-Tłomak, Bedyńska, Skorupska, & Paluch, 2022). Online psychological interventions, which are also consequences of digital transformation, may be beneficial at the organizational level by supporting businesses which would benefit from improved efficiency, satisfaction, and well-being of their employees.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethics statement

The research protocol was approved by the Ethical Committee of the SWPS University of Social Sciences and Humanities, Warsaw, Poland, number of decisions: 47/2020, 50/2020, 3/2021, 8/2021. The study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA, 2010). Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. The questionnaire was activated only after the participants had declared their informed consent to the study. Participation was voluntary, and the participants did not receive compensation for their participation in the study.

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994 Table 1. Type your title here. Obtain permission and include the acknowledgement required
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996 **Tables**

997 Table 1. Sociodemographic information on the participants (Study 1, N=165)
998

Characteristics	Total	% in total	Female	% in total	Male	% in total
n	157		89	57%	62	39%
Age						
18-25	8	5%	7	4%	1	
26-35	33	21%	22	14%	11	
36-45	61	39%	31	20%	30	
46-55	40	25%	25	16%	15	
56-65	5	3%	4	3%	1	
over 65	5	3%	0	0%	5	
University degree						
Middle school						
Bachelor's degree	26	17%	15	17%	11	
University or post graduate degree	123	78%	72	78%	51	
Job seniority						
until 1 year						
1-3 years	8	5%	7	5%	1	4%
3-10 years	26	17%	19	17%	7	12%
10-15 years	19	12%	8	12%	11	5%
15-20 years	33	21%	22	21%	11	14%
20-30 years	55	35%	29	35%	26	18%
over 30 years	11	7%	4	7%	7	3%
Job position						
Independent, Self employment	2	1%	1	1%	1	1%
ICT specialist						
Manager	43	27%	20	27%	23	13%
Operational position	25	16%	22	16%	3	14%
Specialist, annalist, accountant	73	46%	42	46%	31	27%
Teacher	2	1%	1	1%	1	1%
Other	2	1%	2	1%	0	1%

999
1000

Table 2. Mean, standard deviations, and correlations among variables: digital transformation stress, perceived stress and ICT Demands (Study 1, N = 165).

Variables	Reliability Cronbach's alpha	M±SD	Pearson's correlations								
			1	2	3	4	5	6	7	8	9
1. Digital Transformation Stress Scale	α = .91	2.66±0.79	-								
2. Perceived Stress Scale	α = .74	2.60±0.63	.60**	-							
3. ICT Availability	α = .68	3.26±0.71	.31**	.22**	-						
4. ICT Hassles	α = .77	2.17±0.60	.45**	.30**	.21**	-					
5. ICT Responses expectation	α = .60	3.31±1.04	.10	-.03	.36**	.01	-				
6. ICT Lack of control	α = .76	2.08±0.86	.27**	.34**	-.09	.28**	0.15	-			
7. ICT Learn	α = .66	3.22±0.79	.08	-.02	.22**	.05	0.12	-.25**	-		
8. ICT Poor communication	α = .72	1.98±0.64	.34**	.31**	.37**	.29**	.18*	.29**	-.003	-	
9. ICT Monitoring	α = .81	2.42±1.00	.24**	.16	.21**	.17*	.29**	.17*	.22**	.07	-
10. ICT Workload	α = .85	2.81±1.02	.54**	.28**	.47**	.38**	.15	.03	.22**	.17*	- .18*

Note: N = 165.; *p < .05. **p < .001
ICT = Information and Communication Technologies

Table 3. Regression coefficients for the models predicting digital transformation stress with ICT demands (Study 1, N = 138).

Predictors	Unstandardized Coefficients		*Standardized Coefficients*		95% C.I.	R^2	*F(dt)*	*p*
	B	*SE*	*β*	*p*				
ICT Availability	.36	.10	.31	<.001	[.17, .55]	.10	14.44	<.001
ICT Hassles	.63	.11	.45	<.001	[.42, .84]	.20	34.56	<.001
ICT Lack of Control	.25	.08	.27	.001	[.10, .40]	.07	10.511	<.001
ICT Learn	.08	.10	.08	.379	[-.10, .25]	.006	0.78	.379
ICT Monitoring	.19	.07	.24	.005	[.06, .32]	.06	8.28	.005
ICT Poor Communication	.43	.10	.34	<.001	[.23, .63]	.12	18.37	<.001
ICT Response Expectation	.07	.07	.09	.290	[-.06, .20]	.01	1.13	.290
ICT Workload	.42	.06	.54	<.001	[.31, .54]	.29	54.96	<.001

Note: N = 138.; *p < .05. **p < .001
ICT = Information and Communication Technologies

Table 4. Sociodemographic information on the participants (Study 2, N=558)

Characteristics	Full sample		Female		Male	
	N	%	n	%	n	%
Sample size	558		245	43.9	313	56.1
Remote Work	335	60	153	62.4	182	58.1
Education						
Primary	3	0.5	1	0.4	2	0.6
Vocational	33	5.9	8	3.3	25	8.0
Secondary	204	36.6	90	36.7	114	36.4
Studying	13	2.3	7	2.9	6	1.9
University degree	305	54.7	139	56.7	166	53.0
Job position						
Independent, self-employed	23	4.1	15	6	8	3
ICT specialist	18	3.2	4	2	20	8
Manager	75	13.4	27	11	48	20
Operational position	156	28.0	102	42	133	54
Specialist, analyst, accountant	104	18.6	55	22	46	19
Teacher	33	6.0	16	7	15	6
Others	143	26	26	11	43	18

Note. Participants were on average 43.44 (*SD* =10.71) years old, women were on average 41.52 *(SD* =10.99) years old, and men were on average 43.17 (*SD* =10.45)

Table 5. Mean, standard deviations, and correlations among variables: digital transformation stress, occupational self-efficacy, burnout components, ICT Demands and seniority (Study 2, N = 558).

Variables	M±SD			Pearson's correlations								
	All sample	Women	Men	1	2	3	4	5	6	7	8	9
1. Digital Transformation Stress	2.34±0.79	2.53±0.81	2.29±0.77	-								
2. Occupational Self-Efficacy	3.78±0.67	3.76±0.64	3.81±0.70	-.40**	-							
3. Burnout-Exhaustion	2.91±0.95	2.94±1.02	2.88±0.90	.30**	-.46**	-						
4. Burnout-Disengagement	2.53±0.79	2.58±0.81	2.49±0.76	.42**	-.31**	.59**	-					
5. ICT Availability	2.74±0.91	2.77±0.95	2.71±0.87	.21**	.07	-.07	.09*	-				
6. ICT Hassles	1.79±0.81	1.72±0.76	1.85±0.84	.45**	-.23**	.29**	.32**	.21**	-			
7. ICT Lack of control	2.29±0.91	2.25±0.89	2.32±0.93	.11*	-.31**	.44**	.30**	-.32**	.02	-		
8. ICT Poor communication	2.19±0.59	2.21±0.63	2.18±0.57	.47**	-.26**	.17**	.26**	.30**	.41**	-.02	-	
9. ICT Workload	2.31±0.62	2.37±0.66	2.26±0.59	.53**	-.26**	.17**	.35**	.45**	.46**	.10*	.55**	-
10. Seniority	18.90±10.60	17.55±10.43	19.95±10.60	-.04	.13**	-.18**	-.06	-.01	-.08	.07	-.08*	-.02

