Does my Computer Protect me from Burnout?

Cross-country Evidence on the Impact of ICT use within the Job Demands-Resources Model

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Abstract

This paper uses a large sample of employees from 35 European countries to study the direct and indirect effects of ICT use on burnout and work engagement as two opposite poles of employee psychological health, where the former comprises the three dimensions of exhaustion, cynicism and professional efficacy. It applies the Job Demands-Resources (JD-R) model and analyses the mediating role of three job demands (work extensity, work intensity, social demands) and four job resources (social support from management or colleagues, job control, rewards) on workers' psychological health. It accounts for the importance of the place of work for the effect of ICT use on workers' psychological health by differentiating between four types of workers: home-based workers, highly mobile workers, occasionally mobile workers, and workers who always work at the employer's premises. The results show that ICT use is associated with lower levels of exhaustion but is unrelated to work engagement. Furthermore, work intensity, work extensity, social demands and rewards mediate the effect of ICT use on exhaustion, while job control and rewards mediate the effect of ICT use on work engagement. Our multi-group analysis attributes the negative effect of ICT use on exhaustion mainly to occasionally mobile workers and to workers who always work at the employer's premises and highlights that the factors that mediate the effect of ICT use on workers' psychological health differ across the four types of workers. Home-based workers stand out in two important respects: first, ICT use per se is unrelated to burnout; second, only one factor – work intensity – mediates the effect of ICT use on burnout, but its effect is especially strong.

Keywords: ICT use, burnout, work engagement, main place of work, job demands-resources model

JEL classification: I10, I31, J81

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1. Introduction

Digital technologies – especially new information and communication technologies (ICT) – have revolutionised everyday work. It is, however, widely recognised that the use of ICT is a double-edged sword, which produces both positive and negative psychological experiences for employees.

On the one hand, ICT has greatly enhanced workers' connectedness, flexibility and work autonomy in terms of where and when to work, and this has been recognised to improve overall quality of life (including family life), mainly as a result of time saved on commuting, and work engagement (Eurofound and ILO, 2017). Companies can benefit greatly from engaged workers, as these tend to work more and work harder, as well as to be more efficient (Figurska, 2015; Bakker et al., 2004), healthier (Demerouti et al., 2001a; Schaufeli et al., 2002 and 2008), more innovative in their work behaviour (Agarwal, 2014; Agarwal et al., 2012; De Spiegelaere et al., 2016) and to take less absence from work (Schaufeli et al., 2009).

On the other hand, ICT has blurred the boundaries between work and non-work activities and facilitated the encroachment of paid work into the spaces and times normally reserved for personal/family life. In particular, ICT tends to put workers under pressure to be always accessible and responsive to work demands, and this may cause stress, frustration and emotional exhaustion, and potentially results in burnout over time (Baumeister et al., 2021). By and large, the empirical literature corroborates the positive relationship between ICT use and stress, emotional exhaustion and burnout (Berg-Beckhoff et al., 2017; Karimikia et al., 2020) and shows that burnout is associated with substantial costs for the employer (as well as for the employee) in terms of lower organisational commitment, higher job turnover, absenteeism and presenteeism (i.e. lower productivity) (Leiter and Maslach, 1988 and 2009; Schaufeli et al., 2009; Demerouti et al., 2009).

An important consequence of increased ICT use was the uncoupling of paid work from traditional office space. This allows workers to be more mobile and do their work at any place (Eurofound and ILO, 2017). For instance, some workers have moved their workplace to their home and mainly (or exclusively) work from home (WFH). WFH has been on the rise and become the norm for millions of workers in the EU and worldwide during the COVID-19 pandemic because of enforced closures of many workplaces. Before COVID-19, only 20% of employees in the EU WFH; during the pandemic, almost 40% started to WFH (European Commission, 2020). In view of the good experiences with WFH during the pandemic, it will probably remain the dominant work arrangement for many workers. Moreover, other workers frequently or occasionally work outside the employer's premises and the home, while others continue to work at the employer's premises as their type of work cannot be performed off-site. Each of these work arrangements is associated with different working conditions (Eurofound and ILO, 2017) which, in turn, may affect workers' psychological health differently.

This paper takes a broader European perspective and studies the direct and indirect effects of ICT use (i.e. working with computers, laptops, smartphones etc.) on two opposite poles of employee psychological health: burnout and work engagement. Burnout is a stress syndrome, characterised by exhaustion, mental distancing and reduced personal efficacy (Demerouti et al., 2001b) whereas,

conversely, work engagement is a positive and fulfilling work-related state of mind, characterised by vigour, dedication and absorption (Schaufeli et al., 2002). We apply the Job Demands-Resources (JD-R) model (Bakker et al., 2003a, b; Demerouti et al., 2001b) as a theoretical framework to analyse (i) whether and how ICT use directly affects burnout and work engagement, and (ii) how specific job conditions, classified broadly into job demands and resources, mediate the effect of ICT use on burnout and work engagement. For methodological reasons, we analyse the three dimensions of burnout (exhaustion, cynicism and professional efficacy) separately. We use representative data from the 6th European Working Conditions Survey (EWCS), which was carried out in 2015 in 35 countries, which comprised the (then) 28 EU member states, Norway, Switzerland and the five candidate countries for EU membership – Albania, North Macedonia, Montenegro, Serbia and Turkey. Our sample consists of almost 34,000 persons who were employed at the time of the interview.

This study addresses an important gap in the literature: it accounts for the importance of the place of work for the effect of ICT use on workers' psychological health. Specifically, it differentiates between four types of workers, classified on the basis of their main place of work into (i) regular home-based workers, (ii) highly mobile workers, (iii) occasionally mobile workers, and (iv) traditional workers who always work at the employer's premises. This allows us to identify, for each of the four work arrangements, the specific job demands and resources that both ICT and non-ICT workers face and to show which specific job demands and resources mediate the effect of ICT use on both burnout and work engagement.

Our results show that, in contrast to what is typically found in the literature, ICT use is associated with *lower* levels of exhaustion and *higher* levels of professional inefficacy. In contrast, ICT use is unrelated to work engagement. Furthermore, our results point to important mediators between ICT use and workers' psychological health: ICT use is associated with higher work extensity, work intensity and social demands, which in turn result in higher levels of exhaustion. Hence, ICT users have to work more, work faster and are more often exposed to negative behaviour (verbal abuse, threats, humiliating behaviour, bullying/harassment etc.) than non-ICT users, which all result in higher levels of exhaustion. It is also associated with higher rewards, which in turn not only lead to lower levels of exhaustion but also to higher levels of work engagement, which makes rewards a particularly important mediator. ICT use is also associated with higher job control, which leads to higher levels of work engagement. Results from the multi-group analysis show that the negative relationship between ICT use and exhaustion is found primarily among occasionally mobile workers and workers who always work at the employer's premises, while it is absent for home-based workers. Furthermore, for each of the four types of workers, different factors mediate the effect of ICT use on workers' psychological health. Interestingly, for home-based workers, in all our analyses we identify only one relevant mediator, namely work intensity, which only mediates between ICT use and exhaustion, but the effect of which is particularly strong. Specifically, for home-based workers who use ICT – teleworkers – we find that the much higher level of work intensity is particularly detrimental as it is associated with a substantially higher level of exhaustion.

The rest of the paper is structured as follows: Section 2 discusses the related literature on some form of technology use, related important job demands and resources, and their association with workers' psychological health in terms of either burnout or work engagement. Section 3 briefly discusses the underlying theoretical framework of the JD-R model. Section 4 describes the data source, while Section 5 describes variable definitions. Section 6 presents and discusses results. Finally, Section 7 sets out our conclusions.

2. Related literature

Several studies have examined the relationship between some form of exposure to technology and users' psychological health, using different measures of exposure to technology such as the amount of time using technology, frequency of technology use, use of technology at work and at home, computer training, and also specific types of information and communication technologies such as smartphones, (desktop and portable) computers, e-mails and the internet. In this context, different positive and negative health outcomes were analysed, such as stress, strain and related outcomes of burnout as negative outcomes, and work engagement as a positive outcome (for a general overview see Berg-Beckhoff et al., 2017; Karimikia et al., 2020). Given the focus of our study, we will only discuss findings and results from the literature that focus on burnout – as well as its components of exhaustion, cynicism and professional inefficacy – and work engagement.

ICT use and burnout (and its components)

Several studies have established a *direct* positive relationship between some form of technology use and burnout as well as its components (exhaustion, cynicism and professional efficacy), emphasising that technology exposure is detrimental to workers' psychological health.

For instance, Korpinen and Pääkkönen (2009) use survey responses from over 6,000 Finnish workers to study the effect of the use of different types of new technology (at home and at work) – desktop computers, portable mini-computers and mobile phones – on different mental health outcomes, such as sleeping disorder/disturbance, depression, exhaustion, substance addiction, anxiety and fear. They show that only the use of desktop computers was associated with an increase in all mental symptoms, including depression and exhaustion.

Reinke and Chamorro-Premuzic (2014) use data from an online survey of around 200 employees and show that self-reported e-mail overload is positively related to burnout, also when other personality and demographic characteristics were accounted for. Estévez-Mujica and Quintane (2018) use over 52,000 mails from employees of a medium-sized R&D company in Italy to identify the relationship between e-mail communication patterns and exhaustion and disengagement (two dimensions of burnout). They distinguish between three types of e-mail communication patterns, namely e-mail volume to test whether e-mail communication load is related to burnout, as well as employee position in an e-mail communication network, and employee e-mail communication behaviour. Contrary to Reinke and Chamorro-Premuzic (2014), their results show that e-mail volume is unrelated to both exhaustion and disengagement. This suggests that it is the *perceived* volume, instead of the actual volume, of e-mails that is related to burnout and its components. By contrast, e-mail communication behaviour matters. Specifically, the higher the number of e-mails sent during out-of-office hours, the lower a person's level of exhaustion and disengagement. This somewhat counterintuitive result may be explained by employees' compensatory approach to dealing with e-mail (over)load or a preparatory approach that helps employees to pre-organise the work they will be doing during their normal working hours. Conversely, more frequent reciprocal e-mail communication with employees at higher hierarchical levels (superiors) is associated with a higher level of

exhaustion, which may reflect the higher level of demands placed on employees and the stronger control exercised by supervisors.

A positive relationship between some form of technology use and burnout is also found in studies that focus on specific occupations. For instance, Beam et al. (2003) use survey responses from over 400 full-time faculty members in journalism and mass communication who intensely use technology for teaching, communication with colleagues and students, and research. They find that perceived technology-related stressors are associated with higher levels of exhaustion. Similarly, Srivastava et al. (2015) show for a sample of around 150 senior managers who regularly use ICT that technostress – i.e. the strain related to ICT use – is associated with higher levels of burnout. Schaufeli et al. (1995) analyse the particularly stressful situation of nurses in intensive care units (ICUs) and show that the use of technology in an ICU (measured by the percentage of patients who were given mechanical ventilation) is positively related to the nurses' level of burnout.

By contrast, some studies fail to find any significant *direct* relationship between ICT use and burnout. These include the diary study of Derks et al. (2014) on daily smartphone use among workers from four different German firms; Leung (2011) on internet use for a sample of full-time office workers in Hong Kong; Salanova et al. (2000) on frequency of ICT use in a sample of Spanish workers; Fujimoto et al. (2016) on the frequency of mobile technology use (defined as hardware, software, and networking services that include portable IT devices such as smartphones, tablets, notebook computers and PDAs) for a sample of Japanese workers; and Van Zoonen et al. (2017) on social media use for work.

