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The Emerging Technology-Related Stressors Scale: Assessing the Impact of ICTs in the Hybrid Context

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ABSTRACT

The proliferation of Information and Communication Technologies (ICTs) is introducing new psycho-social risks, resulting in technostress. ICTs compel users to work faster and longer, leading to feelings of being overwhelmed and a diminished capacity to manage tech-related demands. The digitization of HR practices can result in stringent productivity controls and raise privacy concerns. Employees may feel inadequate due to technological advancements, perceiving a skills gap and reduced employability. ICTs have also shifted organizational communications to virtual interactions, reducing face-to-face engagement. This study developed and validated the Emerging Technology-related Stressors Scale to measure these sources of technostress, administering items to Italian employees from two different organizations through an online survey. Exploratory and confirmatory factor analysis identified a four-factor structure: technology-related demands, privacy/monitoring, employability, and technology-mediated social interactions, demonstrating good reliability. The scale correlated positively with psycho-physical distress and negatively with job satisfaction, offering a reliable tool for assessing technology-related stressors.

Keywords: Scale validation, Techno-stress, Information and communication technologies

INTRODUCTION

In response to the need for new work arrangements, companies quickly adopted digital solutions to facilitate collaboration, communication, and task management. However, this reliance on ICTs presents challenges and potential adverse psychological, physical, and behavioral outcomes for employees, and counterproductive effects for businesses (La Torre *et al.*, 2019; Sarabadani *et al.*, 2018). Working with technologies can increase perceived workload (i.e., techno-overload) due to added complexity (Rasool *et al.*, 2022), leading to issues like information overload (“data smog”), restrictive deadlines, errors, constant updates and workflow interruptions (Day *et al.*, 2012; Ragu-Nathan *et al.*, 2008). For instance, research shows that individuals spend significant time on email activities, which can reduce productive work time (Gupta & Sharda, 2008; Mark *et al.*, 2016).

Additionally, handling various information streams at high speeds forces workers to multi tasks and switch tasks rapidly, creating cognitive congestion (Judd and Kennedy, 2011; Kamal and Dong, 2017). According to cognitive load theory and task-technology fit perspective, technologies should be task-specific to avoid negative outcomes from excessive complexity and overload (Karr-Wisniewski and Lu, 2010). Techno-overload is linked to increased strain, anxiety, exhaustion, lower satisfaction and productivity (Borle *et al.*, 2021; La Torre *et al.*, 2019). Digital tools and virtual environments also reduce opportunities for direct interaction (Vayre and Pignault, 2014), leading to a phenomenon called "being alone together" where employees communicate via ICTs even when physically close (Stich, 2020; Turkle, 2011). Computer-mediated communication (CMC) can negatively affect interactions, requiring more efforts to coordinate and build relationships (Liao, 2017), leading to workplace stress (Stich *et al.*, 2018), lower trust and leader-member exchange quality, and reduced job satisfaction (Duarte and Dias, 2023; Golden *et al.*, 2008). CMC lacks social cues (e.g., tone, inflection, proximity, eye contact) essential to process relational information, which can lead to misunderstandings, and feelings of isolation (Day *et al.*, 2012). The spread of technology in the workplace has increased employee monitoring (Chang *et al.*, 2015), with around 80% of companies using electronic performance monitoring (EPM) tools like keystroke logs, website tracking, conversation recording, and GPS data (Tomczak *et al.*, 2018). While EPM can improve productivity and safety, it is often perceived negatively by employees, leading to feelings of violation. Evidence shows that constant supervision is a highly stressful experience associated with stress, anxiety, depression, anger and fatigue, decreased job satisfaction and organizational commitment (Ayyagari *et al.*, 2011; Day *et al.*, 2012; Wells *et al.*, 2007). ICTs also disrupt entire market sectors and transform job skills (Frey and Osborne, 2017), leading to "skills discrepancy" that forces continuous learning and increases stress (Day *et al.*, 2012; Wang *et al.*, 2008). The threat of job replacement by technology can cause turnover intentions, cynicism, depression, reduced job satisfaction, and career satisfaction (Brougham and Haar, 2018; Lestari *et al.*, 2023), and lower sense of employability. This perception is essential for workers' well-being as "feeling unable to relocate can generate strong anxiety that can culminate in forms of maladaptive coping and stress" (Giorgi *et al.*, 2012, p. 88). To address these issues, new measurement tools are needed to assess the impact of ICTs on both in-office and remote workers. Thus, this study aimed to develop and preliminarily validate the Emerging Technology-related Stressors Scale. It focused on identifying emerging factors that generate technostress, validating the measurement tool, and verifying associations with psychological distress and job satisfaction. This scale is intended to help organizations identify specific techno-stressors and tailor interventions to mitigate negative mental (e.g., anxiety) and work-related outcomes (i.e., job dissatisfaction), typically related to technostress (Borle *et al.*, 2021; Kumar and Kumar, 2014; La Torre *et al.*, 2019; Suh and Lee, 2017).