Note: N = 558.; *p < .05. **p < .001
ICT = Information and Communication Technologies

Table 6. Values of the fit indices in path models predicting DTS and burnout through occupational self-efficacy (Study 2)

Predictors	X^2	*df*	*p*	*CFI*	*TLI*	*SRMR*	*RMSEA*	95% C.I.	*p*
ICT Availability	12.02	5	.035	.97	.96	.03	.050	[.013, .087]	.44
ICT Hassles	13.74	4	.082	.98	.94	.02	.066	[.030, .106]	.20
ICT Lack of Control	11.76	4	.019	.99	.95	.02	.059	[.021, .099]	.30
ICT Poor Communication	4.76	4	.313	.99	.99	.01	.018	[.001,.069]	.81
ICT Workload	11.87	4	.018	.99	.96	.03	.059	[.022, .100]	.29

Note. ICT = Information and Communication Technologies

Table 7. Path coefficients in the models predicting DTS and burnout (Study 2)

Variables	b[a]	b[b]	*SE*	*CR*	*p*
ICT Availability (AVL)					
DTS →B-D	0.276	0.353	0.043	8.161	<.001
OSES → B-D	- 0.155	- 0.167	0.045	- 3.709	<.001
DTS → B-E	0.105	0.141	0.045	3.148	.002
OSES → B-E	- 0.344	- 0.390	0.044	- 8.846	<.001
SENIOR → B-E	- 0.006	- 0.111	0.031	- 3.600	<.001
OSES → DTS	- 0.487	- 0.412	0.037	- 11.048	<.001
AVL → DTS	0.201	0.240	0.040	6.030	<.001
SENIOR → OSES	0.008	0.130	0.043	2.979	.003
ICT Hassles (HASS)					
DTS → B-D	0.198	0.253	0.040	6.241	<.001
HASS →B-D	0.135	0. 172	0.043	3.982	<.001
OSES → B-D	- 0.156	- 0.169	0.044	- 3.855	.001
HASS → B-E	0.148	0. 196	0.046	4.300	.001
OSES → B-E	- 0. 367	- 0. 415	0.040	- 10.287	<.001
OSES → DTS	- 0.367	- 0.312	0.037	- 8.474	<.001
HASS → DTS	0.375	0.373	0.039	9.463	<.001
HASS → OSES	- 0.189	- 0.221	0.048	- 4.643	<.001
SENIOR → OSES	0.007	0.112	0.042	2.654	.008
ICT Lack of control (LC)					
DTS → B-D	0.280	0.356	0.041	8.693	<.001
LC →B-D	0.161	0.234	0.040	5.821	<.001
OSES → B-D	- 0.086	- 0.093	0.046	-2.036	.042
DTS → B-E	0.109	0.145	0.041	3.508	.001
LC → B-E	0.217	0.332	0.038	8.700	<.001
OSES → B-E	- 0.264	- 0.300	0.046	- 6.452	<.001
OSES → DTS	- 0.468	- 0.398	0.039	- 10.327	<.001
LC → OSES	- 0.225	- 0.302	0.046	- 6.554	<.001
SENIOR → OSES	0.007	0.109	0.042	2.572	.010
ICT Poor Communication (PC)					
DTS → B-D	0.276	0.351	0.043	8.173	<.001
OSES → B-D	- 0.155	- 0.168	0.045	-3.707	<.001
DTS → B-E	0.105	0.141	0.045	3.141	.002
OSES → B-E	- 0.344	- 0.390	0.044	-8.847	<.001
SENIOR → B-E	- 0.006	- 0.111	0.031	- 3.601	<.001
OSES → DTS	- 0.348	- 0.296	0.039	- 7.543	<.001
PC → DTS	0.383	0.392	0.038	10.426	<.001
PC → OSES	- 0.208	- 0.250	0.046	- 5.463	<.001
SENIOR → OSES	0.007	0.108	0.043	2.542	.011
ICT Workload (WL)					
DTS → B-D	0.208	0.264	0.047	5.573	<.001
WL → B-D	0.116	0.171	0.039	4.410	<.001
OSES → B-D	- 0.147	- 0.158	0.044	- 3.582	<.001
DTS → B-E	0.103	0.138	0.045	3.048	.003
OSES → B-E	- 0.358	- 0.406	0.044	- 9.200	<.001
OSES → DTS	- 0.330	- 0.280	0.037	- 7.483	<.001
WL → DTS	0.397	0.459	0.037	12.413	<.001
WL → OSES	- 0.187	- 0.254	0.045	- 5.653	<.001
SENIOR → OSES	0.008	0.126	0.042	2.994	.003

Note. [a]Non-standardized path coefficients [b]Standardized path coefficients
DTS = Digital transformation Stress, B-E = Burnout-Exhaustion, B-D = Burnout-Disengagement, ICT = Information and Communication Technologies, AVL = ICT Availability, HASS = ICT Hassles, LC= ICT Lack of Control, PC = ICT Poor Communication, WL = ICT Workload, OSES = Occupational Self-Efficacy Scale, SENIOR = Seniority

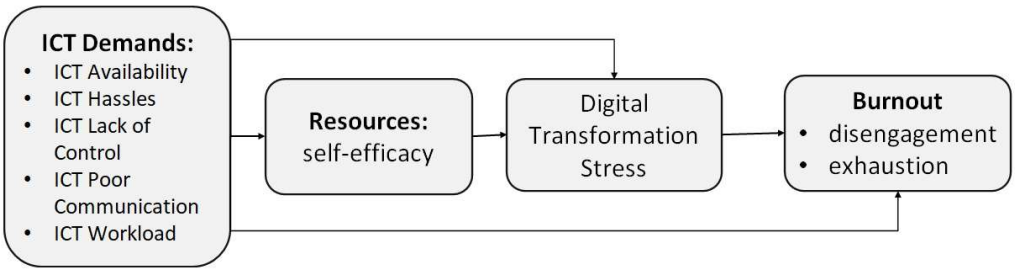
Table 8. Statistics of significant indirect effects of the path models predicting DTS and burnout (Study 2)

	Effect estimate	*SE*	*p*	95% *CI* for effect estimate	
Predictor				*LL*	*UL*
ICT Availability					
→ DTS → Burnout-Exhaustion	.034	.012	.004	.011	.057
→ DTS → Burnout-Disengagement	.009	.018	<.001	.050	.120
ICT Hassles					
→ OSES → DTS	.069	.017	<.001	.173	.332
→ OSES → Burnout-Exhaustion	.087	.022	<.001	.044	.130
→ OSES → Burnout-Disengagement	.035	.012	<.001	.010	.059
ICT Lack of control					
→ OSES → DTS	.12	.020	<.001	.076	.165
→OSES → Burnout-Exhaustion	.091	.018	<.001	.055	.127
→ OSES → DTS → Burnout-Disengagement	.043	.009	<.001	.025	.061
ICT Poor communication					
→ OSES → Burnout-Exhaustion	.10	.022	<.001	.010	.054
→ DTS → Burnout-Exhaustion	.06	.020	.003	.012	.047
→ OSES → DTS → Burnout-Exhaustion	.01	.004	007	.003	.018
→ OSES → Burnout-Disengagement	.042	.015	004	.040	.103
→ DTS → Burnout-Disengagement	.138	.022	<.001	.094	.182
→ OSES → DTS → Burnout-Disengagement	.026	.006	<.001	.013	.039
ICT Workload					
→ OSES → DTS	.071	.016	<.001	.040	.102
→ OSES → Burnout-Exhaustion	.010	.022	<.001	.059	.147
→ DTS → Burnout-Exhaustion	.063	.022	.003	.021	.106
→ OSES → DTS → Burnout-Exhaustion	.010	.004	.008	.003	.017
→ OSES → Burnout-Disengagement	.040	.014	.004	.013	068
→ DTS → Burnout-Disengagement	.0121	.024	<.001	.074	.169
→ OSES → DTS → Burnout-Disengagement	.019	.039	<.001	.008	.029

Note. ICT = Information and Communication Technologies, OSES = Occupational Self-Efficacy Scale, DTS = Digital Transformation Stress

Figures

Figure 1. ICT Job Demands - Resources model in DT context.



