

Article

The Role of Transformational Leadership in Coping with Followers' Technostress. A Quantitative Analysis

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Abstract

This study examines the relationship between transformational leadership, digital work-related stressors, and emotional exhaustion among 952 German employees who regularly use information and communication technology (ICT). Employing structural equation modeling within the framework of the transactional model of stress and coping, the analysis reveals a dual effect of transformational leadership: it intensifies perceived techno-stressors while simultaneously serving as a critical resource for coping with these challenges. The findings offer practical insights for organizations addressing the intersection of leadership, technology use, and employee well-being. Importantly, recovery and techno-stressors act as competing mediators in the relationship between transformational leadership and emotional exhaustion.

Keywords: technostress; transformational leadership; digital stress; strain; recovery**JEL:** I19; J81; M50; M12; O33

1. Introduction

Digital work, understood here as work-related tasks that consist largely of information in digital form (Schwemmle and Wedde, 2012) can differ significantly from analog work, as the former changes where, when, and how work is carried out (Schmidtner et al, 2021; Vargo et al, 2021). These changes can come with opportunities like higher productivity or greater flexibility (Ahlers, 2018), but they also carry a risk of accelerating work, increasing workloads, and blurring borders between work and private life, all of which can induce stress-related reactions in employees (Ayyagari et al, 2011; Riedl, 2013). Stress research often refers to stress that results from using digital technology as technostress and links it to health-related consequences—we refer to it as strain—like emotional exhaustion (Brown et al, 2014; Kim et al, 2015) and burnout (Leung, 2011; Srivastava et al, 2015), although digital work does not have to be perceived as a harmful stressor nor lead to strain. Studies have shown that, in addition to technological (Fortagne et al, 2024) and individual factors, leadership can influence how followers perceive digital work and its consequences (Butts et al, 2015; Fieseler et al, 2014).

Transformational leadership involves leadership behaviors that seek to transform followers' values and mobilize them to achieve organizational goals that are beyond their individual interests (Bass and Avolio, 1994). This kind of leadership has been the subject of scholars' and practitioners' attention and had been shown to be effective, especially when followers must be led through highly volatile

work environments (Diaz-Saenz, 2011; Judge and Piccolo, 2004). Transformational leadership has been shown to reduce followers' stress and stress-related outcomes outside the digital work context (Harms et al, 2017; Tummers and Bakker, 2021), but concerns about these findings' transferability to the digital work context have arisen since leadership's effectiveness depends on situational and contextual factors (Fiedler, 1974; House, 1996). This concern is reinforced by studies that point out digital technologies' influence not only on the nature of work and its demands (Brynjolfsson and McAfee, 2014; La Torre et al, 2019), but also on the dynamics of leader-follower interactions (Rademaker et al, 2023; Schwarzmüller et al, 2018).

Given these concerns, insufficient attention has been devoted to exploring the relationship between transformational leadership and technostress (Rademaker et al, 2023). To the best of our knowledge, an unexplored aspect of this relationship is how transformational leadership affects strain through techno-stressors. Against this background, this study analyzes the influence of transformational leadership through techno-stressors on the subsequent strain. This approach addresses the need to design work environments that foster employee's health by analyzing the intricate dynamics between transformational leadership and followers' technostress. The emphasis on technology-related psychological demands is crucial, given the increasing number of sick days attributed to mental disorders (Storm et al, 2021), especially those that are associated with working in digital environments (Kim et al, 2015; Ragu-Nathan et al, 2008).



2. Literature Review

Technostress can be understood as “stress experienced by end users of information and communication technologies” (Ragu-Nathan et al, 2008). Central publications on technostress (Bondanini et al, 2020; Ragu-Nathan et al, 2008; Tarafdar et al, 2010) rely on the transaction-based model of stress as a theoretical framework, which explains stress as being the result of a transaction between individual and environmental dispositions along two appraisal processes: primary and secondary appraisal (Lazarus and Folkman, 1984; Lazarus, 2012). Applying the transaction-based model of stress as a theoretical framework to the context of technostress, technostress can be understood as the result of transactions among the technology-user, his or her coping options, and digital work as an environmental disposition (stressor). The stressor, digital work, should be recognized as a neutral stimulus that acquires meaning along the two appraisal processes (Lazarus, 2012).

During the primary appraisal, the technology-user assesses whether a stressor is irrelevant, positive, or harmful (Lazarus, 2012), taking individual and situational factors into account. For instance, incoming e-mails may be perceived as irrelevant or positive on a regular workday, but as harmful if sent by an abusive supervisor outside work hours (Butts et al, 2015). We refer to information and communication technology (ICT)-related stressors that are perceived as harmful, including factors such as increased workload, technological complexity, and blurred boundaries between work and private life, as techno-stressors (Ragu-Nathan et al, 2008). In the secondary appraisal, individuals evaluate their resources in dealing with techno-stressors. Sufficient resources mitigate the perceived stress associated with ICT use, while insufficient resources heighten strain (Lazarus, 2012), especially in cases of prolonged exposure without adequate recovery (Sonnentag et al, 2010).