METHOD

Instrument Development

Based on existing literature and prior scales (Ayyagari *et al.*, 2011; Day *et al.*, 2010; Ragu-Nathan *et al.*, 2008), we created items to address emerging work-related challenges posed by ICTs using inductive and deductive approaches (MacKenzie *et al.*, 2011). Team members independently generated items reflecting potential emerging techno-stressors. Using an investigator triangulation approach (Denzin, 1978), three authors independently categorized the items into techno-stressors categories and discussed discrepancies to achieve consensus. The items were assessed for redundancy and construct representativeness. The resulting pool of 23 items was reviewed by three subject matter experts (SMEs), all scholars in techno-stress, who assessed each item's representativeness, relevance, and understandability. Based on their feedback, amendments were made. All SMEs agreed to retain all 23 items, which were included in the final set. The scale included positive and negative items, which were reverse-coded.

Participants and Procedure

The data were collected from two Italian companies: one sample included 3,762 workers from an IT consultancy multinational, and the other comprised 910 employees from the banking sector. Data collection was conducted using SurveyMonkey during 2022 and 2023, with voluntary and anonymous participation. The research adhered to the Declaration of Helsinki, the General Data Protection Regulation, and Italian privacy law, with all participants providing consent. The factor structure of the scale was evaluated using exploratory factor analysis (EFA) on the first sample and confirmatory factor analysis (CFA) on the second sample. The EFA sample included 3,374 predominantly male employees (69.3%), with most aged 31–40 years (27.8%), followed by age groups 41–50 years (26.5%), 20–30 years (23.3%), and over 50 years (22.5%). The CFA sample consisted of 852 predominantly male employees (58%), with the largest age group being over 50 years (38.4%), followed by 41–50 years (37.4%), 31–40 years (17.4%), and 20–30 years (6.8%).

Measurements

The Emerging Technology-related Stressors Scale[1] consisted of 23 items divided into four expected dimensions: 1) technology-related demands (e.g., I am forced to neglect some tasks because new notifications always come in), 2) privacy/monitoring (e.g., The use of technologies could compromise my privacy), 3) employability (e.g., My job future is uncertain due to technology), and 4) technology-mediated social interactions (e.g., The use of technology reduces opportunities for interaction among colleagues). Participants rated their agreement with each statement on a 5-point Likert scale (1=strongly disagree, 5=strongly agree).

[1] Questionnaire available on request by contacting the first author

Psycho-somatic distress was evaluated using the 12-item Italian version of the General Health Questionnaire (GHQ-12; Fraccaroli *et al*., 1991), covering three dimensions: social dysfunction (six items, e.g., Have you felt unable to cope with your problems recently?), general dysphoria (four items, e.g., Have you felt confident in yourself recently?), and loss of confidence (two items, e.g., Have you been losing confidence in yourself recently?). Responses were given on a 4-point Likert scale (from 0 = better than usual/more so than usual to 3 = much less than usual, for positively worded items; and from 0 = not at all to 3 = much more than usual, for negatively worded items), with higher scores indicating greater psycho-physical discomfort.

