TPM Vol. 32, No. S4, 2025
ISSN: 1972-6325
https://www.tpmap.org/

EVALUATION OF TECHNO STRESS IN IOT DEVELOPERS USING PSYCHOMETRIC INSTRUMENTS

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Abstract
The swift growth of the Internet of Things (IoT) has increased developer demands, leading to increased levels of technostress. This study examined technostress of IoT developers using self-report psychometric measures based on existing technostress scales. A sample of 210 IoT professionals completed an online survey measuring five technostress creators: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. The instrument showed very good internal consistency (Cronbach's $\alpha > 0.80$), and five-factor structure was confirmed through confirmatory factor analysis. Results of the regression analysis indicated that techno-overload and techno-complexity were significant predictors of self-reported psychological strain diagnostics and that job autonomy moderated the impact of techno-overload and techno-complexity on psychological strain. Although no study-level differences were established, female developers reported greater perceptions of techno-invasion. Together, results indicate that IoT developers face a unique psychological burden alongside their work with technology and that the developed tool is a valid approach to assess technostress in tailored technologies work contexts. Findings also indicate the need for organizational interventions to track and manage technostress and recommend providing varying levels of autonomy support, workload analysis, and role clarification.

Keywords: Technostress, IoT developers, psychometric assessment, techno-overload, techno-complexity, job autonomy, psychological strain, instrument validation, humantechnology interaction, occupational stress.

I. INTRODUCTION

According to Ragu-Nathan et al. (2008), technostress is the negative psychological reaction that people have when using contemporary information and communication technologies (ICTs). It is made up of five core dimensions: techno-overload (pressure to work faster or longer), techno-invasion (pressure for technology to enter into personal life), techno-complexity (feeling inadequate because of the complexity of a tool), techno-insecurity (feeling one might lose their job because of new, emerging technology), and techno-uncertainty (the constant updates of any ICT tool creating instability) [1]. Each of these techno stressors can be reviewed through the Job Demands–Resources (JD-R) model [3].The JD-R model explains that job demands, such as new technologies and changing technology, will lead to burnout unless matched with job resources, such as autonomy or company support [9].

IoT developers are in the highest risk category because they are not only using rapidly evolving tools, but the resources to learn the new tools are constant [2]. The field demands emerging technologies to be utilized, it demands real-time productivity, and a "job security" demands by constantly keeping their skill set current. Developers do not construct a boundary between work and personal time, increasing their susceptibility to technostress [5].

Another approach for understanding how individual perceptions and their coping resources can influence how technostress, the transactional stress model, and the technostress trifecta (eustress, distress, and design-induced stress) are important. Assessing technostress in this professional group using psychometric tools is imperative to measure risk, validate specific interventions, and ensure both sustainable humantechnology cohabitation and fulfilment, as suggested by the recent TPMAP and ResearchGate [4] [10].

II. RESEARCH OBJECTIVES & HYPOTHESES

This research has two main aims:
To psychometrically evaluate the technostress scales adapted for IoT developers with a particular emphasis on reliability, factor structure, and construct validity [12]; and to explore the relationship between technostress levels and work-related constructs, including moderating variables such as autonomy [6].

