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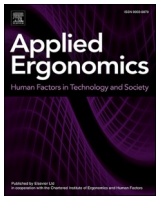

Extent of teleworking and work Stress: The role of information and communication technology and job-related demands and resources

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ABSTRACT

With over 41 million hybrid and high-extent teleworkers in Europe, the landscape of remote work has drastically transformed. Considering the teleworking extent, this study explores the relationships between information and communication technology (ICT) demands, ICT resources, social resources, job demands, and work stress among 1495 Estonian full-time employees engaged in telework and regular ICT use. Hybrid teleworkers reported higher work stress and ICT demands than high-extent teleworkers. In both groups, high e-communication demands, work requiring concentration, and email challenges were associated with increased work stress. Conversely, job resources such as concentration-enabling workplaces, information sharing and collaboration reduced stress. Hybrid teleworkers experienced elevated stress from ICT difficulties, while high-extent teleworkers were more affected by relationship maintenance. Feeling appreciated was related to lower stress for high-extent teleworkers. Moderation analysis revealed that collaboration and information sharing buffered stress from excessive e-communication only for hybrid teleworkers. Findings offer insights for improving telework practices.

1. Introduction

One of the most significant changes in recent years has been the explosion of telework practices. According to Eurostat, in 2022, 10 % of EU workers regularly worked from home, while 12,3 % did so occasionally. Thus, one in five employees works at least sometimes from home, and in some countries, the ratio is even one in three employees (Gschwind and Vargas, 2019). In 2024, the overall number of teleworkers continued to rise slightly. However, the share of regular teleworkers declined by 1,1 %, while the proportion of occasional teleworkers increased by 1,4 % (Eurostat, 2024). Advanced technology-enabled mobile working has emerged as a significant megatrend shaping the future of work (Bentley et al., 2016). However, quick changes and uncertainty can elevate stress levels (Cianci et al., 2024).

Teleworking is a work practice where employees substitute some of their regular work hours (from a few hours per week to almost full-time) with working remotely, usually from home, and utilizing information and communication technology (ICT) to communicate with coworkers as needed to complete tasks (Allen et al., 2015). There is no consensus on whether teleworking positively or negatively affects employees' well-being (Boell et al., 2016). One reason for contradictory findings and paradoxes may be that studies often fail to differentiate between various types of teleworkers. Following Boell et al.'s (2016) and Allen et al.'s (2015) suggestions, we seek to understand under which conditions telework is associated with work stress. Therefore, this study compares two distinct types of teleworkers: *hybrid* and *high-extent*. In the current study, we define and study hybrid teleworkers, who work in locations other than their workplace for 25–75 percent of their working time, and high-extent teleworkers, who work most of the time (more than 75 %) in the locations other than their workplace (see section 1.1 for more details).

This study uses the Job Demand-Resources (JD-R) theory, an established framework for examining employee well-being and ICT-related demands and resources (e.g., Day et al., 2012, 2019), to study exhausting and motivating aspects of telework and ICT usage. According to the JD-R theory, psychosocial work characteristics can be divided into job demands and resources (Bakker et al., 2023; Demerouti et al., 2001; Schaufeli and Taris, 2014). Job demands are physical, psychological, social, or organizational aspects of work that require continuous effort and may lead to strain or health costs (Demerouti et al., 2001). Job resources, on the other hand, "are aspects of the job that can help one achieve work goals, regulate job demands, and/or stimulate personal

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growth" (Bakker et al., 2023, p.28).

ICT encompasses any electronic device that can collect, store, process, and transmit information, including computers and mobile phones (Steinmueller, 2000). ICT usage is closely linked to information ergonomics, an emerging subfield of ergonomics focusing on the behavioral management of information load (Franssila et al., 2016). The increased reliance on ICT has introduced specific demands and resource requirements related to ICT (e.g., Day et al., 2010; Stadin et al., 2021). Prior research indicates that ICT demands are associated with higher stress levels (e.g., Leung and Zhang, 2017; Ninaus et al., 2021; Suh and Lee, 2017), and ICT resources with ICT-related well-being (Mäkiniemi et al., 2019). According to the JD-R theory, job and ICT resources could moderate the positive effect of ICT demands on work stress, weakening the association when resources are abundant. However, the studies by Ninaus et al. (2021) in a public university and a private media company found that while ICT demands were strongly associated with burnout, the appearance of high ICT resources did not reduce unfavorable effects.

This study addresses the knowledge gaps highlighted above. We seek to answer the following research questions: 1) How are ICT demands and resources associated with work stress, and how do these associations differ depending on the extent of telework? 2) Do ICT and job resources moderate the relationship between ICT demands and work stress among hybrid and high-extent teleworkers?

The novelty of this study lies in its consideration of the extent of telework when analyzing work-related stress and contributing factors. Additionally, by examining ICT-related demands and resources, we contribute to the broader understanding of information ergonomics in the context of telework.