Both the primary evaluation of a stressor and the secondary evaluation are influenced by personal factors (Koo and Wati, 2011; La Torre et al, 2019; Shu et al, 2011) and contextual factors like support (Califf et al, 2015) and literacy facilitation (Califf and Brooks, 2020). However, research establishes leadership, understood here as “a process whereby an individual influences a group of individuals to achieve a common goal” (Northouse, 2019), as a significant predictor of followers’ stress in the digital (Rademaker et al, 2023) and analog work environment (Harms et al, 2017; Tummers and Bakker, 2021). Leadership has diverse influences on followers’ work demands (Jian and Dalisay, 2018) and resultant health outcomes (Charoensukmongkol et al, 2016; Harms et al, 2017), as it can both be a resource for followers and limit available resources (Brooks et al, 2019; Demerouti et al, 2001; Lehr et al, 2009) and even present a demand itself (Diebig et al, 2016). Previous research has shown, that supportive as well as empowering and enabling leadership represents an important resource for followers dealing with digital demands (Bartsch et al,

2021; Bauwens et al, 2021). In contrast, followers who are led by destructive leaders reported higher digital demands as well as higher levels of emotional exhaustion (Dolce et al, 2020; Molino et al, 2019). Furthermore, research indicates that ICT can be used by destructive leaders to carry out destructive leadership behaviors (Rademaker et al, 2023), making it more difficult for followers to evade their supervisor’s influence. In addition, availability expectations by supervisors have been shown to be a significant technostressor when it comes to mobile technologies, as they increase followers’ work-life conflicts as well as their ability to recover from work-related demands (Cheng et al, 2021; Obushenkova et al, 2018).

As transformational leaders provide followers with high levels of support, recognition, and opportunities for individual development (Suifan et al, 2018), we anticipate that followers of transformational leaders will adopt a more positive attitude toward techno-stressors. This positive attitude is expected to manifest in their appraisal of stressors as challenges rather than threats (Bakker and Demerouti, 2007). This is consistent with Salanova and colleagues (2013), who have found that transformational-led followers are less skeptical about adopting new digital technologies. In addition, previous studies have shown a positive association between change-oriented leadership behaviors, such as empowering leadership (Bauwens et al, 2021), and followers’ technostress. Therefore, in our first hypothesis we state:

H1: The relationship between transformational leadership and techno-stressors is negative.

In addition, we expect that the empowerment and common vision that transformational leaders provide fosters the intrinsic motivation among followers (Judge and Piccolo, 2004), promotes higher levels of autonomy and openness to new technologies (Jain and Duggal, 2018; Salanova et al, 2013) and thus that followers are less likely to perceive digital technologies as a threat. This view is in line with Fernet and colleagues’ (2015) findings that transformational leadership is a negative predictor of job demands and increases followers’ autonomous motivation and aligns with self-determination theory, which suggests that intrinsically motivated and autonomous individuals are likely to view stressors as challenges rather than threats (Hodgins et al, 2010; Weinstein and Ryan, 2011). Previous studies have indicated that followers who perceive higher autonomy tend to perceive digital demands as less threatening (Mazmanian et al, 2013). In addition, studies show that autonomy is positively correlated with mental health for followers working in a digital work environment (Grant et al, 2019). With this in mind and also in line with Richardson (2010), we assume that autonomy is an important factor when it comes to leading teams through digital demands. Therefore, our second hypothesis states:

H2: The relationship between transformational leadership and techno-stressors is mediated by autonomy.

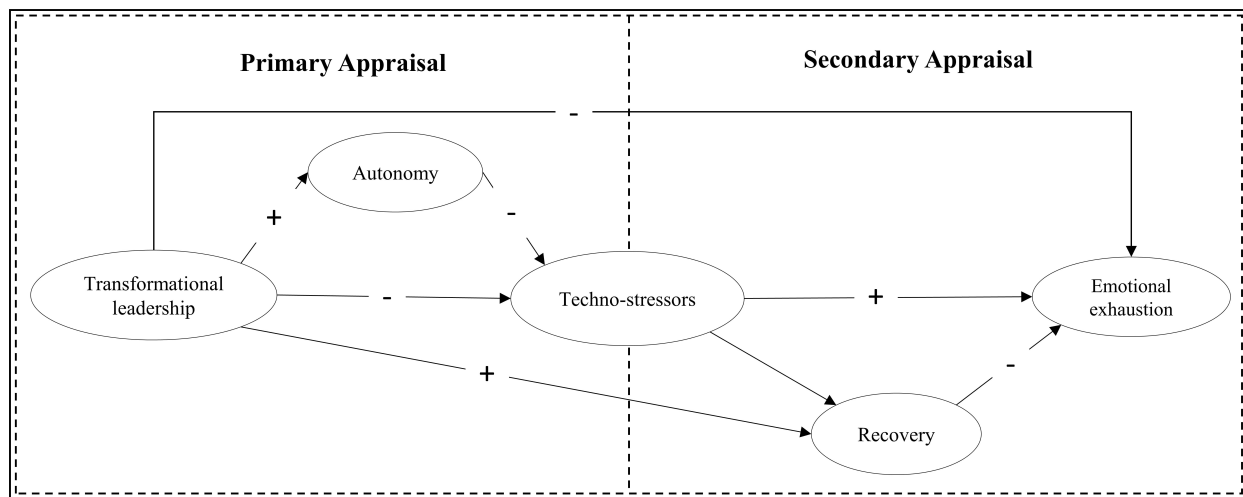


Fig. 1. Conceptual framework of leadership along the transaction-based model of stress.

We predict that transformational leadership has a significant influence on the secondary appraisal and, thus, the stressors-strain relationship, as transformational leaders provide high levels of resources, including information, feedback, and social support, all of which reduce followers' perception of stress in prior studies (Demerouti et al, 2001; Di Tecco et al, 2021). Therefore, we expect that followers who work with digital technologies under the leadership of transformational leaders exhibit less emotional exhaustion.

H3: The relationship between transformational leadership and followers' emotional exhaustion is negative.