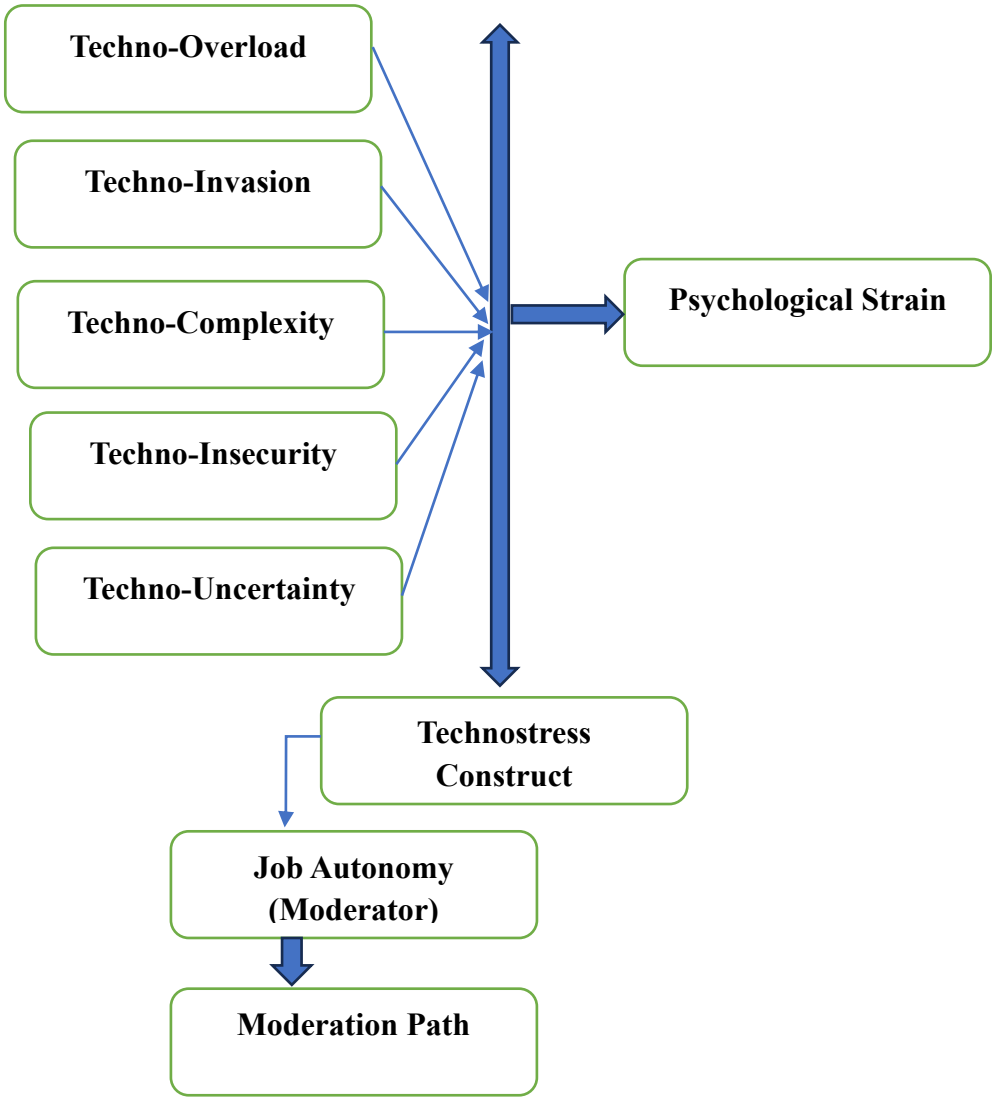

Figure 1: Conceptual Framework for Psychometric Evaluation of Technostress in IoT Developers

Figure 1 presents the theoretical framework that guides the research. Five principal technostress creators-techno-overload, techno-invasion, techno-complexity, techno-insecurity and techno-uncertainty-combine to form the latent construct technostress, which is estimated to predict psychological strain among IoT developers. It also outlines the Job Demands–Resources (JD-R) framework as a conceptual model of moderates, job autonomy, which may act as a moderator that diminish or enhances the effects of technostress on strain outcomes [11]. This block diagram reflects the study's hypotheses and helps illustrate the interactions that will be tested using confirmatory factor analysis and moderated regression. Likewise, it serves as a conceptual map for both psychometric measurement validation and applied interpretation in regards to work [13].The study is based on the Job Demands–Resources (JD-R) model and transactional models of stress that provide an understanding of how contextual resources might interact with specific stressors [14].

Hypotheses:

In this proposal, we assume that all the different technostress variablestechno overload, invasion, complexity, insecurity, and uncertaintywill load is distinguishable in a confirmatory factor analysis, and therefore, confirm the

multidimensionality of technostress [15].There will be a positive significant prediction of higher techno overload, techno complexity, and techno invasion and subsequently greater psychological strain. Job autonomy will moderate each of the relationships; some with buffering effects but some with amplifying effects, which have been shown in previous studies (e.g., Girardi et al., TPMAP, SAGE). We will further uncover differences based on gender differences in perceptions related to techno invasion and techno complexity.

III. INSTRUMENT DEVELOPMENT & PSYCHOMETRIC TESTING

The technostress scale used in this study was adapted from the Questionaries Technostress, which had previously been validated in educational context and general work contexts, and more recently in TPMAP contexts. Adaptation included translation and cultural adaptation, with adjustments to the language, tools, and stressors common in IoT development, (e.g., inclusion of items related to continuous integration workflows, real-time systems) [7]. The adapted instrument was reviewed by experts for content validity and tested with a small convenience sample of IoT professionals, including cognitive interviews to facilitate understanding and relevance of each item in context [8].