1.1. Extent of teleworking

There is no clear metric for the time distribution of remote work between hybrid and high-extent teleworkers. Until recently, the concept of teleworking covered both employees working fully from home and those working in a hybrid way (Appel-Meulenbroek et al., 2022). Hybrid teleworking is defined as working sustainably alone or with others, partly from the employers' premises and partly from home or elsewhere with the help of ICT (Vartiainen and Vanharanta, 2023). Bentley et al. (2016) differentiated between low-extent and hybrid teleworkers, stating that hybrid teleworkers work remotely one or more days per week. Fonner and Roloff (2010) defined high-extent teleworkers as those who worked remotely at least three days a week. Several studies that have investigated differences based on the extent of teleworking use a percentage distribution of working time (e.g., Golden and Gajendran, 2019; Golden and Veiga, 2005; Leung and Zhang, 2017).

Despite the lack of a precise division between hybrid and high-extent teleworkers, the studies mentioned above show that the extent of telework may lead to different outcomes. The meta-analysis by Gajendran et al. (2024) concluded that higher levels of telework are linked to several upsides for employees, with the only significant drawback being perceived isolation. On the contrary, Vartiainen and Vanharanta (2023) concluded that less is more: when telework is practiced only a few days a week, many potential negative impacts do not emerge. Based on the above, our empirical study compares hybrid and high-extent teleworkers.

1.2. ICT demands and resources of teleworking and their association with work stress

ICT demands are any technology-related aspects or processes employees may find stressful and demanding mental and physical effort (Day et al., 2010). In contrast, ICT resources are elements of the work environment related to technology that help achieve work goals, lessen the adverse effects of job and ICT demands, and promote personal development (Ibid.). According to the taxonomy of ICT constructs by Hu et al. (2021), ICT demands could be technical problems, information overload, availability expectations, and interpersonal stressors (e.g., poor communication and cyberbullying). Examples of ICT resources include flexibility in communication (Bordi et al., 2018), organizational support (Day et al., 2012), and technology-related autonomy (Mäkiniemi et al., 2019).

Only a few studies have explored the relationship between telework extent, ICT demands, ICT resources, and work stress. Leung and Zhang (2017) found that greater telework extent was associated with higher work-family conflict, techno-overload, and technostress. In contrast, Suh and Lee (2017) found that low-extent teleworkers were more vulnerable to technostress, possibly because high-extent teleworkers adapt better to digital tools. Similarly, Leitner & Stöllinger (2022) noted that the negative effect of ICT usage to exhaustion is more inherent to employees who primarily or constantly work at employer's premises.

In summary, the literature about the role of the extent of teleworking in the context of ICT usage remains scarce and contradictory. In line with the prior findings and JD-R theory, we hypothesize that.

H1. Higher ICT demands are associated with higher stress among hybrid teleworkers (H1a) and high-extent teleworkers (H1b).

H2. The reported levels and the strength of these associations differ between the groups.

H3. ICT resources are associated with lower levels of work stress among hybrid teleworkers (H3a) and high-extent teleworkers (H3b).

H4. The reported levels and the strength of these associations differ between the groups.

H5. ICT resources can buffer the negative effects of ICT demands on work stress for hybrid teleworkers (H5a) and high-extent teleworkers (H5b).

1.3. Social resources and stress

In addition to ICT resources and demands, teleworking involves general job resources and demands. Social resources include social support, positive workplace relationships, appreciation, and team cohesion (Nielsen et al., 2017; Schaufeli and Taris, 2014). These resources can mitigate stress (Bregenzer et al., 2022), whereas their scarcity can increase it (Thuillard et al., 2024). Moreover, managerial support and regular team communication are key factors in teleworkers' psychosocial well-being (Bentley et al., 2023; Lee et al., 2024).

Since social interactions may be limited in telework, the quality of social resources may be crucial for well-being (Kirchner et al., 2021; Mäkiniemi and Mäkikangas, 2023). Many studies highlight workplace isolation and reduced support as significant job demands for teleworkers (e.g., Charalampous et al., 2019; Gajendran et al., 2024; Grant et al., 2013; Sardeshmukh et al., 2012). This isolation can negatively impact well-being (D'Oliveira and Persico, 2023) and increase exhaustion (Sardeshmukh et al., 2012). Additionally, Heiden et al. (2021) found that conflict-related stress is more present for academics who telework more frequently.

However, some research suggests that teleworking does not necessarily harm workplace relationships. Heiden et al. (2021) found no difference in relatedness ratings among colleagues in different teleworker groups. Similarly, ten Brummelhuis et al. (2010) reported that teleworking does not reduce collegial behavior, as employees may compensate by communicating more effectively and collaborating on in-office days.

Based on prior findings and JD-R theory, we hypothesize that.

