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ORIGINAL RESEARCH

Technostress Among Older Workers: A Central European Perspective

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Introduction: This study explores the impact of two major labor market phenomena—the aging workforce and digitalization, which have global significance. The COVID-19 pandemic accelerated the adoption of digital technologies, resulting in economic growth, improved business processes, and reduced social isolation. However, the study also addresses the challenges and threats associated with digitalization, with a specific focus on technostress. The research analyses the primary techno-stressors experienced by older employees and self-employed individuals in four EU countries. Investigating various demographic factors such as gender, age, education level, employment type, and country of origin, the study aims to identify stress levels related to techno-demands and techno-disruption.

Methods: This study utilized a quantitative research design with a cross-sectional survey approach. A Quota sampling method in combination with Computer Assisted Web Interviewing (CAWI) was used to collect data. The overall response rate was 42% (varied by country) in total data collected. A sample of 1306 workers (aged 50–64), representing diverse demographics, was recruited and interviewed. The techno-stressors were assessed using a 14-item scale encompassing major stress-creating conditions as already reported in earlier studies.

Results: The results reveal intriguing patterns, particularly notable gender-based differences in technostress experiences across age groups. Younger male seniors and female seniors reported higher levels of techno-disruption, while techno-demands were more problematic for female seniors. Additionally, respondents' country of origin also influenced their experiences with technostress.

Discussion: Overall, the study sheds light on the challenges of digitalization for older workers in central European perspective and provides important missing information and data on variation in technostress based on nationality, age, and gender. The results prompt further research on longitudinal trends and discussions on geography, industry, and country specific impact of digitalization on the modern workforce.

Keywords: technostress, older workers, technostressors, Central Europe, age, gender

Introduction

The interplay between an aging workforce and the rapid digitalization of labor markets is becoming a prominent focus of research and discussion in contemporary society. As populations age and technological advancements continue to reshape work environments, understanding the implications of these major social phenomena is crucial for effectively managing the evolving labor landscape. Moreover, the recent outbreak of the COVID-19 pandemic has expedited the integration of digital technologies into both professional and personal domains, amplifying the significance of this topic. Digitalization has influenced all aspects of daily life for employees across the globe. Its advantages are evident in diverse domains, including economic growth, enhanced business processes, and the facilitation of novel business ventures.[1,2] These technologies enable the maintenance of critical working relationships and personal bonds despite physical distancing measures, underscoring their value in times of crisis.[3] Technostress is a phenomenon stemming from the extensive reliance on technology, which can induce pressure and strain on individuals.[4] As individuals navigate the complexities of a digitalized work environment, they may experience various forms of technostress, including information overload, invasion of personal life due to blurred boundaries, difficulties in mastering technology, concerns about privacy and data security, and feelings of exclusion or inadequacy.[5–7]

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In this context, understanding the impact of technostress on older employees and self-employed becomes important. The aging workforce represents a significant demographic segment facing unique challenges and opportunities in the digital era. By investigating the main techno stressors experienced by older workers in the context of digitalization, this study aims to provide valuable insights into the stress profiles of this specific cohort.[8] Moreover, the study seeks to explore how techno stressors interact with demographic variables, such as gender, age, level of education, employment type, and country of origin, to understand potential variations in stress experiences across different subgroups.

Literature Review

There are two major social phenomena occurring all over labor markets in Europe, the first of them is an aging workforce, second is the digitalization of labor market. The number of people aged 65 years or over in the global population will double from 703 million in 2019 to 1.5 billion in 2050.[9] As regards Europe, which becomes the oldest continent in the world, the European Union (EU) has registered the highest old-age dependency ratio (65±(15–64)), representing 31% in 2019, compared to 13.95% at the worldwide level[10] being projected to increase at 57% in 2100.[11] At the same time, digitalization has become a part of the daily lives of workers, employees and self-employed in Europe and beyond. The pandemic COVID 19 even accelerated the role of digital technologies not only in the personal lives but especially at work and in schools.[12] The advantages and contributions of digitalization, like eg economic growth,[13] improved efficiency and effectiveness of business processes,[14] or creating a new business,[15] acceleration of business models and removing business from offline to online[16] are apparent. Digital technologies reduced social isolation during pandemic lockdowns and enabled keeping of working and personal bonds.[17] However, what are the challenges and threats of digital technologies? One of them is technostress.

Technostress – Definition and Measurement

Technostress is defined as A modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner.[18] A broader definition explains technostress as any negative impact on attitudes, thoughts, behaviors, or body psychology caused directly or indirectly by technology.[19] Information and communication technologies (ICT) are creators of stress also in the definition of Tarafdar et al[7] which define technostress as stress created by created by ICT use, which results from the constant evolution of ICTs and the changing cognitive and social requirements related to their use. A link to the organizational context is in the following definition: Technostress is stress that users experience because of their use of information systems (IS) in the organizational context, which can be attributed to characteristics of modern IS such as constant presence and constant change.[20] Technostress is also considered to be multidimensional, and it is defined as a negative psychological state associated with the use or the "threat" to use new technologies, which leads to anxiety, mental fatigue, skepticism, and sense of ineffectiveness.[6,21] A short definition simply links technostress to ITC use: Technostress is stress induced by Information and Communication Technology (ITC) use.[5]

Brod identified anxiety as the main manifestation of technostress, evident through symptoms such as headaches, irritability, insomnia, and an aversion to learning.[18] The subsequent years have seen a myriad of efforts to precisely define technostress, investigating its causes, outcomes, and strategies for both employers and employees to manage it. Though the subject of technostress has been widely studied (as outlined above), there remains a notable gap in understanding how social workers specifically encounter this form of stress.

