

Effects of technostress on the productivity of workers in ICT company: an observational study

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Summary. Introduction. Information and communication technologies (ICT) offer many advantages but also have negative aspects. This study explores the level of stress caused by technology and its impact on productivity, analyzing individual perceptions and use of technology. **Methods.** This observational study used a questionnaire validated by Tarafdar et al., translated into Italian and administered online. Technological stress factors, role stress, and productivity were analyzed using SPSS 27. Multivariate analysis identified relationships between responses and various variables. **Results.** The analysis of 1,746 individuals revealed a significant association between techno-overload, techno-invasion, techno-complexity, techno-insecurity, techno-uncertainty, and demographic and work-related variables. These factors affected productivity. Bivariate and multivariate analyses confirmed the interaction between technology, stress, and work efficiency. In particular, the female gender was associated with techno-overload ($p=0.04$), techno-invasion, and role conflict ($p<0.001$). Age was correlated with techno-invasion ($p=0.001$), techno-complexity ($p<0.001$), role overload ($p<0.001$), role conflict ($p=0.046$), and productivity ($p=0.018$). **Discussion and conclusions.** Technology, while useful, can lead to technostress. The study highlights how various technological stress factors impact gender, age, and work-related stress. This observational study evaluates the phenomenon of technostress, both work-related and non-work-related, experienced by 1,746 individuals. The results particularly indicate that different technological stress factors significantly affect women, age, and work-related stress. Continued research is needed in this field to better understand and clarify the epidemiology, clinical presentation, and causes of the condition.

Key words. ICT, job strain, observational study, productivity, technostressor, technostress work-related, wellbeing.

Introduction

Technology has changed the world, made life easier, and integrated itself into the existence of individuals. The development of digital technology and the

Effetti del tecnostress sulla produttività dei lavoratori nelle aziende ICT: uno studio osservazionale.

Riassunto. Introduzione. Le tecnologie dell'informazione e della comunicazione (ICT) offrono molti vantaggi, ma comportano anche aspetti negativi. Questo studio esplora il livello di stress causato dalla tecnologia e il suo impatto sulla produttività, analizzando la percezione e l'uso individuale della tecnologia. **Metodi.** Lo studio, di tipo osservazionale, ha utilizzato un questionario validato da Tarafdar et al., tradotto in italiano e somministrato online. Sono stati analizzati i fattori di stress tecnologico, stress di ruolo e produttività, usando il software SPSS 27. L'analisi multivariata ha identificato relazioni tra le risposte e diverse variabili. **Risultati.** L'analisi condotta su 1746 individui ha mostrato un'associazione significativa tra tecno-sovraccarico, tecno-invasione, tecno-complessità, tecno-insicurezza, tecno-incertezza, variabili demografiche e lavorative. Questi fattori influenzano la produttività. Le analisi bivariate e multivariate hanno confermato l'interazione tra tecnologia, stress ed efficienza lavorativa. In particolare, il genere femminile è associato al tecno-sovraccarico ($p=0.04$), tecno-invasione e conflitto di ruolo ($p<0.001$). L'età è correlata a tecno-invasione ($p=0.001$), tecno-complessità ($p<0.001$), sovraccarico di ruolo ($p<0.001$), conflitto di ruolo ($p=0.046$) e produttività ($p=0.018$). **Discussione e conclusioni.** La tecnologia, seppur utile, può portare al tecnostress. Lo studio evidenzia come diversi fattori di stress tecnologico influiscano su genere, età e stress lavorativo. Questo studio osservazionale valuta il fenomeno del tecnostress, sia lavorativo che non lavorativo, sperimentato da 1746 individui. I risultati indicano in particolare che diversi fattori di stress tecnologico interessano in modo significativo il genere femminile, l'età e lo stress lavorativo. Naturalmente è necessario continuare la ricerca in questo campo per comprendere meglio e chiarire l'epidemiologia della malattia, la sua presentazione clinica e le sue cause.

Parole chiave. Benessere, ICT, produttività, studio osservazionale, tecnostressor, tecnostress legato al lavoro, tensione lavorativa.

Internet have enabled the advancement of humanity; the World Wide Web has revolutionized businesses that have embraced the digital world, while in the social sphere the development of social media communication has radically changed communication:

at the same time everyone has become both a user and an author of content¹.

Territories have become hyperplaces where the flow of information and data generated by electronic devices have overcome physical barriers. Information and Communication Technologies (ICT) are increasingly present in professional and personal life. Thanks to them we are able to access information flows very easily and quickly, and with social media it is possible to stay in touch with colleagues, friends and family members simultaneously. Overall, such technologies improve our performance.

However, despite the many benefits of ICT, many negative aspects of using technology have also emerged. ICTs are known to cause anxiety and tension in users, a condition called techno-anxiety². In particular, the enormous amount of information that individuals absorb, assimilate and handle daily basis leads to a state of cognitive overload referred to in psychology as “information overload”. The tension that occurs is generated by the large amount of incoming information that is too much compared to what the mind is able to process. This condition generates in the individual a state of anxiety and a widespread fear of being overwhelmed by an immense amount of material that cannot be mastered and organized³.