Note. ICT = Information and Communication Technologies

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Oświadczenie o współautorstwie

Niniejszym oświadczam, że w pracy: Makowska-Tłomak, E. and Bedyńska, S. *Negative consequences of ICT job demands in the workplace: digital transformation stress and burnout*, złożony w Human–Computer Interaction, Submission id: 235662210, mój udział polegał na współtworzeniu modelu, analizie danych i wyników, pisaniu manuskryptu, edycji i korekcie, weryfikacji wyników i tabel. Mój udział w powstaniu pracy wynosi 35%.

…….
Podpis współautora

Co-designing an e-Health Intervention to Address Digital Transformation Stress in the Workplace

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***Abstract*—In this experience report, we describe a series of participatory design workshops, which were held to co-design a tailored IT-based solution in the form of an online psychological intervention, to address Digital Transformation Stress (DTS) in the workplace. Based on analysis of data gathered during the two workshop series, informed by our literature review, pre- and post-workshop surveys and testimonials, we formulate three sets of recommendations. First, we gather insights on designing the DTS intervention system, including its features, content, interaction and the visual style. Second, we formulate guidelines for designing other online psychological intervention systems in a participatory manner. Finally, we list some best practices for conducting such co-design workshops, both online and offline. Our insights may prove valuable for co-designing similar e-health solutions with the direct involvement of end users. Such participatory approach has the potential to significantly lower dropout and align e-therapy tools to the real needs of end users.**

***Index Terms*—co-design, online intervention system, workplace stress, technostress, Digital transformation stress, DTS**

I. General Abstract

Despite unquestionable benefits of digital transformation, this very process may be a source of employees' stress – digital transformation stress, or DTS. This kind of stress is caused mainly by digital and social changes in the workplace. To address this problem, we conducted a series of participatory workshops that helped us identify the main stress factors and co-design an e-therapy tool with those affected. In this experience report we describe these workshops: their methods, execution and outcomes. As a result of the workshops, we formulate three sets of recommendations. First, we gather insights on designing the e-therapy intervention system to address DTS, including the system's features, content, interaction and the visual style. Second, we formulate guidelines for designing other online psychological intervention systems in a participatory manner. Finally, we list some best practices for conducting such co-design workshops, both online and offline. Our insights may prove valuable for co-designing similar e-health solutions with the direct involvement of end users. Such participatory approach has the potential to align e-therapy tools to the real needs of end users. Our research is relevant to managing employee stress levels at the workplace at the time of digital transformation in organizations.

II. Introduction

A. Background

Technology brings indisputable benefits [1] as digital transformation (DT) touches every area of our life [2]. Digital transformation is an important process for countries and their economies. Therefore, since 2002, the European Commission has established an annual research event, which aims to monitor issues related to Information and Communication Technology: namely ICT-based development in companies and by individuals [3].

For organizations, DT is defined as a broad process of implementation of information and communication technologies (ICT). It improves work efficiency and effectiveness of organizations [4], [5]. However, it is also connected with a wide range of social changes [2], [6]: redefinition of the work scope and responsibilities, number of employees, requirements, new tasks, competences and work mode, as well as changes in team management [7], [8].

Recently, many companies experienced the acceleration of such digital changes aimed to reduce the ramifications of COVID-19 [9], [10]. Lockdowns forced the public and private sectors to reorganize daily work and switch to the remote mode practically overnight [11], [12]. The COVID-19 pandemic has radically changed the role and perception of digitalisation in societies and economies. Digital technologies became imperative for working, learning, entertaining, socialising, shopping and accessing everything from health services to culture [13]. Many employees, for the first time,

were strongly dependent on ICT solutions [9], [14] and their current workplace was replaced by a remote one, saturated with ICT solutions to the maximum [15], [16]. The speed of this transformation outpaced many workers' ability to adapt comfortably. Therefore, the benefits of DT come at the price of its pervasive [14], often overwhelming, presence affecting the workers' emotional sphere.

Fig. 1. Brainstorming with participants during Workshop 1 of the offline series

B. Stakeholders

The challenges of dynamically changing work environments, especially in the context of accelerating digital economy, have the potential to cause significant stress to many employees [17]. To describe, study and overcome this problem, we applied the concept of Digital Transformation Stress (DTS). In short, DTS is related to organizational changes caused by digital transformation process itself, the mode of management, the workload related to DT and a change in the nature and manner of employees' work [15], [18], [19].

DTS can affect all employees, regardless of their IT competences, as it is associated with such aspects as time pressure, workload, business requirements and broadly understood organizational changes [7], [20]–[22]. All of these can cause psychological problems, such as the emergence and intensification of maladaptive behaviours, as well as professional burnout [7], [22], [23] and depression [24].

C. Project Goals

The participatory design workshops, described in this paper, allowed us to gather co-design insights for creating a dedicated online intervention system that will facilitate coping with DTS . Based on two series of workshops, we not only formulate recommendations for designing this intervention, which in the course of the workshops received its name: IT-herapy, but also list insights useful for designing other online psychological interventions in the participatory design framework. Finally, we share our experience of conducting online and offline participatory design workshops which may prove valuable for co-designing similar e-health [25] solutions with end users. Participatory design of online psychological interventions is a promising field of study in the area of Human-Computer Interaction (HCI) as it has the potential to significantly lower dropout and align e-therapy tools with the real experiences and needs of end users [15].

III. Literature Review

A. Digital Transformation Stress

The process of digital transformation in organizations is connected to a wide range of social changes: [2] redefinition of the work scope and responsibilities, number of employees, requirements, new tasks, competences and work mode, as well as changes in team management [26]–[28]. Organizational changes can cause resistance due to required additional cognitive resources, unpredictable results and interference with the existing order and structures of the company [6], [20], [29]. The manner of implementing digital changes can change the initial altitude towards digital transformation when job demands [7], [19], [22], [30] and uncertainty [9], [20], [23] increase. These reactions can also be manifested in behaviours, emotional states and attitudes in relation to the implemented or implementing ICT solutions [19], [23], [26], [30]. This resistance can be expressed in terms of passive fears [31], [32], severe distress [18], [32], in some cases aggression [33], as well as professional burnout [7], [34], [35] and even depression [8], [23], [36]. As the main focus of digital transformation work is on technical implementation, the organizational support is often limited to communication of changes, procedures and instructions [37]. Professional development of employees in this area, when changes are introduced, is very often neglected, particularly outside the hard skills, in the area of well-being and burnout prevention [23], [26], [38].