ICT demands and resources

A few studies have gone beyond general measures of technology use and have looked at the relationship between specific ICT demands and ICT resources and employee well-being. Day et al. (2012) use data from a survey of around 300 employees who use ICT in their jobs to identify the effect of eight different perceived ICT demands (availability, communications, ICT control, ICT hassles, employee monitoring, learning, response expectations and workload) and two ICT resources (personal assistance and resources/upgrades support) on the three burnout components of exhaustion, cynicism, and professional efficacy, among other outcomes. Their results show that, after controlling for demographic characteristics, job variables, and general job demands, there is selective evidence that ICT demands are associated with higher levels of burnout. Conversely, ICT support was associated with lower burnout. Similarly, Ninaus et al. (2021) use data from three standardised online surveys (two before and one during the COVID-19 pandemic) among Austrian employees from three different samples (public university, private media company and general online sample) to shed light on the relationship between six ICT demands and six ICT resources and burnout. They show that, while ICT demands are associated with higher burnout in all three samples, ICT resources either have no positive association with burnout (before COVID-19) or only a weak association (during COVID-19).

ICT use and work engagement

Although most studies have focused on the negative effects of some form of technology use, some have examined the positive outcome of work engagement. Results on the *direct* relationship are mixed and inconclusive. For instance, Srivastava et al. (2015) show that technostress is associated with higher levels of work engagement, while Salanova and Llorens (2009) find in a sample of workers from Spanish

private and public companies that the frequency of ICT use is associated with lower work engagement. In contrast, Fujimoto et al. (2016) and Van Zoonen et al. (2017) fail to find any significant relationship between some form of intensity of technology use and work engagement.

ICT use and working conditions

However, several studies stress that what matters for users' psychological health is not only technology exposure per se but the role played by mediating variables, such as job characteristics, job demands and resources.

For instance, technology use is found to permeate the boundaries between work and family and cause important work-life conflicts as workers are expected to be always accessible and responsive to work demands, and therefore increasingly use communication technologies for work-related tasks during their free time. In this context, Wright et al. (2014) show that an increase in the amount of time using communication technologies for work-related tasks outside regular work hours is associated with an increase in work-life conflict. A similar conflict is found by Leung (2011), who shows that more intense internet use blurs the boundaries between work and family, which causes work-family conflicts, when work obligations interfere with family responsibilities, and also family-work conflicts, when family responsibilities interfere with work obligations. A similar effect also emerges with respect to ICT demands, which are found to result in lower work-family balance (Ninaus et al., 2021). Surprisingly, the same study did not find the expected positive effect of ICT resources on work-family balance. Relatedly, workers may find it increasingly difficult to disconnect themselves from work during their out-of-office hours, which impedes their recovery process. This is stressed by Derks et al. (2014), who show that work-related smartphone use after working hours hinders psychological detachment from work. Together, all these studies conclude that the various conflict indicators are important mediators, which in turn further increase the burnout levels of technology users.

The use of technology also contributes to an increase in work interruptions through incoming e-mails, video-conferencing calls and instant messaging, and an accumulation of unanticipated tasks which negatively affects workers' well-being. This is stressed by Ter Hoeven et al. (2016) and Van Zoonen et al. (2017), who show that ICT use as well as social media use for work are associated with more work interruptions and with higher unpredictability, which in turn are related to higher levels of burnout and lower levels of work engagement.

Conversely, on the positive side, modern information and communication technologies have greatly facilitated efficient access to and exchange of information, and enhanced workers' flexibility and work autonomy in terms of where and when to work, as well as how to organise their work, which affects their well-being. This is stressed by Ter Hoeven et al. (2016) and Van Zoonen et al. (2017), who show that ICT use and social media use, respectively, are associated with more effortless, functional and timely communication and better accessibility of/by colleagues, which helps to improve workers' health through both lower levels of burnout and higher levels of work engagement. Furthermore, in a study based on a sample of Japanese full-time employees, Fujimoto et al. (2016) find that mobile technology use is associated with higher perceived job autonomy, encompassing work-scheduling autonomy, decision-making autonomy and work methods autonomy. Moreover, they also show that, in turn, higher job autonomy is related to higher work engagement. This makes job autonomy an important mediator that helps to enhance mobile technology users' work engagement.

Moreover, technology exposure is also related to employees' positive or negative evaluation of and attitudes towards technology, which in turn affects psychological health outcomes. In this context, Salanova et al. (2000) show that both the frequency of use (measured by the percentage of time spent each week on computer-aided technology at work) and computer training are associated with higher computer self-efficacy, and that higher computer self-efficacy in turn was related to lower burnout levels (measured by exhaustion and cynicism) when computer training was high. Similarly, Salanova and Llorens (2009) show that both the frequency of use (measured as in Salanova et al., 2000) and technology training are associated with higher exposure appraisal, and therefore a more positive attitude towards technology, and that higher exposure appraisal is associated with higher work engagement. This renders exposure appraisal an important mediator that enhances ICT users' work engagement.

An important role is also attributed to personality and its effect on the perceived consequences of technology use. Reinke and Chamorro-Premuzic (2014) analyse the role played by the composite indicator of core self-evaluation (CSE), which comprises four of the 'Big Five' personality traits[1] for perceived e-mail overload and burnout. They show that personality is important: a high CSE is related to lower perceptions of e-mail overload; strong feelings of e-mail overload and a low CSE level are associated with higher levels of burnout. Perceptions of e-mail overload, as well as the level of burnout, therefore strongly depend on personality traits.

Job types

Some studies have looked at job types or occupations that are close to our classification of types of workers, based on employees' main place of work. For instance, a few studies have analysed the relationship between telework and workers' psychological health (Sardeshmukh et al., 2012; Wöhrmann and Ebner, 2021; Mihalca et al., 2021). The focus on teleworkers is motivated by the fact that both a workspace away from others – colleagues and superiors – and the absence of the need to commute change how they conduct their work, as well as the nature of their job demands and resources.

These studies point to important *direct* relationships between telework and workers' psychological health. For instance, Sardeshmukh et al. (2012) find a direct negative relationship between the extent of telework and exhaustion and work engagement for a sample of more than 400 employees of a large supply-chain management company in the US Midwest.

They also show that teleworking is associated with specific job characteristics that play an important mediating role for the effect of teleworking on their psychological health. For instance, teleworkers experience higher job autonomy and working time control, as well as lower role conflict, disturbances and interruptions, which in turn are related to lower burnout levels and higher levels of work engagement. Conversely, teleworkers are often also confronted with negative conditions, such as higher role ambiguity and time pressure, as well as lower feedback, lower social support and fewer relations with co-workers. These factors are associated with higher levels of burnout and lower levels of work engagement. Empirical evidence on the effect of teleworking on time pressure is ambiguous and can be either positive (Wöhrmann and Ebner, 2021) or negative (Sardeshmukh et al., 2012). Nonetheless, there

[1] The 'Big Five' personality traits are extraversion, conscientiousness, neuroticism, openness to experience and agreeableness.

is consensus that teleworkers' higher time pressure is detrimental to their health in terms of more psychosomatic health complaints and higher levels of burnout.

Moreover, Fieseler et al. (2014) focus on salespersons, who are characterised by an extremely mobile work environment, with strong dependence on ICT. Their analysis of survey responses from around 500 salespersons from one international industrial enterprise who use ICT in their work shows that technostress is associated with higher work exhaustion. An important role is also attributed to leadership: a leader who is supportive, inspirational, motivating and helps employees to achieve a good work-life balance helps to compensate some of the technostress-induced work exhaustion.

3. Theoretical framework: the Job Demands-Resources model

Conceptually, our analysis relies on the Job Demands-Resources (JD-R) model (Bakker et al., 2003a and b; Demerouti et al., 2001b; Schaufeli and Bakker, 2004), which postulates that prevailing job demands and job resources impact job-related experiences of burnout and work engagement both independently and interdependently. It assumes that, although the particular risk factors associated with job stress vary from occupation to occupation, they can be classified into the two general categories of job demands and job resources, which constitute an overarching model that can be applied to many occupational settings and environments.

In this context, *job demands* refer to the physical, psychological, social, and organisational characteristics of the job that require continued physical and/or mental efforts or skills on the parts of workers and are therefore associated with physiological and psychological costs. Some examples of job demands are heavy lifting (of loads), work overload, and interpersonal conflict (harassment, discrimination). By contrast, *job resources* refer to physical, psychological, social and organisational characteristics of the job that are functional in achieving work goals, help to reduce the physiological and psychological costs of job demands, and stimulate employees' personal growth and development. Some examples of job resources are work control, social support (from colleagues and/or the management), career options and job security (Schaufeli and Bakker, 2004).

Initially, the JD-R model was introduced to analyse burnout, characterised by exhaustion (i.e. feeling emotionally drained and used up), mental distancing (i.e. cynicism, indifference, lack of enthusiasm) and reduced personal efficacy (i.e. feelings of reduced personal accomplishment; doubting one's competences and contribution at work) (Demerouti et al., 2001b). In its augmented version, work engagement – the positive counterpart to burnout – was introduced in addition to burnout. Work engagement is defined as *' … a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption'* (Schaufeli et al., 2002: 74). Vigo[u]r is distinguished by high levels of energy and mental resilience while working, dedication by a sense of significance, enthusiasm, inspiration, pride and challenge, and absorption by being fully concentrated and happily engrossed in one's work (Schaufeli and Bakker, 2004).

The JD-R model assumes that excessive or poorly designed job demands may lead to constant overtaxing and, in the longer term, to a loss of energy – a state of exhaustion and the core aspect of burnout – and to health issues (Demerouti et al., 2001b). Moreover, job resources are considered to have high motivational potential, leading to high work engagement and good work performance. In this context, job resources either play an intrinsic motivational role as they encourage employees' personal growth, learning and development, or an extrinsic motivational role as they are central to the achievement of set work goals (for an overview of different empirical studies which support these two propositions see Bakker and Demerouti, 2007 and 2017). The differentiated JD-R model by Crawford et al. (2010) extends the augmented JD-R model by suggesting additional relationships between job resources and burnout on the one hand, and job demands and work engagement on the other.

Specifically, their meta-analytic analysis shows that job resources not only increase work engagement but also reduce burnout. Conversely, job demands not only increase burnout but also affect work engagement, but the direction of this effect depends on the type of job demand.

In addition to these two main effects of job demands and resources, the JD-R model also posits an interaction between job demands and resources that is of importance for the development of job-related exhaustion and burnout. Specifically, it assumes that job resources help to mitigate the negative consequences of job demands on exhaustion and burnout (for empirical evidence see, e.g., Bakker et al., 2005; Xanthopoulou et al., 2007).

4. Data

The data for this study are taken from Eurofound's 6th European Working Conditions Survey (EWCS-2015)[2] which covers workers – employed and self-employed – in all 28 EU member states (as of 2015), Norway and Switzerland, plus the EU candidate countries (Albania, North Macedonia, Montenegro, Serbia and Turkey). The EWCS-2015 is particularly suited for this analysis as it includes a set of questions that describe the negative and positive sides of employees' psychological health in terms of burnout and work engagement; an indicator that captures ICT use; a set of questions on the frequency of working in different workplaces that are used to identify four different types of workers by their main place and frequency of work; rich information on working conditions that can be used to construct different working condition concepts; and worker characteristics (for more details, see Section 5).

