Working with modern information and communication technologies (ICT): An investigation of the interplay of different factors to predict psychological outcomes of ICT usage at a digitalized workplace

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HANNA HEINRICH

aus Regensburg

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Erstgutachter: Prof. Dr. Peter Fischer

Zweitgutachter: Prof. Dr. Andreas Kastenmüller

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Table of Contents

Abstract

As part of the ongoing digitalization the usage of information and communication technologies (ICT) increases steadily. Previous research has shown that this provides various improvements on both the individual and organizational levels. Nonetheless, there are also downsides of increasing ICT usage, which should be recognized and addressed in research. Therefore, the present thesis examines the interplay of different factors in predicting psychological outcomes of employees' ICT usage in modern work environments.

The findings show that employees' ICT usage behavior (i.e., usage time or usage frequency of different ICT) is a crucial factor. Across three field studies, results indicate that using different digital devices for a long time or with great frequency can foster negative psychological effects such as technostress (i.e., overload, complexity, uncertainty), strain, or detachment problems.

Moreover, the present thesis contributed to the debate whether some individuals are more likely to be affected by detrimental effects of ICT usage than others. The results across the three field studies indicate that technostress and psychological outcomes can differ depending on employees' individual characteristics (i.e., age, gender, and current position). Concerning age, the findings consistently show that perceived technostress seems to increase with age.

In an additionally experimental study the present thesis addressed the research question regarding the distracting nature of digital information load under controlled conditions. The results indicate that being continuously confronted with new, incoming digital information (i.e., high digital information load) can cause interference, and thus negatively influence performance in various objectively measured easy tasks. Theoretical and practical implications for ICT usage in modern organizations are discussed.

Working with modern information and communication technologies (ICT): An investigation of the interplay of different factors to predict psychological outcomes of ICT usage at a digitalized workplace

1. General introduction

To set the stage for the present thesis' purpose, imagine the following situation. You are in your office, reading this paper at your computer. Besides this document, your e-mail inbox is opened on a second screen. While reading, a beep alerts you to a newly received e-mail. You take a quick look at your inbox, and the unread e-mail's subject line indicates that one of your colleagues wants to arrange a Skype meeting with you. To spare him undue delay, you quickly open the e-mail and click on a link to participate in a meeting poll. A new browser window opens automatically and shows you the proposed dates. After a short cross-check with your digital timetable, you select a few and submit the poll. That task finished, you resume reading this paper. A few minutes later, a beep interrupts you again. This time, the smartphone next to your computer indicates an incoming video-call. You answer, and your colleague at the other end waves his hand to welcome you. You can see in the background that he is sitting in a café while working with his laptop. It turns out that he just wants to say thank you for your prompt reply, and after a short conversation, you end the call and return to your reading once more.

This scenario illustrates how contemporary work can be shaped and influenced by the collective use of modern information and communication technologies (ICT). In recent years, technological developments have changed working routines and habits in a genuinely revolutionary manner (Drake, 2010). These developments and changes have provided varying tangible benefits; for example, the use of digital ICT at the organizational level can enable every employee to access critical information within a few seconds; work with experts or in teams regardless of geographical boundaries; or use digital platforms for knowledge-sharing and problem-solving processes across or beyond a single organization (e.g., Colbert, Yee, & George, 2016; Haas, Criscuolo, & George, 2015). However, the use of modern technologies can also be challenging for individuals at a digital workplace.

In the next sections, the concept of a digital workplace will be clarified with regard to how modern ICT are used in the private and working contexts in Germany, as well as what current research suggests concerning the potential beneficial and detrimental effects of steadily increasing ICT usage.

1.1 The digital workplace

As a result of the digital transformation, today's workplace is undergoing a profound change, and it now seems obvious and almost inevitable that different electronic devices will adorn our desks. Though the specific term "digital workplace" (DWP) has been in existence for thirty years, it is a continuously emerging concept, and thus hard to define or put into clear boundaries (Williams & Schubert, 2018). The existing definitions of the DWP vary in their focus, and whereas some researchers try to give an all-encompassing description, others only focus on one particular aspect or facet (Robertson, 2015). For example, Freed (2015) defined a DWP as the experience of work delivered through the collective use of connected devices, software, and

interfaces, whereas Robertson presented it as a holistic set of tools, platforms, and environments for work, delivered in a coherent, usable and productive way.

Williams and Schubert (2018) conducted a literature review and identified three thematic categories included in the definitions most commonly used by practitioners. The first is the DWP as an element of an organizational strategy, and a framework for design. The second is found in nearly all definitions, and focuses on people and work, in the sense that the DWP should provide conditions for people to work productively. The third is the strong emphasis of current DWP definitions on the core technology platform (i.e., the underlying technologies, and the integrated platform that provides all tools and functionality). In their summary, Williams and Schubert (2018) described the DWP as "an integrated technology platform that provides all the tools and services to enable employees to effectively undertake their work, both alone and with others, regardless of location, and is strategically coordinated and managed through DWP designs that are agile and capable of being adapted to meet future organizational requirements and technologies" (p. 480). This definition already implies some consequences of the DWP for employees, which will be addressed later in this chapter. However, in advance, it is also essential to clarify the term "modern information and communication technologies" (ICT).

ICT are a crucial element of the DWP, and per definition, refer to technologies designed for collecting, processing, preserving, and delivering information (Elisha, 2006; Zhang & Liu, 2016). However, given that ICT-related concepts, methods and applications are also continually developing, it is as hard to keep up to date with ICT as it is with the DWP (Elisha, 2006). A body of research has focused on the ability to use digital technology, communication tools and networks appropriately to access, manage, integrate, evaluate or create information, so that people can function in a knowledge-based society (i.e., definition of ICT literacy, ETS, 2002). As one of its

key questions, the present research considers what happens if or when employees show a lack of ICT literacy. The importance of this issue becomes particularly obvious when one considers the frequency with which ICT are used in Germany.

1.2 The digital usage behavior in Germany

An overview of the use of modern ICT in Germany is provided by ongoing large-scale studies by the German Federal Statistical Office, which address both the private and working contexts.

In the private context, the database reveals that 88% of private households are equipped with computers (i.e., desktop computers, laptops, tablets), and 80% of the respondents stated that they used a computer every day, or almost every day. By now, 91% of private households have access to the internet; 94% of them via fixed internet connections such as DSL, and 74% primarily or additionally having mobile internet connections such as LTE.

For mobile internet usage, the most common devices are smartphones (78%), laptops (42%), tablets (32%), or other tools such as e-book-readers or smartwatches (12%). 90% of respondents stated that they used the internet either every day or almost every day, with 84% of them using it several times a day. Data on the purposes of private internet usage were also collected. When communicating, the most frequently utilized method was sending and receiving e-mails (89%), followed by using instant messengers such as Skype or WhatsApp (80%), making video calls (59%), using social networks (54%), and uploading and sharing self-created content on websites (37%).

Among information purposes, the most commonly named were searching for information about goods and services (89%), reading online news or magazines (72%), health topics (68%), using online banking (60%), and selling goods or services

(29%). Furthermore, the internet was also often used for entertainment purposes like listening to music (53%), for making job applications (17%), or for socio-political topics such as political statements on blogs and social networks (12%) (Statistisches Bundesamt, 2019b).

In the working context (cross-sectoral, and concerning all workforce categories), 96% of German companies work with computers, and 95% have access to the internet, with 53% using a mobile internet connection. 77% use the internet for voice and video calls, 66% have a company website, and 48% use social media channels. On average, 60% of the employees have access to the internet, with 25% having additional work-related mobile devices. Of course, the figures vary widely depending on a company's sector and workforce. In some sectors, such as communication, service, and science, the reported rates reach 100% in the current statistics.

Concerning technical support, 19% of the companies employ their own ICT specialists, and 69% report difficulties in recruiting them. Only 32% offer internal or external ICT training courses for employees who work with digital technologies but are not ICT specialists themselves (Statistisches Bundesamt, 2019a). This is surprising, as the German Federal Statistical Office had already noted in 2017 that the efficient use of modern ICT (and its associated open access to all required data and information) as a key strategic factor for organizations.

1.3 ICT usage in current research

Given what is known about the characteristics of a DWP and the steadily increasing usage of ICT, a question remains concerning their possible consequences for individuals, and how organizations can avoid potential downsides. To date, research has only just begun to provide guidance on these issues (Colbert et al., 2016).

1.3.1 Beneficial and detrimental effects of ICT usage

As noted, the use of modern ICT and its potential consequences are widely examined and discussed in the research. Many previous studies have focused on both the beneficial and detrimental effects of specific types of ICT, such as e-mails or smartphones (e.g., Derks & Bakker, 2014).

However, one crucial factor that many ICT have in common is free access to information, and the possibility of communicating with anyone from anywhere, at any time. Modern ICT can thus afford people far greater flexibility. For example, many employees can use ICT to do their job away from traditional offices, and spend part of their regular working hours at other locations, particularly at home. This flexibility can support work-life integration, and have positive effects on both job motivation and performance (e.g., Hill, Ferris, & Märtinson, 2003; Hill, Hawkins, Ferris, & Weitzman, 2001; Peters, den Dulk, & van der Lippe, 2009; Valcour, 2005). However, the positive facets of ICT can provide simultaneous downsides. For example, the increased communication and flexibility can create extra work; require frequent reassessment of work quality and prioritization; cause work-life conflicts; and contribute to a sense of overload (e.g., Bawden & Robinson, 2009; Boswell & Olson-Buchanan, 2007; Chesley, 2005). Moreover, as illustrated in the introductory scenario, ICT can cause normative pressure (as employees feel obliged to react quickly to notifications), or they can function as interferences, disturbing workflow by disrupting attention and concentration (e.g., Colbert et al., 2016; Davenport & Beck, 2002).

In recent years, a variety of research has paid attention to the fact that ICT use is increasingly blurring the line between the private and working spheres. For example, employees often take professional smartphones home, check their e-mail accounts in the evening hours, or use social media for both private and work purposes. It thus seems evident that ICT usage can be associated with detrimental psychological

effects such as work-home interferences, difficulties in maintaining work-life balance, or problems with psychological detachment (e.g., Bakker, Demerouti, & Dollard, 2008; Derks & Bakker, 2014; Ramarajan & Reid, 2013; Reyt & Wiesenfeld, 2015; Sonnentag, 2003). Following Derks and Bakker (2014), the new way of working enabled by ICT implies that formal agreements between employees and organizations are needed to specify how, where, and when to work. However, this has not yet happened for all kinds of ICT usage (e.g., smartphones).

Concerning beneficial effects, a growing body of research has underlined the relevance of ICT for innovation. For example, in the education sector, recent findings have demonstrated that specific ICT activities can be an effective means of promoting educational goals, or attaining high levels of achievement in specific subjects such as math or science (Flores, Inan, & Lin, 2013; Guzeller & Akin, 2014; Zhang & Liu, 2016). Furthermore, some studies have suggested that the use of modern ICT may also positively impact skill development, identity development, interpersonal relationships, and collaboration (Colbert et al., 2016). For example, Yee (2014) discussed how online games and virtual worlds might help individuals develop skills that are also important in managing real world workgroups.

Taken together, ICT usage will continue to develop and change as part of ongoing digitalization. This provides a multitude of possibilities for improvements and advances on both the individual and organizational levels. Nonetheless, there are also various downsides of increasing ICT usage, which should be recognized and addressed in future research. On the individual level, the concept of “technostress” may be a good starting point.

1.3.2 The concept of technostress

Several recent psychological studies from the area of stress research have focused on the concept of technostress, which describes stress experienced by a person due to the use of modern ICT (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). It has been defined as a modern disease of adaptation caused by an inability to cope with new computer technologies healthily, dating back decades (Brod, 1984). However, through increasing digitalization, it has once again come to the fore. Previous research has shown correlations between technostress and job satisfaction, productivity, innovation, role stress, commitment, and intent to stay with an organization (e.g., Ragu-Nathan et al., 2008; Tarafdar, Tu, & Ragu-Nathan, 2010; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007).