H6. Social resources, such as information sharing, collaboration, and feeling appreciated, are associated with lower levels of work stress among hybrid teleworkers (H6a) and high-extent teleworkers (H6b).

H7. The reported levels and the strength of these associations differ between the groups, with social resources being higher among hybrid

teleworkers.

H8. Social job resources moderate the relationship between ICT demands and work stress for hybrid teleworkers (H8a) and high-extent teleworkers (H8b).

1.4. The nature of the work: concentration, communication, and stress

Work tasks in teleworking vary—some require active communication, while others demand deep concentration. ICT solutions and workspaces can either support or hinder collaboration and focus. Although studies generally show that hybrid teleworking allows fewer interruptions from colleagues (Richardson and McKenna, 2014; Tietze and Musson, 2005) and enables better concentration (Biron and van Veldhoven, 2016), there are also some opposing views. For example, Hoeven and Zoonen (2015) argue that hybrid teleworkers experience more interruptions, as colleagues may perceive them as constantly available via various communication tools, negatively impacting well-being. Moreover, ten Brummelhuis et al. (2010) found that continuous connectivity increased work engagement and reduced exhaustion, provided employees had control over their availability.

Given the mixed findings regarding concentration, communication, and work stress, we do not propose a specific hypothesis. Instead, we will analyze how the opportunities for concentration—alongside tasks that primarily require focus versus those that involve communication—relate to work-related stress and how these associations differ between teleworking groups.

2. Methods

2.1. Data and participants

Our study is based on survey data collected in the spring of 2022 by the Estonian Salary Information Agency (ESIA). In 2022, in Estonia, the share of teleworkers was above the EU average: 12.4 % were regular and 13,1 % occasional teleworkers (European Agency for Safety and Health at Work (EU-OSHA), 2022). The purpose of the biannual surveys is to furnish the public and private sectors with data regarding salaries and other work-related issues. The dataset encompasses various industries and professions throughout Estonia. A representative sample of 55,000 residents was included in the poll; as a result, 10,283 persons responded (a response rate of 18.7 %). Participation was anonymous, and replies could not be linked to personal information.

For the current study, we chose a sub-sample (N = 1495) of full-time employees who spend at least 51 % of their work time on a computer. This threshold was set to exclude workers with minimal ICT use, thereby increasing the validity of assessments related to ICT experiences. In addition, to specifically study teleworkers, we included employees who work at least 26 % remotely. We further classified high-extent teleworkers who work at a different location 76–100 % of their work time (n = 801) and hybrid teleworkers who work 26–75 % (n = 694). Most of the respondents were women (60 %), and 25–44 years old (66 %), and they were working as mid-level (30.9 %) or leading specialists (19 %). The demographics of the respondents are presented in Table 1.

Table 1
Respondents' demographics.

Demographics	Item	Full sample %	Hybrid %	High-extent %
Gender	Men	31.5	33	30
	Women	60	58	62
	Prefer not to say/ define	8.5	9	8
Age	16–24	3	3	2.7
	25–34	32	34	30
	35–44	34	36	32
	45–54	19	17	21
	55–64	10	9	11.6
	65–74	2	1	2.8
	>75	0 (1 respondent)	0	0 (1 respondent)
Education	Bachelors' degree	40.3	41.5	39.2
	Masters' degree	32.2	30.7	33.5
	Secondary education	13.3	13.4	13.2
	Vocational education after elementary school	0.2	0.2	0.1
	Vocational education with secondary education	12.5	13	12.1
	Doctorate degree	0.9	0.4	1.2
	Elementary school	0.7	0.7	0.6
Occupation	Mid-level specialist	30.9	29.4	32.2
	Leading specialist	18.5	16.7	20
	Clerk	10	11	9.2
	Head of department or unit	9	10.8	7.5
	Project manager	5.6	6.6	4.6
	Specialist technician	5.4	4.3	6.2
	Head of the division or field	4.3	5.8	3.1
	Customer service representative	4.1	4.2	4
	Line manager, foreman	3.3	3.3	3.2
	Sales or service worker	2.6	2.9	2.4
	Head of the organization	2.4	2.4	2.4
	Skilled or craft worker	0.6	0.3	0.9
	Elementary worker	0.1	0.1	0
	Others	3.2	2.1	4

2.2. Measures

The dependent variable, *work stress,* was assessed with the item: "Please indicate whether you are experiencing tension or stress due to work-related worries" (1 = not at all, 6 = always).

We used principal axis factoring (PAF) on ICT and job resource variables to reduce dimensionality, as PAF is robust to non-normality (Fabrigar et al., 1999).

ICT demands. *Difficulties with ICT tools* were measured with three items (e.g., "I could not handle using ICT tools or solutions," α = 0.77). *Exhausting e-communication* was measured with four items (e.g., "The amount of information coming from e-communication channels was exhausting," α = 0.74). *Problems with emails and messages* were examined with three items (e.g., "It was difficult to understand the content of emails or messages," α = 0.72). Responses were rated on the scale (1 = "very rarely or never" to 5 = "always or very frequently"). The Tucker-Lewis Index was 0.955, and RMSEA was 0.059.

