BRIEFING
Requested by the EMPL committee

European Parliament

The mental health of workers in the digital era

How recent technical innovation and its pace affects the mental well-being of workers

KEY FINDINGS

- New ways of working can have an undesirable influence on both workload and stress.
- Hyperconnectivity has added a new dimension to technostress by prolonging its effects through time, with detrimental consequences to society and individuals.
- Intrusive technology characteristics, such as their accessibility outside the conventional workplace (and work times) are dominant predictors of anxiety, isolation and sleep deprivation.
- Older individuals seem to be influenced more by technostress, while younger individuals are more vulnerable to overload. Males and females present some differences on their relation to technology with the latter more susceptible to technostress.
- Continuous demands for technological adaptation can be psychologically detrimental.
- Working with technology increases the probability of burnout.
- Working with technology can negatively impact the quality of life.
- Working with technology can provoke techno-addiction.
- The above mentioned adverse effects do not depend on the technology itself but on the way it is used.

Background

Technology has shaped the way we work, and has modified the work itself. Faster processes, electronic records, synchronous and advanced communication systems, such as video-audio conferencing, emailing, instant messaging and social networking have enabled a high level of communication; optimising time and minimising space. Thanks to these advances, new professional sectors have been developed under the general description of teleworking including tele-medicine, tele-education, tele-consultancy. However, this growth, based on the associated technological achievements, has not been without a dark side.

As early as 1982 it was recognised that working with new technology, can create a particular type of stress, known as technostress[1]. At the time, the term 'technostress' referred to the stress created while working with a computer. However, today's workplaces are characterised by advances in technology which extend far beyond the evolution of desk-top computers, including devices such as smartphones, laptops and tablets. A key common feature of these technological developments is that they enable the worker to work away from a conventional office set-up. In conjunction with this increased potential mobility, fast internet connections and features such as cloud computing facilitate a new way of working based on a worker potentially having connectivity at any time and anywhere. As a result, mobile devices can remain connected

Policy Department for Economic, Scientific and Quality of Life Policies
Directorate-General for Internal Policies
Authors: Richard Graveling et al.
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for an unlimited time raising the possibility of constant contact with others. However, this any time and anywhere connectivity and contact can be intrusive and unhelpful, potentially blurring the boundaries between work and personal life.

This briefing aims to provide Committee members (and other readers) with an insight into how recent technical innovation and its pace affect the mental well-being of workers. It summarises the findings of the relevant literature and identifies areas requiring further research or data collection.

Methodology for identification and selection of papers

Adopting a methodology previously developed for systematic reviews, the project team compiled two listings of search terms relevant to the subject area to permit the preparation of relevant search strategies. The searching strings combined terms including health effects, novel technology and work, and the umbrella term technostress. A standard protocol reflecting that used in previous systematic literature searches was adopted again to screen these papers. The searches were not intended to be exhaustive (i.e. identifying all papers published on the topic), but were conducted systematically to be reliably indicative of the current impacts of working with new forms of technology on the psychosocial health of workers. The summary of the procedural steps can be seen on Table 1. The 22 papers that were finally included in the study are listed in the references (those *not* highlighted).

Table 1: Summary of the paper selection procedure

Number of papers identified as a result of searching the literature databases	Number of papers selected based screening of title	Number of papers selected for full-text screening	Number of papers included in the briefing
5,662	166	39	22

Due to the volume of papers, (see Annex 1) we applied several criteria (for both technostress and the whole string methods) to decide which articles would be included in the full review. The details of these criteria are presented in Table 2 below.