Based on the transaction-based stress approach (Cooper, Dewe, & O'Driscoll, 2001; Lazarus, 1966; Lazarus & Folkman, 1984; McGrath, 1976), Ragu-Nathan et al. (2008) developed a conceptual model for understanding technostress. The model contains five factors that can create technostress (i.e., techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty). "Techno-overload" describes the experience of ICT users being presented with more information than they can handle; different forms of ICT can cause interruptions or force people to work more, faster, or on different tasks simultaneously. "Techno-invasion" describes the aforementioned concept of always being accessible, or "always being on" as a result of ICT. Associated with a need to be continuously connected, this can lead to individuals experiencing a sense of intrusion on their time. "Techno-complexity" emerges when individuals find it challenging to stay up to date with modern ICT's jungle of applications, software versions, functions, and terminologies. Quickly-evolving ICT require individuals to expend time and effort maintaining pace, and if they cannot, it is possible that they may feel "Techno-

insecurity". This describes the threat of losing a job or being replaced by a more ICT-inclined employee. Moreover, these continuing changes and updates can lead to "Techno-uncertainty", which occurs when frequent alterations to a type of ICT make it hard for individuals to develop a solid experience base for using it effectively (Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2011).

In addition to identifying facets that contribute to technostress, Ragu-Nathan et al. (2008) also identified three factors that can inhibit it (i.e., literacy facilitation, technical support provision, and involvement facilitation). “Literacy facilitation” describes mechanisms that can help individuals to reduce techno-complexity via sharing ICT-related knowledge; for example, through training or user-friendly documentation of applications or systems. "Technical support provision" can reduce techno-complexity and techno-uncertainty by addressing ICT-related problems and supporting employees, such as in getting used to specific devices, processes, or interruptions. Research has also shown that the more individuals are informed of (and involved in) ICT adoption and development, the less they perceive these changes as disruptive; this is described as "Involvement facilitation" (Tarafdar et al., 2011).

Additionally, previous findings have revealed beneficial and detrimental effects for ICT-enabled satisfaction (e.g., content, accuracy, output, ease of use, timeliness) and performance (e.g., productivity, innovation) depending on technological characteristics, user involvement, and organizational support mechanisms (Ayyagari, Grover, & Purvis, 2011; Tarafdar et al., 2010).

Research has also addressed whether some individuals are more likely to be affected by technostress than others. A few studies have examined the roles of certain individual characteristics (e.g., age, gender, computer confidence), with varying results (e.g., Burton-Jones & Hubona, 2005; Tarafdar et al., 2011; Tu, Wang, & Shu, 2005; Venkatesh & Morris, 2000).

Lastly, even though the usage of modern ICT is now quite common in most working sectors, many stress-related studies have examined technostress only for actual ICT professionals (e.g., Ahuja, Chudoba, Kacmar, McKnight, & George, 2007; Moore, 2000).

1.4 Scope of the Present Thesis

The present dissertation aims to provide a deeper understanding of the interplay of different factors in predicting the psychological outcomes of employees' ICT usage in modern work environments. Concretely, three field studies and one experimental laboratory study were conducted to empirically explore (1) the roles of ICT usage time and ICT usage frequency as potential antecedents of technostress; (2) the interplay between individual ICT usage behavior, individual characteristics, organizational IT support, technostress, and ICT-related psychological outcomes (i.e., strain, productivity, and innovation); and (3) the impact of digital information load on individuals' performance and strain in an experimental setting.

As a first step, the field study in ***Chapter 2*** aims to investigate technostress (i.e., overload, complexity, uncertainty) within a broad sample of German employees from different sectors. Previous studies have already developed comprehensive research models for the concept and impact of technostress (e.g., Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2011); however, despite its well-known detrimental effects, it is currently somewhat unclear which individual factors can cause stress due to the use of modern ICT. Therefore, ***Chapter 2*** gives particular focus to the question of whether employees' ICT usage behavior (i.e., usage time of different ICT in both the private and working contexts) functions as a potential technostress antecedent, and can thus foster ICT-related strain, or weaken productivity and innovation. Furthermore, individual differences related to employees' personal

characteristics (i.e., age, gender) were examined. Given that smartphones play a somewhat special role among ICT (and subsequently receive particular attention in current research; e.g., Derks & Bakker, 2014), emphasis was placed on employees' smartphone usage behavior, smartphone overuse tendencies, and their interplay with psychological detachment.

The two studies described in ***Chapter 3*** aim to replicate and extend the first study's findings in specific organizational contexts. Therefore, data from two organizational samples were obtained and comparatively analyzed. The procedure in Study 2 and Study 3 was nearly the same; the two organizations had similar organizational structures, but were located in different sectors. As in Study 1, it was hypothesized that there would be an interplay between individual characteristics (i.e., age, gender), employees' ICT usage behavior, technostress, and both beneficial and detrimental psychological outcomes. In addition, the potential effect of employee position (e.g., managerial vs non-managerial) was considered.

As a further extension of Study 1, usage scenarios for different digital devices and applications were created, with the aims of specifying usage behavior and assessing employees' perceived stress in concrete working situations. A serial multiple mediation model was performed to explore potential underlying psychological processes in the relationship between ICT usage behavior and strain. The model contains two potential mediators. First, the frequency of employees' ICT support usage was included as a potential inhibiting factor. Second, technostress (i.e., overload, complexity, and uncertainty), which was already assessed as a potential mediator in Study 1, was considered. Moreover, employees' training needs and expectations toward ICT support were examined exploratively.

Chapter 4 is concerned with the research question regarding the distracting nature of digital information, and the potentially detrimental effects that ICT usage can

cause for individuals. Previous studies have already provided evidence of different negative consequences of technostress and information overload, but these were mainly correlative in nature, or controlled only the specific amount of digital information (e.g., Ayyagari et al., 2011; Tarafdar et al., 2010; Brooks, 2015). Thus, the fourth study aimed to address a current research gap by investigating the effects of digital information load in an experimental setting. In line with previous research, it was expected that participants who were faced with a high amount of digital information would show lower levels of performance. Based on Baron's distraction conflict theory (DCT), it was also hypothesized that performance would differ depending on the degree of task complexity. Both cognitive load and participants' perceptions of their own computer efficacy were considered as possible moderators. Moreover, it was expected that participants in the low digital information load setting would show less strain than participants faced with a high digital information load. Lastly, it was hypothesized that the relationship between digital information load and strain would be mediated by technostress.

The final ***Chapter 5 (General Conclusion)*** of this thesis provides a summary of the present research results. The findings will be discussed with particular attention to their theoretical and practical implications. This chapter will also include discussion of the limitations of the present research, as well as potential starting points and new avenues for future research.

Chapter 2

A matter of time: The role of usage time in examining individual antecedents and psychological outcomes of technostress

2.1 Abstract

Due to ongoing digitalization, the body of research dealing with the usage of information and communication technologies (ICT) and stress experienced by ICT users (i.e., technostress) has steadily increased in recent years. Although previous research has provided considerable insight into both the concept of technostress and its impact on individuals and organizations, surprisingly little is known about its potential antecedents. Moreover, only a few studies have considered individual characteristics (i.e., age, gender), with somewhat mixed findings.

The present study subsequently aims to clarify these mixed findings by (1) investigating a broader sample of employees ($N = 210$); (2) taking individual characteristics into account (i.e., those which can foster beneficial and detrimental outcomes); and (3) focusing on the time employees spend on different ICT (i.e., smartphones, conventional telephones, desktop computers, laptops, tablets). Given that smartphones currently have a rather specific role among ICT in research, an emphasis was put on employees' smartphone usage behavior.

The results indicate that the use of smartphones is related to technostress (i.e., overload, complexity, uncertainty), which functioned in turn as a predictor for ICT-related strain. Moreover, age range comparisons suggest that younger employees are particularly likely to overuse smartphones, and thus struggle to mentally detach from work.

However, beneficial effects of ICT were also observed. Findings suggest that smartphone usage at work was positively associated with ICT-related productivity and innovation. The theoretical and practical implications of the research are discussed together with its limitations, and suggestions for the direction of future research.

2.2 Introduction

Nowadays, modern information and communication technologies (ICT) play an integral part in everyday life, in both the private and professional spheres. As constant companions, they enable us to be almost always accessible to others, while facilitating our own access to data and information. As a result, ICT can allow us to work to non-standard schedules or unusual times.

In recent years, a large body of psychological research has addressed the impact of modern ICT on employees and organizations. Although these studies have produced important insights, a review of the literature revealed somewhat mixed findings. For example, investment in ICT can lead to benefits such as increased productivity (e.g., Davis, 2002; Kudyba & Diwan, 2002; Pohjola, 2001) and economic growth (e.g., Pohjola, 2001), as well as improving the effectiveness of teams (e.g., Shachaf, 2008) or teaching (e.g., Safdar, Yousuf, Parveen, & Behlol, 2011). However, other studies have shown more detrimental effects, such as employees feeling increased pressure to respond to contacts (e.g., Jarvenpaa & Lang, 2005), or that they must always be "on" and available, even during their leisure time (e.g., Davis, 2002; Green, 2002). Moreover, ICT usage can lead to increased work-home interferences and conflicts (e.g., Bakker et al., 2008; Davis, 2002; Derks & Bakker, 2014), increased stress, and weak recovery (e.g., Härmä, 2006).

Other studies have indicated that ICT usage might not have a significant impact in some situations. For example, Lira, Ripoll, Peiró, and González (2007) examined the influence of communication mediums (face-to-face vs computer-mediated) on group effectiveness in a longitudinal study. The results revealed that the communication medium used by the teams to interact was unrelated to work outcomes, team cohesiveness or outcome satisfaction. In other words, the researchers did not find a significant effect of ICT usage on group processes and outcomes.

Although people now spend a considerable amount of time on different digital devices (e.g., three to five hours per day on smartphones, Statista, 2020a), surprisingly little is known about the interplay of employees' ICT usage times and their psychological outcomes. It thus remains unclear whether employees' increased time spent on digital devices leads to more beneficial effects (i.e., increased ICT-related productivity and innovation) or more detrimental ones (i.e., increased technostress and strain).

Furthermore, only a few studies have taken individual characteristics such as gender and age into account when investigating ICT-related usage behavior and outcomes. The findings were mixed; for example, Tu et al. (2005) indicated that technostress increased with age, whereas other studies found that it decreased with age (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011). A similar pattern emerged concerning individual ICT usage behavior. Whereas Stevic, Schmuck, Matthes, and Karsay (2019) revealed a significant negative influence of passive smartphone use on well-being irrespective of age, van Deursen, Bolle, Hegner, and Kommers (2015) indicated that older people spend less time on their smartphone for social purposes, experience less social stress, and show better self-regulation compared to younger people. Thus, older people seem to be less likely to develop addictive smartphone behavior.

Concerning gender, van Deursen, Bolle, Hegner, and Kommers (2015) pointed out that men experience less social stress than women. Women seem to use their smartphones more to maintain their social relationships, and they also have more conversations than men. However, other studies about ICT usage and technostress indicated that men experienced more technostress than women (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011).

The present research therefore seeks to investigate the interplay between employees' digital usage behavior (conceptualized as the length of time they use different digital devices), technostress, strain, detachment, productivity, and innovation. Participants were working adults who extensively use ICT.

The study aims to contribute to a better understanding of the impact of time employees spend on different ICT. Additionally, the individual characteristics age and gender were taken into account to investigate which employees would be more likely to be affected by ICT-related detrimental outcomes (i.e., technostress, detachment problems, strain), and which would benefit the most from ICT-related facilitations (i.e., productivity, innovation).

2.2.1 ICT usage and the concept of technostress

In 1984, Brod described a common disease caused by the inability of individuals to cope with ICT healthily, naming it technostress. Subsequent research revealed that experiencing technostress could lead to a number of negative effects, including reduced job satisfaction, weakened employee commitment to the employer/organization (e.g., Ragu-Nathan et al., 2008), increased role stress, and reduced productivity (e.g., Tarafdar et al., 2007).