Job satisfaction was measured using a single item that assessed overall satisfaction ("How satisfied have you been with your work?"; Giorgi *et al*., 2015), with higher scores indicating greater job satisfaction (from 0 = no satisfaction to 10 = complete satisfaction).

RESULTS

Exploratory Factor Analysis

A total of 388 multivariate outliers were identified using $p < .001$ criterion for Mahalanobis distance and excluded. Skewness (from −0.83 to 0.99) and kurtosis (from −0.33 to 1.70) indices indicated a normal distribution of the items. Bartlett's test of sphericity was significant ($p < .001$), and the Kaiser-Meyer-Olkin measure was satisfactory (i.e., 0.95). Parallel analysis suggested a 4-factor structure, as the original data's factor had an eigenvalue of 1.17, exceeding the average expected eigenvalue of 1.10. An initial 4-factor EFA was conducted on the EFA group ($n = 3374$), utilizing maximum likelihood (ML) extraction with Geomin rotation. Two items did not meet all the criteria (i.e., factor loading below.40 on the primary factor; Howard, 2014) and were removed. The resulting four-factor solution in the EFA indicated a satisfactory fit ($\chi 2 = 1539.80$, df = 132, $p = .00$; CFI = .96; TLI = .93; RMSEA = .06; SRMR = .02). All 21 item factor loadings met the cutoff criteria outlined by Howard (2016), supporting a four-factor structure comprising 21 items with factor loadings ranging from 0.43 to 0.83. The factors were: 1) technology-related demands (8 items), 2) privacy/monitoring (3 items), 3) employability (6 items), and 4) technology-mediated social interactions (5 items). All factors demonstrated satisfactory internal reliability (overload: $\alpha = .90$; $\omega = .90$; CR = .87; privacy: $\alpha = .70$; $\omega = .70$; CR = .64; employability: $\alpha = .75$; $\omega = .76$; CR = .68; support: $\alpha = .91$; $\omega = .91$; CR = .88). The inter-item correlation was 0.63, and McDonald's omega coefficient for the 21 items was 0.93, indicating good internal consistency for the entire scale ($\alpha = 0.92$). The item-total correlation averaged 0.58, and all items exhibited communalities ranging from 0.45 to 0.76. The factor solution accounted for 62.34% of the total variance

Confirmatory Factor Analysis

A total of 58 multivariate outliers were identified using $p < .001$ criterion for Mahalanobis distance and removed. Skewness (from 0.25 to 0.82) and kurtosis (from −0.76 to 1.61) values indicated a normal distribution for the items. Bartlett's test of sphericity was significant (p <.001), and the Kaiser-Meyer-Olkin measure was satisfactory (i.e., 0.94). The 4-factor model selected in the EFA was tested on the CFA sample (n = 852) using the ML method. This model demonstrated good fit indices (χ^2 = 718.97, df = 183, p = .00; CFI = .93; TLI = .92; RMSEA = .06; SRMR = .04; see Figure 1) and outperformed all alternative models (1-factor model: χ^2 = 1626.59, df = 189, p = .00; CFI = .81; TLI = .78; RMSEA = .09; SRMR = .06; 2-factor model: χ^2 = 1438.64, df = 188, p = .00; CFI = .83; TLI = .81; RMSEA = .09; SRMR = .06; 3-factor model: χ^2 = 1272.30, df = 183, p = .00; CFI = .85; TLI = .83; RMSEA = .08; SRMR = .06). All factors exhibited satisfactory composite reliabilities (technology-related demands: α = .89; ω = .86; CR = .89; technology-mediated social interactions: α = .83; ω = .83; CR = .83; privacy/monitoring: α = .70; ω = .70; CR = .69; employability: α = .75; ω = .75; CR = .74). The total scale showed satisfactory composite reliabilities (α = .92; ω = .92; CR = .95). The average inter-item correlation was 0.62, the item-total correlation was 0.57, with all items exhibiting communalities from 0.44 to 0.73. The factor solution accounted for 58.54% of the variance.