In addition to the resources provided by leaders, we expect that recovery influences the stressor-strain relationship. Understood here as the degree to which followers can emotionally detach from work-related demands and replenish their resources, recovery is a coping mechanism that influences the stressor-strain relationship (Mäntymäki et al, 2022; Sonnentag and Fritz, 2015; Sonnentag et al, 2010). We expect that transformational leadership's responsiveness to followers' needs and high support levels to have a positively effect on followers' recovery and, through that, on the stressor-strain relationship. In addition to transformational leadership's impact on follower's resources, we posit that techno-stressors are substantial predictors of strain (Brown et al, 2014; Gaudio et al, 2017; Kim et al, 2015), so they mediate the relationship between transformational leadership and strain. In short, we expect that followers who are led by transformational leaders to be better equipped to handle techno-stressors and to report lower levels of techno-stressors. Hence, we propose the following hypothesis:

H4: The relationship between transformational leadership and followers' emotional exhaustion is mediated by (H4a) recovery and (H4b) techno-stressors.

Our conceptual framework, shown in Fig. 1, positions transformational leadership as a key situational factor in the primary and the secondary appraisal.

3. Methodology

3.1 Participants and Procedure

To test our hypotheses, we distributed a quantitative online survey through a panel provider to obtain a sample of the population of German followers who regularly use ICT for work-related purposes. To ensure the content validity, we shared it with ten potential respondents and four academics for their feedback. From March 22 to March 27, 2023, 1322 participants completed our survey. Since our research goal is to analyze the relationship between leadership and technostress, we excluded participants who were not employed or did not use ICT regularly for work-related purposes. To control for sequence effects, we randomized the order of the scales as well as the items within the scales. To ensure data validity, we followed Aust and colleagues (2013) in using three instructional manipulation checks, which removed 110 participants, and a consistency check, which excluded another 27 participants. A check of completion time excluded 152 participants who completed the survey in under five minutes, leaving us with a final sample of 952 participants.

The average age of participants in our sample was 44 years (*standard deviation* (*SD*) = 11.76), closely mirroring the average age of employees in Germany (43.3 years according to the 2022 German microcensus). The gender distribution was almost representative, with 49.3 percent of participants male, 50.4 percent female, and 0.03 percent identifying as diverse. This distribution aligns closely matches the average gender breakdown of German employees, with 52 percent of employees reported as male and 48 percent as female in the 2022 German microcensus. As for employment, 77.1 percent of the participants in our sample were employed full-time, 21.4 percent were employed part-time, and 1.5 percent were in apprenticeships. The average work experience of those in the sample was 22.72 years (*SD* = 12.74), with an average period of employment at the cur-

Table 1. Demographic information of the participants in the sample.

Variables	n	%	<i>M</i>
Age			44.42 (<i>SD</i> = 11.76)
20–24	57	6.0	-
25–29	82	8.6	-
30–34	111	11.7	-
35–39	123	12.9	-
40–44	125	13.1	-
45–49	100	10.5	-
50–54	133	14.0	-
55–59	143	15.0	-
60–64	78	8.2	-
Sex			
Male	469	49.3	-
Female	480	50.4	-
Others	3	0.3	-
Education			
Main school degree	37	3.9	-
Secondary school	193	20.3	-
Qualification for university/technical college entrance	235	24.7	-
Apprenticeship	295	31.0	-
University degree	294	30.9	-
Ph.D./doctorate	18	1.9	-
Others	3	0.3	-
Employment			
Full-time employed	734	77.1	-
Part-time employed	204	21.4	-
In apprenticeship	14	1.5	-
Professional experience (in years)	-	-	22.72 (<i>SD</i> = 12.74)
Current employer tenure (in years)	-	-	11.49 (<i>SD</i> = 10.05)
Household			
Living together with a partner	625	65.7%	-
Children are part of the household	360	37.8%	-

M, mean; *SD*, standard deviation.

rent employer of 11.49 years (*SD* = 10.05). Table 1 provides more detailed demographic information.

3.2 Measures

We used validated German translations of established scales (Multifactor Leadership Short Questionnaire (MLQ) Short Questionnaire; Leader-Member Exchange Skale (LMX7); Perceived Stress Scale; Recovery Experience Questionnaire; Work and Family Conflict Scale (WAFCS)) to measure key constructs. A detailed overview of the scales can be found in Appendix Table 4.

Transformational leadership was assessed using Felfe (2006)'s validated translation of Bass and Avolio (1994)'s MLQ Short Questionnaire. The first-order factor ($\alpha = .778$) of transformational leadership was measured by ten items representing the dimensions of “idealized influence attributed”, “idealized influence behavior”, “inspiring motivation”, “intellectual stimulation” and “individual consideration”. Participants rated the frequency of their direct su-

pervisor's leadership behaviors on a five-point Likert scale (1 = “never”; 5 = “on a regular basis”).

Strain was measured using Schneider and colleagues' (2020) German adaption of the Perceived Stress Scale. This second-order factor ($\alpha = .852$) included the subscales “helplessness” (six items) and “self-efficacy” (four items). The latter items were reversed, ensuring that low expressions of self-efficacy contributed more to the perceived stress score than high expressions did. Responses were given using a five-point Likert scale (1 = “never”; 5 = “on a regular basis”).

Techno-stressors, a second-order factor ($\alpha = .839$), were measured using Ragu-Nathan and colleagues' (2008) scales along the dimensions of “techno-invasion” (three items), “techno-overload” (four items), and “techno-complexity” (five items). Responses were recorded on a five-point Likert scale (1 = “strongly disagree; 5 = “strongly agree”).

Recovery from work was assessed using [Sonnentag and Fritz \(2007\)](#)'s Recovery Experience Questionnaire. The second-order factor ($\alpha = .931$) of recovery encompassed the dimensions of "psychological detachment", "relaxation", "mastery", and "control", with four items each, measured on a five-point Likert scale (1 = "never"; 5 = "on a regular basis").