In this situation, there is a state of alarm, an abnormal response (mental and physical) of the body that responds with an intense production of adrenaline and cortisol. The consequences of this activation are symptoms such as cardiovascular, mental and neurological diseases⁴. An individual's interaction with ICT can be characterized by nervousness and apprehension depending on how the individual deals with digital technologies. This mental predisposition can generate certain psychological effects such as insecurity about the use of ICTs and decreased confidence in their use. Such conditions can result in feelings of helplessness and annoyance to the point of causing a genuine aversion or phobia toward the use of computers, a condition called technophobia^{5,6}.

Young's study⁷ also shows that extensive and compulsive use of the Internet and smartphones can cause an addictive condition called techno-addiction. Stress is an adaptive reaction of the body in response to certain factors, called stressors, that alter its homeostasis. The short-term response to a stressor, healthy and physiological, is the resilience mechanism of human beings. What leads to pathological consequences is chronic stress or long-term stress⁸. In the case of Technostress (TS), the stressor seems to stem from the use of technology, particularly ICT.

The term “technostress” was coined by American psychologist Craig Brod in 1984⁹. The psychologist first referred to the stress associated with the use of technology and its impact at the psychological level. Technostress, in Brod's definition, was «a modern

disease of adaptation caused by the inability to cope in a healthy way with new information technologies», referring to computers than software. His insight came about through the observation of a patient who showed signs and symptoms of clinical depression; however, over time, it became apparent that the real cause of the disorder was the constant difficulty in interfacing with the technologies used to perform professional activity.

In 1997, the definition of TS was reworked by Weil and Rosen and described as «any negative impact on attitudes, thoughts, behaviors, or bodily physiology caused directly or indirectly by technology»¹⁰.

For Champion, TS is a serious pathology that causes various symptoms such as panic, anxiety, technophobia, mental fatigue, physical complaints, intolerance, and extreme perfectionism¹¹.

From its first description in the 1980s to the present time, many studies have been conducted to determine the nature and complexity of TS syndrome. The most encountered physical symptoms are cardiovascular disorders (hypertension, coronary artery disease), gastrointestinal disorders (irritable bowel, gastritis, reflux), insomnia and sleep-wake rhythm alterations, headaches, chronic fatigue, sweating, neck pain, hormonal and menstrual disorders in women and stress-related skin disorders (psoriasis, dermatitis). Among mental symptoms, on the other hand, the most frequent are irritability, depression, apathy, memory disturbances and crying fits¹².

At the organizational level, absenteeism, low productivity, isolation, high accident rates, workplace conflicts, dissatisfaction, delay, and malfunction in production, organizational, and management processes occur. Technostress in the company can cause an increase in operating costs as it increases the risk to business health and safety and the need to seek medical and health professionals to manage the negative consequences that occur.

Especially during the period of the Covid-19 pandemic, as indicated in the study by Molino et al.¹³, significant correlations emerged between the dimensions of technostress and two main elements, namely work-related stress and work-family conflict, during the first lockdown in Italy. In particular, the researchers found an increased risk of stress in smart workers who had a high workload: this condition confirms that technostress is related not only to ICT use, but also to how long the individual interfaces with digital devices with an associated high workload.

There are five technostressors identified in the scientific literature and first described by Tarafdar et al.¹⁴ in a cross-sectional study. Technostressors influence our relationship with technologies and the level of stress in their use.

- *Techno-overload*: the enormous amount of incoming informations from different sources

overloads human cognitive functions; the consequence is feeling overwhelmed and burdened by the excessive load of information at hand.

- *Techno-invasion*: ICT makes a person always available, the individual feels invaded, and there is no boundary between work and private life.
- *Techno-complexity*: an element related to the constant innovations of ICTs, which force those who use them to constantly update. This condition causes a sense of aversion, fear and anxiety.
- *Techno-insecurity*: generated by the fear of losing one's job because it has been replaced by ICT or by colleagues who are more familiar with these tools; such fears cause suspiciousness, envy, frustration.
- *Techno-uncertainty*: relates to so-called "decision fatigue", or a difficulty in making decisions that causes dissatisfaction, procrastination, loss of motivation, and quitting^{14,15,16}.

These factors have also been investigated and discussed by other authors, and the questionnaire developed by Tarafdar et al. measuring these five domains has been used in most cross-sectional studies in the literature¹⁴.

Work-related TS has been widely studied in the literature for its impact on productivity and occupational activity. Symptoms has a subjective component, and each person may or may not develop certain symptoms. From these subjective components, it is possible to work on prevention activities, intervening in the inner aspects that "respond" to the stressful event¹⁷.

For the prevention and management of the syndrome, TS should be included in the work-related risk assessment document in all those workplaces where there is frequent and daily use of digital technologies. Recognizing this condition and the corollary of symptoms is essential to implement appropriate prevention measures, such as increased employee training, to counteract the harmful effects of technostress^{1,18,19}.