All of these problems create a niche to be addressed by specialized and tailor-made online interventions aimed to target this specific type of stress, i.e., digital transformation stress.[1]

B. Online Psychological Interventions

Online psychological interventions have been around for over 20 years and analyses have shown that internet-based therapy [41] is less costly but equally effective to traditional therapy [42]. [43]. Psychological internet interventions constitute a range of self-guided or human-assisted programs for health promotion, disorders and emotional distress prevention, risk factor management, treatment, or relapse-prevention. Initially, internet interventions were treated as a supportive tool in therapies, primarily dedicated to countering depression [44], eating disorders, post-traumatic stress and suicidal tendencies [45]–[47]. Their confirmed effectiveness resulted in widening their use to the area of personal and professional development and coping with stress [46], [48], for example, using the tools of cognitive behavioural therapy (CBT) [45], [46], [49],

[1]Although digital transformation stress is related to technostress, it is not identical. Technostress is defined as stress that individuals experience due to their use of Information Systems [39] and users reaction to high IT use demands [30], [40]. In contrast, DTS is closely related to the process of changes in the organization that are a consequence of the implementation of new technologies, increasing workload, time pressure, the need to rapidly increase competences and knowledge, as well as the expectations to increase efficiency [5], [7], [19], [22], [23].

[50]. Such programs are operated through a website, or, more commonly, via mobile applications used by those seeking health- and mental health–related assistance [45], [46], [51]–[53]. Mobile interventions are now becoming more popular due to changing user preferences, data safety and privacy, as well as additional functionalities available through mobile devices (e.g. geolocation, accelerometer) [46], [53]. Psychological internet interventions can be an effective response to the growing gap between the applications needed and the capabilities of the healthcare systems [46], [50], [54]. **Due to the high dropout from psychological, unguided internet intervention programs (even 45%) [50], [55]–[57], online intervention systems should be developed in a participatory manner in order to maximize the intervention's adjustment to the needs of its recipients [52].**

C. Participatory Design

Participatory design, or co-design [58], is the direct engagement of users into the design process. It differs from user-centered design, as popularized by IDEO[2], as it does not make use of a set of tools to approximate the users and empathize with them, but rather invites the users to take part in the design cycle. That way, the design is based on their real, not imagined or stereotyped, needs. The co-creation approach, especially in immersive environments such as Living Labs [59], helps to lower the risks associated with the development of new solutions thanks to unexpected insights it offers [60]. The idea of participatory design is increasingly used in multiple contexts [61], [62], but it is especially potent for groups which are vulnerable, as in the study with women suffering from perinatal depression [63], or teens suffering from stress [64]. The idea of participatory design was taken even further, to include Design for Empowerment [65], [66] where the users become content creators themselves, and design their solutions by themselves. However, this may not work if the users do not have the needed competences, for example in psychology or IT, to develop the solutions on their own or engage with designers on equal ground, especially if potential co-designers may experience DTS. Therefore, the first step of empowerment [67] is needed to familiarize the potential participants with key concepts of psychology, design and co-design; to meet them in a space where they are still comfortable sharing their private experiences, emotions and ideas.

IV. Methods

A. Collaboration with the Industry

We recruited participants through a snowball technique, using contacts in various organizations from educational, public and business sectors. Because the study was aimed at employees who use ICT solutions in their daily work, we asked a few companies' Human Resource (HR) managers to send employees an email invitation to the research. The interested organizations were, among others: a primary school, city hall, as well as two companies from the private, business sector at the multinational level: an FMCG [3] one and a financial one.

Thanks to the cooperation with a multinational, financial company with which we signed consent with the company's Management Board for carrying out more extensive research on stress, we were able to send an invitation to participate in the DTS survey to approximately 100 employees. The company was in the process of digital transformation (DT) for over a year. The DT project was related to the digitization of all business processes and was also associated with organizational changes. The company was interested in monitoring the level of digital transformation stress among employees and enabling them to participate in the psychological interventions addressed to cooping with this kind of stress. Company employees could answer the questionnaire by clicking on the respective link in the newsletter or in the e-mail sent by HR Director.

B. Participant selection

The participants were recruited between June and July 2020, by online survey, concerning digital transformation stress (DTS). The survey invitation was sent via social media, such as LinkedIn and by selected companies communication channels. It was a link to the Quatrics platform, under the license of the university. All participants were professionally active, working in a random sample of diverse office occupations (e.g., analysts, accountants, managers and other back-office employees). All of them declared using ICT solutions in their daily work. All survey participants were informed about research goals and they marked their consent to take part in the survey.

As for the workshops, we invited survey respondents who: 1) declared their willingness to participate in workshops, 2) entered their email address, 3) had the score of DTS greater than or equal to 2.5.

In consequence, only 20 of 145 respondents met all three of above presumptions, to participate in the workshops. Finally, we have recruited 11 people for the workshops, organized in weeks at the turn of July and August. All workshops participants were women.

1) Target group:: People who are not able to address DTS on their own - most often, ones with low self-efficacy[4] [69]. Our workshop participants, among other respondents, took part in a survey-based study aimed to validate the DTS scale. As a result, they became aware that the difficulties they are facing in their professional life might be linked to DTS and they volunteered to help with co-creating the DTS intervention.

2) Participants:: 6 recruited participants took part in the series of stationary workshops, and 7 in the series of online workshops, of which one later resigned. For comparative purposes, two offline workshops participants also took part in the online workshops, so a total of 11 participants were

[2]IDEO is a global company which popularizes design thinking and human-centered design, it also publishes its design kits available for free, which are a source of great inspiration for devising workshop activities

[3]FMCG = Fast Moving Customer Goods

[4]Self-efficacy is defined as one's beliefs about their capabilities to produce designated levels of performance that exercise influence over events affecting their lives [68].

recruited. Additionally, the project team (psychologists, researchers, educators, designers and programmers) took part in both online and offline workshop series[5].

C. Overview of the workshops

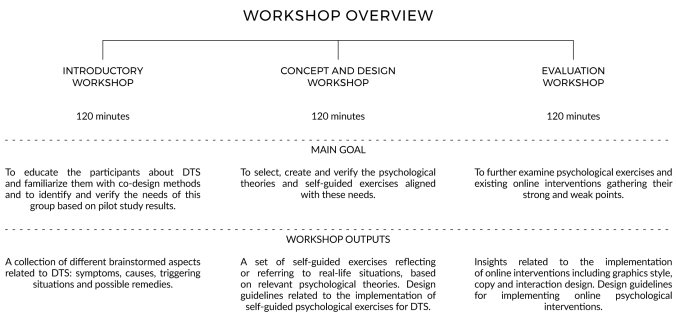

Fig. 2. Overview of Workshop Schedule, Goals and Outputs

The final goal of the workshops was to gather insights for the design of a tailored e-therapy intervention system to address DTS [22]. The objective of the intervention program itself was to create positive change by strengthening the users' knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive on-line based components. The single workshop cycle consisted of three workshops, with the first two happening within a week, and the final one after a week, as in Fig. 2.