Table 2: Criteria applied to abstracts of 166 papers identified

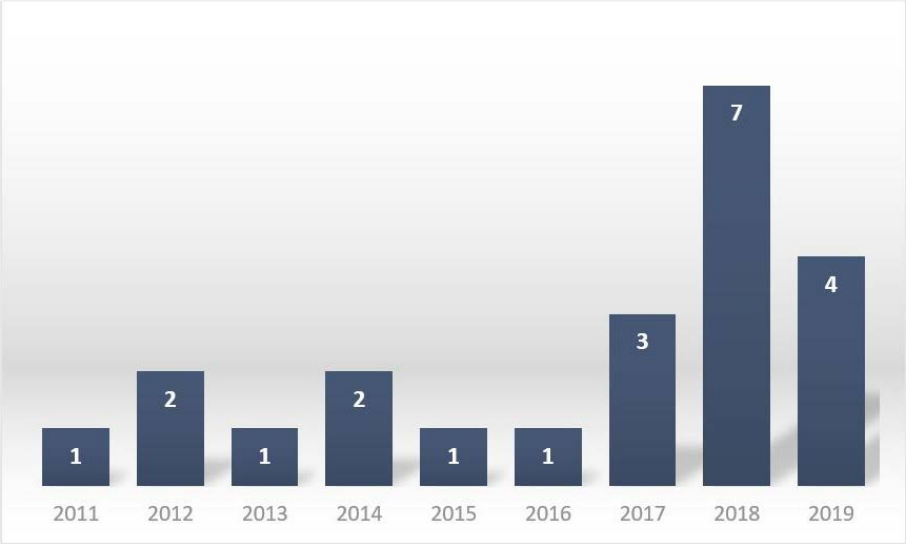
Criteria	Inclusion
Type of technology	New forms of technology, smartphones, tablets
Type of health effect	Health effects related to the use of technology in the workplace (excluding studies which investigate methods on how to cope with technostress and theoretical models of guidance)
Occupation	Employee/worker oriented studies (excluding studies related to younger users of technology, or generally non occupational setting)
Year of publication	Papers published after 2010
Type of study	Reviews, surveys (excluding theoretical studies)

Coverage of papers included in the study

1. Chronological

Although digital technologies have been available for some time, recent technological advances, such as cloud computing, smartphones, and related applications have burgeoned in recent years, as have concerns regarding their possible adverse affects. For this reason we selected only papers published after 2010. The distribution of the selected papers according to years of publication can be seen on Figure 1.

Figure 1: Distribution of papers selected by their year of publication



It can be seen from this that the majority of papers available stem from the last three years, justifying the selection of a ten-year time frame for searches.

2. Type of research papers

The final selection of papers consisted of 22 studies that included adverse psychosocial or mental effects in relation to the adoption of digital technologies, exclusively dedicated to occupational settings. Of these, 21 are research articles and one is a book chapter.

From the 22 articles, 20 are primary studies, one is a review[2] and one is a paper which is a combination of both a review and primary study[3]. Primary studies included both qualitative and quantitative elements.

3. Geographical coverage

The papers cover almost all continents. Although there had been a request to focus on European Member States, this was not strictly possible due to the small number of publications from the EU. However, there appears to be a global geographical balance, as seen in Figure 2.

Figure 2: Geographic location of the selected papers

Note: The map shows those countries from which the papers have been selected where a country is apparent, three papers did not mention the country in which any work was carried out and so they are not presented on the map

The overview

1. Type of technology

Based on the analysis of the selected papers, three major groups of technologies were identified (although not all papers are explicit as to the type of technology considered):

- Intrusive technologies (4 papers) - Intrusive technologies in this context are smartphones, phone applications and social media. These are generally technologies which permit anytime and anywhere connectivity and hint at the potentiality of tracking where the employee is, and what they are doing. The present project did not include other types of intrusive technologies such as Remote Frequency Identification Devices (RFID) or Smartcards;
- ICT (13 papers) - In the context of this project, Information and Communications Technology (ICT) covers the following terms used in the papers; IT, ICT, technology;
- Computer (1 paper) – In the context of this project, the paper explicitly refers to "computer" without reference to other related modern technology such as smartphones or tablet.

It will be noted that most of the papers generally mentioned IT, ICT or technology. This appears to be explained by the relatively recent spread of technological advances in workplaces, including smartphones and cloud computing[4]. None of the papers explored the impact of other technological applications such as robots or AI. Research on robots has mainly looked at their physical impacts, such as threats to safety and accident causing.