The survey was carried out from February to December 2015 by means of face-to-face interviews using computer-aided personal interviewing (CAPI). The sample size varies between a required minimum of 1,000 and 3,400 persons per country.

In each country, a multi-stage, stratified clustered sampling design was used, with stratification based on geographic regions (NUTS 2 level or below) and degree of urbanisation. Three types of weights were applied to guarantee that results can be considered representative for workers in Europe: design weights, to adjust for different selection probabilities in the multi-stage sampling design; post-stratification weights, to ensure that the sample accurately reflects the socio-demographic structure of the target population; and cross-national weights, to adjust for differences in sample size and to ensure that each country is represented in proportion to the size of its in-work population.[3]

Generally, the sample used in the EWCS is representative of individuals aged 15 and over,[4] living in private households and in employment (i.e. who did at least one hour of work for pay or profit during the week before the interview took place, from Monday to Sunday).

The sample of the present study includes all 35 countries covered in the EWCS-2015 and includes those participants who were employed at the time of the survey. We excluded the group of self-employed for whom some of the key concepts of interest (i.e. social support) were not available as the underlying questions were only addressed to employees. This leaves us with a sample of N=33,801, as the maximum number of observations.

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2 So far, seven editions of the EWCS have taken place, in 1991, 1995, 2000/2001, 2005, 2010, 2015 and 2021 in a growing number of European countries. Owing to the COVID-19 pandemic, the EWCS 2021 'extraordinary edition' was conducted by CATI in 2021 and will become available during 2022.

3 For more information on sampling, see the sampling implementation report on the EWCS-2015: https://www.eurofound.europa.eu/sites/default/files/ef_survey/field_ef_documents/6th_ewcs_2015_-_sampling_implementation_report.pdf.

4 16 and over in Bulgaria, Norway, Spain and the UK.

5. Measures

ICT use was measured by the following question '*Does your main paid job involve working with computers, laptops, smartphones etc.?*' on a seven-point scale, with answers ranging from 1 (all of the time) to 7 (never). A dummy was generated, which was set equal to one if the answer was not 7, and zero otherwise.

Employees' main place of work was measured by '… how often you have worked in each location during the last 12 months in your main job/since you have started your main paid job'. Six different answer options were provided: (1) your employer's/your own business premises (office, factory, shop, school etc.); (2) clients' premises; (3) a car or another vehicle; (4) an outside site (e.g. construction site, agricultural field, street of a city); (5) your own home; and (6) public spaces such as coffee shops, airports etc. Each option was measured on a five-item scale, with answers ranging from 1 (daily) to 5 (never). Following Eurofound and ILO (2017) and Eurofound (2020), we specify four different types of workers – depending on their main place of work: (1) regular home-based workers who mainly work from home at least several times a month; (2) highly mobile workers who work in at least two locations other than the employer's premises at least several times a week; (3) occasionally mobile workers who work in one or two places outside the employer's premises less than several times a week; and (4) traditional workers who always work at the employer's premises.

In the EWCS-2015, burnout is measured using the three items of the Maslach Burnout Inventory – General Survey (MBI-GS): '*I feel exhausted at the end of the working day*' (exhaustion), '*I doubt the importance of my work*' (cynicism) and '*In my opinion, I am good at my job*' (professional efficacy). All three measures use a five-point scale, ranging from 1 (always) to 5 (never). We reversed the scales for exhaustion and cynicism but left the scales for professional efficacy unaltered (which therefore measures professional *in*efficacy) so that higher values referred to higher levels of burnout. However, computed internal consistencies (Cronbach's alpha) for a three-item concept of burnout (based jointly on exhaustion, cynicism, and professional inefficacy) as well as alternative two-item concepts of burnout (exhaustion and cynicism; exhaustion and professional inefficacy; cynicism and professional inefficacy) were below the minimum value standard of $\alpha = 0.70$ (Nunnally, 1978). Hence, in our analysis, we use *exhaustion* as the key concept to measure burnout. We are aware that this approach oversimplifies burnout to a one-dimensional construct of exhaustion, which ignores other potentially important aspects of a burnout experience that go beyond chronic fatigue, such as detachment from the job (as captured by cynicism) and a sense of ineffectiveness and lack of accomplishment (as captured by professional inefficacy). Furthermore, research has shown that cynicism may capture the essence of burnout more closely than exhaustion (Leiter and Maslach, 2016). In view of this, we therefore also provide results for the other two burnout dimensions of cynicism and professional inefficacy. Like other studies in this context, we expect to find that different indicators of the quality of work environment – which we capture by different job demands and job resources – play different roles for the three dimensions of burnout (Consiglio et al., 2013).

Work engagement was operationalised by the Utrecht Work Engagement Scale (UWES) (Schaufeli et al., 2002). The EWCS-2015 uses three scales to determine the level of work engagement: '*At my work I feel full of energy*' (vigour), '*I am enthusiastic about my job*' (dedication) and '*Time flies when I am working*' (absorption). All three measures use a five-point scale, ranging from 1 (always) to 5 (never). We reversed all scales so that higher values referred to higher levels of work engagement. Cronbach's

alphas showed that a *work engagement* measure based on all three scales produces the highest value of α =0.73, which we then applied in our analysis.

There is an asymmetry, therefore, in the way we define burnout on the one hand and work engagement on the other. While the former is a one-dimensional measure, the latter is composed of three dimensions. This asymmetry, however, is not voluntarily imposed but is the result of the statistical procedure, which rules out using a multi-dimensional measure for burnout.

We use several concepts that capture different job demands and job resources (for the full list of questions underlying each concept, see Table A.1 in the Annex). Most questions used five-point scale measures, ranging from 1 (strongly agree or always) to 5 (strongly disagree or never). We reversed all the scales so that the higher values refer to higher levels of each job demand and job resource.

Work intensity was measured using two items that refer to either working at very high speed or to tight deadlines. The correlation between the two items was 0.71.

Work extensity was measured using two items that refer to the number of weekly working hours and the prevalence of long working days (with more than 10 hours per day) per month. The correlation between the two items was 0.40.

Social demands comprised five items that capture exposure to verbal abuse, threats, humiliating behaviour, physical violence and bullying/harassment during the course of one's work. Cronbach's alpha was α =0.72.

As regards social support, we distinguish social support received from the management from social support received from colleagues. *Social support from the management* is measured using seven items that capture whether a person receives support from the management/immediate boss in terms of, for example, job targets, recognition, feedback and encouragement. Cronbach's alpha was α =0.89.

Social support from colleagues is measured by three items that refer to help received from colleagues, good co-operation and generally good relationships with colleagues. Cronbach's alpha was α =0.67.

Job control comprises three items that capture whether a person has control over the order of tasks, the method of work and the speed or rate of work. Cronbach's alpha was α =0.77.

Rewards were measured using three items referring to appropriate pay, career prospects and recognition for one's work. Cronbach's alpha was α =0.72.

Furthermore, in the analysis we included an additional set of controls such as sex (with male as reference), the log of age and its square, the highest level of education (ISCED-11 based) classified into low (ISCED-0 to ISCED-02, as reference), medium (ISCED-03 and ISCED-04) and high (ISCED-05 and above), marital status (with single as reference), the number of dependent children in the household, extent of work (part-time as reference, and full-time), occupational groups (ISCO-08, 1-digit), sector of economic activity (NACE rev. 2, 1-digit) and country.

In the analysis, post-stratification weights – as provided in the dataset – were used to compensate for design-specific differences in selection probabilities and to adjust for sampling error and non-response bias.

6. Methodological approach

In our analysis, we follow a two-step approach and first conduct exploratory and confirmatory factor analyses to assess the properties of the different latent constructs. Factor loadings were used to shed light on the dimensionality of each construct and identify the most relevant items of each construct. Cronbach's alpha – which measures internal consistency or reliability – was used to determine how closely related the set of underlying items comprising each construct are as a group. Items with low factor loading and/or which show little internal consistency with the other items in a group were removed from each construct.

In a second step, 'purified' scales were used in our structural equation modelling (SEM) approach to test the relationship between the variables in our model. In the model, ICT use was included as an exogenous variable. The three job demands (work extensity, work intensity and social demands) as well as the four job resources (social support from the management, social support from colleagues, job control and rewards) were treated as mediators. Exhaustion – as well as the two alternative burnout constructs of cynicism and professional inefficacy – and work engagement were treated as endogenous outcome variables. We follow the differentiated JD-R model by Crawford et al. (2010) and allow for and test whether job resources, in addition to a positive effect on work engagement, also exert a negative effect on burnout. Our *conceptual* model is shown in Figure 1 below which can be translated into the following *structural* model:

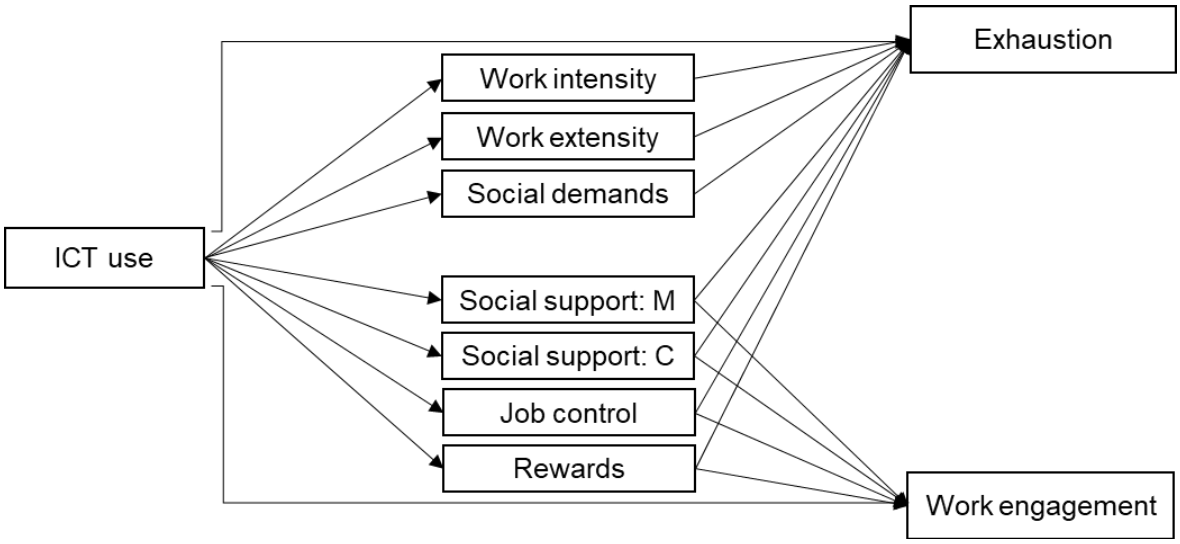
$$M_{iojc} = \alpha_0 + \beta_1 ICTuse_{iojc} + \beta_z X_{ziojc} + \mu_o + \theta_j + \omega_c + \varepsilon_{iojc} \quad (1)$$

$$BO_{iojc} = \alpha_0 + \gamma_1 ICTuse_{iojc} + M_{iojc}^{BO}\pi + \beta_z X_{ziojc} + \mu_o + \theta_j + \omega_c + \epsilon_{iojt} \quad (2a)$$

$$WE_{iojc} = \alpha_0 + \delta_1 ICTuse_{iojc} + M_{iojc}^{WE}\varphi + \beta_z X_{ziojc} + \mu_o + \theta_j + \omega_c + \epsilon_{iojc} \quad (2b)$$

where M_{iojc} refers to the seven different mediators (i.e. work extensity, work intensity, social demands, social support from the management, social support from colleagues, job control and rewards) of individual i in occupation o, industry j and country c and $ICTuse_{iojc}$ to ICT use, X_{ziojc} is a matrix of z additional individual characteristics (such as sex, the log of age and its square, the highest level of education, marital status, the number of dependent children in the household, and the extent of work), while μ_o, θ_j and ω_c refer to occupation, industry and country fixed effects, respectively. BO_{iojc} and WE_{iojc} in equations (2a) and (2b) refer to the two psychological health outcomes burnout and work engagement and M_{iojc}^{BO} as well as M_{iojc}^{WE} to the different mediators associated with either burnout (BO) or work engagement (WE), with $M_{iojc}^{BO} = M_{iojc}$ and $M_{iojc}^{WE} =$ all job resources (social support from the management, social support from colleagues, job control and rewards). Finally, ε_{iojc} and ϵ_{iojt} are the error terms. We use the same specification and structure for each group in our joint multi-group analysis.