This observational study aims to know and understand the level of stress arising from the use of technology (TS) and its impact on productivity and how people perceive and use technology at the individual level. In the questionnaire used in the present study, in addition to technostressors there are three other variables referring to role conflict, role overload and productivity present in Tarafdar's¹⁴ questionnaire.

Materials and methods

Data of this observational study were extracted using a questionnaire proposed and validated by Tarafdar et al.¹⁴ The questionnaire mentioned above was translated in Italian language and it was trans-

formed into an online format with Google Docs form. Online questionnaire methodology let to capture the responses of a wide variety and number of individuals. The duration of the administration was about 1 month, from December 2022 to January 2023.

The Technostress Questionnaire was developed in the context of research examining technostress related to organizational use of ICT¹⁴.

The study focuses on the development and empirical validation of a conceptual model that explores the consequences of technostress for end users in organizations. The questionnaire assesses several dimensions of technostress, such as information overload and role conflict. It includes scales to measure various dimensions of technostress and its consequences for end users. These scales were developed based on existing scales in the literature.

Through the items in the questionnaire, an assessment is made of participants' attitudes, perceptions, or experiences with stress arising from the use of ICT. The authors use a Likert scale to measure various aspects of technostress, empirically validating the hypotheses¹⁵.

The Likert scale is commonly used to measure attitudes, opinions or perceptions of individuals on a given topic. It consists of a series of statements or declarations to which questionnaire participants respond by indicating their degree of agreement or disagreement on a multilevel scale²⁰.

Specifically, in this study, the range of answers has been adapted as following:

- completely in disagreement;
- partially disagree;
- undecided;
- partially agree;
- completely agree.

INDEPENDENT VARIABLES

Between control variables were included age, gender, working activity, position role, type of contract, commercial role. These variables were chosen because research suggestions showed that these may impact how individuals perceive and use technology, as well as experience stress associated with technology.

DEPENDENT VARIABLES

Among the risk factors for the technostress (techno-stressors) were considered five accepted factors in scientific literature and firstly described by Tarafdar et al.¹⁴ in a cross-sectional study: techno-overload, techno-invasion, techno-complexity, techno-insecurity and techno-uncertainty (refers to the constant upgrades of software and hardware that may impose stress on individuals). These fac-

tors have been underlined and discussed by other authors too, and the questionnaire developed by Tarafdar et al.¹⁴, measuring these five domains, has been used in the most of the cross-sectional studies. In addition to techno-stressors, role-stressors (role-overload and role-conflict) and productivity were considered among the dependent variables too.

An additional variable, *job strain*, was used in the present study. The concept of job strain was theorized in 1979 by Robert Karasek. The main assumption of the job strain model is that job stress results from exposure to high demands combined with high psychological load (job demand) and low decision autonomy (decision latitude)²¹.

STATISTICAL ANALYSIS

The statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 27. Descriptive analyses were performed using frequencies and percentages for qualitative variables, mean and SD for quantitative variables.

The bivariate analysis between these variables was performed using the Pearson correlation.

Finally, a multivariate analysis (linear regression model), using a stepwise procedure with backward elimination, was used to confirm the relationship between the answers and the different variables selected. The goodness of fit of the models was assessed using the R^2 .

The statistical significance was set at a p-value of less than 5%.

Results

The following study was performed on a sample of 1746 individuals (response rate=60.6%), of which 604 females (34.6) and 1142 males (65.4). The median age is 50 years (42.2% between 45 and 55 years). Regarding marital status, most respondents are married or cohabitant (1098; 62.9%), followed by single (495; 28.4%). Regarding the educational level, most respondents are graduate (863; 49.4%), followed by high school qualifications (751; 43%). The working categories are represented by white collars with low responsibilities (1254; 71.8%), medium management (399; 22.9%), and top managers (87; 5%). Most of employees (1221; 69.9%) had a job seniority over 10 years.

The univariate analysis (table 1) showed that Gender is significantly associated with *techno-overload* (2.8 males, 2.7 females; $p=0.49$), *techno-complexity* (male 2.3, female 2.5; $p=0.005$) and *role-conflict* (male 2.5, female 2.4; $p=0.005$). Age group is significantly associated with *techno-overload* (2.7 in indi-

viduals <35 years old, 2.7 in individuals aged between 36-44, 2.9 in individuals aged between 45-55, 2.8 in individuals >55 years old; $p=0.13$), *techno-complexity* (2.3 in individuals <35 years old, 2.4 in individuals aged between 35-44 and 45-55, 2.5 in individuals >55; $p=0.003$), *role-overload* (3.4 in individuals <35 years old, 3.6 in individuals aged between 35-44 and 45-55; $p<0.001$) and *productivity* (4.3 in individuals <35 years old, 4.2 in individuals aged between 35-44 and 45-55, 4.1 in individuals >55; $p<0.001$).