ICT resources. *Maintaining relations with the team and the manager* was measured with three items (e.g., "ICT tools and solutions help me maintain good relations with co-workers," α = 0.83). *Achieving work goals* was assessed with two items (e.g., "ICT tools and solutions help me achieve better work results," α = 0.90). "*Providing flexibility*" was measured with two items (e.g., "ICT tools and solutions allow me to choose the location of my work," α = 0.79). Responses were on the scale (1 = "fully disagree" to 5 = "fully agree"). The Tucker-Lewis Index was 0.997, RMSEA was 0.023.

Social resources. *Feeling appreciated* was measured with two items (e.g., "I feel that I am an important team member," α = 0.74). *Information sharing and collaboration* were measured with four items (e.g., "Collaboration in our organization works well," α = 0.86). Responses were on the Likert Scale (1 = "fully disagree" to 5 = "fully agree"). The Tucker-Lewis Index was 0.976, RMSEA was 0.069.

The nature of the work was assessed using three statements. Two questions measured the proportion of time spent on tasks requiring

concentration or active communication, with options ranging from "not at all" to "more than half the time." A third question asked whether the work environment supports undistracted immersion in tasks, rated on a scale (1 = "fully disagree" to 5 = "fully agree").

Controls. Gender, age, education, and occupation were controlled to adjust for demographic and occupational effects, as some evidence shows a possible impact (Marchiori et al., 2019).

2.3. Analysis

R software was employed for the data analysis, and incomplete responses were removed. Factorability was supported by a KMO >0.8 and a significant Bartlett's test ($p < 0.001$). One job resources item was omitted to improve the model fit due to its contribution to an illogical factor and negative impact on internal reliability ($\alpha < 0.7$). This adjustment enhanced interpretability and improved reliability.

Welch's *t*-test was used to identify mean differences, and multiple linear regression analyses were conducted separately for hybrid and high-extent teleworkers to test the hypotheses. Models were assessed for multicollinearity (VIF <10), heteroscedasticity (Breusch-Pagan test), and specification errors (RESET test).

Finally, moderation analyses were performed to examine whether ICT and job resources moderated the relationship between ICT demands and work stress. Following Aiken (1991) and McClelland et al. (2017), responses to concentration-enabling workplace questions were centered to interpret interaction effects. The centered concentration variable was included as a moderator. No additional centering was required for standardized variables derived from PAF.

3. Results

3.1. Descriptive statistics

Means, standard deviations, and correlations are reported in Table 2. Hybrid teleworkers

reported higher stress levels (M = 3.6, SD = 1.03) than high-extent teleworkers (M = 3.5, SD = 1.08) with the difference being statistically significant ($p < 0.05$). The total mean of three ICT demands was 2.43 (SD = 1.17) for hybrid teleworkers and 2.35 (SD = 1.20) for high-extent teleworkers ($p < 0.05$). This indicates that hybrid teleworkers report higher ICT demands. The mean score for social resources was 3.88 (SD = 0.92) for hybrid teleworkers and 3.87 (SD = 0.95) for high-extent teleworkers, with no statistically significant difference ($p = 0.78$). Thus, H7 (social resources being higher among hybrid teleworkers) was not supported.

3.2. ICT demands and resources and work stress

The regression analysis (Table 3) supported H1a, showing that all three ICT demands—"difficulties with ICT tools," "exhausting e-communication," and "problems with emails and messages"—were positively associated with work stress among hybrid teleworkers (Coef. = 0.074, SE = 0.040, $p < 0.1$, Coef. = 0.284, SE = 0.044, $p < 0.01$, Coef. = 0.135, SE = 0.055, $p < 0.05$, respectively). For high-extent teleworkers, "exhausting e-communication" (Coef. = 0.352, SE = 0.044, $p < 0.01$) and "problems with emails and messages" (Coef. = 0.189, SE = 0.051, $p < 0.01$) were significant, but "difficulties with ICT tools" were not. Thus, H1b was partially confirmed, as was H2, given the association differences across groups.

No ICT resources were associated with work stress for hybrid teleworkers. However, for high-extent teleworkers, the perception that ICT tools help maintain relationships with the team and manager was unexpectedly positively associated with work stress (Coef. = 0.095, SE = 0.043, $p < 0.05$), leading to the rejection of H3a and H3b. H4 was confirmed, considering the variations in associations across groups.

The *moderation analysis* revealed no significant buffering effect of ICT resources on the relationship between ICT demands and work stress among both groups, resulting in the rejection of H5a and H5b.

NoteI: ˆ indicates standardized coefficients resulting from principal axis factoring.