Autonomy, a second-order factor ($\alpha = .931$), was measured across the three dimensions of "work-scheduling autonomy" (three items), "decision-making autonomy" (three items), and "work methods autonomy" (three items), using Stegmann and colleagues' (2010) validated translation of the Work Design Questionnaire. Responses were recorded on a five-point Likert scale (1 = "strongly disagree"; 5 = "strongly agree"). The covariables of age, gender, quality of leader-member exchange, and support from colleagues were also included because previous studies demonstrated their impact on technostress and strain ([Avanzi et al, 2018](#); [Choi, 2024](#); [Jin et al, 2020](#); [Kakkar, 2019](#); [Marchiori et al, 2018](#)).

We included age, gender, perceived quality of leader-member exchange (measured by the German translation of the LMX7 by [Schyns and Paul \(2002\)](#)) and support from colleagues as control variables. We chose age and gender because these variables have been shown to influence the perception of stress and technostress in previous studies ([Riedl, 2013](#); [Shu et al, 2011](#)). We controlled for the perceived quality of leader-member exchange as previous studies have already established it as an important resource in coping with stress ([Harris et al, 2015](#); [Jian and Dalisay, 2018](#)). In addition, controlling for leader-member exchange provides a clearer picture of the unique contribution of transformational leadership to followers' technostress, which in turn would address the current debate that measures of positive leadership are influenced by followers' subjective evaluations of their leaders ([Carton, 2022](#)). Support from colleagues was also chosen as a control variable. On the one hand, it has been shown that support from colleagues has a buffering effect on technostress ([Joo et al, 2016](#)) and thus could act as a potential confounding variable. On the other hand, by controlling for this factor, we ensured that possible changes in the outcome were related to transformational leadership and not to the general supportive dynamics within the team.

3.3 Data Analyses

We approached our research objective through a quantitative analysis using structural equation modeling, as it is particularly useful for testing complex models and allows for the estimation of latent variables and, thus, a more accurate representation of the study's constructs. We assessed our measurement model (section 4.1) in the first step and evaluate the structural model (section 4.2) in the second step. We ran factor analyses and structural equation modeling with Mplus version 7.4 (Muthén & Muthén, Los

Angeles, CA, USA). The bootstrapping technique (10.000 resamples) was applied with maximum likelihood estimation to account for possible non-normality in the data, to obtain more accurate standard errors and confidence intervals, and to test the mediating hypotheses ([Preacher and Hayes, 2008](#)). Correlational analysis and reliability assessment were performed using IBM SPSS version 29.0 (IBM Corp., Chicago, IL, USA).

As this study is based on cross-sectional data, it is important to note that data analyses can only describe relationships between constructs and do not allow for directional causal interpretations.

4. Results

4.1 Descriptive Results and Evaluation of the Measurement Model

Table 2 presents the means, standard deviations, and Pearson-product correlation of the constructs used in this study. Transformational leadership correlates positively with autonomy ($r = .353$; $p < .01$) and recovery ($r = .206$; $p < .01$) and negatively with strain ($r = -.320$; $p < .01$). We found no significant correlation between transformational leadership and techno-stressors ($r = -.007$; $p > .05$).

Before testing the structural model, we evaluated the measurement model by testing for reliability and validity. We used Cronbach's alpha and composite reliability (CR) to measure internal reliability, and all constructs' Cronbach's alpha and composite reliability values were above the threshold of 0.7 (Appendix Tables 4,5), indicating good internal consistency ([Diamantopoulos et al, 2012](#)). We assessed convergent validity using the average variance extracted (AVE), for which all constructs scored above the threshold of 0.5 ([Fornell and Larcker, 1981](#); [Hair et al, 2019](#)).

Given the importance of robust measurements in our study, we chose scales that were well-established and previously validated in the literature. To ensure the validity of our measurement model further, we conducted an exploratory factor analysis (EFA) as a preliminary step to assess discriminant validity. The EFA results provided reassuring evidence of our measures' discriminant validity, as all indicators loaded consistently on the factors they were intended to measure, aligning with conceptual considerations. We also employed the Fornell/Larcker test, which requires that the average explained variance of each construct be higher than the squared correlation between the constructs ([Fornell and Larcker, 1981](#)). The inter-construct correlations were below 0.9 in all cases ([Hair et al, 2019](#)), indicating no problems with discriminant validity. The measurement model fits the data adequately ($\chi^2 = 3316.044$; $df = 1738$; $p < .001$; CFI = .954 [Comparative Fit Index]; TLI = .950 [Tucker-Lewis Index]; RMSEA = .032 [Root Mean Square Error of Approximation] (90% CI 0.030; 0.033); SRMR = .038) and shows acceptable indicator loadings for all constructs ([Ford et al, 1986](#)).