Marital status, on the other hand, is significantly associated with *techno-insecurity* (Married 2.0; Non married 2.1; Separated/divorced 2.0; widower 1.9; $p\text{-value}=0.57$) and *role-overload* (Married 3.6; Non married 3.4; Separated/divorced 3.7; widower 3.6; $p\text{-value}=0.003$), while Educational level is significantly associated with *techno-complexity* (junior high school graduation 2.5, high school graduation 2.5 degree 2.8, doctorate/master's degree 2.9; $p=0.003$) and *techno-uncertainty* (junior high school graduation 3.1, high school graduation 3.0. degree 2.8, doctorate/master's degree 2.8; $p=0.009$). The variable Sons, instead, is significantly associated with *techno-invasion* (yes 2.9; no 2.7; $p=0.028$) and *role-overload* (yes 3.6 and no 3.5; $p=0.001$) and *techno-complexity* (apprenticeship 2.5, fixed-term contract 2.2, open-ended contract 2.4; $p=0.26$).

Regarding the types of contracts, we have seen that Type of contract-1 is significantly associated with *techno-invasion* (2.5 apprenticeship, fixed-term contract 2.8, open-ended contract 2.8; $p=0.006$), *techno-uncertainty* (apprenticeship 3.0. fixed-term contract 3.2, open-ended contract 2.9; $p=0.002$), *role-overload* (apprenticeship 3.1, fixed-term contract 3.4, open-ended contract 3.6; $p=0.001$), *role-conflict* (apprenticeship 2.2, fixed-term contract 2.5, open-ended contract 2.5; $p=0.012$) and *productivity* (apprenticeship 4.4, fixed-term contract 4.4, open-ended contract 4.2; $p=0.001$), while Type of contract-2 is significantly associated only with *techno-complexity* (full-time 2.4, part-time 2.8; $p=0.26$).

Furthermore, Job position is significantly associated with *techno-overload* (manager 2.6, worker 2.8, middle manager 3.0. clerk 2.9; $p=0.05$), *techno-invasion* (2.6 manager, 2.8 worker, 3.0 middle manager, clerk 2.9; $p=0.055$), *techno-complexity* (manager 2.0. worker 2.4, middle manager 2.7, clerk 2.3; $p<0.001$), *techno-insecurity* (manager 1.7, worker 2.1, middle manager 2.5, clerk 1.9; $p<0.001$), *techno-uncertainty* (manager 2.6, worker 3.0. middle manager 2.5, clerk 2.7, $p=0.001$) and *role-overload* (manager 3.9; worker 3.4, middle manager 3.6, clerk 3.8; $p<0.001$). In addition, Commercial role is significantly associated with *techno-complexity* (yes 2.1, no 2.8; $p=0.004$), *techno-uncertainty* (yes 2.7, no 2.9; $p=0.022$), *role-overload* (yes 3.9, no 3.5, $p=0.003$) and *productivity* (yes 4.5, no 4.2; $p<0.001$).

Table 1. Results of the univariate analysis.