Confirmatory Factor Analysis (CFA):

Validate the five-factor structure of technostress.

$$\boldsymbol{X} = \Lambda\boldsymbol{\xi} + \boldsymbol{\delta}$$

Where:

X = vector of observed scores (item responses)

Λ = matrix of factor loadings

ξ = vector of latent variables (e.g., overload, invasion)

δ = measurement error

First, Exploratory Factor Analysis (EFA) was performed to start to examine its structure, followed by Confirmatory Factor Analysis (CFA) to test the five factors in the hypothesized model. Internal consistency was examined using Cronbach's alpha and McDonald's Omega. Convergent and discriminant validities were examined using inter-item correlations and average variance extracted (AVE), supporting the apparent psychometric rigor of the scale in a population of IoT developers

IV. APPLICATION STUDY: DATA COLLECTION & ANALYSIS

The researchers surveyed a sample of 210 IoT developers who were working across industries and had expertise levels from junior (1-3 years) senior (>10years). Participants identified as 68% male, 30% female, and 2% non-binary. The researchers collected data anonymously and online with informed consent collected through the rapid and easy digital consent process before starting the survey.

Moderated Regression:

$$Strain = \beta_0 + \beta_1(Technostress) + \beta_2(Autonomy) + \beta_3(Technostress \times Autonomy) + \varepsilon$$

The survey included the adapted technostress scale, a validated measure of job autonomy, and other indicators of psychological strain and burnout. Participants also had the option to submit individual level physiological indicators (e.g., heart rate variability or self-reported cortisol test results) when available, for triangulation of stress responses.

The first analyses conducted were Confirmatory Factor Analysis (CFA) to validate the measurement model, followed by multiple regression and moderation analyses to define the positive predictive and buffering relationships of job autonomy in the JD-R context. Structural equation modelling (SEM) was also considered to apply to the complexity between stressors, autonomy, and outcomes.

V. INTERPRETATION

The Confirmatory Factor Analysis confirmed the five-factor structure of the adapted technostress scale, with all items loading significantly onto their respective dimensions (techno-overload, invasion, complexity, insecurity, uncertainty), thus confirming construct validity. Furthermore, the obtained scale reliability was acceptable for all subscales (Cronbach's α value of 0.82 to 0.89, Omega above 0.85), and the obtained inter-factor correlations, aligned with previous TPMAP research, identified related but different constructs. Next, through regression analysis, techno-overload, techno-complexity and techno-invasion were all statistically significant predictors of psychological strain (value = < .01) while techno-insecurity and techno-uncertainty measured weaker or non-significant effects. Job autonomy significantly moderated the relationships of techno-overload, techno-complexity, and techno invading, the findings suggesting that high job autonomy buffered the negative effects of

both overload and complexity on strain. These findings are consistent with Girardi et al., report along with other research findings.

When examining gender differences, results showed that female developers reported higher levels of techno-invasion and techno-complexity, consistent with literature on gender-stress inequities regarding the effects of information and communication technologies (ICT). Therefore, the excessive demands of IoT work are no different from those of other occupational groups (e.g., educators, IT), however in IoT, fast paced tool cycles, along with integration demand and requires greater attention to risk with the population under review.

VI. CONCLUSION

The results validate the credibility and reliability of the adapted technostress scale (Jian et al. , 2017) for IoT developers and confirm that the five primary dimensions are psychometrically valid and reliable in this highly demanding digital workplace. The stressors techno overload, techno complexity, and techno invasion impacted psychological strain more than others, confirming the JD-R (Bakker and Demerouti, 2007) and transactional models (Lazarus and Folkman, 1984). Job autonomy, has a moderating effect on technostress indicating that the degree of individual control exhibited by the developers may reduce technostress consequences. From a practical point of view, companies employing IoT developers should restructure digital work processes, are clear on their roles and adopt autonomy orientated practices such as flexible work arrangements and participatory decision-making. Additionally, self-regulation, psychological resilience training and technostress monitoring protocols are useful preventive strategies.The study was limited by self-report data, as it can be vulnerable to biases and personal characteristics. Other limitations include the cross-sectional nature of the study, which may limit the inference of the causal effects of IoT job demands and personal characteristics. Future studies should consider longitudinal studies, biomarker assessments (such as level of cortisol, heart rate variability) and interventions aimed at reducing technostress. In summary, this study identified the unique psychological demands of being an IoT developer, validated a specific measurement tool and provided evidence for job process strategies aimed at protecting mental health for workers in variable tech occupations.

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