NoteII: Reference variables – Tasks requiring communication: Less than half of the time; Work requiring concentration: Less than half of the time; Gender Female; Age 16–24; Education Bachelor's degree; Occupation line manager, foreman.

3.3. Job demands and resources and work stress

The regression analysis indicated that all job resources were significantly negatively associated with work stress for high-extent teleworkers: "good information sharing and collaboration" (Coef. = -0.098, SE = 0.051, $p < 0.1$), "feeling appreciated" (Coef. = -0.137, SE = 0.052, $p < 0.01$) and "workplace enables concentration" (Coef. = -0.144, SE = 0.042, $p < 0.01$), supporting the H6b. For hybrid teleworkers, "feeling appreciated" was not significantly related to work stress, but "good

Table 2
Descriptive statistics and correlations of constructs.

Construct	Mean Likert scale 1(low)- 5 (high)	SD	Cronbach's alpha	1	2	3	4	5	6	7	8	9
1)Difficulties with ICT tools	1.7	0.9	0.77									
2)Exhausting e-communication	2.85	1.25	0.77	0.4								
3)Problems with e-mails and messages	2.45	1.0	0.72	0.1**	0.26**							
4)Maintaining relations with the team and the manager	3.4	1.2	0.83	−0.9**	−0.3	−0.13**						
5)Achieving work goals	4.1	1.0	0.9	0.3	−0.4	−0.11**	0.03					
6)Providing flexibility	4.1	1.2	0.79	−0.1**	0.0	−0.05*	0.18**	0.05				
7)Information sharing and collaboration	3.7	0.95	0.86	−0.14**	−0.17**	−0.23**	0.11**	0.26**	0.11**			
8)Feeling appreciated	4.0	0.9	0.74	−0.15**	−0.08**	−0.16**	0.12**	0.22**	0.13**	0.38**		
9) Workplace that enables concentration	3.8	1.0	–	−0.6*	−0.19**	−0.18**	0.09**	0.2**	0.13**	0.28**	0.25**	
10) Work stress	3.5 (Likert scale 1–6)	1.1	–	0.11**	0.36**	0.25**	−0.02	−0.11**	−0.5	−0.25**	−0.17**	−0.25**

Note: *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Table 3
Regression analyses of ICT demands, ICT resources, job demands, and job resources on work stress for hybrid and high-extent teleworkers.
Dependent variable: work stress.

	Hybrid (SE) n = 660	High-Extent (SE) n = 737
ICT demands		
Difficulties with ICT tools ˆ	**0.074*** (0.040)	0.060 (0.043)
Exhausting e-communication ˆ	**0.284***** (0.045)	**0.352***** (0.044)
Problems with e-mails and messages ˆ	**0.135**** (0.055)	**0.189***** (0.051)
ICT resources		
Maintaining relations ˆ	−0.002 (0.045)	**0.095**** (0.043)
Achieving work goals ˆ	0.006 (0.044)	−0.068 (0.042)
Providing flexibility ˆ	−0.014 (0.047)	−0.017 (0.048)
Social job resources		
Information sharing and collaboration	**−0.183***** (0.049)	**−0.098*** (0.051)
Feeling appreciated	−0.028 (0.054)	**−0.137***** (0.052)
Nature of the work		
Communication: more than half of the time	0.104 (0.080)	0.083 (0.082)
Communication: not at all	0.399 (0.460)	−0.043 (0.243)
Concentration: more than half of the time	**0.324***** (0.079)	**0.173*** (0.097)
Concentration: not at all		−1.156 (1.019)
Workplace that enables concentration	**−0.096**** (0.041)	**−0.144***** (0.042)
Controls		
Gender: Male	−0.114 (0.083)	−0.068 (0.085)
Gender: N/A	−0.171 (0.126)	−0.022 (0.140)
Age 25-24	0.110 (0.219)	0.184 (0.233)
Age 35–44	0.031 (0.217)	0.045 (0.234)
Age 45–54	−0.115 (0.228)	0.015 (0.240)
Age 55–64	−0.107 (0.242)	−0.036 (0.252)
Age 65–74	−1.105 (0.407)***	0.116 (0.325)
Education: elementary school	−0.152 (0.426)	0.522 (0.441)
Education: secondary	0.038 (0.115)	0.090 (0.114)
Education: vocational education after elementary school	−1.598 (0.654)	−1.258 (1.007)
Education: vocational education with secondary education	0.034 (0.116)	−0.063 (0.120)
Education: Master's degree	0.050 (0.089)	−0.031 (0.087)
Education: Doctorate degree	0.193 (0.533)	0.498 (0.333)
Occupation: head of the organization	−0.083 (0.326)	0.120 (0.348)
Occupation: head of the division or field	−0.349 (0.255)	0.131 (0.282)
Occupation: leading specialist	−0.329 (0.224)	−0.162 (0.214)
Occupation: project manager	−0.221 (0.250)	−0.043 (0.256)
Occupation: head of department or unit	−0.065 (0.231)	−0.106 (0.233)
Occupation: mid-level specialist	−0.521** (0.216)	−0.123 (0.206)
Occupation: clerk	−0.588** (0.234)	−0.262 (0.229)
Occupation: customer service representative	−0.280 (0.281)	−0.532** (0.268)
Occupation: specialist technician	−0.736 (0.266)	−0.038 (0.247)
Occupation: sales or service worker	−0.734** (0.298)	−0.104 (0.301)
Occupation: skilled or craft worker	−1.301 (0.946)	−0.468 (0.443)
Occupation: elementary worker	1.404 (0.955)	0.371 (1.017)
Occupation: others	−0.060 (0.347)	−0.159 (0.271)
R2	0.284	0.260
Adjusted R2	0.234	0.218
F Statistics	6.292***	6.272***
	*p < 0.1; **p < 0.05; ***p < 0.01	*p < 0.1; **p < 0.05; ***p < 0.01