Variables	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	Role overload	Role conflict	Productivity
Gender								
Male	2.8 (1.0)	2.8(1.02)	2.3 (0.91)	2.0 (0.79)	2.9 (0.9)	3.5 (0.98)	2.5(0.93)	4.2 (0.68)
Female	2.7 (0.98)	2.7(1.04)	2.5 (0.99)	2.1 (0.80)	2.9 (0.83)	3.6 (0.99)	2.4 (0.95)	4.2 (0.69)
p-value	.049	.118	.005	.720	.428	.251	.005	.135
Age								
Until 35	2.7 (0.90)	2.7 (0.98)	2.3 (0.90)	2.1 (0.81)	3.0 (0.84)	3.4 (1.01)	2.4 (0.93)	4.3 (0.60)
36-44	2.7 (0.99)	2.8 (1.04)	2.4 (0.94)	2.0 (0.75)	2.8 (0.81)	3.6 (0.94)	2.5 (0.92)	4.2 (0.67)
45-55	2.9 (1.02)	2.8(1.0)	2.4 (0.93)	2.0 (0.81)	2.9 (0.87)	3.6 (0.97)	2.4 (0.94)	4.2 (0.71)
Over 55	2.8 (1.06)	2.8 (1.10)	2.5 (0.99)	2.0 (0.76)	2.8 (0.90)	3.6 (0.97)	2.5 (0.97)	4.1 (0.74)
p-value	.013	.582	.003	.092	.198	<0.001	.516	<0.001
Marital status								
Married	2.8 (1.01)	2.8 (1.02)	2.4 (0.94)	2.0 (0.77)	2.9 (0.86)	3.6 (0.95)	2.5 (0.93)	4.2 (0.70)
Non married	2.7 (0.95)	2.8 (1.0)	2.4 (0.93)	2.1 (0.81)	2.9 (0.86)	3.4 (1.03)	2.5 (0.93)	4.3 (0.65)
Separated/ divorced	2.8 (1.06)	3.0 (1.12)	2.5 (0.96)	2.0 (0.84)	2.8 (0.81)	3.7 (1.01)	2.4 (1.02)	4.2 (0.66)
Widower	3.1 (1.18)	3.5 (0.99)	2.4(1.07)	1.9 (0.90)	3.1 (1.23)	3.6 (1.28)	1.7 (0.61)	4.1 (0.72)
p-value	.264	.162	.358	.057	.612	.003	.111	.139
Educational level								
Junior high school graduation	3.0 (1.18)	3.1 (0.90)	2.5 (0.81)	1.6 (0.51)	3.1 (0.82)	3.6 (0.94)	2.2(0.48)	4.6 (0.53)
High school graduation	2.8 (0.99)	2.8 (1.02)	2.5 (0.93)	2.1 (0.83)	3.0 (0.87)	3.5 (1.0)	2.4 (0.93)	4.2 (0.70)
Degree	2.8(0.99)	2.8 (1.02)	2.3 (0.94)	2.0 (0.75)	2.8 (0.86)	3.6 (0.97)	2.5 (0.93)	4.2 (0.68)
Doctorate/ master's degree	2.8 (1.07)	2.9 (1.05)	2.3 (0.95)	2.1 (0.83)	2.8 (0.83)	3.6 (0.99)	2.5 (1.06)	4.2 (0.60)
p-value	.917	.158	.003	.078	.009	.396	.741	.241
Sons								
Yes	2.8 (1.02)	2.9 (1.04)	2.4 (0.94)	2.0 (0.78)	2.9 (0.86)	3.6 (0.95)	2.4 (0.94)	4.2 (0.79)
No	2.7 (0.96)	2.7(1.0)	2.4 (0.93)	2.1 (0.81)	2.9 (0.86)	3.5 (1.01)	2.5 (0.94)	4.2 (0.70)
p-value	.077	.028	.364	.056	.356	.001	.212	.199
Type of contract-1								
Apprenticeship	2.5 (0.94)	2.5 (0.92)	2.2 (0.86)	2.1 (0.78)	3.0 (0.84)	3.1 (1.06)	2.2 (0.81)	4.4 (0.56)
Fixed-term contract	2.8 (0.94)	2.8 (1.0)	2.2 (0.93)	2.1 (0.83)	3.2 (0.84)	3.4 (0.97)	2.5 (0.82)	4.4 (0.58)
Open-ended contract	2.8 (1.0)	2.8 (1.03)	2.4 (0.94)	2.0 (0.79)	2.9 (0.86)	3.6 (0.97)	2.5 (0.95)	4.2 (0.69)
p-value	0.006	.018	.026	.469	.002	<0.001	.012	.001
Type of contract-2								
Full-time	2.8 (1.0)	2.8 (1.02)	2.4 (0.94)	2.0 (0.79)	2.9 (0.86)	3.6 (0.98)	2.5 (0.94)	4.2 (0.68)
Part-time	2.7 (0.99)	2.8 (1.02)	2.8 (0.93)	2.2 (0.86)	3.0 (0.85)	3.3 (0.92)	2.3 (0.82)	4.1 (0.74)
p-value	.387	.949	<0.001	.097	.159	.074	.282	.240
Job position								
Manager	2.6 (1.01)	2.8 (0.99)	2.0 (0.80)	1.7 (0.64)	2.6 (0.86)	3.9 (0.84)	2.4 (0.96)	4.4 (0.57)
Worker	2.8 (0.97)	2.7 (1.0)	2.4 (0.95)	2.1 (0.82)	3.0 (0.85)	3.4 (0.99)	2.4 (0.92)	4.2 (0.69)

(Continue)

Continue Table 1.

Variables	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	Role overload	Role conflict	Productivity
Middle manager	3.0 (0.76)	3.3 (0.70)	2.7 (0.76)	2.5 (0.89)	2.5 (0.64)	3.6 (0.91)	2.7 (0.83)	4.0 (0.51)
Clerk	2.9 (1.06)	3.0 (1.07)	2.3 (0.92)	1.9 (0.70)	2.7 (0.86)	3.8 (0.91)	2.5 (0.98)	4.2 (0.66)
p-value	.055	<0.001	<0.001	<0.001	<0.001	<0.001	.329	.052
Commercial role								
Yes	2.7 (1.07)	2.8 (1.15)	2.1 (0.89)	2.0 (0.63)	2.7 (0.92)	3.9 (0.90)	2.3 (0.98)	4.5 (0.55)
No	2.8 (0.99)	2.8 (1.02)	2.4 (0.94)	2.1 (0.80)	2.9 (0.86)	3.5 (0.98)	2.5 (0.93)	4.2 (0.69)
p-value	.421	.995	.004	.301	.022	.003	.221	<0.001
Years of activity								
<2 years	2.6 (0.89)	2.6 (0.99)	2.2 (0.87)	2.1 (0.81)	3.1 (0.85)	3.1 (1.02)	2.2 (0.80)	4.4 (0.54)
2-5 years	2.9 (0.92)	2.9 (0.98)	2.4 (0.95)	2.2 (0.87)	2.9 (0.83)	3.6 (1.0)	2.7 (0.98)	4.3 (0.62)
6-10 years	2.7 (0.94)	2.7 (1.03)	2.2 (0.89)	2.1 (0.76)	2.8 (0.86)	3.5 (0.94)	2.4 (0.89)	4.1 (0.70)
>10 years	2.8 (1.02)	2.8 (1.03)	2.4 (0.95)	2.0 (0.78)	2.9 (0.86)	3.6 (0.95)	2.4 (0.95)	4.2 (0.70)
p-value	.001	.052	.011	.129	.001	<0.001	<0.001	<0.001