The principal tool for assessing technostress is the Technostress Creators Inventory (ICI), formulated by Ragu-Nathan et al.[4] This framework characterizes technostress as an overarching construct, composed of five primary constructs, each reflected through three to five indicators. It encapsulates technostress into five specific facets: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. A unique metric tailored for older adults, which encapsulates prominent stress-inducing conditions previously acknowledged, was devised by Nimrod.[5] Ayyagari et al applied the person-environment fit model as a theoretical perspective, proposing that attributes of technology – such as its usability (incorporating usefulness, complexity, and reliability), intrusiveness (including presenteeism, anonymity), and dynamism (reflecting the pace of change) – correspond with stress-related factors like workload, role ambiguity, privacy invasion, work-home conflict, and job insecurity.[20] A multifaceted framework to explore technostress among university educators was proposed by Wang and Li,[22] revealing that imbalances in person-organization (P-O), person-technology (P-T), and person-people (P-P) interactions within the higher

education environment contributed significantly to technostress. Additional advancements include the Polish adaptation of Technostress Creators and Technostress Inhibitors Scale by Kot,[23] and the piloting of the Technostress Questionnaire (TSQ) by Finstad and Giorgi.[24]

Technostress Creators - Techno Stressors

Several years ago, the problems associated with the use of technology changed from predominantly physical, such as carpal tunnel inflammation, to mental health. People began to suffer from mental health problems. From nomophobia[25,26] which is the fear of being without a phone, through phantom vibration syndrome[27,28] to insomnia due to frequent staring to screens or classical smartphone addiction.[29,30] The perception of personal needs is notably influenced by the FOMO (Fear of Missing Out) syndrome among individuals who actively engage on social media.[31]

The following technostress creators or stressors are most commonly described in relation to technostress.[7]

Techno-invasion describes a stressor that is caused by the belief that a person is always exposed to technology, that people can potentially be found anywhere, anytime, and that people also need to be constantly connected. The regular working day is extended, office work is done at any hour, and it is almost impossible to cut off. For instance, people say:

> I feel that my current private life is disrupted by ICT. I spend less time with my family because of ICT. I was in touch with my work during the holidays thanks to / because of ICT.

Techno-complexity describes situations where complex computer systems used at work force people to spend time and effort learning and understanding how to use new applications and update their skills. People are often scared of various applications, functions and IT jargon and subsequently feel stressed. In this context, people mention these stressful situations and experiences:

> I am not able to find enough time to judge and increase my ICT knowledge. I don't know much about ICT to do my job satisfactorily. It takes me a long time to understand and use a new ICT solution. I find that newly hired colleagues know more about ICT than I do. I often find that ICTs are too complex for me to learn and use.

Techno-insecurity is associated with situations where people feel threatened by job loss, feel threatened by other people who better understand technology, new equipment, applications, etc.

Techno-uncertainty refers to the short life cycles of computer systems. Constant changes and upgrades do not give people a chance to learn to routinely work with a particular system. People find this worrying and stressful because their knowledge quickly becomes obsolete, and they must relearn things quickly and often.

Cyber insecurity stemming from the technologies people use increases the risk of privacy invasion. This situation leads individuals to experience a sense of privacy loss, as well as feelings of danger and fear when it comes to sharing personal data and preferences.

Techno-overload is a situation where the use of computers and technology forces people to work more and faster. Working with digital technologies demanding due to high pace, frequent interruptions, multitasking, extended working hours, expectations regarding response time in digital communication, etc.[7]

Dragano and Lunau are have mentioned the following techno creators.[32]

Techno-unreliability stress included by breakdowns, technical errors low usability etc. of single technologies, which is related to techno-overload and complexity.[20,33]

Stress can also emerge from the interaction between humans and machines. This includes irritation stemming from the unpredictable actions of robots or other machinery, and a generalized anxiety toward these entities, in addition to the inherent complexity of such systems.[34–36] Innovations in technological workplace surveillance have facilitated meticulous oversight of aspects like work performance, geographical location, and working hours. Such close scrutiny may engender feelings of mistrust and a sensation of lost control among the monitored employees.[32] Other phenomena connected to technostress include interruptions mediated by technology.[37]

As workers age, they undergo cognitive and biological transformations. Notable examples of these changes are the diminished capacity to disregard interruptions and maintain focus on a given task, hurdles associated with a decline in memory, and decreased proficiency in utilizing computer input devices. Consequently, older employees become more

susceptible to technological stressors, including technological interruptions, heightening their risk of experiencing the negative impacts associated with technostress.

Technostress at Work

Work stress is caused by a number of factors, most often relationship stress or poor working conditions.[38,39] These are the areas in which occupational psychology has been working for decades.

The interplay between age and technostress is complex and has been the subject of multiple inquiries. Hauk et al suggested that while older employees may be more susceptible to techno-stressors, the aging process is often linked to the development of coping mechanisms, which can mitigate the strain associated with technology over time.[40] Kluge's work further corroborates this, revealing that older individuals perceived techno-stress elements significantly less compared to their younger counterparts.[41] Ragu-Nathan et al add to this perspective by arguing that decreased technostress among older people might be a result of longer organizational tenure and more specific experience, facilitating a more adept handling of ICT-related stress in their professional environment.[4] Ayyagari's research in 2007 discovered a significant correlation between work-home conflict and strain among younger employees,[42] also reported by Tams et al, who observed that older workers might display reduced computer self-efficacy and experience.[43] The challenges of emotional and cognitive overload related to IT afflict both older and younger employees,[44] with age-related tendencies towards different types of overloads, such as feature or information overload. However, older workers, while generally enduring less technostress, might still find technological intricacies and interruptions particularly taxing.[37,45,46] Moreover, Berg-Beckhoff et al identified distinct connections between ICT utilization and stress among middle-aged individuals, which could be tied to concerns over work-family equilibrium or career advancement.[47]

The relationship between gender and technostress presents a complex and nuanced picture. Research has shown that there is little to no difference between men and women in terms of smartphone addiction or excessive use of ICT.[48] However, gender-specific patterns emerge in other areas of technostress. Men have been found to experience more technostress in general ICT use[4,49] and when working under electronic performance monitoring technology.[50] Conversely, women reported more techno-complexity and techno-uncertainty, reflecting different stressors and responses to technology.[45,51] Ayyagari's study further highlighted a strong relationship between the extent of technology presenteeism and the amount of work-home conflict specifically for women.[42]

These findings underscore the importance of considering age and gender as significant factors in understanding and addressing technostress, and they point to the need for more nuanced research and interventions that take into account the distinct experiences and challenges faced by men and women of different age in the context of technology use.