2. Over-arching issues identified

a. Demographics

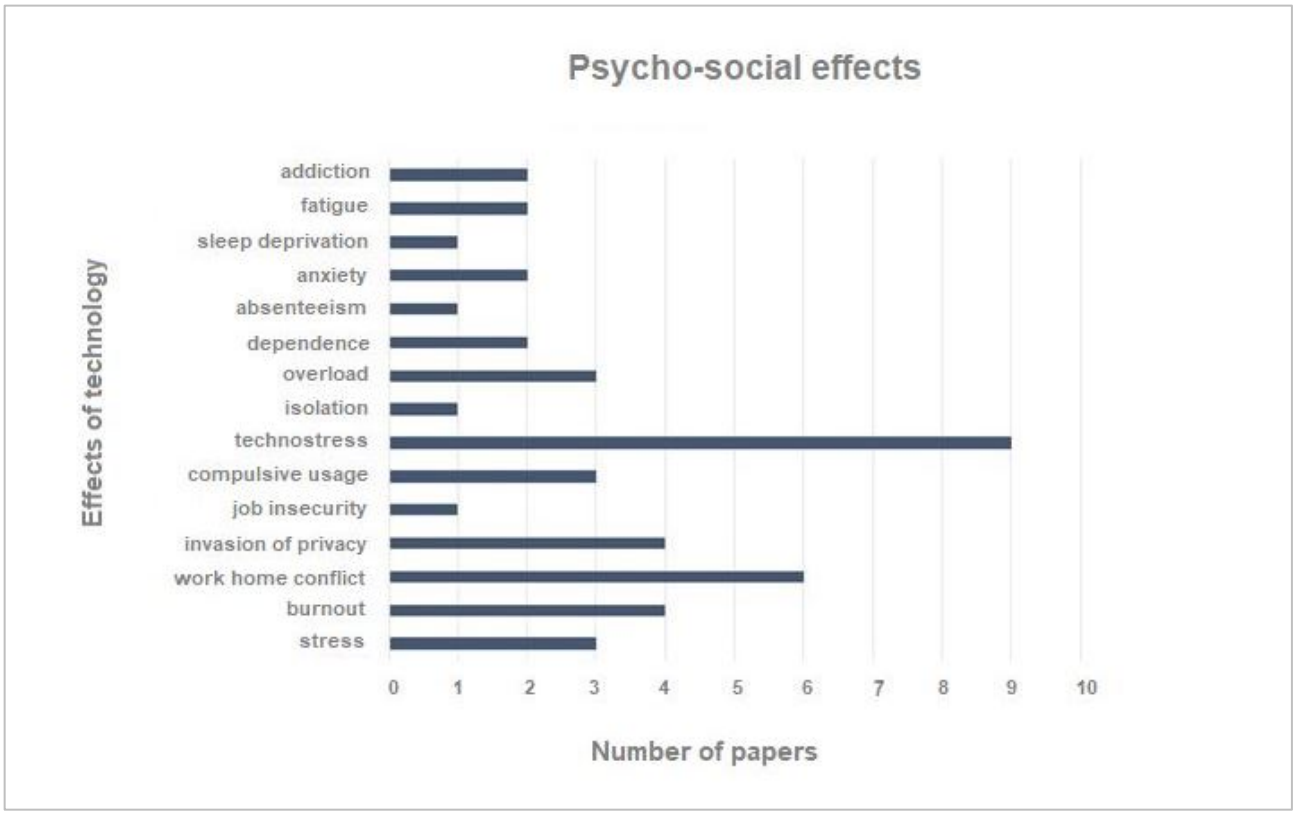
It seems that individual characteristics play an important role in influencing the type of effects created while working with technology. Research[5] showed that age and gender play an important role in predicting these, with women more likely to be exposed to higher levels of techno-complexity and techno-uncertainty, while men suffer more from the effects of techno-overload and techno-invasion. Uncertainty regarding complex technological systems is characterised by concerns of not feeling confident enough while using such systems. Overload on the other hand, is feeling overwhelmed by technology. However, there are indications that this gender differential is closing and merits more research. Masculinity also characterises the relationship with technology, where some see the capability to deal with technology in the workplace as a symbol for increased masculinity[6].

There are also age differences in relation to technology, with older individuals feeling more overloaded by the characteristics of technology (e.g. smartphones) and younger users tending to overestimate the amount of loading information they can handle[7].

b. Effects from technology use in the workplace

The papers identified explored a wide variety of potential adverse effects. Figure 3 summarises these. It can be seen that, apart from the umbrella term technostress, work-home conflicts are the most frequently explored problems and that the scale of evidence in most cases is limited to a very small number of papers. The specific findings of these papers are presented in subsequent sub-sections. It seems that the term technostress serves as a convenient collective term to express psychosocial ill-effects attributable to the introduction of use of new technological systems.