Finally, Years of activity is significantly associated with *techno-overload* (<2 years 2.6, 2-5 years 2.9, 6-10 years 2.7, >10 years 2.8; $p<0.001$), *techno-invasion* (<2 years 2.6, 2-5 years 2.9, 6-10 years 2.7, >10 years 2.8; $p<0.052$), *techno-complexity* (<2 years: 2.2; 2-5 years 2.4; 6-10 years: 2.2; >10 years: 2.4; $p=0.011$), *techno-uncertainty* (<2 years: 3.1; 2-5 years 2.9; 6-10 years: 2.8; >10 years: 2.9; $p=0.001$) *role-overload* (<2 years: 3.1; 2-5 years 3.6; 6-10 years: 3.5; >10 years: 3.6; $p<0.001$), *role-conflict* (<2 years: 2.2; 2-5 years: 2.7; 6-10 years: 2.4; >10 years: 2.4; $p<0.001$) and *productivity* (<2 years: 4.4, 2-5 years 4.3; 6-10 years: 4.1; >10 years: 4.2; $p<0.001$).

In the bivariate analysis (table 2) the statistics show a significative correlation of job strain with *techno-overload* 0.386** (<0.001), *techno-invasion* 0.426** (<0.001), *techno-complexity* 0.205** (<0.001), *techno-insecurity* 0.144** (<0.001), *techno-uncertainty* -0.064** (.008), *role overload* 0.630** (<0.001), *role conflict* 0.479** (<0.001) and *productivity* -0.115** (<0.001). Techno-overload is significantly correlated with *job strain* 0.386 (<0.001), *techno-invasion* 0.586** (<0.001), *techno-complexity* 0.377** (<0.001), *techno-insecurity* 0.326** (<0.001), *techno-uncertainty* 0.125** (<0.001), *role overload* 0.440** (<0.001), *role conflict* 0.371** (<0.001) and *productivity* -0.208** (<0.001).

Has been found a significantly correlation of techno-invasion with *job strain* 0.426** (<0.001), *techno-overload* 0.586** (<0.001), *techno-complexity* 0.309** (<0.001), and *techno-insecurity* 0.334** (<0.001), *techno-uncertainty* 0.060* (0.013), *role overload* 0.515** (<0.001), *role conflict* 0.420** (<0.001) and *productivity* -0.145** (<0.001). Also, techno-complexity is sig-

nificantly correlated with *job strain* 0.205** (<0.001), *techno-overload* 0.377** (<0.001), *techno-invasion* 0.309** (<0.001), *techno-insecurity* 0.467** (<0.001), *techno-uncertainty* 0.129** (<0.001), *role overload* 0.208** (<0.001), *role conflict* 0.263** (<0.001), *techno-complexity* and *productivity* 0.246** (<0.001).

On the other hand, has been found a significantly correlation of techno-insecurity with *job strain* 0.144** (<0.001), *techno-overload* 0.326** (<0.001), *techno-invasion* 0.334** (<0.001), *techno-complexity* 0.467** (<0.001), *techno-uncertainty* 0.156** (<0.001), *role overload* 0.157** (<0.001), *role conflict* 0.354** (<0.001) and *productivity* -0.189** (<0.001).

Furthermore, it emerged a significantly correlation of techno-uncertainty with *job strain* -0.064** (.008), *techno-overload* 0.125** (<0.001), *techno-invasion* 0.060* (0.013), *techno-complexity* 0.129** (<0.001), *techno-insecurity* 0.156** (<0.001) and *productivity* 0.048* (0.44) and a significantly correlation of role overload with *job strain* 0.630** (<0.001), *techno-overload* 0.440** (<0.001), *techno-invasion* 0.515** (<0.001), *techno-complexity* 0.208** (<0.001), *techno-insecurity* 0.157** (<0.001), *role conflict* 0.502** (<0.001), *role overload* and *productivity* -0.072** (0.003).

Finally, has been found a significantly correlation of role conflict with *job strain* 0.479** (<0.001), *techno-overload* 0.371** (<0.001), *techno-invasion* 0.420** (<0.001), *techno-complexity* 0.263** (<0.001), *techno-insecurity* 0.354** (<0.001), *role overload* 0.502** (<0.001), *role conflict* and *productivity* -0.196** (<0.001) and a significantly correlation of productivity with *job strain* -0.115** (<0.001), *techno-overload* -0.208** (<0.001), *techno-invasion* -0.145** (<0.001),

Table 2. Results of the bivariate analysis.