Data and Methods

This study utilizes quantitative research design with a cross-sectional approach. A quota sampling method ensuring a representation in age, gender, educational level, employment type and country of origin was used. The data used in the analysis come from a survey of older workers (aged 50–64 years) conducted in four Central European countries for Mendel University in Brno. All participants in this study provided their data voluntarily in accordance with the principles outlined in the Declaration of Helsinki. Informed consent was obtained, and the privacy and confidentiality of all participants were safeguarded throughout the study. The data were collected by STEM/MARK agency in July and August 2021 by CAWI mode of administration. The language used for administration was local/country specific. The data was purchased from the agency; therefore, Internal Ethics committee approval was not needed. The Human Research Ethics Committee of Mendel University in Brno declared that this study follows Czech legal regulations and does not require further ethics review. The final sample recruited from an online panel by quota sampling method is representative for group of older workers between 50 and 64 for each included country in terms of age, gender, education, region (NUTS 2), and ratio between employees and self-employed. The exception are underrepresented groups of respondents with primary education (Hungary, Slovakia) and self-employed (Poland), which is corrected by weights. The overall response rate (ie, ncompleted questionnaires divided by number of eligible respondents contacted) was 42% in total. The response rate for specific countries was 44% for the Czech Republic, 37% for Hungary, 40% for Poland, and 48% for Slovakia.

The total number of respondents after data cleaning reached 1306. Table 1 shows basic sample characteristics across countries. All four national samples followed the national quota for group of older workers, so the distributions in terms of sex, age, and education category fits the quota. Overall, the prevailing number of respondents are employees (81%), with secondary education (73%), between 50 and 54 years of age (43%) and these distributions are similar across four countries. Table 1 also displays mean numbers of 14-item scale of technostress, as defined and tested for the group of older adults by Nimrod. The higher value of the scale – and the higher value of each dimension of this scale separately – means higher technostress. In this sense, the mean value of technostress is relatively low (39.4 with the natural center of the scale being 42). Respondents from all four countries scored relatively higher in privacy dimension (mean value of 9.8 with 9 as the natural center) and relatively lower in overload dimension (mean value of 7.3 with 9 as the natural center). The descriptive country differences are not large – for instance, respondents from Hungary scored lower in privacy and overload dimensions – but the following analysis will examine the differences in the more complex way.

A measure – 14 item scale developed by Nimrod was applied describing major stress-creating conditions (technostressors) already identified in previous research.[6,7,20,52,53] Nimrod defined the five technostressors as following:[5]

1. Overload – Having to cope with more problems than warranted and eventually perform tasks more slowly.
2. Invasion – Incursion into daily life because of blurred boundaries between public and personal contexts.
3. Complexity – Complexity and constant change rendering ICT use conditions difficult to learn, use and master.
4. Privacy – Personal information threatened because ICT use can be traced, documented and exploited by external factors.
5. Inclusion – A sense of inferiority compared with younger users and consequent pressure to make an effort to be included in the contemporary technological environment.

Table 1 Descriptive Characteristics of the Sample and Key Variables in % (and Means)

		Czech Republic	Hungary	Poland	Slovakia	Total
Sex	Male	51.9	51.2	48.8	51.9	51.1
	Female	48.1	48.8	51.2	48.1	48.9
Age group	50–54	42.4	48.1	38.8	41.6	42.7
	55–59	38.4	29.5	37.2	37.4	35.8
	60–64	19.2	22.4	24.0	21.0	21.5
Education	Primary	2.3	1.8	3.5	1.6	2.3
	Secondary	76.2	70.1	69.4	74.5	72.8
	Tertiary	21.5	28.1	27.1	23.9	24.9
Employment status	Employee	79.4	80.8	86.0	79.7	81.2
	Self-employed	20.6	19.2	14.0	20.3	18.8
Technostress	(mean of 14–70)	40.4	38.1	38.7	39.9	39.4
Overload	(mean of 3–15)	7.5	6.9	7.2	7.5	7.3
Invasion	(mean of 2–10)	5.9	5.6	5.5	5.8	5.7
Complexity	(mean of 3–15)	8.3	8.0	8.0	8.3	8.2
Privacy	(mean of 3–15)	10.1	9.2	9.9	10.0	9.8
Inclusion	(mean of 3–15)	8.6	8.3	8.1	8.3	8.4
N		349	310	258	281	1198

Results and Discussion

The study achieved a total response rate of 42%, with variations across the four participating countries ie Czechia (44%), Hungary (37%), Poland (40%) and Slovakia (48%). This response rate is aligned with typical response rates for online surveys, particularly those conducted through Computer-Assisted Web Interviewing (CAWI). Previous research suggested that web-based surveys generally yield response rates between 30% and 50%, depending on factors such as topic relevance, survey length, and sample recruitment methods.[54,55] Studies comparing CAWI to traditional survey methods indicate that while CAWI facilitates faster data collection and broader geographic reach, it may exclude individuals with lower digital literacy, potentially underestimating technostress levels among older workers with limited technology access.[56] Additionally, research by Fan & Yan reported that response rates in online surveys can be influenced by several factors such as survey design, incentives, and the perceived credibility of the research institution.[57] Given that this study targeted older workers (50–64 years old), the 42% response rate is within an acceptable range, especially considering that older populations may have lower digital engagement, affecting participation in CAWI surveys.[58]

The scale applied in the presented research examines five techno-stressors: techno-overload, techno-invasion, techno-complexity, techno-privacy, techno-inclusion.[5] For the purposes of statistical data processing, latent variables were created: FAC1_overload, FAC1_Invasion, FAC1_Complexity, FAC1_Privacy, FAC1_Inclusion, this is always the first main component in PCA analysis that explains most of the group variability and can be used to replace the whole group of questions (variable is standardized), has zero mean and unit variability. We also present the averages of individual main components for individual techno-stressors for respondents according to the country of origin (Figure 1).