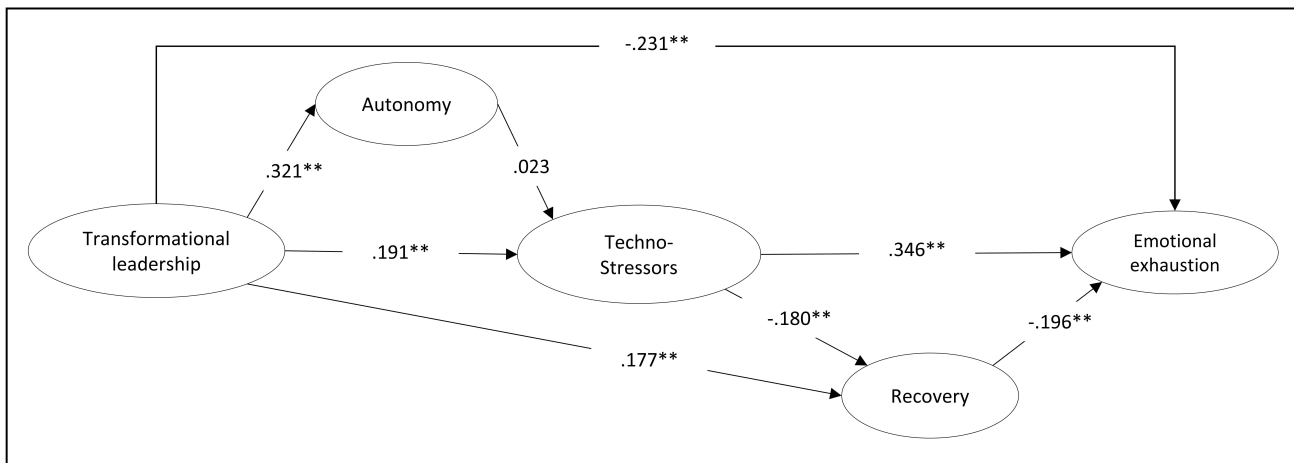


Fig. 2. Simplified representation of the latent mediation model. Note: simplified representation of the latent mediation model. Controlling for gender, age, leader-member exchange quality, and colleague support. $\chi^2 = 3955.037^{**}$ (1806); CFI = .937; TLI = .934; RMSEA = .036 (90% CI 0.035; 0.036); SRMR = .067; standardized results shown. * $p < .05$, ** $p < .01$.

Table 2. Means, standard deviation, and Pearson-product correlations of the variables.

Variable	M	SD	1	2	3	4	5	6	7	8	9
1 Age	44.42	11.77	1								
2 Gender ^a	0.49	0.50	.055	1							
3 LMX	3.83	0.93	-.031	.032	1						
4 CS	3.01	0.63	-.105**	.016	.418**	1					
5 TFL	3.23	0.89	-.167**	.056	.638**	.476**	1				
6 TS	2.26	0.81	-.108**	.039	-.093**	-.187**	-.007	1			
7 Strain	2.63	0.64	-.196**	-.136**	-.270**	-.373**	-.320**	.345**	1		
8 Aut.	3.58	0.88	-.029	.063	.324**	.295**	.353**	-.027	-.285**	1	
9 Rec.	3.69	0.54	.131**	.079*	.217**	.214**	.206**	-.186**	-.363**	.165**	1

Note: ^a1 = Male; LMX, leader-member-exchange; CS, support from colleagues; TFL, transformational leadership; TS, techno-stressors; Aut, autonomy; Rec, recovery; * $p < .05$; ** $p < .01$.

4.2 Evaluation of the Structural Model

Given the vulnerability of complex survey studies to multicollinearity (Becker et al, 2015), we checked for multicollinearity before assessing the structural equation model. A variance inflation factor (VIF) greater than 5 is indicative of potential collinearity issues among predictors. The VIF values ranged between 1.277 and 3.025 for the first-order constructs and between 1.045 to 1.757 for the second-order constructs (Appendix Table 4). Therefore, we concluded that multicollinearity is unlikely in our structural model.

The model demonstrates adequate fit with the data ($\chi^2 = 3955.037$; $df = 1806$; $p < .001$; CFI = .937; TLI = .934; RMSEA = .036 (90% CI 0.035; 0.038); SRMR = .067). Fig. 2 and Table 3 present the results of the structural equational analyses. Age, gender, quality of leader-member exchanges, and peer support were included as covariates. Age was negatively related to the reported levels of techno-stressors ($\beta = 0.109$; $p < .01$; 95% CI [-0.012; -0.001]) and strain ($\beta = -0.250$; $p < .01$; 95% CI [-0.017; -0.008]) and positively related to recovery ($\beta = 0.172$; $p < .01$; 95% CI [0.005; 0.014]). Male participants reported

less strain ($\beta = 0.125$; $p < .01$) than female participants did. Peer support was negatively related to strain ($\beta = -0.242$; $p < .01$) and techno-stressors ($\beta = -0.270$; $p < .01$; 95% CI [-0.502; -0.185]) and positively related to autonomy ($\beta = 0.178$; $p < .01$) and recovery ($\beta = 0.121$; $p < .01$; 95% CI [-0.008; 0.205]). Quality of leader-member exchange showed no significant relationship with any of the key constructs.

Our data contradicted the negative direct relationship between transformational leadership and followers' techno-stressors that we predicted in hypothesis 1. Although the relationship was significant, it was positive ($\beta = 0.191$; $p < .01$; 95% CI [0.036; 0.372]), such that followers reported more techno-stressors to their leader's transformational leadership. Hypothesis 2, which proposed a mediating role for autonomy in the relationship between transformational leadership and techno-stressors, was not supported ($\beta = 0.007$; 95% CI [-0.027; 0.058]). Although we found a significant relationship between transformational leadership and autonomy ($\beta = 0.321$; $p < .01$; 95% CI [0.197; 0.463]), we found no evidence of a relationship be-

Table 3. Direct and indirect effects of the structural model.

Path	Standardized estimate	SE	<i>p</i> -value	BC Bootstrap 95% CI
Direct effects				
TFL → TS	0.191	0.073	.009	0.036; 0.372
TFL → AUT	0.321	0.045	.000	0.197; 0.463
TFL → REC	0.177	0.048	.000	0.044; 0.250
TFL → STRAIN	−0.231	0.062	.000	−0.393; −0.081
AUT → TS	0.023	0.041	.571	−0.070; 0.155
TS → STRAIN	0.346	0.060	.000	0.174; 0.465
TS → REC	−0.180	0.041	.000	−0.271; −0.087
REC → STRAIN	−0.196	0.049	.000	−0.317; −0.088
Specific indirect effects				
TFL → AUT → TS	0.007	0.014	.583	−0.027; 0.058
TFL → TS → STRAIN	0.066	0.033	.020	0.012; 0.145
TFL → REC → STRAIN	−0.035	0.012	.005	−0.068; −0.010
TS → REC → STRAIN	0.035	0.013	.006	0.014; 0.072

Note: Controlling for gender, age, leader-member exchange quality, and colleague support. $\chi^2 = 3955.037^{**}$ (1806); CFI = .937; TLI = .934; RMSEA = .036 (90% CI 0.035; 0.036); SRMR = .067; standardized results shown. SE, standard error; BC Bootstrap CI, bias-corrected bootstrap confidence interval.

tween autonomy and techno-stressors ($\beta = 0.023$; $p < .571$; 95% CI [−0.070; 0.155]). Instead, transformational leadership exhibited a direct positive relationship with techno-stressors ($\beta = 0.191$; $p < .001$; 95% CI [0.036; 0.372]).