Figure 1 / Conceptual model



Note: M = management, C = colleagues.

Owing to the non-linear (ordered) nature of the various burnout components, we use the generalised structural equation model (gsem) approach as implemented in Stata (version 15.1) and use ordered logit regressions when one of the three burnout components is the dependent variable and standard ordinary least squares (OLS) regressions for all remaining dependent variables. Furthermore, except for ICT use and the three burnout components, we use standardised measures to ease interpretation and comparability. As our data do not meet the joint normality assumption (due to the ordered nature of the burnout components), standard goodness-of-fit statistics of our model are not available.

We should emphasise here that our analysis is subject to some limitations. First, our analysis is correlational in nature. While the SEM-approach informs about the possible direction of effects, the cross-sectional nature of our study does not allow us to draw conclusions about causal relationships between variables. Second, for the same reason, we also do not account for reverse causality (endogeneity) between the different variables which is best handled with time series data. We do recognise that reverse-causal relationships could exist between our study variables (Demerouti et al., 2004; Llorens et al., 2007) which potentially introduces bias to our estimates. Third, our main focus is on job-related factors and characteristics of the work environment, for which there is detailed information in our dataset, the EWCS-2015. However, since the EWCS-2015 does not include information on personal resources (such as self-efficacy, resilience, personality traits etc.) we do not consider them in our analysis. Personal resources have been found to play an important role in the JD-R model (Xanthopoulou et al. 2007 and 2009; Van den Broeck et al., 2008 and 2011; Brenninkmeijer et al., 2010) but their exact place in the JD-R framework is yet unclear (Schaufeli and Taris, 2014). Finally, since we apply the same specification for each group in the multi-group analysis, we do not analyse specific aspects of individual groups. For instance, we do not investigate the prevalence and importance of family-work and work-family conflict which home-based workers tend to face.

Table 1 / Means (M), standard deviations (SD), internal consistencies (Alpha) and zero-order correlations (columns 1-18) – total sample

	M	SD	Alpha	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Control variables																						
1. Female	0.49	0.51	-	1.00																		
2. Ln age	3.68	0.30	-	0.03***	1.00																	
3. ISCED-Medium	0.49	0.50	-	-0.04***	-0.02***	1.00																
4. ISCED-High	0.36	0.48	-	0.09***	-0.03***	-0.72***	1.00															
5. Married	0.68	0.46	-	-0.03***	0.22***	-0.01***	0.02***	1.00														
6. # dep. children	0.64	0.93	-	0.02***	-0.04***	-0.05***	0.05***	0.33***	1.00													
7. Full-time	0.82	0.38	-	-0.20***	0.00	0.01	0.06***	0.03***	-0.02***	1.00												
ICT																						
8. ICT use	0.68	0.47	-	0.06***	-0.03***	-0.13***	0.36***	0.02***	0.04***	0.08***	1.00											
Job demands																						
9. Work intensity	7.35	3.70	0.71	-0.04***	-0.11***	0.00	-0.01**	0.00	0.02***	0.05***	0.02***	1.00										
10. Work extensity	39.43	14.13	0.40	-0.21***	-0.03***	0.00	0.02***	0.03***	0.02***	0.49***	0.04***	0.14***	1.00									
11. Social demands	0.29	0.79	0.72	0.02***	-0.02***	-0.02***	0.03***	-0.02***	0.02***	-0.01**	0.08***	0.12***	0.05***	1.00								
Job resources																						
12. Support: mgmt	26.60	7.27	0.89	0.00	-0.08***	-0.02***	0.07***	0.01*	0.01**	0.04***	0.10***	-0.05***	0.01*	-0.18***	1.00							
13. Support: coll.	12.45	2.87	0.67	-0.07***	-0.05***	-0.03***	0.11***	0.03***	0.03***	0.13***	0.15***	0.05***	0.11***	-0.06***	0.42***	1.00						
14. Job control	1.97	1.17	0.77	0.02***	0.06***	-0.13***	0.19***	0.03***	0.04***	0.00	0.20***	-0.09***	-0.01*	-0.03***	0.09***	0.04***	1.00					
15. Rewards	9.73	3.07	0.72	-0.05***	-0.11***	-0.08***	0.16***	0.01	0.02***	0.05***	0.18***	-0.07***	0.01*	-0.19***	0.46***	0.30***	0.17***	1.00				
Psychological health																						
16. Exhaustion	3.17	1.04	-	0.04***	-0.04***	0.02***	-0.06***	0.00	0.02***	0.06***	-0.09***	0.28***	0.14***	0.14***	-0.11***	-0.04***	-0.09***	-0.20***	1.00			
17. Cynicism	1.89	1.09	-	-0.03***	-0.07***	0.02***	-0.05***	-0.02***	-0.02***	-0.01	-0.05***	0.09***	0.00	0.05***	-0.10***	-0.12***	-0.07***	-0.10***	0.20***	1.00		
18. Inefficacy	1.60	0.66	-	-0.01*	-0.04***	0.01*	0.02***	-0.01**	-0.01**	0.00	0.06***	0.01**	-0.03***	0.02***	-0.12***	-0.16***	-0.04***	-0.08***	-0.02***	0.22***	1.00	
19. Work engag.	11.70	2.17	0.73	0.04***	0.04***	-0.06***	0.12***	0.04***	0.04***	-0.01**	0.10***	-0.09***	-0.03***	-0.11***	0.32***	0.26***	0.18***	0.44***	-0.16***	-0.23***	-0.35***	1.00

Note: * p<0.05, ** p<0.01, *** p<0.001. Alpha refers to Cronbach's alpha, columns 1-19 report zero-order correlations.

7. Findings

7.1. MEASUREMENT MODEL

Table 1 presents the means, standard deviations, alpha coefficients, and intercorrelations of all variables used in the analysis. Except for work extensity and social support from colleagues, all the alpha values meet the minimum criterion of 0.70 (Nunnally, 1978). The remaining variables range between 0.89 and 0.71. The correlation coefficients show that ICT use is positively and significantly related to all job demands and resources as well as the two outcome variables of professional inefficacy and work engagement. Conversely, ICT use is negatively significantly related to the two burnout components of exhaustion and cynicism. Means and standard deviations of the four types of workers are reported in Table A.2 in the Annex.

7.2. STRUCTURAL EQUATION MODELLING

The results of the econometric analyses are presented in three parts. These are *(i)* the results for the direct effects of ICT use and the job demands and job resources on burnout and work engagement; *(ii)* the mediating role of job demands and job resources for the effect of ICT use on burnout and work engagement; and *(iii)* the direct and indirect effects of ICT use for four different types of workers, in the context of a multi-group analysis.

Direct effects of ICT use. The results for the direct effects of ICT use on burnout and work engagement obtained from the empirical JD-R models are summarised in Table 2. Therein, the main model focuses on exhaustion as the main dimension of burnout, while cynicism and professional inefficacy serve as alternative burnout dimensions. For each dimension of burnout as well as for work engagement, the table contains a 'basic' model and a 'full' model. The basic models include ICT use as explanatory variable. The full models follow the theoretical guidance of the JD-R framework and – in addition to ICT use – include job demands and job resources to explain burnout and job demands to explain work engagement, as well as an additional set of control variables (see Section 5).

The basic model for exhaustion (model I) already holds a first unexpected result: in contrast to what is typically found in the literature, ICT use shields from exhaustion, a result that is confirmed in the full specification (model II). In both cases the coefficient of ICT use is statistically significant at the 1% level and amounts to -0.25 in the full specification. Given that the burnout specifications are estimated using ordered logit regressions (in the framework of the gsem), the magnitude of the coefficients cannot be easily interpreted. We will, however, put them in some context later when we discuss the average marginal effects.

The full model for exhaustion (model II) yields further interesting results. Above all, it provides strong support for the predictions of the JD-R model as each of the job demands delivers a positive and statistically significant coefficient (at the 1% level), meaning that they increase the level of burnout. Similarly, all job resources, including social support from management and colleagues, job control, and

rewards, yield a negative coefficient, suggesting that all these factors reduce the level of exhaustion. Except for job control, all job demands are statistically significant, at least at the 5% level.

As concerns work engagement, no significant effect of ICT use is identified, either in the basic or the full model.[5] Thus, working with computers and mobile phones does not, on average, contribute to the work engagement of employees across Europe. This result is in line with other findings in the literature such as Fujimoto et al. (2016) or Van Zoonen et al. (2017).

Table 2 / Effect of ICT use on burnout and work engagement

	Main model for burnout and work engagement				Models for alternative burnout measures			
Dependent variable	**Burnout**		**Work engagement**		**Burnout (alternative)**		**Burnout (alternative)**	
	Exhaustion				**Cynicism**		**Professional inefficacy**	
	model (I)	**model (II)**	**model (I)**	**model (II)**	**model (I)**	**model (II)**	**model (I)**	**model (II)**
Explanatory variables	**(basic)**	**(full)**	**(basic)**	**(full)**	**(basic)**	**(full)**	**(basic)**	**(full)**
ICT use	-0.142***	-0.244***	0.013	-0.033*	0.072*	0.058	0.277***	0.321***
	(-4.099)	(-6.253)	(0.716)	(-1.845)	(1.932)	(1.450)	(6.888)	(7.238)
Work intensity		0.538***				0.123***		-0.037*
		(27.733)				(5.972)		(-1.849)
Work extensity		0.268***				-0.034*		-0.052***
		(14.878)				(-1.876)		(-2.813)
Social demands		0.153***				-0.008		-0.107***
		(10.348)				(-0.496)		(-6.304)
Social support: mgmt		-0.043**		0.131***		-0.133***		-0.123***
		(-2.155)		(13.906)		(-6.541)		(-5.689)
Social support: coll.		-0.060***		0.210***		-0.407***		-0.626***
		(-3.218)		(23.079)		(-20.784)		(-25.138)
Job control		-0.017		0.043***		0.001		-0.037*
		(-0.958)		(5.262)		(0.045)		(-1.845)
Rewards		-0.273***		0.293***		-0.125***		-0.040*
		(-12.531)		(28.529)		(-5.218)		(-1.818)
Constant			4.184***	-1.317				
			(4.528)	(-1.378)				
Obs.	33,453	33,453	33,453	33,453	33,453	33,453	33,453	33,453

Note: Results obtained from a weighted structural equation model (SEM). Observations include employees only. Mgmt = management, coll. = colleagues. Control variables listed in Section 5 are included in all models but are not individually reported. All dimensions of burnout are scaled such that higher values indicate higher risk/degree of burnout. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. t-values in parentheses. All regressions are estimated using Stata's gsem command.