information sharing and collaboration" (Coef. = -0.183, SE = 0.049, p < 0.01) and "workplace enables concentration" (Coef. = -0.096, SE = 0.041, p < 0.05) were also negatively related to work stress. Therefore, H6a was partially confirmed.

Work tasks requiring concentration for more than half the workday were positively related to stress in both groups (hybrid: Coef. = 0.324, SE = 0.079, p < 0.01, high-extent: Coef. = 0.173, SE = 0.097, p < 0.1), indicating no difference in this relationship.

M*oderation analysis* indicated that only "*good information sharing and collaboration"* buffered the relationship between "exhausting e-communication" and stress, and only for hybrid teleworkers (Coef. = -0.12, p < 0.05), partially confirming H8a and rejecting H8b. Graphical representations of the interaction (Fig. 1) were made using the standardized regression coefficients of the regression lines for hybrid teleworkers reporting high (1 SD above the mean) and low (1 SD below the mean) levels of information sharing and collaboration. This indicates that the negative association between exhausting e-communication and work stress was weaker among those hybrid teleworkers who reported higher (vs. lower) levels of information sharing and collaboration.

4. Discussions

In the current study, we analyzed how ICT demands and resources are associated with work stress, how these associations differ between hybrid and high-extent teleworker groups, and whether ICT resources and job resources can moderate the negative association between ICT demands and work stress. We used the Job Demands-Resources theory as a framework in our study. The central assumption of our study was that the extent of telework is a critical factor to consider, as it can substantially shape the findings (Bentley et al., 2016; Gajendran et al., 2024).

4.1. Extent of telework

Our findings confirm that the extent of telework may affect work-related outcomes like work stress. We found several noteworthy differences concerning ICT demands, ICT resources, and social job resources with work stress in both teleworker groups. Moreover, our analyses indicated that hybrid teleworkers have reported higher levels of work stress and ICT demands than high-extent teleworkers. Additionally, among hybrid teleworkers, all three ICT demands – difficulties with ICT tools, exhausting e-communication, and problems with emails and messages - were associated with higher stress. These findings are in line with the prior findings suggesting that low-extent teleworkers are more vulnerable to technostress than high-extent teleworkers (Suh and Lee, 2017), and the adverse effect of ICT usage to exhaustion is shown to be more inherent to employees who primarily or constantly work at employer's premises (Leitner and Stöllinger, 2022). One possible explanation is that high-extent teleworkers are more adjusted to digital tools than low-extent teleworkers (Suh and Lee, 2017), and hybrid

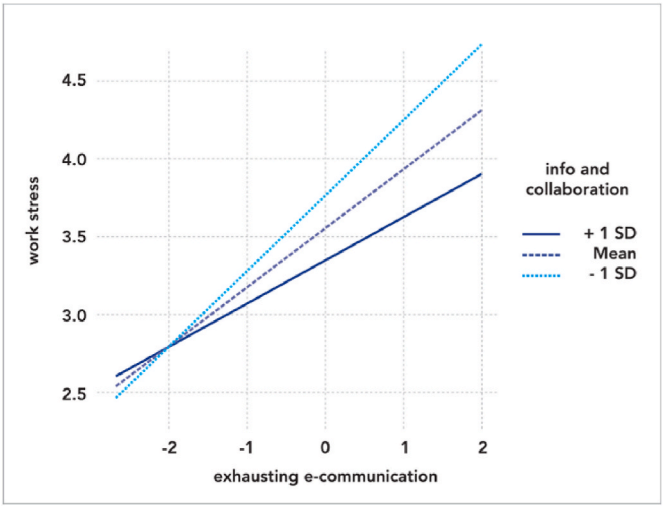

Fig. 1. The buffering effect of information sharing and collaboration on the relationship between e-communication demands and work stress among hybrid teleworkers. *Note:* Work stress is shown on its original 6-point scale; other variables are standardized (z-scores).

teleworkers are more interrupted by various communication tools (Hoeven and Zoonen, 2015). Therefore, our findings suggest that although hybrid teleworking may seem like a good compromise between flexibility and in-person collaboration, it may increase exhaustion.