Our data supported hypothesis 3, which proposed a negative relationship between transformational leadership and strain ($\beta = -0.231$; $p < .01$; 95% CI [−0.393; −0.081]). As for hypotheses 4a and 4b, competitive mediations of the relationship between transformational leadership and strain were observed via recovery ($\beta = -0.035$; 95% CI [−0.068; −0.010]) and via techno-stressors ($\beta = 0.066$; 95% CI [0.012; 0.145]). Transformational leadership also had direct positive relationships with both techno-stressors ($\beta = 0.191$; $p < .001$; 95% CI [0.036; 0.372]) and recovery ($\beta = 0.177$; $p < .01$; 95% CI [0.044; 0.250]), with techno-stressors being positively related to strain ($\beta = 0.346$; $p < .01$; 95% CI [0.174; 0.465]) and recovery being negatively related to strain ($\beta = -0.196$; $p < .01$; 95% CI [−0.317; −0.088]). Transformational leadership retained its direct negative impact on strain ($\beta = -0.231$; $p < .01$; 95% CI [−0.393; −0.081]).

5. Discussion

5.1 Discussion and Implications

The objective of this study was to analyze the relationships among leadership, techno-stressors, and the emotional exhaustion of followers in digital work environments. Thus, the study builds on the limited yet growing body of technostress literature that deals with leadership's influence on followers' technostress and extends this body of literature by identifying transformational leadership's relationship with followers' technostress along the transaction-based model of stress. To test our research model, we

conducted structural equation modeling based on a large amount of cross-sectional data ($n = 952$) of followers who use ICT regularly in their workdays. Next, we will discuss our findings in light of recent research and identify their implications for contemporary leadership.

Our results show that, although most of our participants scored comparatively low on techno-stressors, the relationship between techno-stressors and overall strain is significant in followers who work in digital work environments. This finding is in line with previous studies (La Torre et al, 2019) and underscores the importance of a health-oriented design of digital work, as persistent strain is linked to negative health outcomes like burnout and is associated with increased sick days (Storm et al, 2021). In accordance with our expectations and with previous studies, the presence of techno-stressors is not solely due to technological factors but can also be affected by contextual factors like transformational leadership. Contrary to our initial expectations, we observed a positive relationship between transformational leadership and techno-stressors (hypothesis 1), a finding that opposes the positive view of transformational leadership in the leadership literature and other studies that deal with transformational leadership's relationship with followers' stress (Fernet et al, 2015; Harms et al, 2017). Explanations for this counterintuitive finding might be found in the characteristics of transformational leadership. Transformational leadership aims at transforming followers' values and motivation by creating a vision, emphasizing personal responsibility and high expectations for performance. Thus, it aims to make followers work harder than they would normally be expected to. It is likely that followers whose leaders were able to create a vision of the greater good and the necessity of full engagement in re-

alizing this vision, are willing to increase their workload and blur boundaries between work and private life as it is for the greater good. Followers who perceive higher expectations from their leaders may interpret digital stressors as a threat to their ability to meet those expectations, especially if they feel unsupported in managing these stressors because of the emphasis on personal responsibility. Transformational leadership may also affect the stressors themselves.

The strong correlation between transformational leadership and techno-invasion suggests that transformational leaders may increase technological-enabled blurring of boundaries between work and private life. Research has shown that leaders' own ICT-use has great impact on followers' ICT-use, as leaders may create implicit availability norms when using ICT for work-related communication outside work hours (Stana and Nicolajsen, 2021). As transformational leadership measures "idealized influence" with how leaders are willing to put their own interest aside when it comes to the well-being of the team and the importance to fully engage into work. It therefore seems likely that transformational leaders may engage into work even outside work hours and that followers are more likely to copy their behavior if they see their leader as a role model.

While our study's findings suggest that transformational leadership is an antecedent of technostress, it also shows that transformational leadership has a positive impact on followers' ability to deal with these technostressors, as followers who are led by transformational leaders report lower levels of emotional exhaustion. This paradoxical result suggests that transformational leadership, while potentially elevating followers' perceptions of techno-stressors, also equips them with enhanced resources and coping mechanisms, confirming the findings of studies outside the technostress context that point to a negative relationship between transformational leadership and strain (Diebig et al, 2016; Harms et al, 2017; Skakon et al, 2010).

However, the positive relationship between transformational leadership and strain is partially mediated by the extent to which followers perceived techno-stressors and their ability to recover from them in competitive mediations. These findings highlight the pivotal role of recovery in predicting strain for followers who engage with digital technologies. Recovery's partial mediation of the relationship between techno-stressors and strain underscores the challenges followers face in disconnecting from their work-related responsibilities in the digital context. This view aligns with qualitative studies that emphasize the impact of ICT on followers' ability to detach from work (Obushenkova et al, 2018; Stana and Nicolajsen, 2021).

Recovery was a negative predictor of followers' strain in our study, which suggests that high levels of digital-related demands at work are particularly problematic when they are sustained over an extended period without followers being able to replenish resources and gain emotional dis-

tance from the demands of work. In the face of high levels of connectivity through ICT, our finding that technostress is negatively related to recovery underscores the importance of time to recover from work without being connected to work through mobile devices.