The work engagement model, like the burnout model, fits the predictions of the JD-R framework: all job resources deliver positive and highly significant coefficients. As a linear estimator is used for the work engagement model, it is possible to interpret the size of the coefficients directly. In this vein, the results suggest comparatively large effects of rewards (0.30) and social support from colleagues (0.21) on work engagement. The impact of the support from colleagues is also interesting in comparison to the support provided by the management, insofar as the former is quantitatively larger. Our results therefore suggest that mutual support and constructive interaction among peers is particularly conducive to work engagement.

[5] The coefficient of ICT use is statistically significant at the 10% level, which we deem too weak to draw any reliable conclusions.

Two key messages emerge from the main model. First, ICT use reduces the risk of burnout, while having no measurable effect on work engagement. Second, using the JD-R framework as theoretical guidance, all job demands and job resources have the predicted effects on exhaustion and work engagement.

Next, we turn to the two alternative dimensions of burnout in Table 2, cynicism and professional inefficacy. Here we find that ICT use has no significant impact on cynicism, but a positive effect on professional inefficacy, at the 1% level of statistical significance. In other words, employees working with computers, laptops, mobile phones and the like tend to question their competences and qualification for their job. Note that these divergent effects of ICT use on the various dimensions of burnout do not point to any inconsistency. The factor analyses pointed against merging the three burnout dimensions into one measure and in favour of treating them as separate concepts that feed into burnout. Therefore, the finding that ICT use affects exhaustion, cynicism and professional inefficacy in different ways is not surprising. In any case, ICT use is estimated to reduce the level of exhaustion, while undermining professional efficacy. As there is no way to weigh one dimension of burnout against another, it is not possible to derive general conclusions on the relationship between ICT use and burnout. Rather, separate conclusions for the individual dimensions of burnout must be drawn.

We now return to the interpretation of the magnitude of the estimated effects. Any coefficient of ICT use on work engagement can be interpreted directly as marginal effect, though a meaningful interpretation can only be given for significant ones. However, given the ordered nature of the burnout variables, the situation is different for the corresponding models. Therefore, the average marginal effects (AMEs) of ICT use across all observations in the sample were calculated. These can be interpreted as relative probabilities of ICT users and non-ICT users to reporting any of the five exhaustion levels defined in the five-item response (i.e. never, rarely, sometimes, most of the time, always). For example, the estimated coefficient of ICT use in the exhaustion model in Table 3 (panel (a)) implies that the probability of ICT users to indicate that they never feel exhausted is 1.1 percentage points higher than that of non-ICT users. ICT users are also more likely to feel rarely exhausted (+2.7 percentage points) or sometimes exhausted (+0.9 percentage points), while they are less likely to feel exhausted most of the time (-2.4 percentage points) or always (-2.4 percentage points).[6] The AMEs of ICT use on cynicism (panel (b)) and professional inefficacy (panel (c)), as well as those of the covariates, can be interpreted in the same way. Unlike the estimated raw coefficients, the AMEs lend themselves to comparisons. For example, the AMEs of ICT use on professional inefficacy seem to be larger for workers who never or rarely experience professional inefficacy. However, the differences between ICT and non-ICT users are smaller for persons who suffer more frequently from feelings of professional inefficacy. We abstain from discussing the AMEs of all job demands and job resources. However, we note that the observation that social support from colleagues tends to have a greater impact than support from management, which emerged in the context of work engagement, is found across all three dimensions of burnout. The difference between the two forms of social support is most pronounced in the case of professional inefficacy (panel (c)).

[6] As all respondents belong to one of the five categories, the probabilities add up to 0.

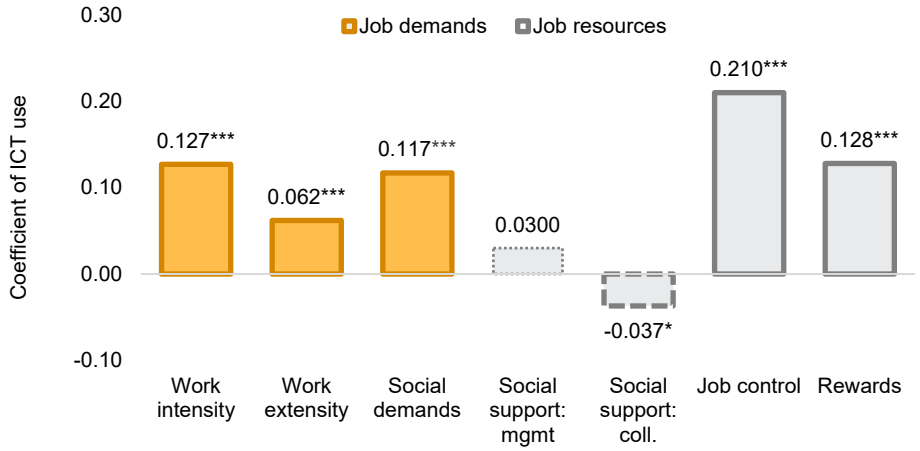
Table 3 / Average marginal effects of ICT use on burnout

Category	ICT use	Work intensity	Work extensity	Social demands	Social support: mgmt	Social support: coll.	Job control	Rewards
(a) Exhaustion								
never	0.011***	-0.025***	-0.013***	-0.007***	0.002**	0.003***	0.001	0.013***
	(6.446)	(-18.941)	(-13.021)	(-9.732)	(2.143)	(3.159)	(0.957)	(11.167)
rarely	0.027***	-0.061***	-0.030***	-0.017***	0.005**	0.007***	0.002	0.031***
	(6.280)	(-28.224)	(-14.543)	(-10.190)	(2.157)	(3.217)	(0.959)	(12.294)
sometimes	0.009***	-0.017***	-0.008***	-0.005***	0.001**	0.002***	0.001	0.009***
	(4.925)	(-10.037)	(-9.107)	(-7.684)	(2.130)	(3.142)	(0.948)	(8.884)
most of the time	-0.024***	0.052***	0.026***	0.015***	-0.004**	-0.006***	-0.002	-0.027***
	(-6.192)	(27.361)	(14.507)	(10.213)	(-2.147)	(-3.186)	(-0.957)	(-12.317)
always	-0.024***	0.051***	0.025***	0.015***	-0.004**	-0.006***	-0.002	-0.026***
	(-6.012)	(22.743)	(14.378)	(10.164)	(-2.165)	(-3.243)	(-0.957)	(-12.436)
(b) Cynicism								
never	-0.013	-0.028***	0.008*	0.002	0.030***	0.092***	-0.000	0.028***
	(-1.452)	(-5.987)	(1.877)	(0.496)	(6.572)	(21.723)	(-0.045)	(5.250)
rarely	0.003	0.007***	-0.002*	-0.000	-0.008***	-0.024***	0.000	-0.007***
	(1.429)	(6.095)	(-1.892)	(-0.497)	(-6.420)	(-16.423)	(0.045)	(-4.965)
sometimes	0.005	0.010***	-0.003*	-0.001	-0.011***	-0.034***	0.000	-0.010***
	(1.449)	(5.951)	(-1.871)	(-0.496)	(-6.436)	(-19.932)	(0.045)	(-5.076)
most of the time	0.003	0.006***	-0.002*	-0.000	-0.007***	-0.021***	0.000	-0.007***
	(1.462)	(5.648)	(-1.860)	(-0.495)	(-6.274)	(-16.110)	(0.045)	(-5.396)
always	0.002	0.004***	-0.001*	-0.000	-0.004***	-0.012***	0.000	-0.004***
	(1.472)	(5.574)	(-1.865)	(-0.497)	(-6.498)	(-15.351)	(0.045)	(-5.447)
(c) Professional inefficacy								
never	-0.069***	0.008*	0.011***	0.023***	0.026***	0.133***	0.008*	0.009*
	(-7.253)	(1.851)	(2.818)	(6.332)	(5.717)	(27.891)	(1.844)	(1.819)
rarely	0.052***	-0.006*	-0.008***	-0.017***	-0.019***	-0.099***	-0.006*	-0.006*
	(7.083)	(-1.845)	(-2.826)	(-6.345)	(-5.695)	(-29.472)	(-1.842)	(-1.818)
sometimes	0.014***	-0.002*	-0.002***	-0.005***	-0.006***	-0.028***	-0.002*	-0.002*
	(7.355)	(-1.859)	(-2.772)	(-6.072)	(-5.581)	(-16.365)	(-1.846)	(-1.815)
most of the time	0.002***	-0.000*	-0.000***	-0.001***	-0.001***	-0.004***	-0.000*	-0.000*
	(6.070)	(-1.849)	(-2.683)	(-5.181)	(-4.956)	(-8.815)	(-1.823)	(-1.802)
always	0.001***	-0.000*	-0.000***	-0.000***	-0.000***	-0.002***	-0.000*	-0.000*
	(5.462)	(-1.778)	(-2.614)	(-4.646)	(-4.500)	(-6.760)	(-1.756)	(-1.742)

Note: Average marginal effects are derived on the basis of the results reported in Table 2. Mgmt = management, coll. = colleagues. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. t-values in parentheses. Marginal effects were obtained with Stata software using the post-estimation command 'margins' with the option 'vce(unconditional)' to take the sampling design and weighting structure into account.

Mediators between ICT use, burnout and work engagement. The coefficients of ICT use in the econometric models reported in Table 2 show the direct effect of ICT use on burnout and work engagement. However, ICT use may also affect burnout and work engagement indirectly through different job demands and resources. This mediating role of different job demands and resources depends on whether they are significantly related to both ICT use on the one hand, and burnout and work engagement on the other hand. The results in Table 2 already pointed to a significant relationship between the different job demands and resources on burnout as well as work engagement. Therefore, in a next step, we determined whether the relationship between ICT use and the different job demands and resources is also significant. Results of the OLS regressions are presented in Figure 2; the size of the bars indicates the magnitude of the effects of ICT use on each job demand and resource.

Figure 2 / Relationship between ICT use, job demands and resources (full model specification)



Note: Results obtained from a weighted structural equation model (SEM). Observations only include employees. The bars show the estimated coefficient from a regression of the respective job demand and job resource on ICT use. Mgmt = management, coll. = colleagues. All dimensions of burnout are scaled such that higher values indicate higher risk/degree of burnout. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. All regressions are estimated using Stata's gsem command.

As regards job demands, our results show that work intensity, work extensity and social demands are all positively associated with ICT use at the 1% level of significance. A comparison of coefficients shows that the strongest effect of ICT use is on work intensity – i.e. the need to work faster – and social demands. The latter seems to suggest that, through greater anonymity and the lack of personal face-to-face interactions, ICT facilitates behaviour that is abusive, humiliating, harassing or threatening, which ICT users experience more frequently than non-ICT users. Conversely, only two of the four job resources are significantly related to ICT use: job control and rewards are both positively associated with ICT use at the 1% level of significance, with the strongest effect of ICT use on job control.