Previous studies also investigated whether certain factors could reduce technostress-creating conditions, and subsequently improve ICT-related outcomes. For example, Tarafdar et al. (2010) pointed out the roles of user involvement and innovation support mechanisms as such essential factors.

However, only a few studies have centered on factors that contribute to the development of technostress. Ayyagari et al. (2011) took technological characteristics into account, establishing a person-environment fit model. In this model, technological characteristics functioned as antecedents to stressors (i.e., individuals' perceptions of

technologies), and in turn, these predicted ICT-induced strain. The results indicated that intrusive technology characteristics (i.e., presenteeism, anonymity) were the most dominant predictors of stressors. Work overload and role ambiguity turned out to be the most dominant stressors and predictors of strain.

The present study placed its focus on potential individual antecedents of technostress, and their interplay with psychological outcomes. Most notable is the amount of time spent by employees on different digital devices. Based on Ayyagari's approach, we propose a model with three variables: individual characteristics (i.e., age, gender, time spent on different digital devices), stressors (i.e., overload, complexity, and uncertainty, adapted from Ragu-Nathan et al. 2008; Tarafdar et al., 2010), and two kinds of outcome variables (i.e., strain as a manifestation of stress, productivity and innovation as a manifestation of facilitation). Figure 2.1 provides an overview of the present research model.

With this model, the study could be classified as testing the person-technology fit. Following this approach, a misfit could occur between a person's abilities and the environment's demands. Such a misfit could manifest itself through stressors, which could lead to adverse outcomes such as strain (Ayyagari et al., 2011). However, stress from the use of digital devices is not the only stressor individuals have to deal with at work. As Ayyagari et al. (2011) described, stressor overload might have more components than just the one from ICT use, such as having a naturally demanding job. Therefore, Figure 2.1 also shows the boundaries of the present research, and how it fits into an overall model of stress.

The study also fits with the theoretical background of the broad utilization-focused research area. Based on theories of attitudes and behavior such as Fishbein and Ajzen (1975), utilization-focused studies assume and examine relationships between users' attitudes towards systems, intent to utilize systems, real utilization, and

performance (for an overview, see Goodhue & Thompson, 1995). To the best of our knowledge, the present study is the first to bring utilization of different digital devices together with technostress creators and outcomes related to ICT usage (i.e., strain; facilitation).

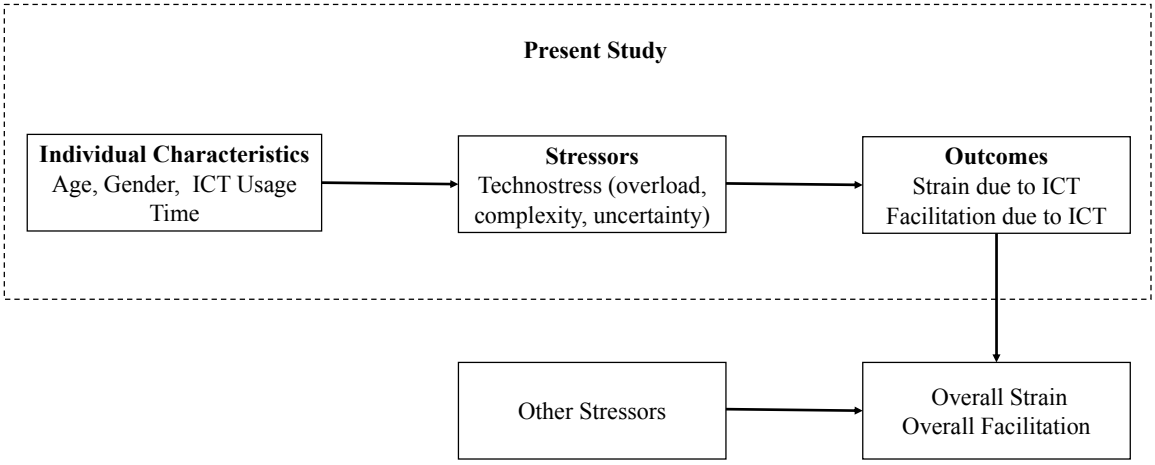

Figure 2.1. Research model and boundaries of Study 1.

2.2.2 The specific role of smartphones among modern ICT

Smartphones have recently received particular attention in psychological research. Despite starting as a niche product, the number of smartphone users has steadily increased (Statista, 2020a). As smartphones become a central part of our lives, they have also started to shape today's workplaces (Chen, 2012; Pitichat, 2013). According to the latest global statistics, 26% of the respondents used their smartphones for more than seven hours per day, whereas only 24% spent less than three hours on them daily (Statista, 2020b).

Moreover, prior research has revealed that individual characteristics affect smartphone use duration (e.g., Andone et al., 2016; De-Sola Gutiérrez, Rodríguez de Fonseca, & Rubio, 2016; Stevic et al., 2019; van Deursen et al., 2015; Volkmer & Lermer, 2019). Via smartphone tracking, Andone et al. (2016) revealed that on

average, women use smartphones for 167 minutes per day, and men for 154 minutes per day. In addition, data showed that that the average daily time spent on smartphones is inversely related with age. Whereas teenagers aged between 12 and 17 spent an average of 194 minutes per day on their smartphones, adults older than 51 years averaged 118 minutes per day. Questions thus arise as to the potential psychological effects associated with smartphone usage, and how these effects might differ among individuals.

Concerning the potential psychological outcomes of smartphone usage, a review of the current literature revealed mixed findings. Some studies pointed out positive impacts; for example, smartphones at the workplace can promote autonomy by enabling immediate access to information, and via facilitating working relationships independent of location and time. In turn, these benefits can increase well-being, pleasure, and productivity, or help employees to advance their careers (e.g., Boswell & Olson-Buchanan, 2007; Davis, 2002; Leftheriotis & Giannakos, 2014; Locke, 2005; Stevic et al., 2019; Voderer, Krömer, & Schneider, 2016).

However, a number of studies have also reported detrimental effects of smartphone usage. Smartphones can trigger a norm whereby individuals feel that they must be constantly available to both private and professional contacts. This can itself result in a strongly perceived pressure to respond (e.g., Davis, 2002; Jarvenpaa & Lang, 2005). Moreover, a high level of smartphone use can lead to lowered well-being, life satisfaction and mindfulness (e.g., Volkmer & Lermer, 2019), or to increased work-home interferences and conflicts (Derks & Bakker, 2014). Stevic et al. (2019) showed in a broad demographic sample that even passive smartphone use (such as viewing or reading content) could reduce well-being.

To address these hot topics in the present research, particular focus was placed on the impact of smartphone usage behavior when examining ICT use and its outcomes among employees.

2.2.3 Smartphone use and detachment

As employees often take professional smartphones home (or even use their private smartphones for professional purposes), it seems unsurprising that smartphone usage is associated with work-home interference, difficulties in finding an appropriate balance between work and private life, and problems with psychological detachment (e.g., Bakker et al., 2008; Derks, Ten Brummelhuis, Zecic, & Bakker, 2012; Sonnentag, 2003).

A negative effect of too much smartphone use might be that employees are less able to detach themselves from work. A core component of recovery seems to be psychological detachment (e.g., Sonnentag & Bayer, 2005; Sonnentag, Binnewies, & Mojza, 2010; von Thiele-Schwarz, 2011), which was initially characterized by Etzion, Eden, and Lapidot (1998) as an "individual's sense of being away from the work situation" (p. 579). This means that once employees are no longer at work (e.g., being at home in the evening), they should no longer be dedicating themselves to any work-related issues. Sonnentag and Fritz (2007) expanded the definition in the sense that psychological detachment also includes mentally disengaging from work; for example, ceasing to dwell on work-relevant topics or problems. Therefore, a crucial factor is not just physical departure from the workplace, but also psychological disengagement from work.

A variety of research has demonstrated the importance of psychological detachment from work in the evening; pointing out that continuous involvement with work during non-work time, and the inability to mentally "switch off" from work, can

foster various health issues such as fatigue and sleep problems (e.g., van Hooff, Geurts, Kompier, & Taris, 2006), and is generally an indicator of poor well-being (e.g., Grebner, Semmer, & Elfering, 2005, McDaniel & Coyne, 2016). Moreover, prior research indicated that detachment can have an impact on employees' performance and work engagement (e.g., Binnewies, Sonnentag, & Mojza, 2009; Sonnentag & Fritz, 2007; Sonnentag et al., 2010), as well as burnout symptoms (e.g., Derks & Bakker, 2014).

With the growing prevalence of smartphones, problematic smartphone use behavior and addiction have come to the fore. Based on previous literature, Derks and Bakker (2014) drew a comparison between workaholics and intensive smartphone users; hypothesizing that (intensive) smartphone use moderates the negative relationship between recovery experiences and work-home interference. In other words, daily recovery (i.e., psychological detachment and relaxation) can reduce work-home interferences, especially for employees who use their smartphones intensively. The results supported this hypothesis, indicating that the negative relationship between psychological detachment and work-home interference is stronger for intensive smartphone users. This implies that such individuals may benefit from applying particular effort to psychological detachment, so that they may decrease their degree of work-home interference.

Based on these findings, the present study investigated whether smartphone usage time at work is related to detachment, and whether smartphone overuse tendencies function as a potential moderator in this relationship.

2.2.4 The Present Research

With digital devices having become an integral part of our private and professional lives, emerging research has addressed the impact of modern ICT on

employees and organizations. These studies have developed comprehensive research models and granted great insight into the concept of technostress (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2007; Tarafdar et al., 2010). However, only a few studies have focused on potential antecedents of technostress (e.g., Ayyagari et al., 2011).

Given that employees spend a considerable time using ICT, surprisingly little is known about the effect of ICT usage duration on psychological outcomes. Following current, available statistics (Statistisches Bundesamt, 2019a), we focused on the usage times of the four ICT most commonly utilized by German employees (i.e., smartphones, conventional telephones, desktop computers/laptops, and tablets). We aimed to investigate the paradoxical nature of ICT usage by examining both its potential beneficial and detrimental outcomes.

To explore potential detrimental effects, we examined whether the usage times of different types of ICT functioned as a potential antecedent of technostress (i.e., overload, complexity, uncertainty). In addition, we expected technostress to foster ICT-related strain.

Given that smartphones have received particular attention in recent research, we put a special focus on the impact of employees' smartphone usage; specifically exploring whether employees' smartphone usage time at work would function as a predictor of detachment problems, and whether smartphone overuse tendencies in after-work hours would moderate this effect. As Derks and Bakker (2014) report, most studies of smartphone use are qualitative. Thus, the present study aims to contribute to the existing body of quantitative research about smartphone use and psychological detachment by (1) investigating a broad demographic sample of employees from different sectors, and (2) exploring the interplay between smartphone usage at work, smartphone overuse tendencies in after-work hours, and detachment with the aforementioned moderator analysis.

To examine potential beneficial effects, we also considered whether the usage times of different digital devices might encourage ICT-related productivity and innovation. Finally, building on previous research, (e.g., Andone et al., 2016; Stevic et al., 2019; Tu et al., 2005; van Deursen et al., 2015) we also investigated the effects of the individual characteristics age and gender on technostress, and the outlined ICT-related outcomes. Given that prior findings are somewhat mixed, we aim to contribute to the existing debate.

2.3 Study 1

2.3.1 Method

Participants and Design

210 employees (106 women, 104 men) participated in this correlative field study by completing an online survey (M_{age} = 41.7, SD_{age} = 13.43, age range: 19–77 years). They were recruited via e-mail lists and calls put out over different social media and business platforms. The precondition for participating was being employed. Sample characteristics are given in Table 2.1, including education, vocational sector, and working hours. Most of the employees were well educated, and around 90% worked in sectors where digital ICT are commonplace, with 65% in full-time employment. These demographics indicate that the employees were able to answer the questions regarding ICT usage behavior, and its potential beneficial and detrimental outcomes.