D. Detailed Scenarios of the Participatory Workshops

Workshop 1

1) We **introduced the goal of the workshops and empowered the participants** by showing how we are all experts: everyone interacts with design and technology and encounters some related issues in everyday lives.
2) We described **key concepts** related to digital transformation stress (DTS) [19] and technostress [38] and how they may differ for everybody so the experience of every participant is important.
3) We explained how **brainstorming** ought to work, including the no judgment principle. The participants then worked individually and wrote down the issues related to DTS one by one in three separate categories:
   - what problems does DTS cause and how does it show (red post-its)
   - what specific situations may cause it (yellow post-its)
   - what situations may trigger it (blue post-its)
4) All of the post-its from each category were collected on a board. Subsequently, they were read aloud and grouped together in the process of **affinity-diagramming to form key clusters of causes (yellow), problems (red) and situations (blue)**. Finally, key clusters were named on orange-colored post-its.
5) Afterwards, there was a **presentation about different types of stress**: what causes it, how to cope with it, and why and how it can be beneficial. Finally, the participants **brainstormed on green post-its on how they may deal with DTS**, and in what ways it can be alleviated.

[5]The transformation of rooted patterns of behaviour and value systems requires participation of many expert groups, including managers, psychologists and educators [7] and we wanted all of the people involved to participate on equal footing.

Fig. 3. Brainstorming results of the offline workshops - collective

Workshop 2

1) We started with a brief presentation of the concept of **psychological interventions** in general, e-health, and online psychological interventions in particular.
2) We introduced the participants to the **psychological theories** that can facilitate helping individuals affected by DTS.
3) We presented **self-guided exercises** connected to these theories and used in psychological practice to help patients.
4) Each person got a printed copy of **a psychological exercise to fill out and evaluate**. After each exercise, there were a few minutes to discuss the strong and weak points of the exercise as a group (previously written down individually by participants on green and red cards, respectively).
5) We finished with a brainstorming session to gather **general design guidelines** and feedback related to the exercises, their presentation, instructions, clarity, flow and content.

Workshop 3

1) We **reviewed** what we have so far learned in these workshops and continued the evaluation of further offline psychological exercises.
2) We empowered the participants during **an interactive presentation on online psychological interventions with an introduction to key concepts of user interface (UI) and interaction design** (buttons, grid, ways of interacting) as shown on designs familiar to all the participants. This stage was meant to give the participants the confidence and vocabulary to express their opinions about the implementation. This part also primed the participants to pay attention to the user experience (UX) [70], [71].

3) The participants were **asked to express their opinions and ideas on the design of such intervention systems** related to different aspects of their experience of browsing the showcased online (including mobile) psychological interventions, such as UX, UI, copywriting, and interactivity of the online intervention.
4) As the final home assignment, the participants are asked to fill out at home a **qualitative questionnaire** encompassing different aspects of user experience and concepts important for psychological interventions.
5) Finally, the participants were thanked and **invited to alpha test the draft of online psychological intervention** and to stay in touch with us.

E. Adjustments to the above scenario for the online cycle

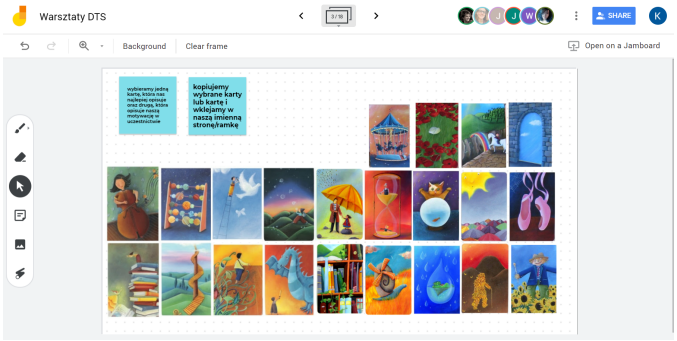

Fig. 4. Icebreaker at the first online workshop based on cards from Dixit boardgame

During Workshop 1 online, we have created an introductory task where the participants had to choose and explain their choices of two cards from a set of cards from the Dixit boardgame (the exact set can be seen in Figure 4) presented on Jamboard: one that best described them, and one that best represented their motivation for joining the workshops. At the same time they learned to use the Jamboard tool.

During Workshop 2, the users were presented online psychological exercises on Jamboard, an interactive business whiteboard, and used the tool to give feedback on the exercises.

During Workshop 3, the more in-depth online psychological exercises were turned into online questionnaires to enable participants to interact with them individually. The participants found this more enjoyable than reading the text on Jamboard. They gave their feedback within the questionnaires after each exercise part. Finally, there was an introduction to human-centered design concept in general and personas [71], as well as a collective creation of a persona in the Hubspot's Make My Persona tool. This time we asked the participants to create an example persona as their home assignment. [6]

F. Background, Safety and Ethical Arrangements

The workshop was preceded by a survey that:

1) measured the level of DTS among employees,
2) collected information on the impact of COVID-19 on the stress levels,
3) helped find people interested in co-designing online interventions.

The survey and workshops are part of research related to the stress of digital transformation and the effectiveness of online interventions to counteract this type of stress. The study was conducted in compliance with ethical standards adopted by the American Psychological Association (APA 2010). The research protocol (with all text contents and compliance with the GDPR) was approved by the Ethical Committee of the University. Accordingly, prior to participation, all participants were informed about the general aim of the research and the anonymity of their data. After marking informed consent to the study, the questionnaire was activated. Participation was voluntary, and participants did not receive compensation for taking part in the study. The workshop followed relevant regulations and safety guidelines. To ensure proper distance was kept we relied heavily on individual brainstorming instead of pair and group work.

V. Results

A. Details about the participants

All participants were women and have declared university level of education. The average age was 40.5. Most of the participants have declared medium level of ICT skills (6/11), while two women have declared advanced level and one very advanced level. Two participants have not declared the ICT skill level. Average score of perceived Digital Transformation Stress Scale (DTSS) of both groups of participants was 2.85 (SD = 0.66). The DTSS score was high moderate for the online group (M = 2.73, SD= 0.67) and for the offline group, the DTSS score even was higher (M = 2.94 (SD = 0.69). General stress, measured by Perceived Stress Scale [72] at work was at 3.08 (SD = 0.63) for offline group and 2.46 (SD = 0.78) for online groups. One participant has resigned after first day of online workshop because of personal issues. As the main motivation to take part in the workshops, the participants have indicated their social commitment and willingness to learn how to deal with the stress of digital transformation. In the post-workshop survey, the majority replied to the question: "which of the statements is closest to your motivation of participate in such workshops?" indicating statements "I like to help in scientific and social activities" (9 women of 11) and "I was hoping to get to know new ways to work on solving the problem or learn something new" (8 of 11). 5 participants have indicated expression: "I personally experience the digital transformation stress (DTS) and want to learn to deal with". 6 participants thought the workshop was on an - "interesting topic". 4 women indicated that they knew people suffering from DTS and wanted to help them.

B. Key aspects of DTS

At the beginning the participants identified key aspects of stress related to digital transformation. In a brainstorming

[6]The Make My Persona Tool used for this is available free of charge at: https://www.hubspot.com/make-my-persona

session they shared their personal experience of DTS concering its symptoms, causes, situations triggering it and finally possible remedies.

Both groups (stationary and online) identified similar aspects of DTS. These aspects are presented below grouped into clusters.