The implication for contemporary leadership is that health-oriented use of digital technologies should be a long-term priority and that health-oriented leaders should be sensitive to how their behavior affects followers' technostress. Rather than seeing technologies as the sole cause of technostress, our findings emphasize that leaders themselves can have a significant influence on whether digital work poses risks to followers' health. Change-oriented leadership can be a valuable resource for followers who face digital demands, which is consistent with Rademaker and colleagues' (2023) findings that leadership behaviors that are change-oriented and supportive of followers reduce technostress, but the positive relationship between transformational leadership and techno-stressors underscores the role that leaders play in creating digital-related demands.

5.2 Limitations and Future Research

As with most studies, our research is not without limitations. First, while our study provides valuable insights into the relationship between transformational leadership and followers' technostress, the cross-sectional data restricts our ability to make robust claims about causality and long-term effects. The relationship between stressors and resources could also take the form of gain and loss cycles, as suggested by Hobfoll's conservation of resources theory (Hobfoll, 1989; Hobfoll et al, 2018). However, the cross-sectional nature of the data limits the scope for testing of such reciprocal explanations. Future research efforts could address this limitation by examining the effects of transformational leadership on followers' technostress using longitudinal data, which would not only provide a more nuanced understanding of the relationship between transformational leadership and the recovery process in terms of the secondary appraisal but also explore potential lagged effects and temporal dynamics.

Second, the data in this study was collected from followers through self-reports, introducing the possibility of common method biases (Wulff et al, 2023). In the face of this limitation, some readers may argue exploring leader-follower relationships through dyadic designs or assessing the demands of digital technology using objective instruments, rather than self-reports. Although dyadic studies and objective instruments have undeniable benefits, we contend that they could introduce considerable limitations in pursuing the objective of this study. A dyadic research design could introduce significant selection biases and disproportionately high acquisition effort, which could outweigh its benefits.

Third, this study focuses exclusively on the technostressors "techno-overload", "techno-complexity", and

“techno-invasion”. We posit that these three technostressors serve as suitable indicators of the increased workload attributed to ICT, the demands that arise from the complexity of using ICT, and ICT’s potential to blur the boundaries between work and private life. However, technology is dynamic, especially given recent advances in artificial intelligence (AI) and the easy access to AI tools. Anticipating the substantial impact of these tools on how work is conducted, including their potential to substitute tasks or instill fear of substitution or degradation among followers (Långstedt et al, 2023), might raise concerns about the relevance of the three techno-stressors we chose. While the scale we chose has been effective in capturing certain aspects of digital work demands, future research could expand its focus to assess the demands that followers face when working with emerging technologies like AI.

Fourth, our study did not consider digital technologies as a concrete channel through which leadership is carried out. Studies show that some forms of technology use by leaders, such as using ICT to contact followers outside work hours or to monitor them (Dolce et al, 2020; Valle et al, 2021), increase followers’ technostress, so future research could consider how much of transformational leaderships impact on techno-stressors can be explained by leaders’ own use of ICT. Furthermore, previous research emphasizes that leadership itself is affected if it is carried out through digital channels (Rademaker et al, 2023), so not just qualitative but also quantitative research should investigate how transformational leaders use ICT.

Fifth, our study analyzed transformational leadership as an independent variable. The use of this construct allows only limited conclusions to be drawn about the relationship between actual transformational leadership behaviors and followers’ technostress. This is because most positive leadership styles do not cover actual leadership behaviors, but rather evaluations of those behaviors or their underlying intentions (Fischer and Sitkin, 2023), or even conflate leadership behaviors with leadership outcomes (Fischer et al, 2024). Moreover, these evaluations may be influenced by the personal relationships that followers have with their leaders, as well as attributions of traits (Carton, 2022). We acknowledge this criticism and believe it is important to consider when interpreting the results of our study, particularly in light of the unexpected findings related to transformational leadership. However, given that perceptions of stressors and resources are understood in the transactional model of stress and coping as the result of subjective appraisals, we argue that the analysis of subjective appraisals of transformational leadership still provides valuable insights into the origins of technostress. To understand better how leaders’ behaviors affects followers’ technostress, future research should focus on specific leadership behaviors rather than leadership styles and, where possible, combine surveys with objective measures (Carton, 2022).

6. Conclusion

By analyzing the relationship between transformational leadership, digital work stressors, and emotional exhaustion, this study contributes significantly to the growing literature on the relationship between leadership and followers’ technostress. Based on structural equation modeling with a large sample of followers, we were able to identify several noteworthy findings regarding the relationship between transformational leadership and followers’ technostress. The degree of transformational leadership was positively related to the perception of technostressors but negatively related to emotional exhaustion. This suggests that transformational leadership may amplify techno-stressors while providing followers with sufficient resources to cope with these stressors. Furthermore, the results of this study suggest that followers of transformational leaders may be particularly vulnerable to techno-invasion and highlights the importance of recovery when dealing with techno-stressors.

Availability of Data and Materials

The datasets generated and analyzed in the current study are not publicly available, but anonymized data can be provided by the author upon reasonable request.

Author Contributions

Conceptualization: TR and SS; Methodology: TR; Analysis: TR; Writing—original draft preparation: TR; Writing—review and editing: SS; Supervision: SS; Project administration: SS; Funding acquisition: SS. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare no conflict of interest.

Appendix

See Tables 4,5.

Table 4. Overview of variables.