Table 2.1

Sample demographics from Study 1.

	n	%
Education		
No formal education	3	1.4
Secondary school	45	21.4
High school	55	26.2
Academic degree	99	47.1
Others	8	3.8
Total	210	100
Vocational sector		
Agriculture, horticulture, forestry	3	1.4
Raw material extraction, production	5	2.4
Construction, architecture, surveying, building technology	5	2.4
Science, geography, informatics	18	8.6
Logistic, transport, safety, security	12	5.7
Commercial services, commodity trading, sales, tourism	21	10
(Company) administration, accounting, law	87	41.4
Health, social issues, teaching, education	51	24.3
Humanities-, social-, language-, literature-, culture, arts, media	6	2.9
Others	2	1.0
Total	210	100
Working hours		
Full-time	137	65.2
Part-time	33	15.7
Self-employment	14	6.7
Mini-job	4	1.9
Trainee	4	1.9
Student	14	6.7
Others	4	1.9
Total	210	100

Materials and Procedure

We confirm that the procedure of the reported research is in line with the Declaration of Helsinki and the APA's ethical guidelines. The survey link was sent via email to the employees, together with a description of the study's purpose. Those

interested simply had to click on the link, and the survey started automatically. First, employees were informed that participation was voluntary, that their responses would be confidential, and that the collected data would be used for scientific purposes only. Subsequently, ICT usage behavior was measured, followed by the different psychological variables. The questionnaire concluded with a demographic section in which the employees indicated their age, gender, education, professional area, average work time, and family status.

Measures and Variables

Digital usage behavior. The digital usage behavior of the employees in the private and working contexts was assessed using a self-constructed scale. Based on current statistics (Statistisches Bundesamt, 2019a), we decided to focus on the four most commonly utilized types of ICT in Germany (i.e., smartphones, conventional telephones, desktop computers/laptops, tablets). Employees were asked to indicate how much private time and how much working time they spent per day using these ICT on two 7-point Likert scales (1 = *no usage*, 2 = *less than 30 minutes,* 3 = *30 minutes to 1 hour,* 4 = *1 hour to 2 hours,* 5 = *2 hours to 4 hours,* 6 = *4 hours to 6 hours,* 7 = *more than 6 hours*).

Smartphone overuse tendencies. To measure the extent to which employees used their smartphones in after-work hours, we utilized a translated version of Derks and Bakker's (2014) four-item scale for smartphone overuse (α = .77; all presented α-values are Cronbach α-values). All items were rated on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*). An example item is: "When my smartphone blinks to indicate new messages, I cannot resist checking it".

Strain. A translated subscale from Ayyagari et al. (2011) was used (α = .83). Based on Moore's work exhaustion construct (2000), it measures whether individuals

feel ICT-induced strain. Employees were asked to indicate how often they felt tired, burdened, or exhausted from the use of digital ICT (1 = *never*, 7 = *daily*). For example: “I feel drained from activities that require me to use information and communication technologies.”

Detachment. To measure psychological detachment from work, a translated version of Sonnentag and Fritz’s (2007) four-item scale was used (α = .94). Employees indicated the extent to which they agreed or disagreed with statements like, "During my non-work time, I distance myself from work" (1 = *strongly disagree*, 7 = *strongly agree*).

Technostress. To specify the relationship between ICT usage behavior in the working context and strain, we took three technostress creators into account as possible mediators. Adapted from Ragu-Nathan et al. (2008) and Tarafdar et al. (2010), we used three translated subscales to measure overload (α = .87), complexity (α = .88) and uncertainty (α = .88), and integrated them into an overall scale of technostress (α = .87). Employees indicated how much they agreed or disagreed with statements such as "I am forced by modern technologies to do more work than I can handle.” (Contextual definition about modern technologies was given; item from the overload subscale; 1 = *strongly disagree*, 7 = *strongly agree*).

Techno facilitations. To reveal potential beneficial effects of ICT usage at work, we used two subscales to measure productivity (α = .93) and innovation (α = .94), translated from Tarafdar et al. (2010), and based on Torkzadeh and Doll (1999). An example of an item statement is "Modern technologies help me come up with new ideas relating to my job." (from the innovation subscale; 1 = *strongly disagree*, 7 = *strongly agree*).

2.3.2 Results

No participants had to be excluded from the dataset due to missing data, suspicion, or revision of their preliminary decision to participate.

Descriptive statistics for ICT usage behavior

Analysis of the ICT usage times revealed that smartphones were used for the longest time in the private context. Only 4.3% of the employees did not use a smartphone, whereas 23.8% no longer used a conventional telephone. In the working context, desktop computers and laptops were used for the longest time, with conventional telephones also having more of a role; only 11.4% of the employees reported no longer using them at work. In comparison, 31.0% did not use smartphones at work. Descriptive statistics for employees' ICT usage behavior in the private and working contexts are provided in Table 2.2.

Table 2.2

Employees' ICT usage times in the private and working context in Study 1. Percentage

	Private context				*Working context*			
	Smartphone %	PC /Laptop %	Telephone %	Tablet %	Smartphone %	PC /Laptop %	Telephone %	Tablet %
not used	4.3	7.1	23.8	43.3	31.0	1.9	11.4	64.8
< 0.5 hours	19.5	31.9	62.9	27.6	27.1	4.8	31.9	21.9
0.5 - 1 hour	27.1	28.6	10.0	12.4	21.9	5.7	29.5	5.2
1 - 2 hours	19.0	16.2	2.4	11.4	9.5	9.0	16.2	4.8
2 - 4 hours	21.9	12.9	0.5	3.3	6.2	14.8	6.7	2.9
4 - 6 hours	5.2	2.4	0.0	1.9	2.9	21.0	2.4	0.5
> 6 hours	2.9	1.0	0.5	0.0	1.4	42.9	1.9	0.0
Total	100	100	100	100	100	100	100	100

Individual differences in ICT usage behavior

A one-way ANOVA was conducted to assess age differences in ICT usage behavior. To enable a comparison between employees in different life and work stages (e.g., Bruch, Kunze, & Böhm, 2010), age was divided into three categories: younger age (35 years and younger), middle age (36 to 49 years of age), and higher age (50

years and older). There was a significant difference in smartphone usage times in the private context between the different age categories (Welch's $F(2,134.50) = 33.83$, $p < .001$). Games-Howell post-hoc analysis revealed a significant difference between private smartphone use time for all three groups. Usage time decreased from young age to middle age (1.05, 95% CI[.51, 1.59]), from middle age to high age (.57, 95% CI[.09, 1.05]), and from young age to high age (1.62, 95% CI[1.16, 2.09]).

Regarding computer usage time in the private context, there were also significant age differences (Welch's $F(2,137.14) = 4.61$, $p = .012$). Games-Howell post-hoc analyses showed a significant decrease from young age to middle age (.61, 95% CI[.08, 1.14], $p = .019$) and from young age to high age (.57, 95% CI[.06, 1.07], $p = .023$).

In the working context, employees' time spent using conventional telephones differed significantly between age groups ($F(2,207) = 6.04$, $p = .003$). Tukey post-hoc analysis revealed that telephone usage time increased significantly from young age to middle age (-.70, 95% CI[-1.21, -.19], $p = .004$), and from young age to high age (-.58, 95% CI[-1.09, -.07] $p = .021$).

Concerning gender, a *t*-test indicated that women ($M = 2.09$, $SD = 0.86$) used conventional telephones in the private context for significantly longer than men did ($M = 1.80$, $SD = 0.64$), $t(208) = -2.83$, $p = .005$, $d = -0.38$. A similar effect was found for the use of conventional telephones in the working context. Once more, women ($M = 3.09$, $SD = 1.35$) used the telephone for significantly longer than men did ($M = 2.69$, $SD = 1.25$), $t(208) = -2.24$, $p = .026$, $d = -0.31$.

However, men ($M = 2.78$, $SD = 1.60$) used smartphones for significantly longer times in the working context than women did ($M = 2.17$, $SD = 1.19$), $t(190.23) = 3.12$, $p = .002$, $d = 0.43$. Men also used tablets when working ($M = 1.76$, $SD = 1.13$) for

significantly longer than women did (M = 1.45, SD = 0.92), t(198.16) = 2.16 , p = .032, d = 0.30.

Detrimental effects of ICT usage

Pearson correlations were conducted to explore the interplay between the different ICT usage times, technostress (i.e., overload, complexity, uncertainty), smartphone overuse tendencies, detachment, and strain. Data showed that smartphone usage time at work was positively associated with overload (r = .311, p < .001), complexity (r = .469, p < .001), and uncertainty (r = .157, p = .023). It was also positively correlated with smartphone overuse (r = .245, p < .001), and negatively associated with detachment (r = -.147, p = .034).

Again, a one-way ANOVA was conducted to check for age effects. The three age groupings differed significantly in perceived overload (F(2,207) = 4.51, p = .003). Tukey post-hoc analyses revealed significant differences between the young and high age groups (-3.68, 95% CI[-6.63, -.72], p = .010; see Figure 2.2).

Data also revealed a significant age effect for complexity (F(2,207) = 7.35, p = .003). Tukey post-hoc analyses demonstrated significant differences between the young and high age categories (-4.49, 95% CI[-7.26, -1.72], p = .001; see Figure 2.3). Furthermore, uncertainty differed significantly among the three age groups (F(2,207) = 3.47, p = .003). Tukey post-hoc analyses showed significant differences between the young and high age groups (-2.58, 95% CI[-5.06, -.09] p = .040; see Figure 2.4).

As shown in Figures 2.2 to 2.4, all three technostress variables increased significantly from young age to high age. Moreover, smartphone overuse differed significantly among the three age categories (Welch's F(2,134.46) = 13.28, p < .001). Games-Howell post-hoc analysis showed a significant decrease from young age to

middle age (1.82, 95% CI[.38, 3.28], p = .010), and from young age to high age (3.08, 95% CI[1.63, 4.53], p < .001; see Figure 2.5). Lastly, we found a significant age effect for detachment (F(2,207) = 3.15, p = .003), which significantly increased from young age to middle age (-2.80, 95% CI[-5.53, -.08], p = .042; see Figure 2.6).

A t-test revealed that the level of strain was significantly higher for women (M = 18.38, SD = 5.43) than for men (M = 16.31, SD = 5.43), t(208) = -2.76, p = .006, d = -0.38. Furthermore, women (M = 16.35, SD = 7.06) perceived a significantly higher level of complexity than men did (M = 13.64, SD = 7.12) did, t(207.85) = -2.76, p = .006, d = -0.38. However, there was no significant gender effect for overload, (men: M = 18.13, SD = 7.54; women: M = 18.37, SD = 7.66), t(208) = -0.23, p = .817, d = -0.03, nor for uncertainty, (men: M = 16.19, SD = 6.10; women: M = 15.26, SD = 6.58), t(208) = 1.06, p = .291, d = 0.15, detachment, (men: M = 16.45, SD = 6.74; women: M = 16.55, SD = 7.10), t(208) = -0.10, p = .921, d = -0.01, or smartphone overuse (men: M = 13.00, SD = 3.93; women: M = 12.65, SD = 3.97), t(208) = 0.64, p = .523, d = 0.09.