1) DTS Symptoms (red cards): Six main clusters of DTS symptoms were identified during the offline and online workshops:

1) **Aggression:** swearing, violence, physical violence towards the device.
2) **Avoidance:** powerlessness, downplaying the need to use the software.
3) **Procrastination:** postponing duties.
4) **Decrease in Motivation:** discouragement, frustration, sense of defeat.
5) **Over-mobilization:** excessive preparations, focusing only on this task.
6) **Physiological symptoms:** tears, anxiety, fatigue, aches, sweating.

2) DTS Causes (yellow cards): DTS causes can be divided into two large groups:

1) **Internal causes:** fear of failure, heightened sense of responsibility, perfectionism, shame to admit the lack of knowledge, uncertainty about one's competence and skills, awareness of the need to gain more knowledge, fear about one's insufficient ability to learn quickly, comparing oneself to others in terms of performance, not knowing much about the programs needed for work and not knowing how to accomplish a certain task.
2) **External causes:** novel and untested equipment, hardware failure, slow operation, low battery, time pressure, loud sounds, poor Wi-Fi connection, indecisiveness on what tools to use, the need to comply top-down change management, taking unfair blame from others.

3) Situations triggering DTS (blue cards): These were divided into four groups:

1) **Equipment and device related situations:** unexpected updates, lack of access to better tools, software errors, system failures and old hardware.
2) **Deadline-related situations:** rapid implementations and projects with short deadlines, difficulties in dealing with formal matters online, no time for fixing hardware/software, pressure from others, multitasking.
3) **Design-related situations:** bad UI, making it hard to find certain information, changes made to familiar software (e.g. changing the location of familiar icons), strange language and using unfamiliar vocabulary.
4) **Competence-related situations:** the need to ask for help, being asked for help and then expected to take responsibility for a task, agreeing to take on a task beyond one's competence, public speaking/presenting, lack of understanding from others when working together.

Moreover, the participants noticed that often these situations and conditions are combined, which makes them even more stressful.

4) Possible remedies for DTS (green cards): Finally, the participants created a list of possible DTS remedies that included clusters of both short-term, and long-term remedies:

1) **Entertainment and distractions**: looking at cat memes, watching a comedy movie, listening to music, computer games, shopping, meeting friends.
2) **Rest and relaxation**: running / jogging, sport in general, "charging one's batteries", going to sleep, talking to a friend, turning on "airport mode", meditation, isolating from others until work is done, counting from 1 to 10 slowly, taking a deep breath.
3) **Improving our resources**: easy instructions, asking for help, getting help from experts, receiving information about the changes in advance, investing in new hardware and software, honesty in the contact with employer.
4) **Prevention**: learning new skills, doing backups, restraining from doing updates, buying a new/backup battery pack.
5) **Psychological adaptation**: learning to trust oneself, nurturing balance in life, allowing oneself to lack knowledge, practising mindfulness, planning time and organizing work better.

C. Impressions of Psychological Exercises

After introducing the subject of psychological internet interventions (methodology and historical background), we distributed exercises [73] which were based on cognitive–behavioral therapy (CBT) [74] - printed out during the stationary workshops, and using Jamboard and Google Forms during the online workshops. During both workshops, we asked the participants to write down all positive comments about each exercise on green post-its (what parts of exercises they perceived as enjoyable, useful or helpful in an intervention) and negative comments on red sticky notes (everything that they found frustrating, pointless, or discouraging). It was also possible to voice opinions on how to improve the exercises on yellow cards.

The exercises with short psycho-educational introduction or/and hints as well as short self-assessment (e.g. "Are you a perfectionist?", "Do you like to work with people", "Are you a procrastinator?") were evaluated as better than exercises without contextual narration or without explanation concerning self-development. Three areas of evaluation can be distinguished:

1) visual (text formatting, text length, graphic/pictures used),
2) content (expressions used, tasks formulation, time commitment),
3) task performance (predefined options and the need to write a lot).

D. Impressions of Online Psychological Interventions

During the second workshop, the participants were shown a few demos of psychological online interventions and were

asked to express their opinions regarding the presented examples. In online workshops, they added their notes next to the relevant screenshots, as shown in Figure 5. [50]

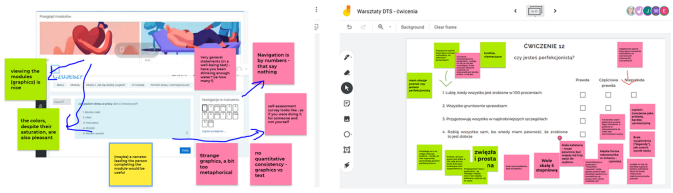

Fig. 5. Left: A an example screen from MedStres (an online psychological intervention) shown during the workshops. Right: Exercise feedback during online workshops.

Most of the participants focused on the functionality and accessibility of the application. They emphasized the need for approachable interface, intuitiveness and lack of perceived pressure. For example, Responded 1 (R1) said it should be: "Easy to use, intuitive, what matters most is the content (words), and the graphics as the background (non-intrusive)", while R2 described it as: "Easy to use (intuitive), not complicated in terms of technology, in which the content plays the main role and the graphics are only a background that harmonizes with it". Common themes appearing in the discussion and the post-workshop surveys are gathered as guidelines in the discussion section.

E. Feedback from Surveys

All participants have declared a wish to take part in next such workshops as they enjoyed the direct and open atmosphere (R6 and R7), the opportunity to learn about stress (R1 and R3) and to meet new and interesting people (R2). It is worth noting that both workshop groups declared a preference to participate in subsequent workshops in the same format as previously attended.

F. Personas

Because any problems related to mental health can be sensitive, we have decided to introduce personas to the participatory design process as an approximation of the real users [75], so that none of the participants have to talk about themselves, unless they choose to. This also allows the personas to work as proxies for their own feelings and needs and to create a safe distance and space where the participants can express themselves without the fear of being judged by their co-workers.

During online workshops we have co-created one persona - a potential user of online psychological DTS intervention. The participants were also asked to prepare their own personas at home; we received 3 other personas (2 female and one male).

Prepared personas were at similar to their authors in terms of age and professional situation - i.e. the requirements, profession or position. Sources of digital transformation stress were also common, e.g. fear of losing their job or the need to quickly increase competences. In the block "what should the psychological intervention (application) be", personas have expected the application to be simple, intuitive, with customizable settings, and attractive.

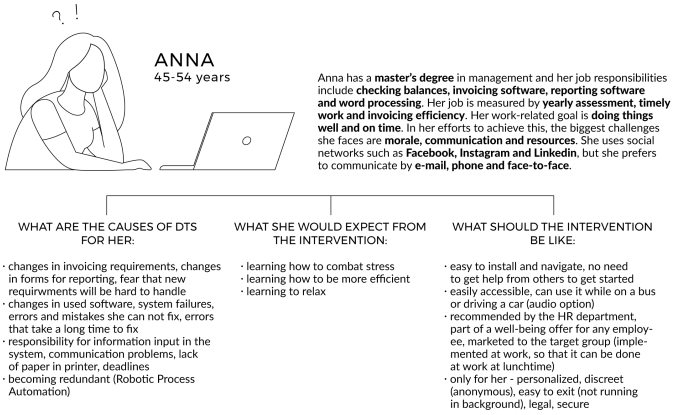

Fig. 6. The persona created online together with the participants.

Key information about the persona created online together with the participants is given in Fig. 6.