Although the indirect effects cannot be calculated in the current (non-linear) generalised SEM context, our results in Table 2 and Figure 2 above nonetheless allow us to identify important mediators. For instance, significant relationships between each of the job demands and exhaustion on the one hand (see Table 2), as well as job demands and ICT use on the other (see Figure 2), suggest that all job demands are important mediators. Specifically, our results show that ICT use is associated with higher work intensity, work extensity and social demands, which in turn are associated with higher levels of exhaustion. Similarly, among job resources, rewards turn out to be an important mediator: ICT use is associated with higher rewards, which in turn are associated with lower levels of exhaustion. As the coefficients are insignificant for the remaining job resources (either for ICT use or exhaustion), they are unlikely to be relevant mediators. As regards the remaining burnout dimensions, our results suggest that work intensity as well as rewards mediate the effect of ICT use on cynicism, while work extensity and social demands mediate the effect of ICT use on professional inefficacy. Interestingly, work extensity and social demands work in the same direction: ICT use is associated with higher work intensity and social demands, which in turn are associated with lower professional inefficacy. Hence, as suggested above, our results show that the relevant mediators differ across burnout dimensions.

We also find important mediators for the relationship between ICT use and work engagement, in terms of job control and rewards. Specifically, ICT use is associated with both higher job control and rewards, which in turn are associated with higher work engagement.

We now turn to the quantification of the direct, indirect and total (direct plus indirect) effects of ICT use on the different burnout components and work engagement. To this end, we take recourse to OLS regressions within an SEM context and therefore use a linear model also for the three burnout components. This also helps us to substantiate the above observations concerning the role of different mediators. Results are presented in Table 4.[7] We should emphasise here that missing values are treated differently in the linear SEM than in the non-linear generalised SEM approach, which explains why estimated coefficients reported in Table 2 and Table 4 differ somewhat.[8] Table 4 shows that all direct effects of ICT use on burnout are fully confirmed: ICT use helps to shield from exhaustion but increases the likelihood of professional inefficacy, with no significant result found for cynicism. The only noteworthy difference is that the effect of ICT use on work engagement comes out as statistically significant at the 5% level in the work engagement regression.

Furthermore, as regards the mediating role of the different job demands and resources, Table 4 confirms the above observations: all three job demands (work intensity, work extensity, social demands) as well as rewards (as the sole job resource) mediate the effect of ICT use on exhaustion. Quantitatively, the strongest effects stem from work intensity and rewards. Likewise, work intensity and rewards mediate the effect of ICT use on cynicism, with work intensity exerting the strongest effect. Social demands, job control as well as rewards all mediate the effect of ICT use on professional inefficacy. The strongest effect stems from social demands, followed by job control and, finally, rewards. Job control and rewards mediate the effect of ICT use on work engagement, with the strongest effect coming from rewards.

It is also interesting to compare the direct effect of each burnout dimension with the total effects. The key insight is that in all cases the direct effect prevails. This means that the total effect of ICT use on exhaustion is negative (-0.095) and the total effect of ICT use on professional inefficacy is positive (+0.114), both statistically significant at the 1% level, pointing to partial mediation. The total effect in the cynicism model is statistically insignificant, mirroring the result of the direct effect. In the exhaustion model, the effects of the countervailing mediating factors (work intensity, work extensity and social demands) exceed those of the mediating factors that support the direct effect (rewards), resulting in a slightly smaller total effect of ICT use compared with the direct effect. In the case of the professional inefficacy model, the relevant mediators (social demands, job control and rewards) all work against the direct effect but are very small in terms of magnitude, and so the total effect is very close to the direct effect.

There are two main take-aways from this analysis. First, there are several mediators via which ICT use affects burnout and work engagement indirectly. Although the relevant mediators generally differ across the various health outcomes, one is relevant for all, namely rewards. Secondly, while relevant, all

[7] We also used bootstrapping as recommended by Hayes (2013) which better takes account of the irregularity of the sampling distribution of the indirect (product) term and therefore yields inferences about the indirect effects and the presence of mediation in our model that are more accurate. Bootstrapping of indirect effects produces very similar results to what is reported in Table 4. For the sake of brevity, results are not reported here but are available from the authors upon request.

[8] We also ran gsem estimations for the same sample, which are qualitatively identical to those presented in Table 2 and Figure 2.

mediating factors are not large enough to overcompensate the direct effect of ICT use on exhaustion (negative), cynicism (not significant) and professional inefficacy (positive).

Table 4 / Direct, indirect and total effects of ICT use on burnout (full model specification)

	Burnout Exhaustion model (II)	Burnout Cynicism model (II)	Burnout Professional inefficacy model (II)	Work engagement model (II)
Direct effects				
ICT use	-0.115***	-0.010	0.120***	-0.037**
	(-6.16)	(-0.49)	(6.20)	(-2.17)
Indirect effects				
Work intensity	0.022***	0.006***	-0.001	
	(4.24)	(3.53)	(-1.63)	
Work extensity	0.006**	-0.001	-0.001*	
	(2.56)	(-1.57)	(-1.86)	
Social demands	0.009***	0.001	-0.006***	
	(5.54)	(0.96)	(-4.69)	
Social support: mgmt	-0.000	-0.001	-0.001	0.003
	(-1.03)	(-1.26)	(-1.22)	(1.32)
Social support: coll.	0.001	0.006	0.009*	-0.007
	(1.45)	(1.63)	(1.65)	(-1.60)
Job control	-0.002	-0.001	-0.004**	0.009***
	(-1.06)	(-0.34)	(-2.06)	(5.01)
Rewards	-0.015***	-0.003**	-0.002**	0.035***
	(-5.47)	(-2.02)	(-1.98)	(6.11)
Total effects				
	-0.095***	0.003	0.114***	0.004
	(-4.78)	(-0.15)	(5.44)	(0.21)

Note: Results obtained from OLS regressions within a structural equation model (SEM). The results from the work engagement regression stem from the estimation of the joint exhaustion/work engagement model. The corresponding results for the cynicism and the professional inefficacy models are very similar to those of the exhaustion model and are therefore not separately reported. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. Z-values in parentheses.

Effects of ICT use for different types of workers – a multi-group analysis. We also applied a refined model of the effects of ICT use on burnout and work engagement which, depending on their workplace and workplace mobility, distinguishes the following four types of workers: regular home-based workers, highly mobile workers, occasionally mobile workers and traditional workers who always work at the employer's premises. This distinction allows us to identify for each of the four types of workers the specific relationship between ICT use on the one hand and the three burnout dimensions and work engagement on the other, and the particular job demands and resources that mediate the effect of ICT use on the different burnout dimensions and work engagement.

Results are presented in Table 5 that confirm the general pattern for the effect of ICT use on the three dimensions of burnout and work engagement from the main model (see Table 2): ICT use tends to reduce the level of exhaustion but increases the level of professional inefficacy, with no significant effects on either cynicism or work engagement. However, Table 5 also reveals that these effects are quantitatively very different across the four types of workers. Interestingly, for the group of home-based workers, the direct effect of ICT use is never significant, irrespective of the psychological health outcome considered.

Table 5 / Effect of ICT use on burnout and work engagement by type of workers (full model specification)

	Main model for burnout and work engagement								Models for alternative burnout measures							
	Burnout Exhaustion				Work engagement				Burnout Cynicism				Burnout Professional inefficacy			
	home-based	highly mobile	occ. mobile	at premises	home-based	highly mobile	occ. mobile	at premises	home-based	highly mobile	occ. mobile	at premises	home-based	highly mobile	occ. mobile	at premises
ICT use	-0.227	-0.156**	-0.300***	-0.246***	-0.091	-0.005	-0.059*	-0.030	-0.133	0.043	0.098	0.052	0.067	0.349***	0.235***	0.348***
	(-0.708)	(-2.292)	(-3.868)	(-4.235)	(-0.575)	(-0.160)	(-1.776)	(-1.173)	(-0.350)	(0.611)	(1.185)	(0.894)	(0.219)	(4.644)	(2.692)	(5.115)
Work intensity	0.592***	0.491***	0.574***	0.529***					0.029	0.175***	0.094***	0.130***	-0.079	-0.099***	-0.008	-0.005
	(7.848)	(14.519)	(16.651)	(18.827)					(0.352)	(5.075)	(2.778)	(4.458)	(-1.000)	(-2.714)	(-0.239)	(-0.169)
Work extensity	0.348***	0.269***	0.231***	0.296***					0.013	-0.040	-0.071**	-0.003	-0.057	-0.104***	0.002	-0.050
	(3.930)	(9.521)	(7.271)	(8.667)					(0.176)	(-1.387)	(-2.240)	(-0.069)	(-0.677)	(-3.449)	(0.043)	(-1.412)
Social demands	0.162**	0.125***	0.139***	0.188***					0.029	-0.002	0.002	-0.018	-0.085	-0.066**	-0.119***	-0.159***
	(2.545)	(5.234)	(5.462)	(6.957)					(0.514)	(-0.091)	(0.052)	(-0.671)	(-1.391)	(-2.450)	(-3.946)	(-4.965)
Social support: mgmt	-0.088	-0.063*	-0.007	-0.059*	0.140***	0.109***	0.113***	0.151***	-0.207***	-0.167***	-0.062*	-0.155***	-0.150*	-0.205***	-0.148***	-0.060*
	(-1.096)	(-1.682)	(-0.218)	(-1.836)	(4.215)	(5.969)	(7.203)	(10.456)	(-2.714)	(-4.356)	(-1.812)	(-5.003)	(-1.717)	(-4.954)	(-3.871)	(-1.787)
Social support: coll.	-0.167**	-0.043	-0.075**	-0.056*	0.132***	0.239***	0.198***	0.211***	-0.319***	-0.448***	-0.420***	-0.391***	-0.460***	-0.577***	-0.645***	-0.676***
	(-2.360)	(-1.317)	(-2.381)	(-1.926)	(4.227)	(15.089)	(13.140)	(15.167)	(-3.922)	(-13.034)	(-12.373)	(-12.957)	(-5.472)	(-14.174)	(-15.612)	(-18.029)
Job control	-0.030	-0.040	0.000	-0.027	0.023	0.032**	0.044***	0.045***	0.023	0.009	-0.011	0.003	0.099	0.017	-0.058*	-0.063**
	(-0.343)	(-1.304)	(0.005)	(-1.187)	(0.601)	(2.224)	(3.252)	(3.817)	(0.260)	(0.274)	(-0.348)	(0.101)	(1.061)	(0.491)	(-1.696)	(-2.194)
Rewards	-0.246***	-0.259***	-0.265***	-0.285***	0.211***	0.291***	0.297***	0.306***	-0.184**	-0.039	-0.211***	-0.110***	-0.057	0.008	-0.040	-0.073**
	(-2.801)	(-6.455)	(-7.036)	(-8.465)	(5.575)	(16.252)	(17.922)	(19.193)	(-2.373)	(-0.876)	(-5.647)	(-3.190)	(-0.686)	(0.190)	(-1.050)	(-2.285)
Obs.	33,453				33,453				33,453				33,453			

Note: Results obtained from a weighted structural equation model (SEM). Observations only include employees. Mgmt = management, coll. = colleagues. Control variables listed in Section 5. All dimensions of burnout are scaled such that higher values indicate higher risk/degree of burnout. For each dependent variable all coefficients for the four types of workers belong to the same SEM. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. t-values in parentheses. All regressions are estimated using Stata's gsem command.

To assess the relative importance of the effects across these types of workers, we again rely on AMEs, which are presented in Figure 3, confined to those for ICT use.[9] As regards exhaustion, the results suggest that the difference between ICT and non-ICT use is most pronounced among occasionally mobile workers, followed by workers at the employer's premises.[10] For example, occasionally mobile workers who use ICT have a 3.6-percentage point higher probability to indicate that they rarely feel exhausted than non-ICT workers of the same group. One possible explanation for this result is that occasionally mobile workers and workers located at the employers' premises are able to keep their living space free from work-related use of computers and mobile phones. Although the data do not allow us to substantiate this interpretation, the hypothesis that the use of ICT can shield from exhaustion, especially in an environment in which work and private life can more easily be kept apart, seems to be a plausible one.