Table 1. EFA (n = 3374): factor loadings and communalities of the selected items, explained variance and reliability of the factors.

	Factor				
Items	**1**	**2**	**3**	**4**	**h^2**
Item 22	**.56**	.11	.12	−.04	.52
Item 40	**.69**	−.02	.02	.11	.62
Item 38	**.79**	.01	.12	−.09	.74
Item 19	**.74**	.01	−.02	.01	.60
Item 11	**.75**	.04	−.11	.06	.64
Item 39	**.46**	.02	.11	.20	.48
Item 53	**.65**	.10	.05	−.03	.63
Item 16	**.71**	−.04	−.05	.12	.61
Item 7	−.03	**.79**	.11	−.06	.72
Item 49	.11	**.73**	.04	−.01	.73
Item 4	−.03	**.83**	.05	−.03	.74
Item 54	.00	**.80**	−.05	.10	.76
Item 9	.17	**.67**	−.10	.09	.70
Item 47	−.13	.01	−.04	**.70**	.70
Item 28	.07	.09	.17	**.50**	.56
Item 43	.10	−.01	.16	**.62**	.66
Item 5	.04	.20	**.43**	.09	.45
Item 45	.20	.03	**.48**	.15	.54
Item 30	−.02	−.01	**.66**	.01	.61
Item 27	−.02	.02	**.65**	.02	.58
Item 29	.16	−.03	**.49**	−.05	.47
	Factor 1	Factor 2	Factor 3	Factor 4	Total
Explained variance (%)	41.15	8.36	7.16	5.67	62.34
Cronbach's alpha	.90	.91	.70	.75	.92

Note. h^2= item communality. Factor loadings > |.40| are in bold. Factor 1=

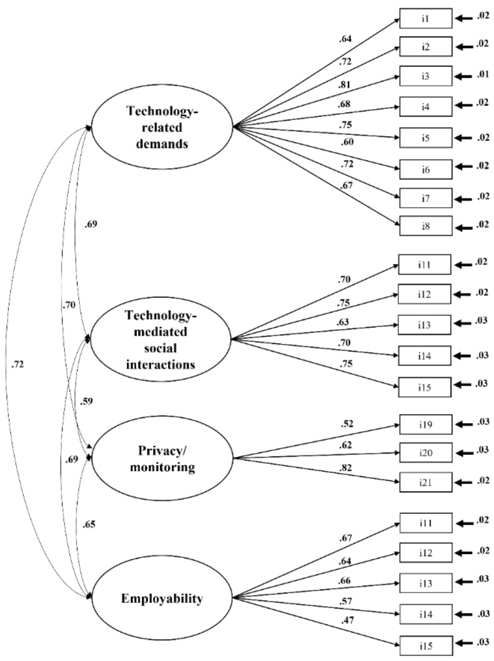

Figure 1: Standardized coefficients of the four-factor model. *Note. p<.001 for all coefficients.*

Nomological Validity

The total and sub-dimensions scores of the scale were positively related to psycho-physical distress, while negatively linked to job satisfaction (see Table 2).

Table 2. Descriptive statistics and intercorrelations among the study's variables in the CFA sample (N = 852).