The results show differences between respondents according to their country of origin. A positive average approaching the number "1" indicates a higher level of perceived stress for a particular techno-stressor, while a negative average approaching the number "-1" indicates a lower level of perceived stress. Respondents from the Czech Republic achieve the highest values in techno-privacy, also in all other techno-stressors, they achieve averages of positive results, therefore they show a higher degree of stress compared to respondents from other countries surveyed (Table 2). The potential reasons could be greater awareness of data protection laws and higher exposure to the workplace surveillance.[59] Only the average of the main techno-overload component is highest among respondents from Slovakia, suggesting increased pressure from workplace digitalization and automation.[32] Respondents from Hungary perceived techno-stressors as less stressful than respondents from other countries, especially techno-stressors: techno-overload, techno-complexity, and techno-privacy (Figure 2). This could be due to slower pace of digital transformation or more traditional work structures that reduces reliance on technology,[60] Techno-invasion and techno-inclusion are the least stressful for respondents from Poland, which may be attributed to stronger labor protections limiting digital overwork and government-sponsored digital inclusion initiative.[61]

Final Cluster Centers

	Cluster 1	2	3	4
Overload_1	3,37	1,61	2,28	2,42
Overload_2	2,46	1,70	2,34	2,13
Overload_3	3,64	1,80	2,60	2,93
Invasion_1	3,63	2,27	2,67	3,54
Invasion_2	3,58	1,73	2,28	3,31
Complexity_1	3,67	1,76	2,74	2,66
Complexity_2	3,76	1,72	3,00	2,39
Complexity_3	3,79	1,79	2,68	2,81
Privacy_1	3,99	2,68	2,90	4,03
Privacy_2	4,00	2,69	2,91	4,06
Privacy_3	3,67	2,42	2,61	3,59
Inclusion_1	3,40	2,42	3,36	2,64
Inclusion_2	3,60	1,60	2,87	2,12
Inclusion_3	3,91	1,88	2,91	2,78

Number of Cases in each Cluster

Cluster	1	295,000
	2	307,000
	3	316,000
	4	280,000
Valid		1198,000
Missing		,000

Figure 1 Four clusters created on the respondent's answers in particular technostressors, comparison of respondents according to their country of origin.

Table 2 The Averages of Individual Main Components for Individual Techno-Stressors of Respondents According to the Country of Origin (Report of Means – Country – PCA Factors Mean)

Country of Orig.	FAC1_Overload	FAC1_Invasion	FAC1_Complexity	FAC1_Privacy	FAC1_Inclusion
Czechia	0.068	0.095	0.065	0.150	0.087
Slovakia	0.095	0.062	0.042	0.071	−0.006
Poland	−0.001	−0.114	−0.054	−0.010	−0.073
Hungary	−0.185	−0.069	−0.070	−0.247	−0.024
Total	0.000	0.000	0.000	0.000	0.000

The results show that employees are more stressed by techno-overload and techno-invasion (Table 3). This indicates that structured workplace environments impose greater pressure to use multiple digital tools, meet productivity demands, and remain connected beyond regular working hours.[7] Other studies also reported that corporate employees face increased expectations for digital multitasking and rapid technology adaptation, contributing to heightened stress and work-life imbalance.[8] In contrast, self-employed individuals experience higher techno-complexity and techno-privacy stress, likely because they must independently manage their digital tools, cybersecurity risks, and changing technological requirements without the support of corporate IT departments.[62] Self-employed workers are more vulnerable to data security threats and digital exclusion, as they rely on freelance platforms and online business tools, often with limited formal training in digital risk management.[4]

As presented in Table 4, the averages of the main components, men are less stressed than all the techno stressors examined than women, the biggest difference is in techno-complexity and techno-inclusion. These findings align with existing research suggesting that women often perceive greater challenges in adopting workplace technologies due to differences in digital self-efficacy, training opportunities, and workplace roles.[45] The Digital Divide Theory[63] also highlights that gender disparities in technology adoption stem from historical inequalities in access to digital education and skill development, which may contribute to women experiencing more difficulties with complex digital tools and a stronger sense of exclusion from

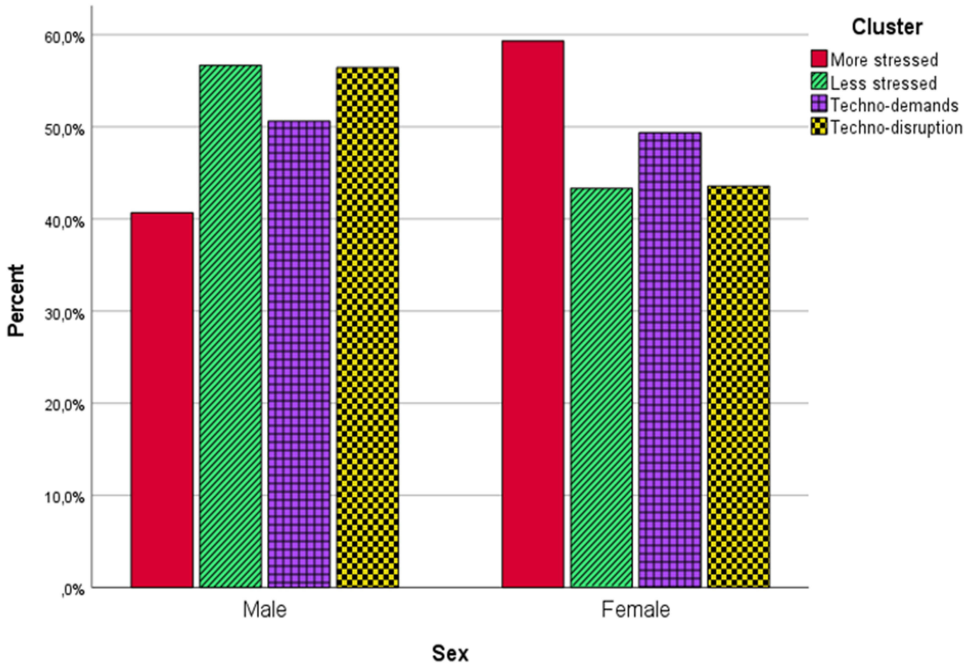

Figure 2 Four clusters created on the respondent's answers in particular technostressors, comparison of respondents according to their age.