VI. Discussion

A. Insights for the Design of IT-herapy - the Online Intervention targeting DTS

Participatory workshops allowed for the collection of a preliminary specification for internet interventions to counter the stress of digital transformation. Three general areas of concern on the development of the DTS intervention have emerged. These are presented below together with an explanation in the context of this specific intervention:

1) **Functionality**
   - **Doing things at work**: The intervention should be available to do everywhere, but especially at work, close to the problems at hand.
   - **Available in chunks when needed**: Help should be easy to find, so that a person can reach for the intervention when they have a specific problem related to DTS that they want help with.
   - **Short checkpoints for self-evaluation**: The intervention should show progress made by the user, as well as test if it is still relevant to the user or if it is helping, and then be adjusted to the new answers.
   - **Ability to review key points**: The intervention should support highlighting of key useful points, so that they can be easily returned to in stressful situations.
   - **Reminders**: Reminders should be available to set for the times when the user just starts work, with some useful advice, or when they finish it, with something to remember.
2) **Design**
   - **Friendly**: One important issue raised during workshops was the term "online intervention" itself. All participants proposed that it should be called

something different than intervention, i.e. ”psycho-educational application” or simply a ”program” - the name ”IT-herapy” was also devised during the brainstorming session, as visible in Figure 7.

- **Discreet**: Able to be used without anyone noticing that you are using it. The design could either be inconspicuous or allow the user to hide it, or ”kill it” without much effort. The visual design also should not draw attention, so that one could use it on the way home on a bus or tram.

3) **Content**
   - **Relevant to the work environment**: The intervention should refer to real-life situations from work and other areas which trigger DTS, and some helpful ways of managing or preventing it.
   - **Self-guided exercises**: The exercises should be explained in a friendly way, without using a lot of jargon, or contextualized to the specific conditions of work, and situations causing DTS.
   - **Supplementary information available**: Each problem and solution should be explained with psychoeducational materials with references to relevant research on DTS, Stress or Best Practices at Work, which could help create better relationships.

B. General Insights for the Designing Online Psychological Interventions

In general, the participants wanted the intervention to be:

1) **User-friendly** – meaning easy to use and intuitive, with modern graphics and soothing colors. Navigation at each step should be clear and approachable, featuring progression/completion status.
2) **With good but brief content** – with coherent and friendly language focused on the content. The language should be natural and avoid unnecessary psychological jargon. The application should convey key information efficiently while avoiding overly formal tone, as it creates communication barriers.
3) **Non-intrusive graphics** – which are utilized only as a background and harmonize with the content.
4) **Always easily available** - preferably in the form of smartphone application, but also accessible on a website to be used on smartphone or a laptop. It should feature audio files to enable using the intervention while driving.
5) **Personalized and adjusted to the needs but with ability to change the focus by the user manually** – the intervention should be tailored, to automatically adapt to the needs of the user based on a short introductory survey and the feedback given after the exercises, regarding them or the user moods. The user should also have the possibility to manually adjust the intervention settings if they feel that such profiling failed.
6) **Quick to work and containing ready-made solutions to problems** - advice on how to deal with issues should be given immediately, and the benefits from using the intervention should not be delayed without previous explanation. It should offer some specific solutions to common problems that could be readily implemented.
7) **Educational** - the intervention should enable the user to learn more about each raised topic if they so choose, for instance in the form of a ”learn more” button showing more related content.
8) **Reminding about itself** - it should have an option to turn on notifications featuring reminders, everyday hints, recommendations or highlighted notes that would be visible on one’s cell phone if the user wishes so.

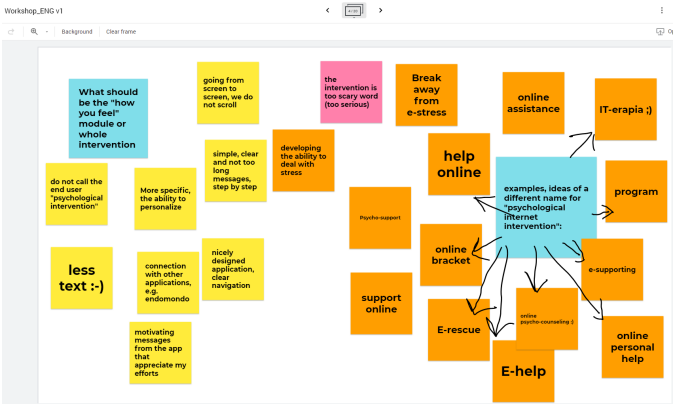

Fig. 7. What should online interventions be like, and what should we call them? Translated Jamboard from online workshops

C. Offline vs Online Workshop Series

Such co-design workshops can be conducted online with only minor adjustments with the help of such tools as: Zoom (for presentations and group work), Klaxoon (for Brainstorming), Google Docs (for co-writing, doing surveys) and Proto.io or online platforms (for testing). Overall, we feel that there is a great opportunity for cooperation between psychologists and UX designers to create pleasant online e-health experiences informed by both of these areas.

1) Brainstorming: We had the chance to compare organizational aspects of similar offline (stationary) and online workshops. For example, during the stationary workshops, participants were asked to stick their cards on dedicated boards concerning a given problem (symptoms, causes, situations). Then we discussed these and (during the brainstorming session) we tried to isolate clusters of similar issues. During online workshops the clustering and brainstorming were much more effective, more legible, and faster - participants could immediately read each other’s notes and the clusters could be identified simultaneously with discussion.

2) Evaluation of Psychological Exercises: 10 minutes were allocated for each exercise. We noticed that exercises were done much faster and more efficiently during the online workshops, when they filled in the exercises on Google Forms, and gave their feedback using Google Jamboard. Two participants (P4 and P1) suggested that the exercises instead of on paper during the stationary workshops could be done online, as

it imitated the final intervention conditions better. However, when the participants were doing the exercises on paper during the stationary workshops, the feedback was more in-depth and there were many more digressions. The spontaneous and free discussion during on-site workshops was very valuable as it generated multiple new ideas regarding the shape and functionality of our DTS intervention, while the discussion during online workshops felt more controlled.

D. Conducting Co-Design Workshops for Online Interventions

What follows is a list of issues we have encountered when organizing and running the co-design workshops, which admittedly may appear in many different kinds of workshops, but which have especially stood out in ours. They are given below with recommendations on how to address them:

1) **Gender balance/fair representation** – Women seem more likely to take part in such workshops, but even though the topic is more relevant to them, it still should be explored from many points of view. So, we recommend to start the recruitment process well in advance.
2) **Fear of one's experience being unique and not relevant** – Some participants feared that their own experience may be not relevant to others. However, the brainstorming session showed multiple similarities at a deeper level. This may be a barrier to signing up for workshops, so the recruitment call should mitigate this.
3) **Activating the silent participants** – As the topic of the workshops is quite personal, the participants may not be ready to easily share their experience of stress. We have used individual brainstorming on post-its to activate the less confident participants as well as gave all individual tasks to share and reflect upon with others.
4) **Doing psychological exercises on-site.** We recommend not to inform that the exercises are to be assessed later during the workshop, initially focusing only on the task of completing them. This way the participants may fully concentrate on completing the exercises, without engaging in simultaneous assessment.
5) **Balancing the educational, experiential and design aspects** – This practice keeps the participants' motivation high, as they feel they are learning from the project team and each other, but also sharing their (sometimes very personal) experience and insights.
6) **Equality of participation and vulnerability** – The fact that the project team was involved in brainstorming and the exercises together with the recruited participants encouraged everyone to share their personal experience, because everyone was showing vulnerability thus removing the barrier between outside participants and insiders.
7) **Ability to be fully open** – It may be good to keep workshops within single companies and limit participation based on the place of employment - this enables the participants to feel more at ease with each other from the start, but it is also motivated by ease of organization, possible NDAs, and shared context.
8) **Empowerment** Educational components make workshops more attractive to the participants empowering them to actively take part, without feeling limited by lack of knowledge on any of the key topics: DTS, therapy, UI or UX.