Construct	Scale & References	Dimensions (if second-order Factor)	Manifest item
Perceived stress (VIF = 1.431; Cronbach's α = .852)	German adaption (Schneider et al, 2020) of the Perceived Stress Scale (Cohen et al, 1983)	Helplessness (VIF = 1.531; Cronbach's α = .761)	In the last month, how often have you... ...been upset because of something that happened unexpectedly? ...felt that you were unable to control the important things in your life? ...felt nervous and "stressed"? ...found that you could not cope with all the things that you had to do? ...been angered because of things that were outside of your control? ...felt difficulties were piling up so high that you could not overcome them?
		Self-efficiency (VIF = 1.477; Cronbach's α = .706)	...felt confident about your ability to handle your personal problems? ...felt that things were going your way? ...able to control irritations in your life? ...felt that you were on top of things?
Techno-stressors (VIF = 1.232; Cronbach's α = .839)	Technostress scale by Ragu-Nathan et al (2008)	Techno-Invasion (VIF = 2.275; Cronbach's α = .716)	I feel my personal life is being invaded by this technology. I have to sacrifice my vacation and weekend time to keep current on new technologies. I have to be in touch with my work even during my vacation due to this technology.
		Techno-Complexity (VIF = 2.079; Cronbach's α = .741)	I do not know enough about this technology to handle my job satisfactorily. I often find it too complex for me to understand and use new technologies. I do not find enough time to study and upgrade my technology skills. I find new recruits to this organization know more about computer technology than I do.
		Techno-Overload (VIF = 2.479; Cronbach's α = .768)	I need a long time to understand and use new technologies. I am forced to change my work habits to adapt to new technologies. I am forced by this technology to work with very tight time schedules. I have a higher workload because of increased technology complexity. I am forced by this technology to do more work than I can handle.

Table 4. Continued.

Construct	Scale & References	Dimensions (if second-order Factor)	Manifest item
Transformational leadership (VIF = 1.882; Cronbach's α = .778)	Validated German translation (Felfe, 2006) of the MLQ Short questionnaire	-	Ten items covering the dimensions of transformational leadership: idealized influence attributed (two items), idealized influence behavior (two items), inspirational motivation (two items), intellectual stimulation (two items) and individual consideration (two items). For copyright reasons, we do not list the specific items, but refer to Felfe (2006) for a complete list of items.
Autonomy (VIF = 1.224; Cronbach's α = .931)	Validated German translation (Stegmann et al, 2010) of the Work Design Questionnaire	Decision-making autonomy (VIF = 2.983; Cronbach's α = .865)	The job gives me a chance to use my personal initiative or judgment in carrying out the work. The job allows me to make a lot of decisions on my own. The job provides me with significant autonomy in making decisions.
		Work scheduling autonomy (VIF = 1.904; Cronbach's α = .842)	The job allows me to make my own decisions about how to schedule my work. The job allows me to decide on the order in which things are done on the job. The job allows me to plan how I do my work.
		Work methods autonomy (VIF = 3.047; Cronbach's α = .856)	The job allows me to make decisions about what methods I use to complete my work. The job gives me considerable opportunity for independence and freedom in how I do the work. The job allows me to decide on my own how to go about doing my work.
		Psychological detachment (VIF = 1.378; Cronbach's α = .760)	I forget about work. I don't think about work at all. I distance myself from my work. I get a break from the demands of work.
Recovery (VIF = 1.163; Cronbach's α = .931)	Recovery Experience Questionnaire (Sonnentag and Fritz, 2007)	Relaxation (VIF = 1.711; Cronbach's α = .836)	I kick back and relax. I do relaxing things. I use the time to relax. I take time for leisure.
		Mastery (VIF = 1.367; Cronbach's α = .751)	I learn new things. I seek out intellectual challenges. I do things that challenge me. I do something to broaden my horizons.
		Control (VIF = 1.730; Cronbach's α = .827)	I feel like I can decide for myself what to do. I decide my own schedule. I determine for myself how I will spend my time. I take care of things the way that I want them done.

Note: VIF, Variance Inflation Factor; MLQ, Multifactor Leadership Short Questionnaire.

Table 5. Correlation matrix of first-order factors.

	CR.	AVE.	TS_I	TS_O	TS_C	HLF	SLBST	TFFL	LMX	REAB	REENT	REMAS	REC_K	APLAN	AENT	AMET
TS_I	.759	.513	.716													
TS_O	.851	.590	.848*	.768												
TS_C	.858	.550	.692*	.775*	.741											
HLF	.891	.579	.512*	.475*	.424*	.761										
SLBST	.748	.499	.082	.128*	.143*	.528*	.706									
TFFL	.938	.605	.135*	-.001	-.023	-.145*	-.448*	.778								
LMX	.886	.530	-.034	-.124*	-.117*	-.168*	-.429*	.715*	.728							
REAB	.845	.578	-.125*	-.087*	-.076*	-.161*	-.345*	.190*	.200*	.760						
REENT	.903	.699	-.327*	-.193*	-.072	-.253*	-.276*	.039	.078*	.453*	.836					
REMAS	.838	.564	.213*	.098*	-.097*	-.066	-.348*	.296*	.249*	.372*	.121*	.751				
REC_K	.866	.684	-.228*	-.191*	-.158*	-.225*	-.307*	.194*	.291*	.677*	.418*	.377*	.827			
APLAN	.879	.709	-.034	-.072	-.027	-.145*	-.335*	.259*	.299*	.104*	.129*	.113*	.176*	.842		
AENT	.899	.747	.048	-.049	-.040	-.172*	-.456*	.371*	.362*	.122*	.080*	.216*	.186*	.717*	.864	
AMET	.892	.733	.037	-.014	-.003	-.155*	-.413*	.396*	.394*	.084*	.055	.196*	.205*	.734*	.878*	.856

Note: * = $p < .05$. Cronbach's Alpha scores in bold. CR, composite reliability; AVE, average variance extracted; TS_I, techno-invasion; TS_O, techno-overload; TS_C, techno-complexity; HLF, helplessness; SLBST, self-efficiency; TFFL, transformational leadership; LMX, leader-member exchange quality; REAB, psychological detachment; REENT, recovery relaxation; REMAS, recovery mastery; REC_K, recovery control; APLAN, work scheduling autonomy; AENT, decision-making autonomy; AMET, work methods autonomy.

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