In addition, according to numerous studies (e.g., Charalampous et al., 2019; de Vries et al., 2019; Gajendran et al., 2024; Grant et al., 2013) that have found teleworking's associations with loneliness and social isolation, we expected that high-extent teleworking poses lower levels of social resources than hybrid teleworking. However, there appeared to be no mean differences in social resources. This supports the findings of Heiden et al. (2021) and ten Brummelhuis et al. (2010) and suggests that the extent of teleworking does not affect social job resources. An important finding from our study is that for high-extent teleworkers, feeling appreciated is a significant job resource negatively associated with work stress.

4.2. ICT demands, ICT resources, and work stress

Following the fundamental proposition of the JD-R theory, we hypothesized that ICT demands are associated with higher levels of work stress, and job and ICT resources are related to lower stress levels (Bakker et al., 2023; Schaufeli and Taris, 2014). Our study supports the notion that ICT demands resemble job demands linked to lower well-being at work. Unexpectedly, only one of the ICT resources was directly associated with work stress, and this association was in the opposite direction. Moreover, according to the JD-R theory, job resources are not only directly and positively associated with well-being at work but can also mitigate the adverse effects of job demands (Demerouti et al., 2001). In other words, when job resources are high, the positive relationship between demands and work stress is weakened. However, our results from the moderation analysis showed that only information sharing and collaboration had a moderating effect, helping to buffer against the negative impact of exhausting e-communication on work stress. This finding was observed only among hybrid teleworkers. However, none of the ICT resources showed such an effect.

Consequently, this result contradicts the fundamental assumption of the JD-R theory. However, it aligns with the findings of Ninaus et al. (2021), who suggested that in the context of ICTs, the expected relationships between demands, resources, and well-being outcomes may not fully apply. One possible explanation lies in the nature of the ICT demands and resources examined. These may not correspond closely enough; for instance, high levels of flexibility may be insufficient to counterbalance the strain caused by technical difficulties. According to De Jonge and Huter (2021), resources are most effective as moderators when demands, resources, and outcomes align on the same underlying dimensions. These findings underscore the need for further research to refine the JD-R theory in ICT-driven work environments. Additionally, novel types of ICT-related resources should be considered in future analyses.

4.3. ICT in the context of communication and concentration

ICT has become the primary means of communication in today's work environment, and our study highlights its implications for work stress. Across both groups, information sharing and collaboration emerged as important social job resources that may help reduce stress. However, ICT-related communication demands—such as the volume of information from multiple e-communication channels, feelings of constant availability, and frequent virtual meetings—along with difficulties in understanding emails and messages, were positively and significantly associated with work stress.

Moreover, among high-extent teleworkers, the perception that ICT helps maintain relationships with team members and managers was unexpectedly linked to higher stress levels, suggesting a reinforcing effect. These findings imply that organizations should be cautious not to overly depend on ICT for communication. Instead, they should invest in purposeful and balanced communication strategies across multiple channels. As Ninaus et al. (2021) proposed, technology should not completely replace human interaction.

Consistent with this, our results also show that tasks requiring sustained concentration for more than half of the workday are positively associated with stress, whereas access to a work environment that supports concentration is negatively related to stress across both groups. We suggest that in contexts of intensive ICT-mediated communication, maintaining concentration has become increasingly difficult for employees. This supports the growing recognition that managing information load is a central challenge in modern work ergonomics (Franssila, 2019).

4.4. Demographics and occupational factors

In line with Miller et al. (2000) and Rauschenbach et al. (2013), we found no significant associations between gender, age, or education and work stress, except among hybrid teleworkers aged 65–74. However, this finding should be interpreted with caution due to the small sample size (1 %). Occupational differences were more pronounced: compared to line managers, roles such as mid-level specialists, clerks, and sales or service workers reported significantly lower work stress among hybrid teleworkers. A similar pattern was observed for customer service representatives among high-extent teleworkers. Since occupational distributions were relatively balanced, we attribute these differences to task characteristics, though this remains tentative and warrants further study.

4.5. Practical implications

Organizations should consider the extent of their employees' telework in designing sustainable well-being strategies for different types of teleworkers. Our study shows that hybrid teleworkers may be more susceptible to work stress and ICT demands than high-extent teleworkers and would need more ICT and time management support. On the other hand, being more away, high-extent teleworkers may need more reflection on the fact that they are important members of the team and their opinions matter. Moreover, more deliberate practices are needed in information sharing and communication. Firstly, organizations must carefully assess and plan which communication channels to use and for what purposes. Otherwise, employees may become overwhelmed by the amount of information coming from different channels, but their need for social resources – good collaboration and information sharing – may still not be fulfilled. Secondly, organizations need to establish work conditions that allow workers to concentrate if they need to.