Figure 3: Effects of technology at work explored by the papers selected



3. Synopsis of specific findings

a. Addiction

Two papers from the same group of authors in 2013[8] and 2014[9] explored the concept of addiction or, more specifically techno-addiction (a term that they regard as strongly related to the more general workaholism). They suggest the term to refer to:

> *« an uncontrollable compulsion to use ICT "everywhere and anytime" and to use it for long periods of time in an excessive way. »*

In a questionnaire study of just over 1,000 ICT users (formed from two sub-groups of intensive and non-intensive users) the authors found the job demands of using such technologies (including the recognised psychosocial risk factors of work load, role ambiguity, emotional overload and a lack of autonomy and social support) are related to indices of 'technostrain' such as anxiety and fatigue; and that a similar cluster of job demands are also related to technoaddiction (which can itself lead to technostrain).

b. Compulsive usage

Sometimes addiction is accompanied by a compulsive usage which is the status of being obsessive[8,9,10]. An example of this in relation to new technologies includes the act of checking messages even when this is inadvisable, such as when driving or waking from sleep. Indirectly this raises new safety concerns, and suggests a need for exploratory research of the gravity and scale of this issue.

c. Dependence

In these studies dependence has the meaning of users' beliefs that they cannot live without technology, such as their phones. Another aspect of techno dependence is when professionals work on a particular technological medium such as computer and/or software, for example when medical doctors are working with mobile electronic medical records. A study of physicians from Taiwan[11] found that they perceive a dimension of technostress as techno-dependence as it is necessary for them to work with the technological advances, and the stress to remain up to date for future working programmes.

d. Fatigue

Fatigue was among the effects of using technology in the workplace in one paper[8] and later (from the same group) a similar book chapter[9] (in relation to Addiction). It is described as lower activation mechanisms of psychological arousal and can include feelings of exhaustion. If it is caused by technology, it can be Information Fatigue syndrome which can have consequences of poor decision making, poor memory and poor attention.

e. Sleep deprivation

A paper from Finland studied the relationship of insufficient or low quality sleep and the use of social network sites. Although this study was not strictly work related, it was selected as providing a sample of effects by social network sites[12], these sites and instant messages are being increasingly used in workplaces. Based on a series of 32 qualitative narrative interviews all interviewees had used such sites when in bed and six described sleep problems as a result.

f. Anxiety

Characterised by high levels of physiological activation with consequential feelings of tension and discomfort anxiety can also be described (in terms of relation to technology) as technostrain. A review which analysed 190 research articles from 1,542 initially selected for the years 1963-2014, found different types of negative emotions cited in the literature such as anxiety, technostress and not so often, technophobia. The authors also conducted empirical studies (a cross-sectional survey with 191 participants; and a controlled experimental study with 351) which demonstrated that these three adverse negative emotional responses, (anxiety, technostress, technophobia) are conceptually distinct. The results suggested that the adverse phenomena can be manifested in one individual as a result of a cumulative exposure to technology. Anxiety is manifested prevalently among non-intensive ICT users, rather than experts, with accompanied thoughts of inefficacy and scepticism[9].

g. Absenteeism

Absenteeism is a term used for describing when an employee is absent from work. This clearly has direct economic consequences, and indirect organisational consequences. The reasons behind absenteeism might differ, but one paper[13] demonstrated that one indirect reason behind high rates of absenteeism, is working with smartphones provided by the company. The authors of this study from New Zealand, that entailed semi-structured interviews with 28 participants explain that, according to their findings, when the smartphone is provided by the company, the employees perceive it as a constant link between managers and employees based on non-stop connectivity. The authors suggested that this can lead to burnout, absenteeism and work life conflict.

h. Overload

Overload means that individuals are expected to manage more problems than they are supposed to, and as a result, tend to perform tasks more slowly than they otherwise would. This effect has been found to be a predominant factor of burnout in public librarians[14] (sample of 53); as a main problem for older users[15] (survey of over 500 older users); and, in a study of just over 1,000 users, it has also found to be related to the introduction of new portable devices[16].

i. Isolation

Isolation is a negative feeling or status. A multi-methods study (~500 survey responses and 23 interviews)[17] concluded that working with an organisation's social network system, messaging and video conferencing, provokes isolation from family and creates a need for more time working. A study of public librarians in Sweden also studied the isolation phenomenon in a social context. This paper concluded that working with technological systems, contributes to social isolation, in terms of a lower degree of relationship to the community and was specifically present in those employees who were more cynical. Cynicism is also a negative working parameter and is considered to be the effect of a problematic organisation.

j. Invasion of privacy

Invasion of privacy occurs because of blurred boundaries between public and personal contexts. Personal information is threatened because ICT use can be traced, documented and exploited by external factors. There is a constant worry that actions on digital media can be traced and monitored[16,18,19,20,21].