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Table 3 The Averages of Individual Main Components for Individual Techno-Stressors of Respondents According to the Form of Their Employment: Employees vs Self-Employed

Employment	FAC1_Overload	FAC1_Invasion	FAC1_Complexity	FAC1_Privacy	FAC1_Inclusion
Employee	0.010	0.011	−0.017	−0.009	−0.002
Self-employed	−0.046	−0.053	0.078	0.040	0.009
Total	0.000	0.000	0.000	0.000	0.000

Table 4 The Averages of Individual Main Components for Individual Techno-Stressors for Respondents by Gender

Gender	FAC1_Overload	FAC1_Invasion	FAC1_Complexity	FAC1_Privacy	FAC1_Inclusion
Men	−0.044	−0.013	−0.115	−0.020	−0.172
Women	0.046	0.013	0.120	0.021	0.179
Total	0.000	0.000	0.000	0.000	0.000

technological advancements in the workplace (Figure 3). An additional factor influencing these differences is technology confidence and perceived competence. Studies have shown that women, particularly in older age groups, tend to rate themselves lower in digital skills even when their actual proficiency is comparable to men.[64] This is supported by Stereotype Threat Theory,[65] which suggests that cultural perceptions of technology as a male-dominated field may subconsciously discourage women from engaging fully with digital tools, increasing feelings of inadequacy and stress. Moreover, workplace norms and structural barriers may further contribute to these gender differences. Research indicates that men are more likely to work in IT-intensive roles, where digital training is prioritized, while women are overrepresented in administrative and service roles, where exposure to advanced digital tools may be more limited.[66]

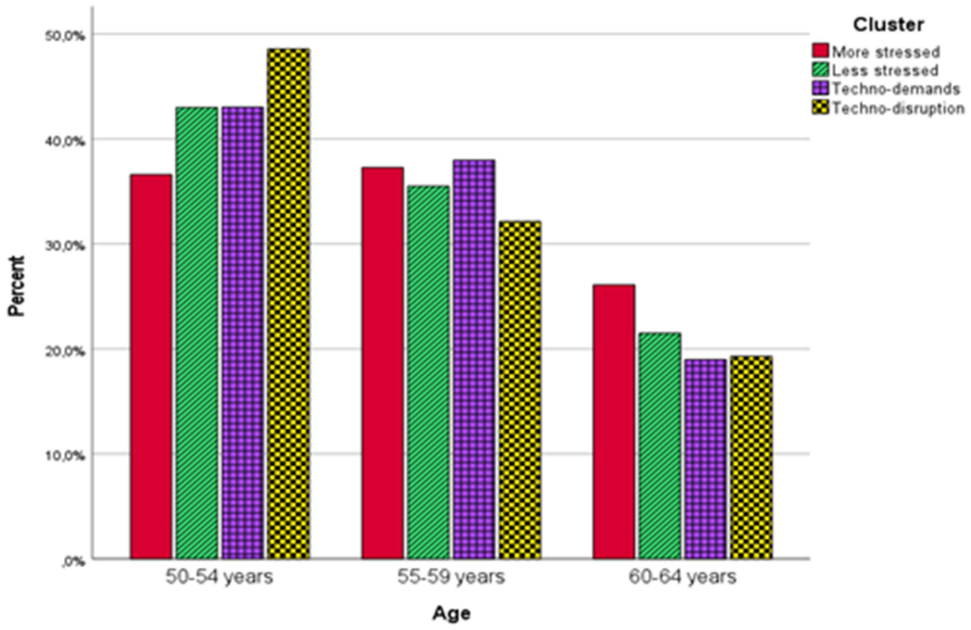

Figure 3 Four clusters created on the respondent's answers particularly technostressors. Comparison of respondents according to their age and gender.

Additionally, techno-inclusion stress—the feeling of being left behind by digital advancements—is notably higher among women, reinforcing findings that women are less likely to receive formal digital upskilling opportunities in workplaces.[47] In contrast, men report lower overall technostress levels, potentially due to higher exposure to workplace technologies throughout their careers and greater confidence in problem-solving digital challenges.[67] However, some studies indicate that men may experience higher techno-overload stress, as they are often expected to manage multiple digital tools and high-tech work responsibilities.[7]

A comparison of three groups of respondents according to their age reflects differences in the perception of individual technostress. Respondents aged 50–54 were stressed by techno-invasion and techno-privacy, respondents aged 55–59 are stressed by techno-overload, techno-complexity, and techno-inclusion. The oldest generation of respondents (aged 60–64) was stressed by techno-complexity, techno-privacy and techno-inclusion. These results align with existing research on cognitive aging, digital adaptation, and work-life integration in an increasingly digitalized work environment.[5,40] The higher techno-invasion stress among younger seniors suggests that the work-life balance is increasingly blurred for this group, due to greater professional responsibilities and digital expectations. Employees in this age range are often in mid-to-senior management roles, where digital connectivity is required for productivity, collaboration, and leadership.[7] Research showed that individuals in their early 50s are expected to maintain constant digital availability, contributing to higher stress from work intruding into personal life.[8] Moreover, the expansion of remote work and digital communication tools has further exacerbated this stress, as workers feel pressure to respond to emails and engage in digital meetings outside of regular working hours.[3]

Respondents were further divided into four groups / clusters according to their answers for individual techno-stressors (Figure 4).

Group 1 grouped respondents (N = 295) who showed the highest value (highest level of perceived stress) for most of the questionnaire scale, this group we call the most stressed people. The high-technostress cluster consists of individuals struggling with all dimensions of technostress, due to limited digital literacy and minimal training opportunities, aligning with Digital Divide Theory.[63]

Group 2 grouped the respondents (N = 307) who showed the lowest value (lowest level of stress) for all questionnaire items. We call this cluster the least stressed people. This least-technostress cluster represents digitally resilient workers, who report greater confidence and workplace support, supporting the Person-Environment Fit Theory, which suggests that better resources reduce stress.[20]

Group 3 grouped respondents (N = 316) who answered on average in all items and at the same time perceived more stress in the items of techno-complexity and techno-inclusion. We named this cluster people stressed by techno-demands.