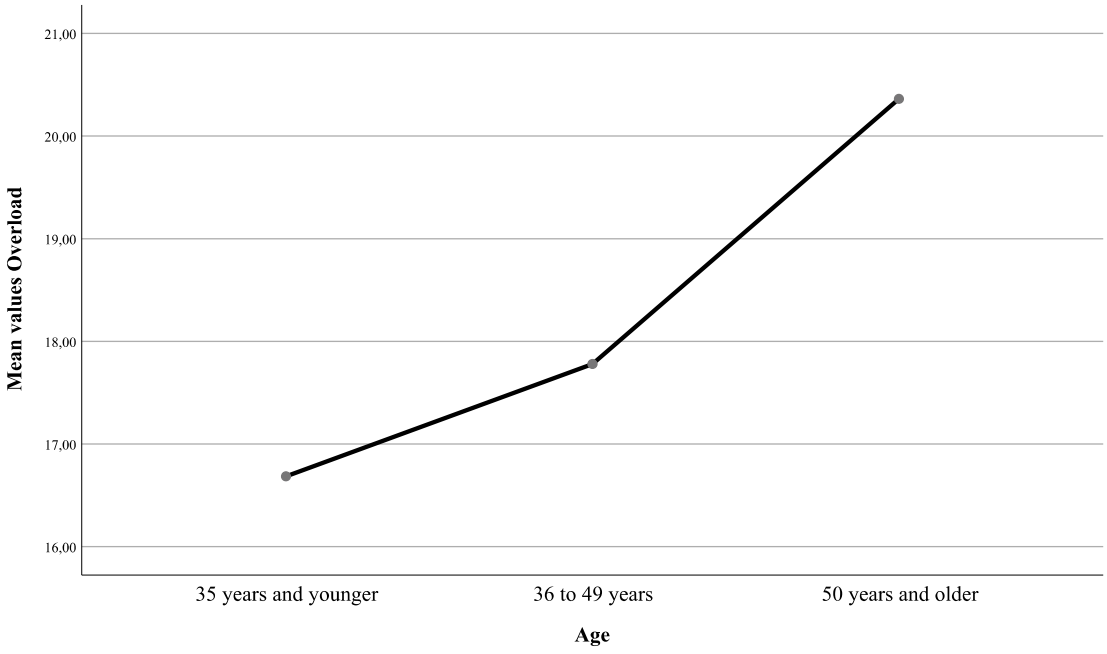

Figure 2.2. Means of overload for the three age categories in Study 1.

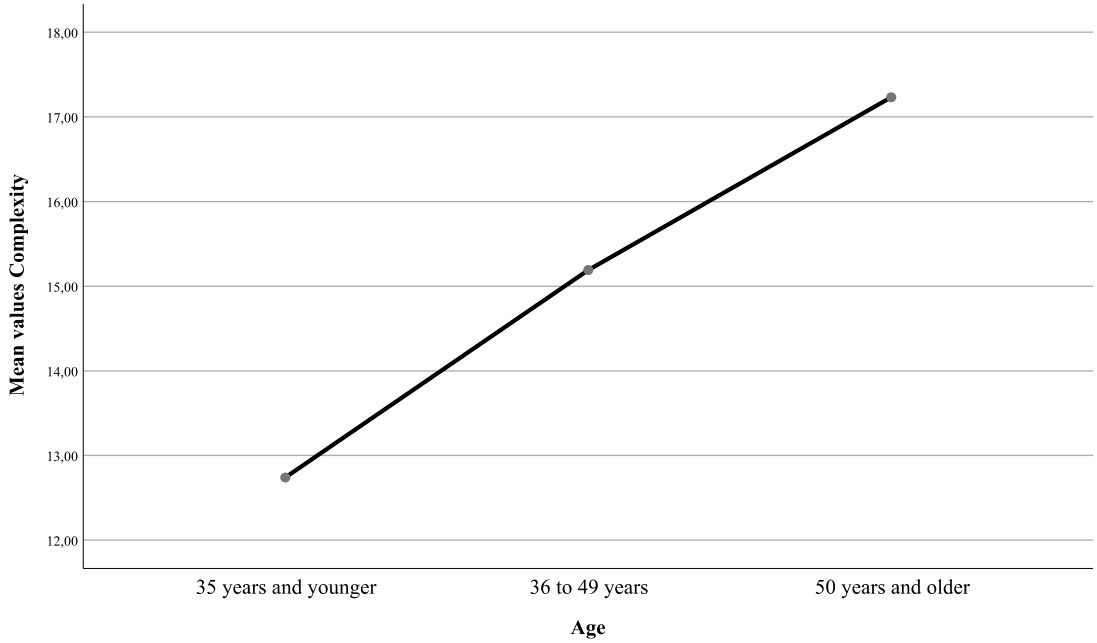

Figure 2.3. Means of complexity for the three age categories in Study 1.

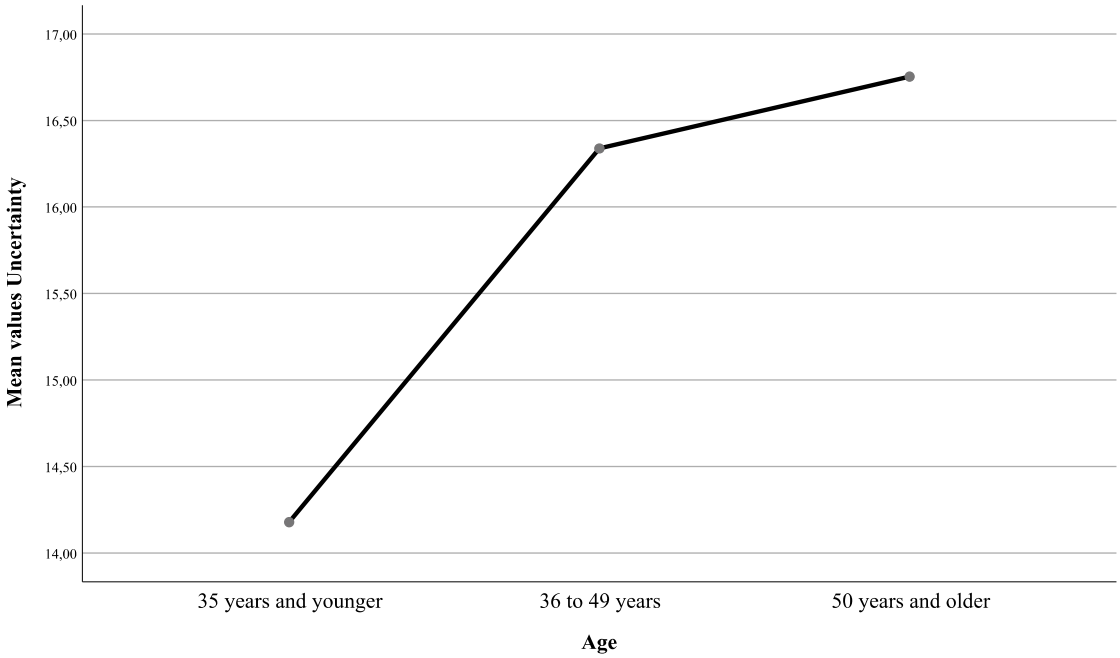

Figure 2.4. Means of uncertainty for the three age categories in Study 1.

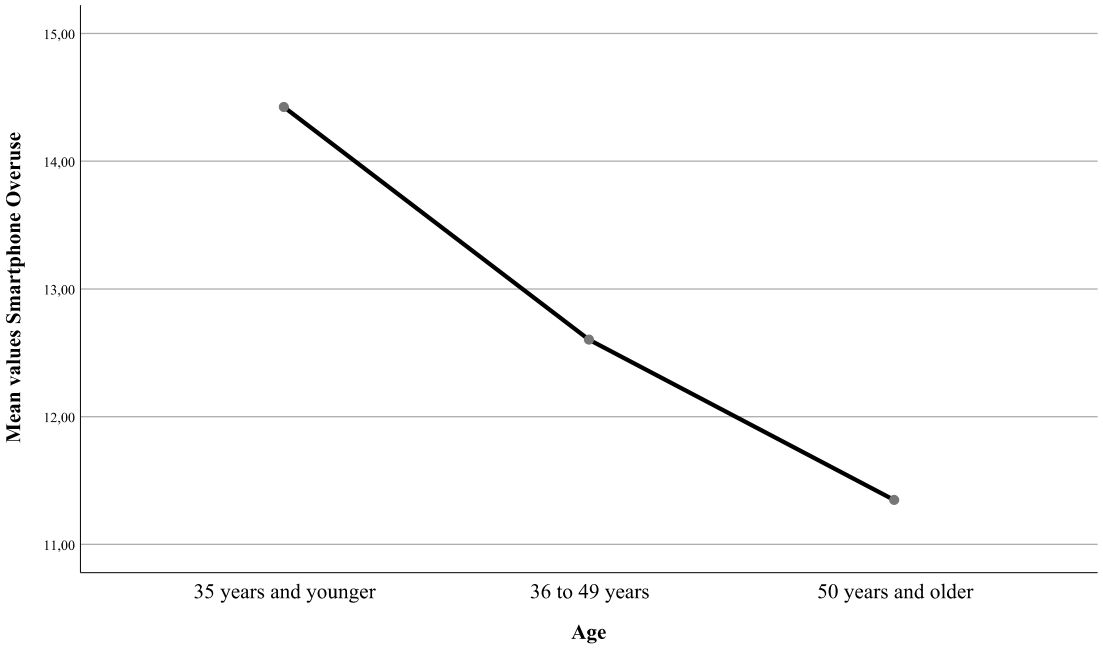

Figure 2.5. Means of smartphone overuse tendencies for the three age categories in Study 1.

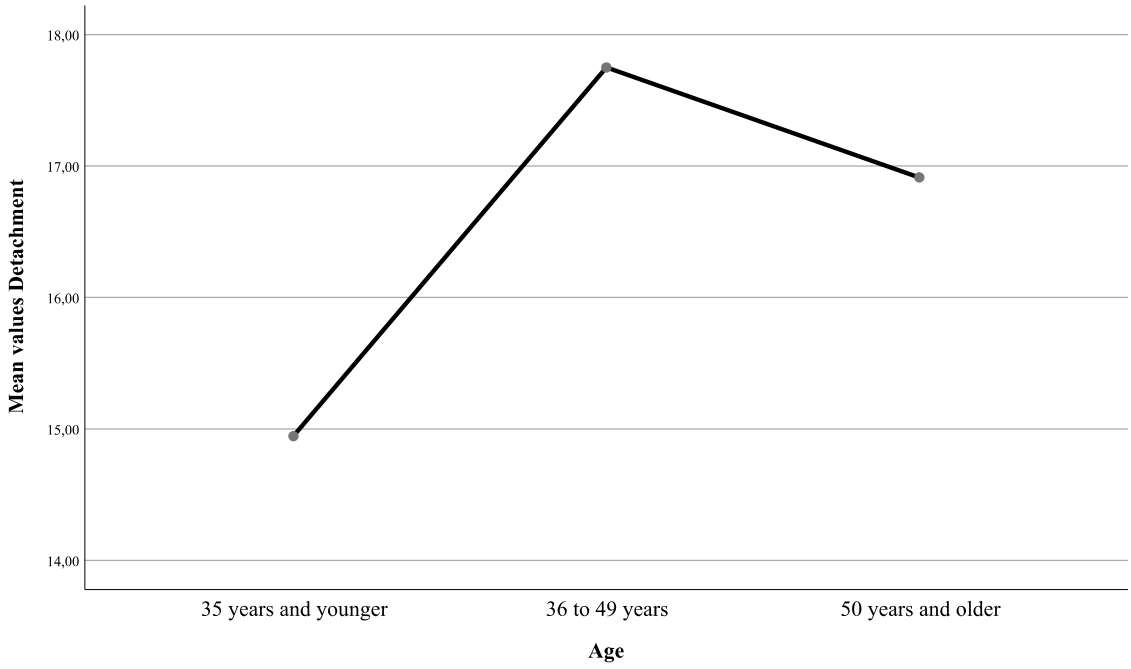

Figure 2.6. Means of detachment for the three age categories in Study 1.

Mediational analysis for the impact of technostress on strain

To assess whether an indirect effect of ICT usage times on strain could be found, mediational analyses were performed using Hayes' (2018) PROCESS macro (model 4). More specifically, it was tested whether ICT usage times in the working context predicted strain, and whether technostress would mediate the direct path. Bootstrapping with 5000 samples and heteroscedasticity consistent standard errors (Davidson & MacKinnon, 1993) were used to compute the confidence intervals and inferential statistics.