A similar effect, or a direct consequence of this invasion or privacy, also occurs in relation to work-home conflict. Work-home conflict is a term that indicates blurred roles between personal and working life, increasingly technology facilitates this invasion of work in to personal life due to constant connectivity. As seen in the research[14,16,20,21,22] this is becoming an increasing concern and issues worldwide.

k. Technostress

There is the feeling that this old (1982) term which means the stress created by the interaction with technology is even more enhanced with the advent of newer 'new technologies'. Nowadays technological advances are becoming potentially more intrusive, and additional adverse phenomena, such as addiction and information overload, have become apparent. A vicious cycle between addiction and necessity play a dominant role in the creation of technostress. An extensive survey which included extended parameters (strain, work home conflict, ambiguity, new learning demands, overload, job insecurity, invasion of privacy) for understanding modern types of technostress concluded that intrusive characteristics of technology are dominant predictors of stressors[21]. This first questionnaire was later translated and enriched by several other research groups. It is generally accepted that working with IT creates technostress[23]. The newer form of technostress is linked to social media[12,19,23] and connected technologies[14,17,20,22,24], whilst new ways of working such as mobile electronic records increase the security risk and add a new dimension to technostress[11].

l. Insecurity

Job insecurity can occur when a fast pace of technological change creates a continuous demand for professional development. This professional development is perceived as necessary for continuing to work and it is particularly prevalent in some sectors e.g. IT. An extensive exploratory survey (661 usable responses) on different negative aspects of working with technology included this factor of job insecurity[21]. Another study (amongst over 2,500 marketing and communication professionals) demonstrated this type of insecurity among higher ranking professionals and their relation to social media[19]. Insecurity created by technological demands for working purposes, is also called technoinsecurity.

m. Stress

A qualitative study[17] investigated the relationship between desired and undesired email load on workplace stress. Although the results seem to be expected, with undesired email seen as increasing workplace stress, what is quite interesting is that new forms of technology and connection facilitate an increased level of information in real time than was previously possible. In a qualitative study of workers in advertising, public relation and journalism sectors in Hong Kong (13 interviewees) and Austria (12 interviewees)[25] investigated the stress created by devices which allow continuous connection. The results indicate that the stress created by the continuous connection of a work device can mainly be attributed to inherent characteristics of a person rather than to the organisation. In line with the above propositions, another study showed that personal stressors are more important in determining strain when social networking for working purposes[20].

n. Burnout

Burnout is included in the 11th Revision of the International Classification of Diseases (ICD-11)[25] as an occupational phenomenon (ICD-11, 28 May 2019) rather than a medical condition. It is however widely recognised and can be characterised as a syndrome with three dimensions related to work: exhaustion; negativism or cynicism (job related); and reduced efficacy. A recent qualitative study from Sweden has shown that working with technology is among the predictive factors of burnout for librarians[15]. However it seems that burnout has a relationship to technology in almost all occupational settings, with indications of complications between desktop IT and other portable devices[2]. One of the reasons for the relationship between burnout and portable devices is to be found in their main characteristic of hyperconnectivity[14,25].

Overall findings

It is clear from the papers identified and selected for inclusion in this review that the potential adverse effects of new technologies are only now being researched to any extent, although the underlying concept of 'technostress' is not that new. None of the papers identified explored the use of relevant technologies in industrial settings (for example stock-picking systems or AI devices) possibly because the technology is neither sufficiently mature or widely adopted to attract significant research on the possible health consequences (although media stories that can perhaps best be regarded as case-studies are widespread).

At present, the scale of evidence for specific effects is limited and often based on qualitative research meaning that the numbers involved are relatively limited compared, for example to large scale quantitative studies. However, this can be seen as reflecting the relative immaturity of the area as a research topic with many of the studies being described as 'exploratory'. Thus researchers are still exploring which specific aspects to study more extensively. However, despite the limitations of the available 'data set' with regard to any specific issue amongst the many listed above, the collective impression is that there is a body of evidence to support the contention that the new technologies studied can have adverse psychosocial effects on those using them for work purposes.

Many sources of occupational ill-health are not exclusive to the work situation. Thus the two most prevalent problems of musculoskeletal disorders and problems associated with psychosocial risks in general often have contributions from both work and non-work factors. This does not however negate the duty of employers to minimise any relevant risks arising from their workplaces or working practices.

Working with new technologies can create or trigger a number of adverse effects on the individuals using them and, as a result, on society generally. Technology can contribute to the possibility of burnout, occupational stress, psychological overload and fatigue. The intrusive characteristics of the technology can aggravate phenomena such as isolation, technoaddiction, sleep deprivation, emotional exhaustion and anxiety, with negative consequences creating a poor quality of life.