Variables	Job strain	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	Role overload	Role conflict	Productivity
Job strain	-	.386** (< 0.001)	.426** (< 0.001)	.205** (< 0.001)	.144** (< 0.001)	-.064** (.008)	.630** (< 0.001)	.479** (< 0.001)	-.115** (< 0.001)
Techno-overload	.386** (< 0.001)	-	.586** (< 0.001)	.377** (< 0.001)	.326** (< 0.001)	.125** (< 0.001)	.440** (< 0.001)	.371** (< 0.001)	.208** (< 0.001)
Techno-invasion	.426** (< 0.001)	.586** (< 0.001)	-	.309** (< 0.001)	.334** (< 0.001)	.060* (.013)	.515** (< 0.001)	.420** (< 0.001)	.145** (< 0.001)
Techno-complexity	.205** (< 0.001)	.377** (< 0.001)	.309** (< 0.001)	-	.467** (< 0.001)	.129** (< 0.001)	.208** (< 0.001)	.263** (< 0.001)	.246** (< 0.001)
Techno-insecurity	.144** (< 0.001)	.326** (< 0.001)	.334** (< 0.001)	.467** (< 0.001)	-	.156** (< 0.001)	.157** (< 0.001)	.354** (< 0.001)	-.189** (< 0.001)
Techno-uncertainty	.064** (.008)	.125** (< 0.001)	.060* (.013)	.129** (< 0.001)	.156** (< 0.001)	-	-.020 (.402)	-.001 (.955)	.048* (.044)
Role overload	.630** (< 0.001)	.440** (< 0.001)	.515** (< 0.001)	.208** (< 0.001)	.157** (< 0.001)	-.020 (.402)	-	.502** (< 0.001)	-.072** (.003)
Role conflict	.479** (< 0.001)	.371** (< 0.001)	.420** (< 0.001)	.263** (< 0.001)	.354** (< 0.001)	-.001 (.955)	.502** (< 0.001)	-	.196** (< 0.001)
Productivity	-.115** (< 0.001)	-.208** (< 0.001)	-.145** (< 0.001)	.246** (< 0.001)	-.189** (< 0.001)	.048* (.044)	-.072** (.003)	-.196** (< 0.001)	-

techno-complexity -0.246** (< 0.001), *techno-insecurity* -0.189** (< 0.001), *techno-uncertainty* -0.048* (0.044), *role overload* -0.072** (0.003) and *role conflict* -0.196** (< 0.001).

In the multivariate analysis (Table 3) the following results emerge, confirming most of the correlations found in the univariate analysis.

Female gender is significantly associated techno-overload with a standardized beta coefficient (β) of -0.064 ($p=0.04$), with techno-invasion with a β of -0.053 ($p=0.15$) and role-conflict with a β of -0.084 ($p<0.001$), while Age is significantly associated with techno-invasion with a $\beta=-0.084$ ($p=0.001$), with techno-complexity with a standardized beta coefficient (β) of 0.092 ($p<0.001$), with role-overload with a standardized beta coefficient (β) of -0.012 ($p<0.001$), with role-conflict with a $\beta=0.050$ ($p=0.046$) and with productivity with a standardized beta coefficient (β) of -0.081 ($p=0.018$).

Both variables, Sons and Open ended contract, are associated only with role-conflict with a standardized (β) beta coefficient of 0.053 ($p=0.027$) for the first one and 0.041 ($p=0.076$) for the second one. Type of contract is associated with techno-complexity with a $\beta=-0.064$ ($p=0.008$) and Middle manager is significantly associated with techno-invasion with a standardized beta coefficient of -0.060 ($p=0.011$), with techno-complexity with a $\beta=-0.128$ ($p<0.001$), with techno-insecurity with a standardized beta coefficient (β) of -0.016 ($p<0.001$), with role-overload with a $\beta=0.116$ ($p<0.001$) and productivity with a $\beta=-0.097$ ($p<0.001$);

Instead, Commercial role is significantly associated with techno-complexity with a $\beta=-0.054$ ($p=0.023$), with role-conflict with a $\beta=-0.048$ ($p=0.022$) and productivity with a $\beta=0.075$ ($p=0.002$) and Years of employment is significantly associated with role-overload, with a $\beta=0.107$ ($p<0.001$) and with productivity with a $\beta=-0.080$ ($p=0.017$).

Finally, Educational level is significantly associated with techno-complexity with a $\beta=-0.67$ ($p=0.006$), with techno-uncertainty with a $\beta=-0.085$ ($p<0.001$) and role-overload with a $\beta=0.042$ ($p=0.026$), while Job strain is significantly associated with *techno-overload* with a $\beta=0.388$ (< 0.001), *techno-invasion* with a $\beta=0.428$ ($p=0.001$), techno-complexity with a $\beta=0.210$ ($p<0.001$), *techno-insecurity* with a $\beta=0.210$ ($p<0.001$), *role-overload* with a standardized beta coefficient (β) of 0.614 ($p<0.001$), *role-conflict* with a significantly $\beta=0.491$ ($p<0.001$) and *productivity* with a $\beta=-0.107$ ($p<0.001$).

Discussion

Our study conducted a comprehensive analysis of technostress among 1746 individuals, exploring the relationship between various techno-stressors, role-stressors, and productivity. It identified significant associations of techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty with demographic and job-related variables. The study also highlighted the impact of these

Table 3. Results of the Multivariate analysis.