Individual analyses for the different types of ICT (i.e., smartphones, conventional telephones, desktop computers/laptops, and tablets) revealed that employees whose smartphone usage time at work was high showed increased technostress, $a = 1.82$, $t(208) = 2.43$, $p = .016$, 95% CI [0.34, 3.30], and employees with increased technostress also reported increased strain, $b = 0.17$, $t(207) = 6.82$, $p < .001$, 95% CI [0.12, 0.21]. The confidence interval for the indirect effect of technostress ($ab = 0.30$) did not include zero (0.061 to 0.539). Thus, technostress mediated the relationship between smartphone usage time at work and strain.

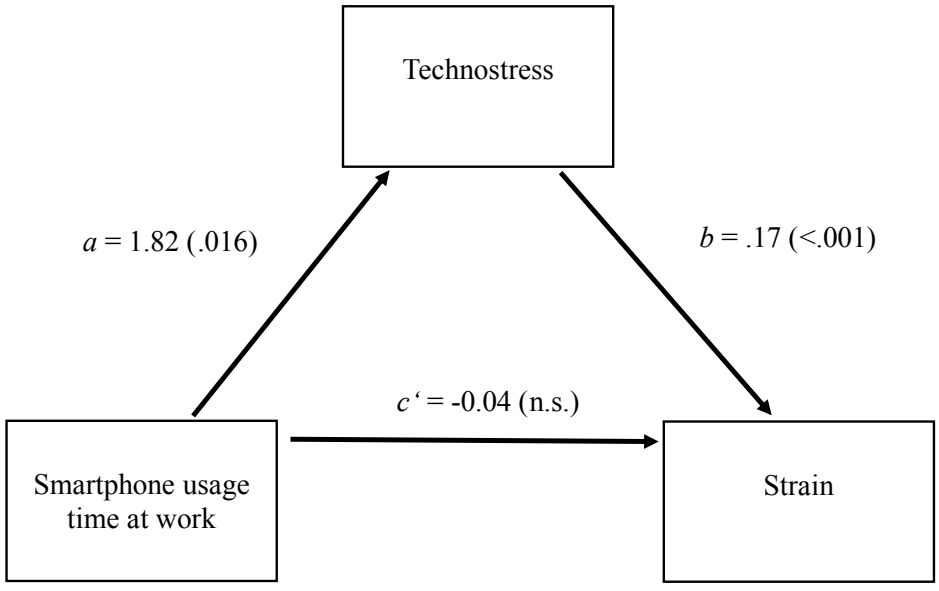

Figure 2.7. Mediation model for Study 1.

Moderation analysis for the impact of smartphone overuse on detachment

It was next assessed whether smartphone overuse tendencies in after-work hours moderated the effect of smartphone usage time on detachment. A moderation analysis was performed using the Hayes' (2018) PROCESS (model 1). Smartphone usage time at work, smartphone overuse tendencies, and the interaction between them acted as predictors, while detachment was used as the dependent variable.

Data showed that smartphone overuse tendencies function as a moderator of the effect of smartphone usage time on detachment (β = -.208, $t(206)$ = -2.417, p = .017, R^2-*Incr.* = 5.1%). Furthermore, conditional regression coefficients revealed that when smartphone overuse was either below average (one standard deviation below the mean) or average, smartphone usage time at work was not a significant predictor of detachment (below average: β = .633, p = .313; at average: β = -.404, p = .251). However, when smartphone overuse was above average (one standard deviation above the mean), smartphone usage time significantly predicted a reduced ability to detach from work, β = -1.234, p = .003. See also Figure 2.8.

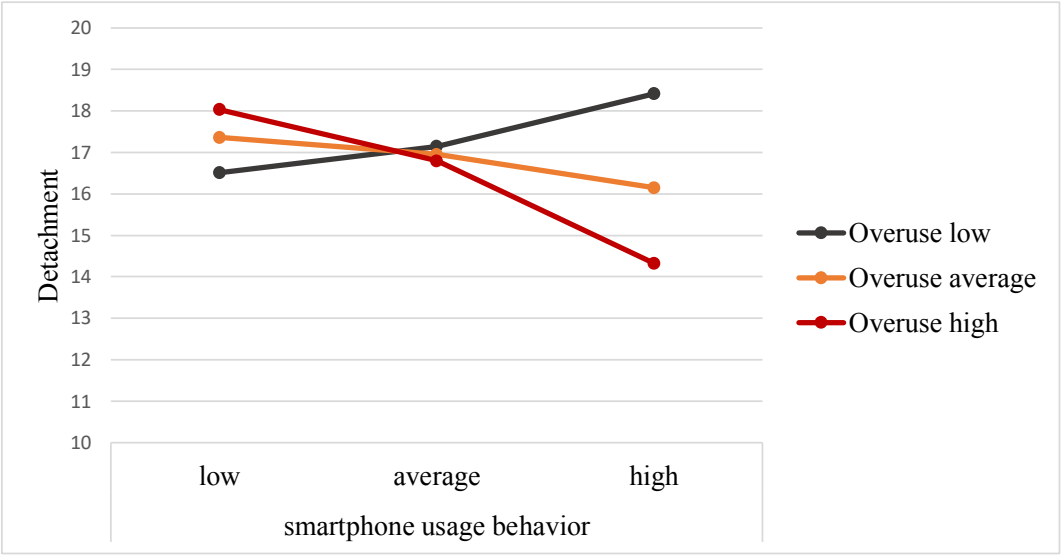

Figure 2.8. Detachment when smartphone usage time at work and smartphone overuse are low, average and high in Study 1.

Beneficial effects of ICT usage

Pearson correlations were conducted to explore the interplay between the usage times of different ICT, productivity, and innovation. Data showed that the usage time of smartphones at work was positively associated with productivity (r = .194, p = .005) and innovation (r = .233, p = .001).

To check for age effects, a one-way ANOVA was performed. However, the data revealed neither a significant effect for productivity, $F(2,207) = 0.56$, p = .571, nor for innovation, $F(2,207) = 0.46$, p = .631.

Concerning gender effects, a t-test revealed that men (M = 21.88, SD = 5.19) reported a significantly higher level of perceived productivity than women did (M = 19.00, SD = 6.07), $t(208) = 3.70$, $p < .001$, d = 0.51. A similar effect was found for innovation, with men's level of perceived innovation (M = 13.96, SD = 4.77) being significantly higher than women's (M = 12.11, SD = 5.16), $t(208) = 2.69$, p = .008, d = 0.37.

2.3.3 Discussion

The present research uses a field study to examine the interplay between ICT usage behavior, technostress, detachment, ICT-related strain, ICT-related productivity and innovation, and individual characteristics in a sample of employees. More precisely, we examined whether the time an employee spends on different digital devices functions as an antecedent of technostress (i.e., overload, complexity, and uncertainty), and hypothesized that technostress would foster ICT-related strain.

Following prior research (e.g., Derks & Bakker, 2014), we placed special emphasis on the use of smartphones. Therefore, we explored whether smartphone overuse tendencies had a moderation effect on the relationship between smartphone usage time at work and detachment. Besides these detrimental effects, we also aimed

to assess potential beneficial effects of ICT usage for employees by measuring ICT-related productivity and innovation. In line with previous research (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011), we placed further focus on individual differences, to investigate whether employees' age or gender would have an effect on ICT use and the other ICT-related variables.

Descriptive statistics indicate that digital devices are used differently in the private and working contexts. In the private context, employees reported using smartphones for the longest times. In contrast, they spent most of their time at work on desktop computers and laptops, as well as using conventional telephones. Concerning smartphones, the results differ significantly from the global statistics on daily usage times (Statista, 2020a). Around 48% of the employees spent a maximum of one hour each of their private and working time using a smartphone. Only 2.9% reported using smartphones for more than six hours in the private context, and only 1.4% for more than six hours in the working context.

In line with previous research (e.g., Andone et al., 2016; Colbert et al., 2016; Stevic et al., 2019; van Deursen et al., 2015), our results show that employees' ICT usage behavior differs significantly depending on the individual characteristics age and gender. For example, younger employees reported spending significantly more time on smartphones and significantly less time on conventional telephones compared to older employees. Concerning gender, we found that women spent significantly more time on conventional telephones at both home and work than men did. However, men used smartphones and tablets at work for significantly longer than women.

The results indicate different detrimental effects of ICT use among the employees. First, we found that smartphone usage time was positively associated with technostress (i.e., overload, complexity, and uncertainty). In addition, employees' smartphone usage time correlated positively with smartphone overuse tendencies, and

negatively with detachment. The data showed that the longer employees used smartphones at work, the more they tended towards intensive smartphone usage in their private time (smartphone overuse), and the less they were able to experience psychological detachment. Young employees (i.e., aged 35 years or younger) were particularly likely to overuse their smartphones and have detachment problems, whereas employees older than 35 were more capable of psychologically distancing themselves from work in the evening.

Second, to specify the relationship between smartphone usage time at work and detachment, a moderator analysis was performed. Intensive smartphone use tendencies in after-work hours significantly moderated the effect of smartphone usage at work on detachment. Conditional regression coefficients showed that this is especially true for high levels of smartphone overuse. In other words, when employees rated themselves as intensive smartphone users, their smartphone usage behavior at work was a significant predictor of detachment difficulties. This means that employees had many more problems stopping themselves from thinking about work (and mentally disengaging from it) when they used smartphones for a long time at work, compared to when they used them for briefer periods. This result suggests that it is important to consider ICT usage behavior in both private and working hours, and that smartphone use during after-work hours is not simply an issue of personal choice. Instead, organizations should address this topic in their work policies.

Furthermore, the findings support previous research that explored smartphone overuse tendencies as a process variable. For example, Derks and Bakker (2014) showed that intensive smartphone use increased work-home interference, and thus that intensive users might derive particular benefit from activities that promote psychological detachment. The data from Study 1 support this assumption, and further it by establishing a connection to smartphone usage time at work.

Third, the findings indicate age effects for technostress. In line with Tu et al. (2005), comparisons showed that employees aged 50 or older reported significantly higher levels of perceived overload, complexity, and uncertainty than young employees (i.e., 35 years or younger). This result implies that employees need support in working with digital ICT that is tailored to their needs and difficulties. For an elaboration of this point, see the implications discussed below.

Fourth, contrary to our assumptions, no significant direct relationship was found between the usage time of different digital devices and strain. A possible explanation for this unanticipated result may be that simply knowing the time a person spends using ICT might not be enough. However, this issue has been discussed in previous research for a long time. For example, Goodhue and Thomson (1995) argued that knowing that a person used a system for a specific time can mean different things depending on the situation or task. However, in a mediation analysis that took technostress (i.e., overload, complexity, uncertainty) into account, data showed an indirect effect between smartphone usage time at work and strain.

The finding that a high level of technostress was associated with a high level of strain is in line with prior research (e.g., Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2011). To be more specific, data show that consistent with other studies, overload, complexity, and uncertainty can act as significant predictors of ICT-related strain. For example, the effect can occur when digital technologies require continuous updating, cause a higher work demand, or require employees to acquire additional technological skills. The present findings extend the existing literature by showing for the first time that employees' ICT usage time (i.e., smartphone usage time) can function as an antecedent of technostress.

The results also indicate some beneficial outcomes of ICT usage. For example, the usage time of smartphones at work was positively associated with productivity and

innovation, even though the reported values may be considered statistically low. Concerning individual differences, data reveal no significant age effects. However, gender comparisons show that men rated their productivity and innovation significantly higher than women did. Taken together, the findings underline the multidimensional nature of ICT and its use.

Theoretical and Practical Implications

From a theoretical point of view, the present study contributes to a better understanding of the interplay between employees' ICT usage behavior, technostress, ICT-related strain, detachment, and ICT-related productivity and innovation. Additionally, the findings underline the impact of the individual characteristics age and gender. By focusing on specific, selected types of ICT in individual analyses, the study also addressed a research gap discussed in recent literature (cf. Ayyagari et al., 2011).

Considering the important role smartphones now play in everyday life, the findings that employees' smartphone usage behavior was associated with both technostress and psychological detachment problems are of particular interest. Thus, the study has theoretical implications for future research, such as exploring which types of smartphone activities might foster detrimental effects like technostress or strain, and which might provide beneficial effects like increased productivity or innovation.