The main reasons for these effects appear to stem from the manner in which the technology is used, with usage for prolonged periods being a major factor for provoking technostress and technoaddiction. Most of the devices used for work have not been designed primarily for working purposes, or for prolonged usage.

It should be emphasised that working with technology *per se* is not a harmful activity, but that the way the technology is used, can create adverse or potentially harmful conditions. Thus, as yet unpublished research into the use of smartphones for email checking[26] found the facility to voluntarily check for emails out of working hours to be beneficial but, when that checking was seen as a requirement (rather than a choice) the perceived benefits were lost. These, not yet optimised and thus not regulated, ways of working with technology need further investigation. The present analysis hints reasons behind the non optimal usage; portable devices have not been designed primarily for work. Laptops, smartphones and tablets have been designed for improving flexibility and physically distant communication. Their use, however, has been shifted towards working tasks, adapting applications, whose primary scope was leisure or short communication (such as brief instant text messages) for work purposes.

Another reason behind the adverse affects, while using modern technology, is to be found in the blurred boundaries they create. Their main potentiality of being connected anytime and anywhere has become their main threat. Working in a global market, we are expecting instant communication without taking into consideration distance and time. Some of the personal expressions below are indicative of the way individuals perceive their mobile devices for work[5]:

I got a smartphone from my employer, so I am always available, no matter when or where I feel as if I have to be available at all times. For instance, when I'm in the car, I check my emails at every red traffic light.

I permanently check my emails, sometimes even in the middle of the night, I wake up and automatically reach to my phone, I feel pressured to do so.

These expressions mean that the fact a company provides a smartphone to employees, is perceived as a message of obligated connection, even outside working hours.

Limitations

The present analysis was oriented towards occupational settings with the main purpose of extracting information specifically in relation to work, and mental health. It is likely that further important information such as effects of prolonged usage of smartphones, the physical and some psychosocial effects (such as social isolation) can also be researched in non-work situations, possibly increasing the scale of data sources available. Such further research will help to understand the level of capacity to process load of information and how technological communication contributes to isolation.

Conclusions

Technology has shaped our society, and permits us to work in areas and in ways never before imagined. However this has not been without a dark side where the capabilities offered by the technologies are consciously (or unconsciously) abused. In this respect it is, for example, noticeable that, in one study, more employees believed themselves to be expected to check emails out of work than the number of managers who indicated that expectation.

The present briefing has collected some of the most characteristic research of evidence of adverse effects of recent developments in what is generally referred to as 'new technology' (e.g. digitalisation, robots and artificial intelligence) in working places. The findings are indicative and they are not meant to be exhaustive. With a relatively new and developing area of research such as this, the evidence has a tendency to be somewhat piecemeal and unfocussed, as researchers begin to explore and understand the implications. However, taken collectively there is clear evidence for adverse psychosocial effects arising with the use of new technologies in the workplace. Although the term 'technostress' provides a useful umbrella term and therefore frequently featured in articles, it is noteworthy that the second most common psycho-social effect mentioned in the articles reviewed was that of 'work-life balance', providing a clear indication of concerns regarding the blurring of the boundaries between work and non-work.

As with many other risks to health and wellbeing these effects are not universally experienced and only a proportion of any workforce will be affected. Although not explored in any depth in this brief article there is a developing body of evidence to aid in understanding the individual characteristics that mediate these effects. Although the scope of the searches encompassed a wide variety of technological applications (including robots, artificial intelligence, augmented reality, etc.) the literature identified tended to focus on the relatively narrow field of the use of smartphones. However, this is an area which is important because of the proportion of workers potentially at risk. At this stage in the uptake of other new technologies in the workplace (such as AI or robots) the absence of evidence for any effects should not be interpreted as an absence of effect.

Finally, as well as evidence for potential ill-effects, there is evidence from the literature that the adverse effects presented in this briefing can in many cases be countered by appropriate organisational (and if necessary regulatory) measures to control their use. Put simply, the technology is not inherently harmful, but the way it is used can be. For example, the facility to check emails on a smartphone after working hours is not itself harmful, but the expectation that an employee will do so can be which is why it is this expectation that needs to be managed.

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**References in bold were not part of the body of articles identified through the strategic search*

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Administrator responsible: Stefan SCHULZ; Editorial assistant: Roberto BIANCHINI
Contact: Poldep-Economy-Science@ep.europa.eu
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