With regards to professional inefficacy, the – in this case positive – impact of ICT use is most pronounced for highly mobile workers and workers who always work at their employer's premises. The effect for occasionally mobile workers is statistically significant too, while that of home-based workers is insignificant.

The multi-group analysis, the results of which are depicted in Figure 3, also reveals that the overall effect of ICT use on exhaustion and professional inefficacy reported in Table 3 stem from different categories of workers. In the case of exhaustion, the average marginal effects of ICT use are most pronounced for the occasionally mobile workers, followed by those who always work at the employer's premises, while the effects are smaller for the highly mobile workers. In contrast, for professional inefficacy, the average marginal effects are largest for the highly mobile workers and those who always work at the employer's premises.

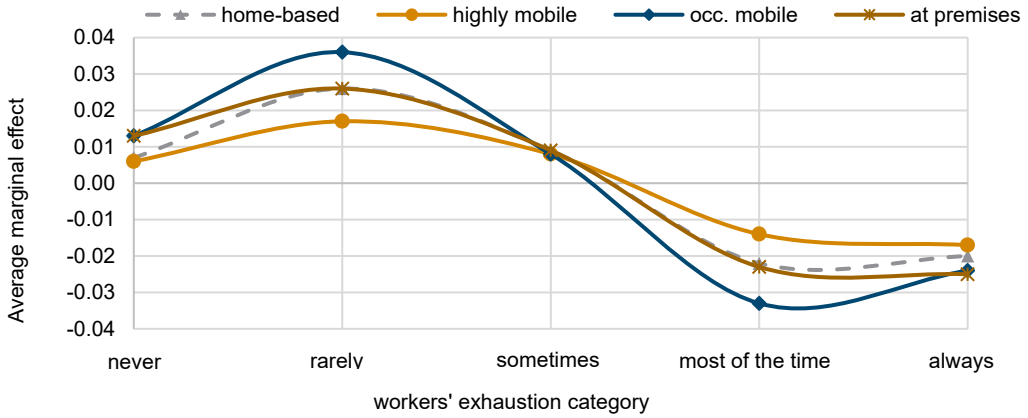
We again investigate the indirect effects of ICT use. For this purpose, the effect of ICT use on the different job demands and resources need be taken into account again, together with results from Table 5 that also report the effects of the different job demands and resources on the three burnout dimensions and work engagement. Figure 4 shows that the effects of ICT use on the three job demands – work intensity, work extensity and social demands – are relatively homogeneous across the different types of workers. In all cases, ICT use tends to intensify job demands. A comparison of coefficients points to two important findings: first, and in line with results for the entire sample (see Figure 2 above), except for those who always work at the employer's premises, the effect is generally highest for work intensity and social demands. Hence, ICT use is particularly strongly associated with the need to work faster and a more frequent exposure to abusive, humiliating, harassing or threatening behaviour. Second, the effect is always highest for home-based workers, followed by highly mobile workers and occasionally mobile workers. Therefore, among home-based workers, those who use ICT – i.e. teleworkers – experience substantially higher levels of work intensity and social demands than those who do not use ICT. Conversely, the effect of ICT use on job demands is always lowest for workers who always work at the employer's premises and only significant for work extensity and work intensity.

[9] For the sake of brevity, the calculated AMEs for all job demands and resources are not reported here but are available from the authors upon request.

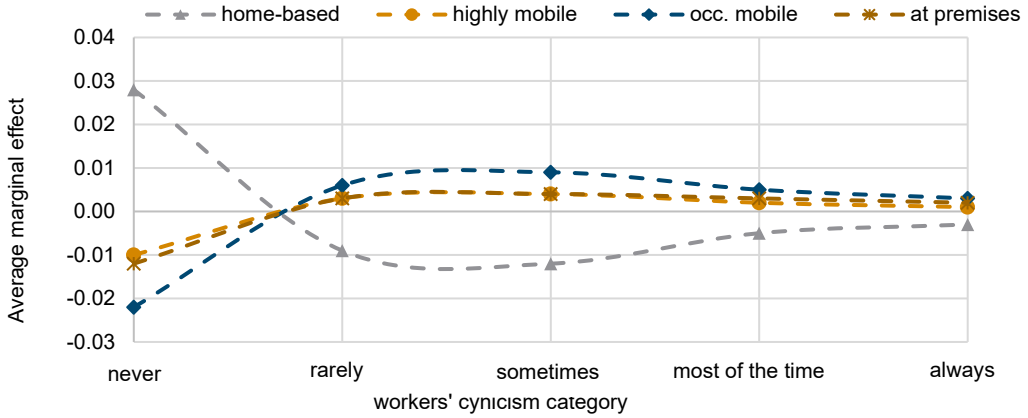
[10] The obtained AMEs of ICT use for the home-based workers are similar in magnitude to those of the work-based workers, but this is statistically not significant.

Figure 3 / Average marginal effects of ICT use on burnout, by type of workers (full model specification)

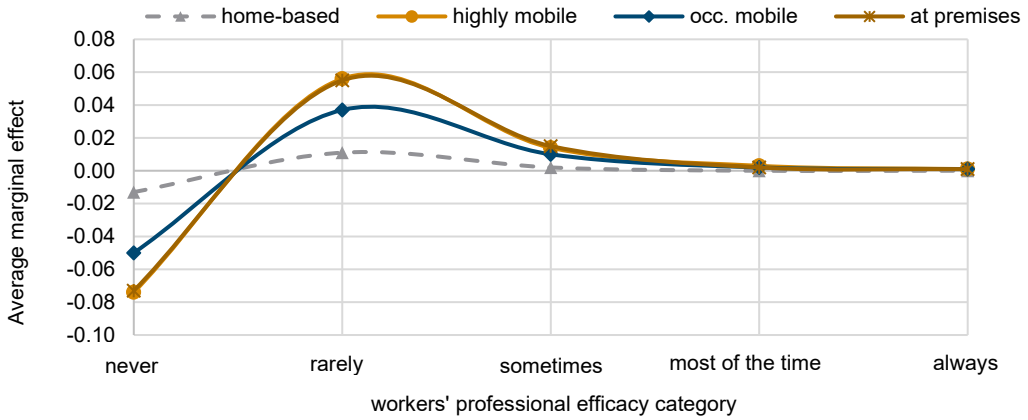
(a) Exhaustion



(b) Cynicism



(c) Professional inefficacy



Note: Average marginal effects are derived on the basis of the results reported in Table 5. Occ. mobile = occasionally mobile workers; at premises = workers always working at employer's premises (traditional workers). Dashed lines indicate that the estimated coefficients are not statistically significant. Marginal effects were obtained with Stata software using the post-estimation command 'margins' with the option 'vce(unconditional)' to take the sampling design and weighting structure into account.

The picture is more mixed when it comes to job resources. For home-based workers, none of the four job resources proves significant. This suggests that ICT and non-ICT users have similar job resources at their disposal. For the remaining groups of workers, ICT use tends to foster job control and rewards, with the effect of job control always about twice as high as that of rewards. Furthermore, ICT use also affects social support structures. For instance, for highly mobile workers, ICT use is associated with significantly lower social support from colleagues, while ICT use among workers who always work at their employer's premises is associated with higher social support from the management.

Figure 4 / Relationship between ICT use on job demands and resources by type of worker

Note: Results obtained from a weighted structural equation model (SEM). Observations only include employees. The bars show the estimation coefficient from a regression of the respective job demand (job resource on ICT use). Mgmt = management, coll. = colleagues. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. All regressions are estimated using Stata's gsem command.

To quantify the direct, indirect and total effects of ICT use on the different burnout dimensions and work engagement, we again take recourse to OLS regressions within a SEM context. Results are shown in Table 6, which qualitatively confirm all direct effects of ICT use on the three burnout dimensions and work engagement (as reported in Table 5).

Table 6 / Direct, indirect and total effect of ICT use on burnout by type of worker (full model specification)

(a) Home-based workers

	Burnout Exhaustion model (II)	Burnout Cynicism model (II)	Burnout Prof. inefficacy model (II)	Work engagement model (II)
Direct effects				
ICT use	-0.103	-0.198	0.038	-0.084
	(-0.81)	(-1.30)	(0.36)	(-0.74)
Indirect effects				
Work intensity	0.089***	0.009	-0.01	
	(3.15)	(0.73)	(-0.94)	
Work extensity	0.018	0.001	-0.002	
	(1.30)	(0.28)	(-0.33)	
Social demands	0.020*	0.003	-0.006	
	(1.74)	(0.38)	(-0.68)	
Social support: mgmt	0.000	0.001	0.001	-0.003
	(0.13)	(0.13)	(0.15)	(-0.13)
Social support: coll.	0.003	0.004	0.006	-0.004
	(0.23)	(0.24)	(0.25)	(-0.23)
Job control	-0.004	0.004	0.012	0.002
	(-0.42)	(0.37)	(1.15)	(0.27)
Rewards	0.003	0.002	0.001	-0.008
	(0.26)	(0.26)	(0.23)	(-0.26)
Total effects				
	0.026	-0.174	0.041	-0.097
	(0.19)	(-1.15)	(0.38)	(-0.71)

(b) Highly mobile workers

	Burnout Exhaustion model (II)	Burnout Cynicism model (II)	Burnout Prof. inefficacy model (II)	Work engagement model (II)
Direct effects				
ICT use	-0.071**	-0.020	0.124***	-0.008
	(-2.20)	(-0.56)	(3.72)	(-0.25)
Indirect effects				
Work intensity	0.038***	0.017***	-0.006**	
	(4.43)	-3.56	(-2.02)	
Work extensity	0.009*	-0.001	-0.003	
	(1.78)	(-1.05)	(-1.55)	
Social demands	0.009***	0.001	-0.004**	
	(3.18)	-0.44	(-2.08)	
Social support: mgmt	-0.001	-0.001	-0.001	0.002
	(-0.47)	(-0.36)	(-0.47)	(0.48)
Social support: coll.	0.001	0.01	0.013	-0.012
	(0.92)	(1.41)	(1.41)	(-1.36)
Job control	-0.005	-0.002	0.001	0.007**
	(-1.41)	(-0.70)	(0.15)	(2.27)
Rewards	-0.010**	0.001	0.000	0.025**
	(-2.37)	(0.62)	(0.06)	(2.48)
Total effects				
	-0.029	0.005	0.123***	0.015
	(-0.87)	(0.13)	(3.44)	(0.42)

(c) Occasionally mobile workers

	Burnout Exhaustion model (II)	Burnout Cynicism model (II)	Burnout Prof. inefficacy model (II)	Work engagement model (II)
Direct effects				
ICT use	-0.142***	0.011	0.096**	-0.061**
	(-4.10)	(0.26)	(2.50)	(-1.97)
Indirect effects				
Work intensity	0.022**	0.004*	-0.001	
	(2.14)	(1.78)	(-0.52)	
Work extensity	0.003	-0.001	0.000	
	(0.85)	(-0.80)	(-0.36)	
Social demands	0.011***	0.002	-0.009***	
	(3.78)	(0.84)	(-3.01)	
Social support: mgmt	0.000	0.000	0.000	-0.001
	(-0.11)	(0.09)	(0.20)	(-0.13)
Social support: coll.	0.002	0.009	0.015	-0.01
	(1.19)	(1.32)	(1.40)	(-1.37)
Job control	0.000	-0.001	-0.007**	0.009**
	(-0.07)	(-0.41)	(-2.10)	(2.83)
Rewards	-0.015***	-0.009**	-0.002	0.038***
	(-3.31)	(-2.71)	(-1.06)	(3.70)
Total effects				
	-0.120***	-0.015	0.093**	-0.025
	(-3.23)	(-0.35)	(2.23)	(-0.67)