Regarding the finding that younger employees had more detachment problems than older employees, it would be interesting to find out which detachment strategies could possibly ease these problems. Perhaps doing so would enable the potential stressful effects of smartphones to be identified and addressed before they completely replace conventional telephones in organizations.

Furthermore, our results may help organizations to better support their employees when working with ICT. As the analyses revealed, employees show different usage behavior depending on age. In turn, this makes it evident that they have to deal with different challenges, and therefore need different kinds of support. In line with other research, the study shows that ICT usage does not necessarily lead to exclusively beneficial effects like higher productivity and innovation. Thus, a core task of organizations is to find a suitable way for employees to work with ICT in a manner that enhances the benefits and minimizes the detrimental aspects. Moreover, organizations should have targeted support for the implementation of new technologies, rather than expecting employees to make the adjustment independently.

Concerning smartphones, the findings of the present study support prior research, and underline the importance of clear organizational regulations concerning smartphone usage in private/leisure time (e.g., Derks & Bakker, 2014).

Limitations and Future Directions

Although Study 1 makes a valuable contribution to the existing literature, it has a few limitations. However, we believe that these limitations offer potential starting points for fruitful future research.

First, as the sample demographics show, the employees came from diverse vocational sectors. This is a positive aspect, considering that it is an entirely random sample and that workplace changes stemming from the use of digital devices concern almost all areas. Otherwise, nothing is known about the private or organizational context of the employees, and thus about other positive or negative influences. For example, Tarafdar et al. (2010) showed that supportive organizational mechanisms could increase users' satisfaction and decrease technostress creators. Hence, contextual factors should be acknowledged in future studies.

Additionally, the sample may be biased by a self-selection mechanism. The survey link was spread via email lists, as well as by different social media and business platforms. Therefore, it is conceivable that the sample skewed towards employees who are very interested in digitalization topics, or have more strongly held beliefs about ICT and its perceived beneficial or detrimental effects.

Second, the study is correlative in nature, and the items reflect the subjective assessments and perceptions of the employees. These self-reported measures can be prone to measurement errors or socially desirable answers (Holbrook, 2008; Naab, Kranowski, & Schlütz, 2018; Sharkow, 2019). Furthermore, the results cannot reveal a causal link between ICT usage behavior and beneficial or detrimental psychological effects. Future studies could thus continue from this point, perhaps by using objective measurements for performance instead of productivity. Similarly, usage time could be measured via digital time tracking or ambulatory assessment methods (Naab et al., 2018). However, to assess such data in a field study is both difficult and costly. Therefore, researchers should carefully reflect upon their choice of study design, and consider not only its strengths and weaknesses, but also those of the alternatives (Taris & Kompier, 2014).

Third, assessing only the length of time for which different ICT are used might not be enough. It would be interesting to figure out why employees spend more or less time on certain devices. For example, to specify usage behavior, activities could be assessed using everyday private or work scenarios. In doing so, the measurement of perceived stress could be more accurately specified.

2.4 Conclusion

The present study takes one step further in investigating the paradoxical nature of ICT and its usage among employees. To the best of our knowledge, our findings are among the first ones highlighting the role of ICT usage time in addition to gender and age as individual characteristics. With particular regard to smartphone usage, we made an important contribution to the existing literature by showing that the time employees spend on smartphones at work is linked to perceived technostress and detachment problems. The present study offers a starting point for future research on ICT by suggesting that usage time can matter, even if it is not the sole factor of note.

Chapter 3

Working with digital devices:

Two comparative field studies about the causes, inhibitors, and psychological outcomes of technostress in modern organizations

3.1 Abstract

Information and communication technologies (ICT) have increasingly changed the nature of work in modern organizations. Despite considerable benefits, emerging research has also begun to explore factors that may lead to an inability to adapt or cope with ICT in a healthy manner, and thereby cause technostress. However, there has not yet been sufficient investigation into which factors foster technostress, how it varies across individuals, and what might be optimal approaches for organizations looking to mitigate detrimental outcomes for their employees.

The present research extends the existing technostress literature in different ways. First, it takes individuals' usage frequencies for different digital devices into account as a potential antecedent of technostress. Second, it looks at the usage rate of ICT support services as a potential inhibiting mechanism of technostress. Third, it investigates the paradoxical nature of ICT by examining both its beneficial and detrimental outcomes. In two studies, the present research collects data from two different organizations (an international appliance manufacturer, $N = 247$; and an energy company, $N = 175$) with the intent of examining the interplay between ICT usage frequency, ICT support, technostress and strain, as well as the roles of individual characteristics. Based on an explorative serial multiple mediation model, the results support the idea that a high ICT usage frequency can increase technostress, and in turn lead to increased strain. In contrast, a high usage rate of ICT support does not have the expected effect of decreasing technostress. Additional analyses of ICT usage scenarios indicate that not only ICT usage frequency, but also the specific ICT activity affects employees' perceived stress levels. Moreover, the findings underline the effects of individual characteristics (i.e., age, gender, employees` position in the company) on technostress, productivity, and innovation. Theoretical and practical implications, limitations, and future research directions are discussed.

3.2 Introduction

As digitalization advances worldwide, work environments are continuously changing, posing new challenges for organizations. Though physiological workload has steadily regressed, the psychological workload has been increasing over the last few years, mainly caused by changes in the work environment (i.e., the rise of digital technologies). Consequently, it is essential to determine which factors are possible causes or inhibitors of ICT-related stress in modern organizations, and to examine the underlying psychological processes that foster employee health and efficiency.

Previous research has already provided great insights into the phenomenon of technostress, which is characterized as stress experienced by users of modern ICT when they cannot adapt to or cope with them healthily (Brod, 1984). However, only a small number of recent studies has focused on technostress among employees who use ICT as part of their regular work (e.g., Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2011), but are not ICT professionals themselves (e.g., Ahuja et al., 2007; Chilton, Hardgrave, & Armstrong, 2005; Moore, 2000). Furthermore, only a few studies have taken individual characteristics (e.g., age, gender, education, computer efficacy) and organizational context variables (e.g. ICT support services, technological involvement) into account (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011). To the best of our knowledge, no study to date has focused on employees' digital usage behavior (conceptualized as the frequency at which employees use different digital devices and applications) as a potential antecedent of technostress.

Therefore, the present research seeks to investigate the interplay between employees' digital usage behavior, ICT support, technostress, strain, productivity, and innovation in two organizational field studies. In both studies, participants were working adults who regularly use ICT. The studies aim to contribute to a better understanding of the underlying psychological processes of ICT-related stress in

modern organizations. In addition, individual characteristics (i.e., age, gender, position in the company) were taken into account to examine which employees would be more likely to be affected by ICT-related detrimental outcomes at work (i.e., technostress, strain), and which might benefit the most from ICT-related facilitations (i.e., productivity, innovation).

3.2.1 The transaction-based stress approach and the conceptual model of technostress

Both the transaction-based stress approach (Cooper et al. 2001; Lazarus 1966; Lazarus & Folkman, 1984; McGrath 1976) and the technostress model (Ragu-Nathan et al., 2008) provide the basis for the present research model. The conceptual model of technostress (Ragu-Nathan et al., 2008) built a nomological net for technostress in order to understand the influence of technostress and its consequences for ICT users in organizations. Its framework was drawn from the transaction-based approach (Cooper et al. 2001; Lazarus 1966; Lazarus & Folkman, 1984; McGrath 1976), which follows the suggestion that stress occurs through a combination of stress-creating factors or conditions, and the individual's responses to them. Factors that create stress (i.e., role-related or task-related stressors) can lead to a negative outcome for the individual (i.e., strain), and can thus lead to negative organizational outcomes such as absenteeism or high turnover. Situational factors (e.g., job redesign, stress management training, social support) were also included in the transaction-based model of stress as organizational mechanisms that can buffer or reduce the impact of stressors (Ragu-Nathan et al., 2008; Tarafdar et al., 2011).

In Ragu-Nathan et al.'s model (2008), technostress creators represent factors that can lead to technostress in organizations (i.e., overload, insecurity, invasion, uncertainty, complexity). In turn, technostress affects job satisfaction, which can be

seen as an inverse equivalent to strain in the transaction-based stress model (for a detailed explanation of technostress, see Chapter 1, section 1.3.2). Besides job satisfaction, employees' commitment to their organization and their intent to remain in their present job were included as broader organizational outcomes. As indicated by its name, a technostress inhibitor (i.e., technical support provision, literacy facilitation, involvement facilitation) represents a mechanism that can reduce technostress. Additionally, Ragu-Nathan et al. (2008) included age, gender, computer confidence, and education in their conceptual model to assess the effect of individual differences on technostress. This model has since made an essential contribution to the conceptual and empirical understanding of technostress, and has received considerable support from subsequent research in this area (e.g., Ayyagari et al., 2011; Tarafdar et al., 2010; Tarafdar et al., 2011).

The present research follows Ragu-Nathan et al. (2008) and the transaction-based stress approach by investigating the interplay between different technostress creating variables (i.e., overload, complexity, uncertainty), ICT support as a potential inhibiting mechanism, and strain as an outcome of technostress for employees. However, unlike the model from Ragu-Nathan et al. (2008) and the transaction-based stress approach, no other organizational outcomes were included, but productivity and innovation were added as potential beneficial outcomes. In addition, the individual characteristics age, gender, and employee position in the company were considered. As a further contribution to the emerging literature on ICT use and technostress, we focused on employees' ICT usage behavior (i.e., ICT usage frequency), which has not yet been included in a research model on technostress.

Table 3.1 illustrates the correspondences between the transaction-based stress model, the conceptual model of technostress from Ragu-Nathan et al. (2008), and the

model tested in the present research. For a detailed overview of the present research model, see Figure 3.1.

Table 3.1

Correspondences between the transaction-based model of stress, the conceptual model of technostress and the present research model.

Model / Components	Transaction-Based Model of Stress	Conceptual Model of Technostress	Present Research Model
(1)	Stressors	Technostress creators	Technostress creators
(2)	Situational factors	Technostress inhibitors	Technostress inhibitor
(3)	Strain	Job satisfaction	Strain
(4)	Other organizational outcomes	Organizational continued commitment	Productivity Innovation

3.2.2 ICT usage and the roles of individual characteristics and organizational support

To understand ICT-related stress at work and provide helpful, practical recommendations for organizations, it is important to clarify which factors lead to beneficial outcomes for employees (e.g., increasing their productivity or innovation) and which foster detrimental ones (e.g., technostress or ICT-related strain). Given that most organizations provide ICT support services (in the form of a helpdesk that employees can contact in case of a problem), it is also essential to examine whether the usage of these services has an impact on these factors. Thus, we addressed the following questions: (1) does working with certain types of digital technologies lead to more stress than working with others? (2) Does the frequency with which an employee uses a certain digital device matter, or is overall ICT activity the bottom line? (3) Does

an employee's age or company position make a difference? (4) What role does ICT support play, especially for employees who are not ICT experts themselves?

Although previous research has provided great insight into single aspects of these questions, to the best of our knowledge, little research has investigated them simultaneously. For example, a few studies have mainly focused on the effects of individual characteristics on technostress (e.g., Burton-Jones & Hubona, 2005; Tu et al., 2005), whereas others primarily considered organizational aspects (e.g., Wang, Shu, & Tu, 2008). However, the studies that developed broad statistical models for investigating the relationships between technostress creators, technostress inhibitors, individual characteristics and other constructs aggregated participants' perceptions across various types of ICT, and thus did not consider the individual use of different ICT (e.g., Ayyagari et al., 2011; Tarafdar et al., 2011).

Concerning the effects of individual characteristics, the findings of previous research are somewhat mixed. Studies from the technology acceptance and technostress literature indicate negative effects of age (e.g., Tu et al., 2005). For example, Burton-Jones and Hubona (2005) reported that older employees found ICT harder to use, even though they did not find them less useful for their work. However, other researchers have pointed out that older employees experience less technostress than younger employees. They argued that a reason for this might be older employees' longer organizational tenure, which leads them to have a better understanding of how to deal with stress-creating ICT effects when doing their job (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011).