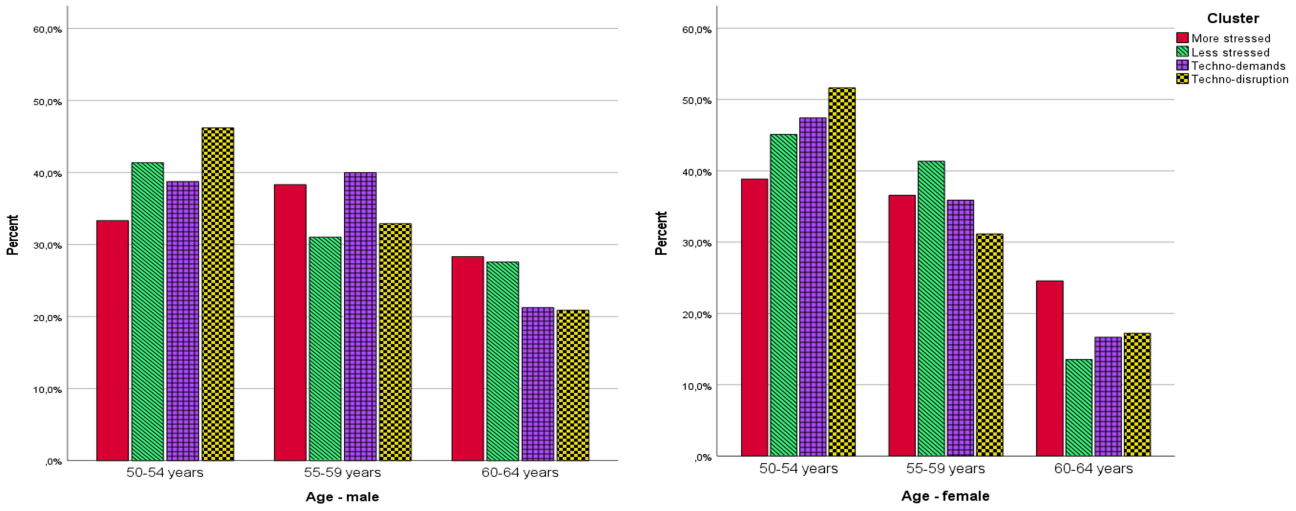

Figure 4 Four clusters created on the respondent's answer in particular technostressors.

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This moderate-technostress cluster can be viewed as workers who cope with technology but struggle with its rapid evolution, reflecting research on workplace digital adaptation challenges.[49]

Cluster 4 grouped respondents (N = 280) who answered on average in all items and at the same time perceived more stress in the items techno-invasion and techno-privacy. We used the term "techno-disruption" for this group. This group can also be classified as selective-technostress cluster, it experiences stress in specific areas, such as techno-privacy or techno-invasion, indicating that digital stress is context-dependent, influenced by data security concerns or work-life balance issues.[3,62]

More stressed are women, the difference in stressed men and stressed women is 19%, whereas the least stressed group is dominated by men (57%), the difference between the least stressed men and women is 14.6%. Almost the same number of women and men, half of them (50.5% of men and 49.5 of women) are suffering from techno-demands. Techno-disruption is more common for men (56.2%) than for women (43.1%). The Gender-based differences in Figure 5 reveal that women report higher techno-complexity and techno-inclusion stress, reinforcing research that women tend to have lower digital self-efficacy and fewer training opportunities in technology-related roles.[45,64] This aligns with Stereotype Threat Theory, which suggests that societal perceptions of technology as a male-dominated field contribute to women's higher digital adaptation stress.[65]

Based on the age of respondents, we see that significantly more stressed in the three age groups of respondents are people between 50 and 59 years (36%, resp. 37%), whereas in the oldest group of respondents it is only 27% of all respondents. The least stressed are the younger respondents between 50 and 54 years old (43%), the middle age (55–59 years old 36%), 21% of the people who are the least stressed is the older generation.

Techno-demands and techno-disruptions are perceived differently among the three age groups. Whereas the younger group (50–54) suffers more from techno-disruption, the middle age group (55–59) perceives more stressful the techno-demands. The oldest group suffers equally from techno-demands and techno-disruptions (18.5%, resp.19%). Younger seniors (50–54 years old) report higher techno-invasion stress, suggesting they face greater digital work-life balance challenges due to expectations of constant availability, aligning with previous research on remote work and digital overconnectivity.[3] In contrast, older seniors (60–64 years old) experience higher techno-complexity and techno-inclusion stress, supporting findings that cognitive aging and lower prior digital exposure contribute to greater difficulty in adapting to workplace technologies.[40,63]

If we look closely at the differences between men and women in different age groups, we see that the differences are smaller. The youngest male as well as female respondents suffer mostly from techno-disruption (47% of male respondents between 50–54 and 51,2% of female respondents of the same age). The techno-demands are bigger problem for female respondents (48%) than for their male counterparts (39%). Interesting differences between women and men are in the middle age group (55–59), there are