(d) Workers at employer's premises

	Burnout Exhaustion model (II)	Burnout Cynicism model (II)	Burnout Prof. inefficacy model (II)	Work engagement model (II)
Direct effects				
ICT use	-0.115***	-0.007	0.128***	-0.035
	(-4.02)	(-0.22)	(4.41)	(-1.40)
Indirect effects				
Work intensity	0.007	0.002	0.000	
	(0.94)	(0.94)	(-0.26)	
Work extensity	0.006**	0.000	-0.001	
	(2.12)	(-0.31)	(-1.04)	
Social demands	0.005**	0.000	-0.003**	
	(2.08)	(0.62)	(-2.02)	
Social support: mgmt	-0.001	-0.003	-0.001	0.008*
	(-1.04)	(-1.62)	(-1.12)	(1.75)
Social support: coll.	0.000	0.002	0.004	-0.003
	(0.40)	(0.42)	(0.41)	(-0.40)
Job control	-0.003	0.000	-0.005*	0.009***
	(-1.12)	(0.07)	(-1.95)	(3.41)
Rewards	-0.019***	-0.003	-0.005**	0.042***
	(-4.06)	(-1.08)	(-2.41)	(4.71)
Total effects				
	-0.119***	-0.008	0.116***	0.021
	(-3.92)	(-0.25)	(-3.75)	(0.72)

Note: Results obtained from OLS regressions within a structural equation model (SEM). The results from the work engagement regression stem from the estimation of the joint exhaustion/work engagement model. The corresponding results for the cynicism and the professional inefficacy models are very similar to those of the exhaustion model and are therefore not separately reported. Mgmt = management, coll. = colleagues. All dimensions of burnout are scaled such that higher values indicate higher risk/degree of burnout. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. z-values in parentheses.

As regards the indirect effects of ICT use, important differences are evident across the four types of workers in terms of the factors that mediate the effect of ICT use on workers' psychological health. For instance, work intensity stands out as a particularly relevant mediator in terms of magnitude more generally. This is especially true for home-based workers, whose significantly higher ICT-induced work intensity puts a particularly strong strain on their psychological health in terms of higher exhaustion. In the context of home-based workers, it is also interesting to note that work intensity is the only relevant mediating factor between ICT use and any of the three burnout dimensions. For the other three groups of workers, the situation is more complex as at least three mediating factors are relevant, though not necessarily the same ones. For instance, for all of them, social demands as well as rewards are found to mediate the effect of ICT use on exhaustion. Quantitatively, the effect of social demands is strongest for occasionally and highly mobile workers, which suggests that they suffer the most from the ICT-induced increase in social demands (i.e. they are more frequently exposed to abuse, humiliation, harassment or threats) in terms of higher exhaustion. Conversely, the effect of rewards is strongest for those who always work at the employer's premises, which suggests that they profit the most from the ICT-related increase in rewards in terms of lower exhaustion. Furthermore, only for those who always work at the employer's premises, work extensity is also an important mediator between ICT use and exhaustion, in that the ICT-induced increase in work extensity – i.e. more and longer working hours – is associated with higher exhaustion.

Results are more homogeneous for work engagement: both job control and rewards mediate the effect of ICT use on work engagement for all types of workers except for those who work from home. Quantitatively, the effect is strongest for rewards and for those who always work at the employer's premises as well as occasionally mobile workers. Therefore, their higher rewards from ICT use are associated with especially high levels of work engagement.

Concerning the total effects, Table 6 shows that for the exhaustion and professional inefficacy models, the total effects are significant whenever the direct effects are significant, pointing to partial mediation. The only exception is highly mobile workers. Their total effect in the exhaustion model is insignificant, which points to total mediation – i.e. the relevant mediating factors, notably work intensity, fully explain the relationship between ICT use and exhaustion.

Finally, it should also be mentioned that the results from the multi-group analysis are fully compatible with results from the main model reported in Table 4, which shows for the exhaustion model that the total effect of ICT use is negative. The additional information provided in Table 6 is that this negative total effect is primarily attributable to workers at the employer's premises and to occasionally mobile workers.[11]

[11] If we were to consider the professional inefficacy model, we would find that the highly mobile workers are also decisive for the overall result.

8. Summary and conclusion

In this analysis, we use the Job Demands-Resources (JD-R) model and apply structural equation modelling to analyse the direct and indirect effects of ICT use – in terms of working with computers, laptops, smartphones etc. – on the two opposite poles of employee psychological health: burnout and work engagement. Burnout is measured by its separate dimensions of exhaustion, cynicism and professional efficacy. We use a large sample of over 33,000 employees from the 6th European Working Conditions Survey, which was carried out in 2015 in 35 European countries.

Our results show that unlike the typical findings in this line of literature, ICT use is associated with *lower* levels of exhaustion and *higher* levels of professional inefficacy (but is unrelated to cynicism). Hence, on average, ICT shields users in Europe from exhaustion but makes them more prone to question their competences and qualification for their job. Conversely, ICT use is unrelated to work engagement.

In addition to the direct effects, our results reveal important indirect effects of ICT use and identify several important job demands and job resources that mediate the effect of ICT use on workers' psychological health. Specifically, we find that ICT use is associated with higher work extensity, work intensity and social demands; these in turn lead to higher levels of exhaustion. This suggests that ICT users have to work more, work faster and are exposed more often than non-ICT users to negative behaviours such as verbal abuse, threats, humiliating behaviour or bullying/harassment, all of which lead to higher levels of exhaustion. ICT use is also associated with higher rewards, which lead to both lower levels of exhaustion and higher levels of work engagement. Hence, among ICT users, rewards play an important role as they are not only associated with lower levels of exhaustion but also with higher levels of work engagement. Furthermore, ICT use is also associated with higher job control, which feeds into higher levels of work engagement.

Results from our multi-group analysis show that the *negative* relationship between ICT use and exhaustion is found primarily among occasionally mobile workers and workers who always work at the employer's premises, while the *positive* relationship between ICT use and professional inefficacy is mainly observable among workers who always work at the employer's premises and highly mobile workers. In both cases, however, we find no significant direct relationship between ICT use and either exhaustion or professional inefficacy for the group of home-based workers.

Furthermore, for each of the four types of workers, we identify different job demands and job resources that mediate the effect of ICT use on workers' psychological health. Three factors are particularly interesting and worth discussing: work intensity stands out in terms of magnitude, especially for teleworkers – i.e. home-based workers who use ICT – whose much higher level of work intensity takes a heavy toll as it is associated with a substantially higher level of exhaustion. Importantly, our analysis shows that for home-based workers, this is also the only relevant mediator, irrespective of psychological health indicator analysed. Social demands are quantitatively also important, especially for occasionally and highly mobile workers, who suffer the most from the ICT-related increase in abuse, humiliation, harassment or threats in terms of higher exhaustion. Lastly, rewards are especially beneficial for workers

who always work at the employer's premises. For them, ICT use is associated with much higher rewards, which are in turn associated with much lower exhaustion and substantially higher work engagement.

Our results are important as they show that the direct and indirect effects of ICT use differ according to the place of work: in each of the four places of work analysed, different working conditions prevail, which in turn affect ICT and non-ICT users' psychological health differently. With these results, we therefore point to factors which either alleviate or aggravate the consequences of ICT use on individual workers and on which organisations that implement ICT should focus to guarantee workers' well-being.

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Annex

Table A.1 / Key concepts, underlying questions and question range

Concept	Question	Range
Work extensity	How many hours do you usually work per week in your main paid job?	1-105
	Normally, how many times a month do you work more than 10 hours a day?	0-31
Work intensity	Does your job involve working at very high speed?	1-7
	Does your job involve working to tight deadlines?	1-7
Social demands	Over the last month, during the course of your work have you been subjected to verbal abuse?	0-1
	Over the last month, during the course of your work have you been subjected to threats?	0-1
	Over the last month, during the course of your work have you been subjected to humiliating behaviours?	0-1
	Over the past 12 months, during the course of your work have you been subjected to physical violence?	0-1
	Over the past 12 months, during the course of your work have you been subjected to bullying/harassment?	0-1
Social support from management	Your manager helps and supports you	1-5
	Your immediate boss respects you as a person	1-5
	Your immediate boss gives you praise and recognition when you do a good job	1-5
	Your immediate boss is successful in getting people to work together	1-5
	Your immediate boss is helpful in getting the job done	1-5
	Your immediate boss provides useful feedback on your work	1-5
	Your immediate boss encourages and supports your development	1-5
Social support from colleagues	Your colleagues help and support you	1-5
	There is good co-operation between you and your colleagues	1-5
	I generally get on well with my colleagues	1-5
Job control	You are able to choose or change your order of tasks	0-1
	You are able to choose or change your methods of work	0-1
	You are able to choose or change your speed or rate of work	0-1
Rewards	Considering all my efforts and achievements in my job, I feel I get paid appropriately	1-5
	My job offers good prospects for career advancement	1-5
	I receive the recognition I deserve for my work	1-5

Source: EWCS-2015.

Table A.2 / Means (M) and standard deviations (SD) by type of worker

	Home-based workers (N=2,015)		Highly mobile workers (N=8,500)		Occasionally mobile workers (N=10,374)		Always at employer's premises (N=13,025)	
	M	SD	M	SD	M	SD	M	SD
Female	0.62	0.48	0.27	0.47	0.49	0.51	0.61	0.50
Ln age	3.73	0.27	3.69	0.30	3.67	0.31	3.67	0.31
ISCED-Medium	0.19	0.38	0.54	0.50	0.45	0.50	0.53	0.50
ISCED-High	0.77	0.42	0.25	0.43	0.44	0.49	0.31	0.46
Married	0.74	0.44	0.69	0.46	0.68	0.46	0.67	0.47
# dep. children	0.80	0.99	0.64	0.95	0.63	0.92	0.61	0.91
Full-time	0.81	0.39	0.85	0.36	0.80	0.40	0.82	0.39
ICT use	0.89	0.31	0.57	0.50	0.75	0.43	0.66	0.48
Work extensity	6.97	3.48	7.71	3.75	7.20	3.53	7.29	3.81
Work intensity	38.70	14.74	42.34	16.18	38.41	13.89	38.47	12.41
Social demands	0.31	0.80	0.37	0.90	0.28	0.77	0.23	0.71
Support: Manag.	26.69	7.50	26.08	7.67	26.68	7.22	26.85	6.99
Support: Coll.	12.32	3.14	12.33	3.07	12.46	2.73	12.55	2.80
Job control	2.45	0.88	1.96	1.18	2.09	1.12	1.80	1.21
Rewards	10.11	2.95	9.53	3.13	10.02	2.98	9.57	3.10
Exhaustion	3.16	0.99	3.25	1.05	3.08	0.99	3.17	1.08
Cynicism	1.78	0.95	1.89	1.10	1.92	1.07	1.88	1.11
Efficacy	1.65	0.60	1.57	0.66	1.65	0.66	1.56	0.66
Work engagement	12.12	1.86	11.73	2.21	11.72	2.08	11.61	2.25

Source: EWCS-2015.

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