4.6. Limitations and future research

The primary limitations of this study arise from its cross-sectional design that prevents detecting causal relationships, highlighting the need for longitudinal studies to explore these mechanisms. Additionally, we worked with a limited set of questions included in the ESIA study, restricting the use of validated scales, which may impact the comparability and robustness of our findings. Despite these constraints, the ESIA dataset offers a valuable foundation due to its large and nationally representative sample. However, the heterogeneity in occupational roles, education levels, and demographics may influence how ICT use and work stress are experienced. Future studies should explore these subgroup differences in more detail.

Another contextual limitation is the data collection timing, which occurred shortly after the COVID-19 pandemic. This was a transitional period when many employees were still adjusting to hybrid work arrangements, which may have shaped their perceptions of ICT-related demands and resources.

Furthermore, Estonia's technologically advanced context and high

digital literacy (Annus, 2022) may have influenced reported levels of ICT demands. For instance, according to EU-OSHA (2022), only 17 % of Estonian respondents felt that digital technologies increased their workload, compared to 33 % across the EU. Cross-cultural studies are thus needed to assess these findings' generalizability and to examine how national digital contexts influence the experience of ICT demands.

Finally, greater conceptual clarity is needed regarding the relationships between ICT demands, ICT resources, and well-being-related outcomes, as proposed by the JD-R theory. While some studies (e.g., Day et al., 2012) have shown that ICT resources can alleviate stress and buffer the effects of ICT demands, other studies, including the current one (see also Ninaus et al., 2021), do not support this. Further research is required to better understand under what conditions ICT resources alleviate stress.

5. Conclusion

In conclusion, our study highlights that hybrid teleworkers face greater challenges related to ICT demands and work stress than high-extent teleworkers. While some ICT and job demands and resources are similarly significant for both groups, important differences emerge. This underscores the necessity for tailored strategies to manage teleworkers across varying levels of telework effectively. Notably, our findings suggest that the relationship between ICT resources and work stress may differ from what is typically expected in the JD-R theory, as ICT resources did not show a negative association with work stress or a buffering effect on the relationship between ICT demands and work stress. These results emphasize the importance of a more nuanced and comprehensive approach to understanding ICT usage and its impact on work-life outcomes.

While preparing this work, the authors used Grammarly to assist with spelling and language editing. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

CRediT authorship contribution statement

Kaire Piirsalu-Kivihall: Conceptualization, Writing – original draft, Methodology, Formal analysis. **Jaana-Piia Mäkiniemi:** Writing – original draft, Conceptualization.

Declaration of interests

The authors declare that the work described in this article has not been published previously. The article is not under consideration for publication elsewhere. The publication of this article is approved by both authors and, where applicable, by the responsible authorities at the institution where the work was carried out. If this article is accepted for publication, it will not be published elsewhere in the same form, in English or any other language, including electronically, without the written consent of the copyright-holder.

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APPENDIX A. Factors, questions, and path loadings in principal axes factoring

Construct/Factor (code)	Questions	Path loading
ICT demands		
1)Difficulties with ICT tools (ictdifficulties)		
	• New ICT tools or solutions created stress.	0.9
	•I could not handle using ICT tools or solutions.	0.6
	•Problems with ICT tools prevented the work from being done.	0.6
2) Exhausting e-communication (ecommun)		
	•The amount of information coming from e-communication channels was exhausting	0.9
	•Using different e-communication channels caused stress	0.6
	•I felt like I had to be available all the time	0.4
	•Participating in virtual meetings caused fatigue	0.4
3) Problems with e-mails and messages (emailsmess)		
	•It was difficult to understand the content of e-mails or messages	0.6
	•Information from e-communication channels was unnecessary	0.6
	•E-mails or messages interfered with the concentration	0.5
ICT resources		
4) Maintaining relations with the team and the manager (relations)		
	•ICT tools and solutions help to create a feeling of a united team	0.9
	•Help maintain good relations with co-workers	0.7
	•Enable my manager to support me remotely	0.6
5) Achieving work goals (goalsachiev)		
	•Help me organize my work better	0.8
	•Help me achieve better work results	0.8
6)Providing flexibility (flexib)		
	•Allow me to choose the location of my work	0.8
	•Allow me to choose my working hours	0.7
Job resources		
7)Information sharing and collaboration		
	•Collaboration in our organization works well	0.8
	•I receive sufficient information required for my work	0.7
	•I'm informed about developments in our organization	0.6
	•Work division and responsibilities in our structural unit work well	0.5
8) Feeling appreciated		
	•I feel that I'm an important member of the team	0.7
	•My opinions and suggestions are taken into account	0.7

Note. $N = 1495$. The extraction method was principal axis factoring with an varimax rotation.

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