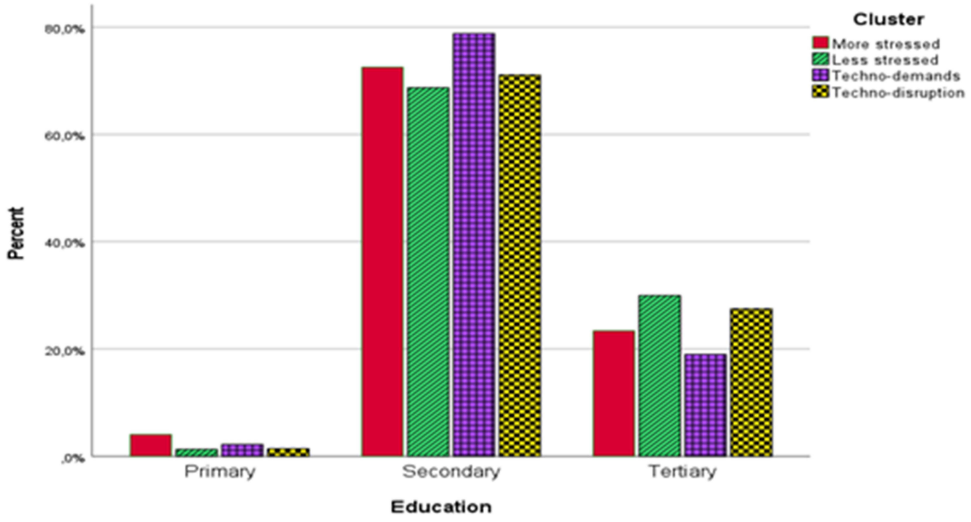

Figure 5 Four clusters created on the respondent's answers in particular technostressors, comparison of respondents according to their gender.

Table 5 The Averages of Individual Main Components for Individual Techno-Stressors for Respondents by Age

Age of respond.	FAC1_Overload	FAC1_Invasion	FAC1_Complexity	FAC1_Privacy	FAC1_Inclusion
50–54-year-olds	−0.006	0.041	−0.028	0.055	−0.026
55–59-year-olds	0.010	−0.019	0.012	−0.066	0.006
60–64-year-olds	−0.005	−0.051	0.035	0.002	0.043
Total	0.000	0.000	0.000	0.000	0.000

more women who are the least stressed (41%) than men (30.5%), men in this age group are more stressed by techno-demands (40%) than women (36%). The oldest group of respondents is the least represented in both men and women, however, still the dominant cluster in both genders are the most stressed (similar for men and women 28% and 25%), whereas among men in this age group are the least stressed represented similar as the most stressed (27%), among oldest women the least stressed are only 14% of respondents (Table 5). In general, more stress is experienced by women and older individuals. Among women, higher stress levels are evident in the younger age category. Techno-demand is more prevalent among women in the younger age category compared to men. Techno-disruption is more represented in the age category of 50–54 in both genders.

Apparently, the most represented group of respondents regarding their education were those with secondary education. So, if we compare the shape of the three educational groups, we see that the most stressed are respondents with primary education, then those with secondary education. In the tertiary education those who are least stressed prevail. If we compare the secondary and tertiary educated respondents, they differ in techno-demands and techno-disruption. The biggest cluster at the secondary educated respondents is the techno-demand, it is the smallest in tertiary educated ones, who suffer more from techno-disruption. Figure 6 presents the role of demographic factors in shaping technostress, confirming that workers with lower education levels experience higher techno-complexity and techno-inclusion stress, supporting Digital Divide Theory.[63] Women report greater challenges in digital adaptation, aligning with research on stereotype threat and gender disparities in workplace technology use.[65] Employees in highly digitalized workplaces exhibit higher techno-invasion stress, indicating that constant connectivity pressures contribute to work-life imbalance and digital burnout.[7] Meanwhile, older workers with less prior technology exposure struggle with digital inclusion, reinforcing the need for workplace digital mentoring and structured learning programs.[40]

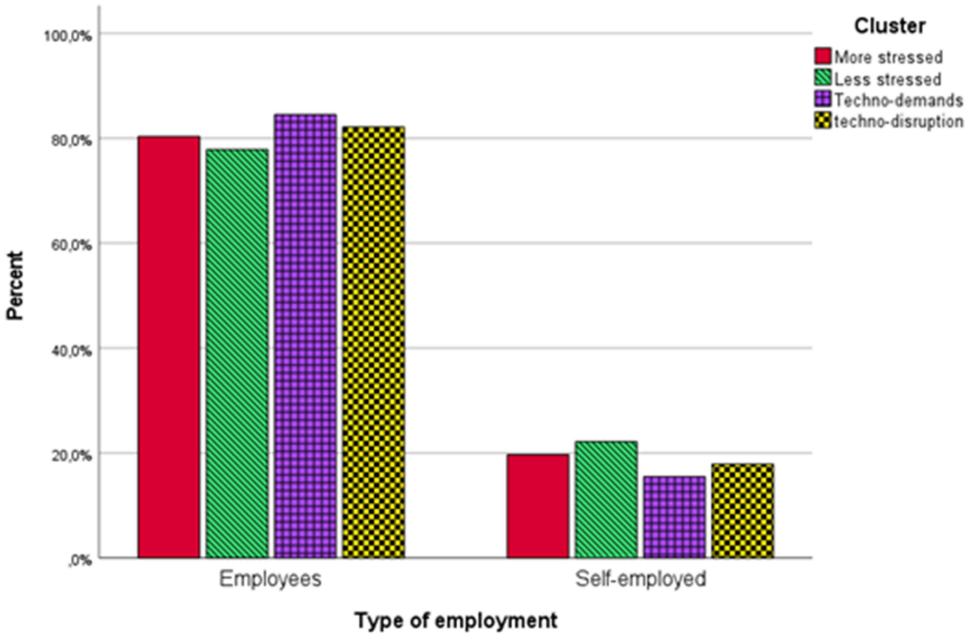

Figure 6 Four clusters created on the respondent's answers in particular technostressors, comparison of respondents according to their education.