VII. Limitations

The present study has several limitations that need to be emphasized. First, the data for this study were collected mainly using social media, particularly trough LinkedIn. This may limit how our findings generalize to specific groups of respondents. In our study, participants presented similar characteristic in age range, educational level, seniority range. The majority of the participants were higher educated and female across both group of participants. Therefore all workshops participants were female. Recruiting a more diverse sample of employees would be of great importance in the future research.

Moreover, the cross-sectional measure of digital transformation process is based only on self-report of employees. It would be better to examine the level of digital transformation stress at certain intervals to measure the initial employee's' attitude toward the digital transformation just before the digitization process and next during the process of e.g., IT project. Such research design would allow to evaluate dynamical change in stress level across time in the digitization process and would deliver more reliable information about its causal relationship with employees' attitudes and behavior.

VIII. Conclusions

This research offers both theoretical and practical contributions. Designing online e-health interventions that help alleviate Digital Transformation Stress (DTS) is an important issue, as recently many employees were forced into a dynamic digital transformation they were not ready for, which has caused some of them significant stress.

A. Impact for Software Enginnering

In this article we described a series of offline and online participatory design workshops to develop an online intervention system (IT-herapy) to alleviate DTS. We listed insights gathered on the design of this system targeting DTS in particular, such as its need to be discreet, portioned into digestible chunks and readily available at work with relevant hints. We also formulated accompanying insights applicable to the broader scope of online psychological interventions, such as having all highlighted notes in one place, being brief but also fully customizable and affective, reacting to user needs, changes and moods. Moreover, we formulated preliminary guidelines for practitioners in Human-Computer Interaction to help plan for the challenges (e.g. fair representation or vulnerability) of co-design workshops for e-health.

B. General Conclusions

Overall, we are convinced that true participatory approach, bringing together the project team and the target group, can help provide IT-based solutions tailored to the emotional and

adaptive challenges of dynamically changing work environments. In the context of accelerating digital economy and heterogeneous, hybrid and distributed workplace environments it is important to support seamless change of modality between on-site and on-line work modes and to prepare employees to face resulting challenges and ensure business continuity.

C. Future Work

Our future work will focus on developing the IT-herapy system with the support of our workshop participants and the wider end user group. All participants declared their willingness to cooperate on its development, e.g. by participating in future workshops and to test its subsequent versions. We will also explore such co-design workshops, not only in their capacity to inform design choices, but also in their potential to act as a form of group therapy, which was also one of the insights from the participants. Therefore, we are planning another series of participatory workshops, with additional measurement of stress and self-efficacy after the workshops.

Moreover, we will start cooperation with human resources departments to organize participatory workshops to co-design more systems integrated into business tools, that, with the help of Machine Learning, Natural Language Processing and sentiment analysis, could detect and evaluate the occurrence of DTS among employees [19], [76], [77]. Increasing the awareness of organisations (HRs, employers) in this regard and co-designing IT-based support solutions may increase employees' well-being, commitment and efficiency.

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Publications & Conferences

2023	**Makowska-Tłomak, E.,** Bedyńska, S., Skorupska, K., & Nielek, R., ***Women Have It Worse: An ICT Workplace Digital Transformation Stress Gender Gap and Potential Tools to Address it,*** CHI 2023. The ACM CHI Conference on Human Factors in Computing Systems is the premier international conference of Human-Computer Interaction (HCI), (submitted, id 3777)
	Makowska-Tłomak, E., Skorupska, K., Kornacka, Jaskulska, A. & M., Kopeć, W., **Insights from Co-designing an Online Intervention System to Address Digital Transformation Stress in the Workplace** (in process of submission).
	Makowska-Tłomak, E. and Bedyńska, S. (submitted). **Negative consequences of ICT job demands in the workplace: Digital Transformation Stress and Burnout**. Human–Computer Interaction, Submission id: 235662210
	Smoktunowicz, E.; Xanthopoulou, D.; **Makowska-Tlomak, E**.; Studzinska, A.; Roczniewska, M. *What helped dual earner couples mitigate work-family conflict when remote work was mandatory? An intensive longitudinal study,* submitted in Human Relations, manuscript ID is HR-2023-0020.
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	INTERDISCIPLINARY Ph.D. STUDENT CONFERENCE ICT&PSYCHOLOGY: **Makowska – Tłomak, E**, presentation: **Sentiment Analysis as alternative tool in Digital Transformation Stress detection** https://medium.com/crossing-domains/sentiment-analysis-as-stress-detector-99fad02599c1
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2021	**Makowska-Tlomak, E.,** Nielek, R., Skorupska, K., Paluch, J., & Kopec, W. (2021, December). Evaluating a Sentiment Analysis Tool to Detect Digital

	Transformation Stress. In *IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology* (pp. 103-111).
	INTERACT 2021 conference, WS10. Participatory Design Landscape for the Human-Machine Collaboration, Interaction and Automation at the Frontiers of HCI (PDL 2021), **Program Committee Member: Ewa Makowska-Tłomak** https://pdl.pja.edu.pl/ ,
2020	Participation in Competition Ma thèse en 180 secondes 2020, organised by – Centre de civilisation française et d'études francophones of University of Warsaw : **Digital transformation stress presentation** https://youtu.be/vdq6_QjIkVM
2019	XIII PhD Conference SWPS Warsaw, **Makowska, E.,** *Psychological internet intervention aimed to coping with occupational stress during digital transformation in organization: protocol for a pilot study* poster
	6th ESRII Conference, 2019 European Society for reasearch on internet interventions. ESRII, **Makowska, E., *Psychological internet intervention aimed to coping with occupational stress during digital transformation in organization: protocol for a pilot study*** poster

Research & Projects

2022-2023	PM: Agata Graczykowska (Kozlowska), Team: Anna Rogala, **Ewa Makowska-Tłomak**, Adaptation and analysis of psychometric properties of the Polish version of the Career Decision Self-Efficacy Scale, with cooperation with SWPS Career Office.
2020 - 2023	PM: Marta Roczniewska; Team: Smoktunowicz, E.; **Makowska-Tlomak, E**.; Studzinska, A.; **Couples in a pandemic: coping with work-family and family-work conflicts during social distancing. Intensive longitudinal research in dyads.** https://www.hellozdrowie.pl/milosc-w-czasach-pandemii-jak-sobie-radzic-gdy-oboje-partnerzy-pracuja-z-domu/
2019 - 2022	PM: Ewa Makowska-Tłomak, Digital Transformation Stress, surveys, analysis, workshops, cooperation with interdisciplinary organization KOBO https://kobo.org.pl/

Teaching experience

2023	SWPS, Project Management in Information Technology, workshops, co-leading classes, starting Mars 2023
Oct 2021- Jan 2022	SWPS, Psychology and Technology – online workshops, co-leading classes