	M	SD	Skew.	Kurt.	1	2	3	4	5	6	7	8	9
1. Total scale	2.61	.51	−.09	.55	**.92**								
2. Demands	2.65	.66	.08	.01	.85^{**a}	**.89**							
3. Relations	2.34	.63	.32	.26	.80^{**a}	.61^{**a}	**.83**						
4. Privacy	3.16	.71	−.16	.04	.79^{**a}	.55^{**a}	.46^{**a}	**.70**					
5. Employ-ability.	2.27	.55	.01	.45	.77^{**a}	.56^{**a}	.52^{**a}	.45^{**a}	**.75**				
6.Psychophysical malaise	1.96	.42	1.06	1.04	.43^{**a}	.45^{**a}	.35^{**a}	.30^{**a}	.29^{**a}	**.82**			
7. Satisfaction	7.09	1.69	− 1.06	1.62	−.39^{**a}	−.37^{**a}	−.31^{**a}	−.30^{**a}	−.29^{**a}	−.50^{**a}	–		
15. Gender	–	–	–	–	−.06^{b}	−.05^{b}	−.08^{*b}	−.04^{b}	.01^{b}	−.04^{b}	−.02^{b}	–	
16. Age	–	–	–	–	.17^{**c}	.14^{**c}	.10^{**c}	.10^{**c}	.25^{**c}	.05^{c}	−.04^{c}	−.10^{**b}	–
17. Tenure	–	–	–	–	.19^{**c}	.19^{**c}	.11^{**c}	.14^{**c}	.24^{**c}	.05^{c}	−.08^{**c}	−.03^{b}	.65^{**c}

Note. Boldfaced numbers on the diagonal represent Cronbach's alpha; Demands = technology-related demands, Relations = Technology-mediated social interactions; Privacy = privacy/monitoring, Employab. = Employability; sex: 0 = male, 1 = female; Age: 1 = 20-30 years, 2 = 31–40 years, 3 = 41–50 years, 4 = <50 years; Tenure = job tenure: : 1 = <1 year, 2 = 1–5 years, 3 = 6–10 years, 4 = 11–20 years, 5 = > 20 years; M = means; SD = standard deviations; Skew. = skewness; Kurt. = kurtosis; *p<05; **p < .01. a = Pearson's correlation coefficients; b = Spearman's rho correlation coefficients; c = Kendall's coefficients of rank correlation tau-subb.

DISCUSSION

This study advances our understanding of the main factors contributing to technostress and offers a novel and reliable assessment tool for their evaluation. Both the EFA and the CFA results confirmed a four-factor structure: 1) "technology-related demands" includes interruptions in activities due to ICTs, feelings of pressure and urgency, heavier workload, fatigue from ICT use, and increased deadlines due to excessive virtual engagement; 2) "privacy/monitoring" involves concerns about work monitoring through ICTs, privacy impairment due, and beliefs about excessive company monitoring through technology; 3) "employability" addresses uncertainty about job future due to technological advancements, concerns related to marketability of technological skills, and competitiveness of those skills; 4) "technology-mediated social interactions", measures perceive limitations in face-to-face relationships and fewer interaction opportunities due to ICTs. The study confirmed items' adequacy and the scale's satisfactory internal consistency. The results supported the nomological validity of the scale, showing positive associations between the four sources of techno-stress and psycho-physical distress, and negative relationships with job satisfaction, which is consistent with the previous literature on technostress (Borle *et al.*, 2021; Kumar *et al.*, 2013; La Torre *et al.*, 2019; Rasool *et al.*, 2022; Sarabadani *et al.*, 2018; Suh & Lee, 2017). Given its cross-sectional and self-reported nature, this study does not allow us to infer causal relationships. To alleviate participants' evaluation apprehension and social desirability concerns, only minimal socio-demographic information was collected. Future studies should gather data from multiple sources on larger and more gender-balanced samples of employees from different countries and organizational sectors to validate our preliminary findings and adopt a longitudinal design to verify the test-retest reliability of the scale. The results of this study can guide the effective implementation of ICTs by identifying potential sources of techno-stress and addressing them proactively. This can also encourage practices that enhance technology-mediated social interactions, including implementing collaborative platforms, promoting peer support networks, and facilitating virtual social activities. The scale also provides valuable information for developing targeted training programs to help employees improving their technological skills and employability.

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