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As presented in Figure 7, technostress differences based on employment type and variations between employees and self-employed workers, confirm that workplace structure influences digital stress experiences. Employees report higher techno-overload and techno-invasion stress, suggesting that structured workplaces impose greater pressure to use multiple digital tools, meet productivity demands, and remain connected beyond working hours.[7] This is also supported by the research showing that corporate employees face increased digital multitasking and communication expectations, contributing to heightened stress and work-life imbalance.[8] In contrast, self-employed workers experience greater techno-complexity and techno-privacy stress, likely due to the need to independently manage digital tools, cybersecurity risks, and evolving technology requirements.[62] Without the institutional IT support available to employees, self-employed individuals may struggle more with adapting to new software, securing data, and maintaining digital competence.[4]

An examination of clusters from the viewpoint of the participants' nationality confirmed that Czech respondents experience the highest levels of stress in comparison to other groups. In the cluster designated as 1, representing those most affected by stress, Czech individuals were found to be the most prevalent, Likely due to more advanced workplace digitalization and stricter data security awareness.[59] It is followed by Slovaks and Poles, with Hungarians being the least represented in this category. In contrast, within cluster 2, which corresponds to the least stressed individuals, Hungarian respondents were found to be the majority, with other national groups represented in the following sequence: Czechs, Poles, and Slovaks. The disparities between respondent groups based on their country of origin in cluster 3, those stressed by techno-demands, were relatively minimal, with representation in the order of Czechs, Slovaks, Hungarians, and Poles. In cluster 4, which comprises individuals stressed by the techno-intrusion into their private lives, Czechs and Slovaks were the most common, whereas Hungarians and Poles were less frequently represented. These findings emphasize the need for country-specific digital policies to mitigate technostress, such as tailored digital training programs in fast-digitizing economies and structured digital inclusion efforts in regions undergoing digital transition.

Addressing technostress in central Europe requires a multipronged approach by all stakeholders to ensure a balanced digital transition. Based on the results of this study, the policymakers in the Czech Republic and Poland, where digitalization is rapid, should implement right-to-disconnect laws to reduce techno-invasion stress.[68] Slovakia and Hungary, with slower adoption, should focus on state-sponsored digital upskilling to lower techno-complexity stress.[63] Mental health and technostress awareness programs should be incorporated across all labor policies.[5] Employers in high-tech sectors (Czech Republic, Poland) should adopt flexible work policies and digital detox initiatives to prevent techno-overload.[7] Manufacturing-heavy economies (Slovakia, Hungary) should prioritize gradual tech adoption and hands-on training.[40] Secure, user-friendly digital

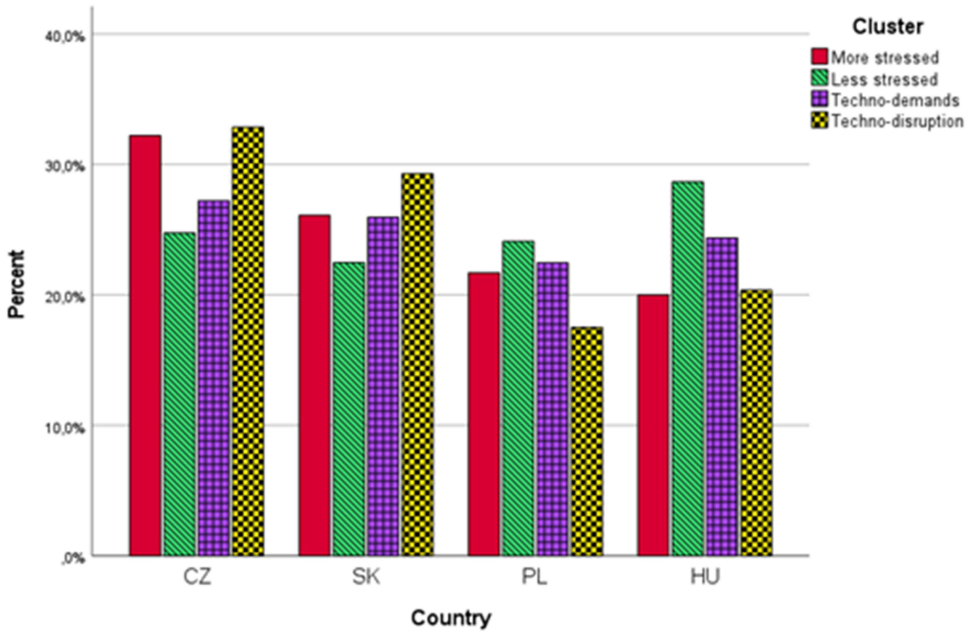

Figure 7 Four clusters created on the respondent's answers in particular technostressors, comparison of respondents according to their form of employment.

tools are essential across all industries to address techno-privacy concerns.[4] Employees should engage in upskilling programs, with peer mentoring for older workers in Poland and the Czech Republic and basic digital literacy training in Slovakia and Hungary.[20,45] Educators should tailor training to workforce needs, emphasizing advanced IT skills in Czech and Polish institutions and basic digital proficiency in Slovak and Hungarian vocational schools.[40,63] Technology developers should design localized, user-friendly digital tools, with AI-driven interfaces in corporate sectors (Czech Republic, Poland) and simplified platforms in Slovakia and Hungary.[4,62] Balancing cybersecurity with usability is crucial across the region.[7]

Limitation and Future Research

While this study provides important insights into technostress among older workers, several limitations should be considered. First, its cross-sectional design limits the ability to determine causal relationships, as it captures only a snapshot of technostress rather than its evolution over time. Future research should employ longitudinal approaches to track digital adaptation. Second, reliance on self-reported data may introduce response bias, as perceptions of technostress may differ from actual experiences. Integrating physiological stress indicators or workplace productivity data could improve measurement accuracy.[69] Third, the use of the Computer-Assisted Web Interviewing (CAWI) method presents challenges such as sampling bias, self-selection effects, and the exclusion of less tech-savvy individuals.[56] Additionally, CAWI surveys lack interviewer supervision, increasing the risk of misinterpretation of questions and superficial responses.[70] Future studies should incorporate mixed-method approaches, including face-to-face or phone interviews, to enhance data quality. Fourth, while the study covers multiple Central European countries, findings may not be fully generalizable to other regions with different digital infrastructures, labor policies, or workplace cultures. Additionally, industry-specific differences were not fully explored, yet certain sectors may face unique technostress challenges due to varying levels of digitalization. Finally, the study does not account for coping mechanisms, digital self-efficacy, or personality traits, which can influence how individuals perceive and manage technostress. Addressing these limitations in future research would improve the applicability of findings and inform more targeted workplace interventions.

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