Variables	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity	Techno-uncertainty	Role overload	Role conflict	Productivity
Female	-.064 (.004)	-.053 (.015)	.043 (.073)				-.084 (< 0.001)	
Age		-.084 (.001)	.092 (< 0.001)			-.112 (< 0.001)	-.050 (.046)	-.081 (.018)
Sons		.042 (.087)					-.053 (.027)	
Open-ended contract					-.067 (.006)		.041 (.076)	
Type of contract			-.064 (.008)					
Middle manager		.060 (.011)	-.128 (< 0.001)	-.160 (< 0.001)	-.127 (< 0.001)	.116 (< 0.001)		.097 (< 0.001)
Commercial role			-.054 (.023)				-.048 (.022)	.075 (.002)
Years employment						.107 (< 0.001)		-.080 (.017)
Educational level			-.067 (.006)		-.085 (< 0.001)	.042 (.026)		
Job strain	.388 (< 0.001)	.428 (.001)	.210 (< 0.001)	.167 (< 0.001)	-.041 (.090)	.614 (< 0.001)	.491 (< 0.001)	-.107 (< 0.001)
R ² of the model	.153	.191	.080	.046	.033	.417	.244	.042

stressors on productivity. Bivariate and multivariate analyses confirmed these associations, providing valuable insights into the complex interplay of technology, stress, and work efficiency in a modern work environment.

Work related stress is an increasingly relevant concern in the modern workplace. It refers to the stress and strain that arise due to the skills, needs and environment of the workplace. Workers face challenges like techno-overload, where the pace and complexity of technology exceed their ability to cope, and techno-invasion, which blurs the boundaries between work and personal life. Additionally, rapid technological changes can lead to techno-insecurity, affecting job security, and techno-complexity, which demands continuous learning. Understanding and addressing technostress is crucial for maintaining employee well-being and productivity.

Recent scientific evidence has shed light on the multifaceted nature of stress among workers, particularly during the Covid-19 pandemic. A study published in the *Journal of Business Research* explored the effects of stress on British workers during the lockdown. It revealed that remote working led to increased management of many digital platforms and applications, often leading to heightened stress levels due to the overload of information and the blurring of work-life boundaries. Interestingly, the study found

that employees with previous remote working experience coped better with technostress. However, prolonged remote working situations also led to feelings of alienation and loneliness, contradicting the belief that working from home invariably improves worker satisfaction and well-being^{22,23}.

In another systematic review published on *Frontiers in Psychology*, various work-related stressors were identified and analyzed for their impact during the Covid-19 lockdown. These included techno-complexity, where technology is perceived as difficult to use, causing feelings of inadequacy among workers; techno-insecurity, where workers feel insecure in their job roles, fearing dismissal for distractions or underperformance; and techno-uncertainty, where frequent changes and upgrades in information and communication technologies require constant learning and adaptation. The review emphasized the need to understand the individual, organizational, and technological factors that exacerbate these stressors, as they can significantly influence workers' experiences of technostress²².

These studies underscore the complexity of stress in the workplace, highlighting how factors like work overload, role ambiguity, job insecurity, and the conflict between work and home demands can contribute to the phenomenon. The transition to extensive virtual work, spurred by the pandemic, has brought

technostress into sharper focus, with its implications for employee well-being and productivity.

STRENGTHS

The study used an online questionnaire, based on a previously validated work by Tarafdar et al.¹⁴. This approach allowed for data collection from a broad sample of 1746 individuals, examining variables such as age, gender, job activity, position, contract type, and commercial role. As mentioned, the study focuses on five technostress factors and two role-related stress factors, in addition to considering productivity. The document presents a detailed breakdown of the associations between various factors like gender, age, job position, and type of contract with technostressors such as techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. The study also examines role-stressors (role-overload and role-conflict) and their impact on productivity. These findings are critical for understanding how different demographic and occupational factors interact with technostress and its components.

LIMITATIONS

This study has some limitations. First, non-probability sampling techniques limit the generalizability of the results. The cross-sectional nature of the study allows us to describe general associations but not to determine the cause-and-effect relationship between the predictor variables and the dependent variable.

However, this sampling method allowed the research to be conducted in a cost- and time-efficient manner given the breadth and complexity of the topic. An additional limitation identified lies in addressing multiple stressors simultaneously and their consequences.

Conclusions

Technology is diffuse in every area of an individual life and if its usefulness is undeniable, its use can lead to negative consequences to end users, such as technostress. This observational study evaluates the phenomenon of technostress, both work-related and non-work related, experimented by 1746 individuals. The results indicate that different techno-stressors significantly influence female gender, age, and the job strain. Of course, there is need to continue the research in this field to better understand and clarify the epidemiology of the disease, its clinical presentation as well as its causes.

The answers derived from the research are useful to find solutions and manage the consequences of technostress.

Primary interventions can be carried out in two different areas: at the individual level, using problem-solving strategies to help employees implement supportive actions to change situations; at the managerial and organizational level, multiple applications for staff at the managerial level, implementing technical support and providing effective training for their proper²⁴.

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