Prior studies on the effect of gender have revealed similarly mixed findings. Some studies revealed that women struggle more with ICT and might be therefore less likely to use them at work (e.g., Venkatesh & Morris, 2000; Gefen & Straub, 1997), whereas other studies reported that men experience more technostress than women

(Ragu-Nathan et al., 2008; Tarafdar et al., 2011). One potential explanation for the varying findings might be that women and men differ in their decision-making processes regarding technology acceptance and use. For example, a longitudinal study by Venkatesh and Morris (2000) showed that perceived usefulness was a more salient factor for men than women when deciding whether to use a new piece of technology. On the other hand, women consider perceived ease of use to a greater extent than men did. Indeed, perceived ease of use was not a salient factor for men at all.

Two further individual characteristics that might provide a potential explanation for differing effects of ICT usage are education and computer self-efficacy. For example, Tarafdar et al. (2011) found that participants' computer confidence had a major influence on technostress. They argued that individuals with high levels of computer confidence have strong faith in their ability to handle disruptions arising from technostress-creating conditions, and subsequently experience less technostress. In the study, participants with greater levels of formal education reported being more exposed to computers in general, and thus experienced less technostress. Moreover, they found it easier to adapt to technostress. However, when compared to other demographic factors (i.e., gender, computer confidence) participants' education levels had only a relatively minor effect on technostress.

Regarding the effects of organizational environments, the number of studies is sparse. Tarafdar et al. (2011) suggest that organizations can help their employees offset the intensity and outcomes of technostress via four kinds of organizational mechanisms. The first is literacy facilitation, which describes mechanisms that draw on sharing ICT-related knowledge, such as practices to increase ICT-related awareness. Second is the technical support provision offered to employees in the context of their ICT use, such as an easily reachable ICT help desk. Third is technology involvement facilitation, which describes mechanisms that keep employees

involved in ICT adaption and development, such as maintaining a transparent information policy. The final mechanism is innovation support, which addresses mechanisms that encourage employees to explore, learn or develop new ideas.

As shown in Figure 3.1, the present research model focuses on employees' ICT usage frequencies for different digital devices and applications, and their interplay with technostress, strain, productivity, and innovation. Additionally, the effects of age, gender and company position are tested to investigate their influence on the variables included in the model.

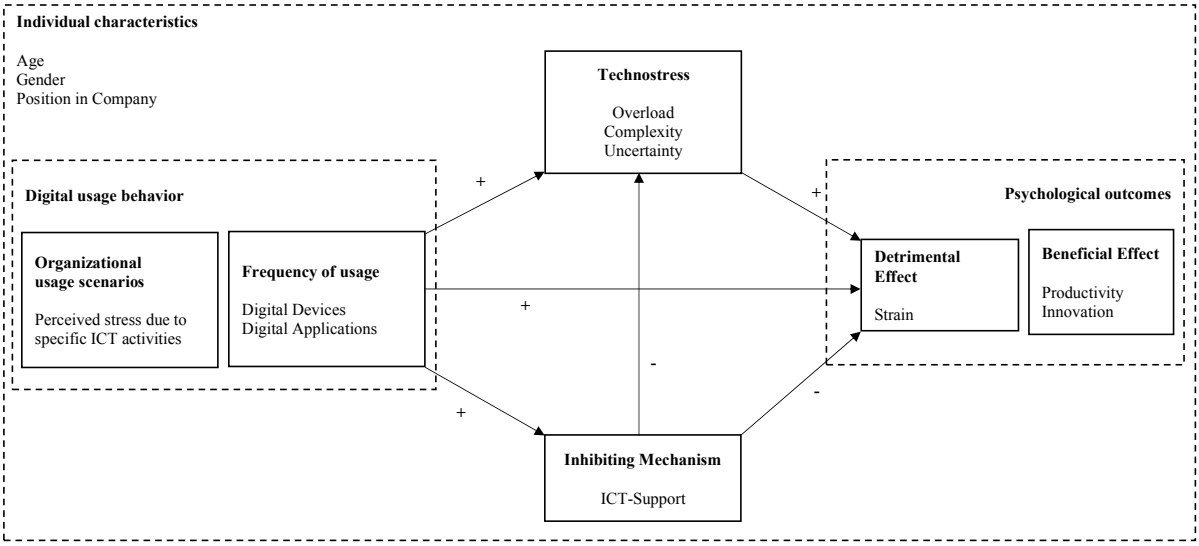

Figure 3.1. Research model of the two present organizational field studies.

3.2.3 The Present Research

With the rise of digital technologies in modern organizations, emerging research has addressed the question of which factors might lead to beneficial outcomes for employees (e.g. increased productivity and innovation), and which might foster detrimental ones such as technostress or ICT-related strain. Previous research has already provided great insight into the concept of technostress; however, considering that employees are spending more and more time working with modern ICT,

surprisingly little is known about whether the usage frequencies of different types of ICT can influence technostress, or how the type of ICT activity affects employees' perceived stress. More precisely, prior research mainly focused on (1) individual characteristics (e.g., Burton-Jones & Hubona, 2005; Tu et al., 2005), (2) organizational aspects (e.g., Wang et al., 2008), or (3) developed broad aggregated statistical models (e.g., Ayyagari et al., 2011; Tarafdar et al., 2011) that did not consider employees' individual usage behavior for different digital devices (i.e., frequency of use, activity).

The present research therefore aims to contribute to the existing literature via two organizational field studies. In two companies from different sectors, we examined the interplay between employees' individual ICT usage behavior, employees' usage of organizational ICT support, technostress, ICT-related strain, ICT-related productivity and innovation, and individual characteristics. The present research attempts to integrate the named variables in a formal model that is similar to the conceptual models of technostress from Ragu-Nathan et al. (2008), and Tarafdar et al. (2011).

As shown in Figure 3.1, overload, complexity, and uncertainty are raised as technostress creators. As an extension of previous models, the individual usage frequencies of different digital devices are included as a potential antecedent of technostress. To the best of our knowledge, this is the first attempt to investigate the impact of ICT usage frequency on technostress. As an organizational mechanism to potentially reduce technostress, employees' usage of ICT support services is included (Tarafdar et al., 2011). ICT-related strain is investigated as a detrimental outcome of stress on the individual level (Cooper et al., 2001). Moreover, employees' ICT-induced productivity and innovation are assessed to detect potential beneficial outcomes of ICT usage in organizations.

Given that prior findings on the effect of individual characteristics are mixed (e.g., Tu et al., 2005; Ragu-Nathan et al., 2008; Tarafdar et al., 2011; Venkatesh & Morris, 2000), additional analyses were performed to investigate whether employees' age, gender or current position has an effect on both ICT usage, and the ICT-related variables included in the model.

Moreover, by developing organization-specific usage scenarios, we attempted to discover whether ICT activity affects ICT usage frequency and employees' perceived stress.

3.3 Study 2

The second study aimed to replicate the findings of Study 1 in a specific organizational context. As in Study 1, it was hypothesized that there would be an interplay between individual characteristics (i.e., age, gender), individuals' digital usage behavior (i.e., ICT usage frequency), and both beneficial and detrimental psychological outcomes. Additionally, the position an employee holds within the company was considered.

As a further extension of Study 1, organization-specific usage scenarios for different digital technologies were created, to assess employees' perceived stress in concrete working situations. A serial multiple mediation model was performed to explore the underlying psychological processes. As in Study 1, the three technostress variables overload, complexity, and uncertainty were considered as stressors. The frequency of employees' ICT support usage was also included in the model as a potential technostress inhibitor.

3.3.1 Method

Participants and Design

247 employees (108 women, 139 men) from an international appliance manufacturer were recruited to participate in the correlative field study. Participants were aged between 18 and 63 years (M_{age} = 39.99, SD_{age} = 11.44). Sample characteristics are given in Table 3.2, including education level and position in the company. All of the participants used ICT at work. Data show that a large proportion of the participants were well educated, and around 60% were employees on a permanent basis, with 33% being in leadership positions.

Table 3.2

Tabular comparison of the sample demographics from Study 2 and Study 3.

	Company Study 2		Company Study 3	
	n	%	*N*	%
Education				
No Formal Education	0	0.0	1	0.6
Secondary School	27	10.9	23	13.1
High School	56	22.7	24	13.7
Academic Degree	159	64.4	123	70.3
Others	5	2.0	4	2.3
Total	247	100	175	100
Position in the Company				
Students and Trainees	14	5.7		
Assistants	22	8.9	158	90.3
Clerks	128	51.8		
Middle Management	68	27.5	16	9.1
Higher Management	14	5.7		
Others	1	0.4	1	0.6
Total	247	100	175	100

Materials and Procedure

We confirm that the procedure of the reported research is in line with the Declaration of Helsinki and the APA's ethical guidelines. Study 2 was designed as an online survey so that the link could be distributed via the company's intranet. The link was placed on the intranet's start page, together with a call for participation from the workers' council and a short description, in the hope that it would appeal to as many employees as possible. Additionally, employees were recruited by the researcher via tablets by personal consultation in the reception and rest areas.

Upon clicking the link, the survey started automatically. Employees were first welcomed and informed about the research, with a subsequent data protection declaration notifying them that participation was voluntary, they could quit at any time without giving a reason, and that all data would be collected and evaluated anonymously for research proposes only. Afterwards, ICT usage behavior and different psychological variables were measured. Furthermore, employees were asked about their needs pertaining to working with digital devices, and their use of organization-provided ICT support. Finally, we assessed employees' demographic information (i.e., age, gender, education, and their current position).

Measures and Variables

Digital usage behavior. A self-constructed scale was used to assess the employees' ICT usage behavior. The usage frequency of smartphones, conventional telephones, desktop computers, and laptops was addressed. To specify employees' activities, the usage rates of the following digital applications were measured: Internet, intranet, short message service (SMS), WhatsApp, Skype, e-mail programs (e.g., Outlook), Excel, Word, PowerPoint, business software programs such as SAP, ERP or CRM, and business platforms such as Sharepoint. Moreover, employees were able to

add additional applications to the list via an open field. They were asked to indicate how often they used the described types of devices and applications on a 7-point Likert scale (1 = *not at all*, 7 = *very frequent*).

Usage scenarios. Eleven scenarios were created to specify ICT usage behavior and assess employees' perceived stress in each respective scenario. The scenarios represented situations whereby employees had to deal with different digital devices and applications at work (see Table 3.5). For example: "Imagine the following situation: The operating system has been updated, and you have to become acquainted with it independently." The perceived stressfulness of each scenario was rated on 7-point scale (1 = *not at all stressful*, 7 = *very stressful*).

Strain. As in Study 1, the four-item scale from Ayyagari et al. (2011) was used (α = .93; all presented α-values are Cronbach α-values) to measure the feelings of strain induced in employees by modern ICT. On a 7-point scale (1 = *never*, 7 = *daily*), employees indicated how often statements like "Working all day with ICT is a strain for me" applied to them.

Technostress. As in Study 1, technostress was assessed via the subscales of overload (α = .88), complexity (α = .83) and uncertainty (α = .80). Again, the three translated subscales from Ragu-Nathan et al. (2008) and Tarafdar et al. (2010) were used, and for some analyses, integrated into an overall scale (α = .86). For example: "I often find it too complex for me to understand and use modern technologies." (Contextual definition about modern technologies was given; item from the complexity subscale; rated from 1 = *strongly disagree*, to 7 = *strongly agree*).

Techno-facilitations. To determine the potential beneficial effects of ICT usage, the employees responded to the items of Tarafdars' subscales for productivity (α = .87) and innovation (α = .93). All items were rated on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*). An example of a statement from the

productivity subscale was "Modern technologies help me accomplish more work than would otherwise be possible."

Individual training needs and organizational ICT support. Employees were asked how often they called the ICT help desk (1 = *never*, 2 = *rarely,* 3 = *occasional*, 4 = *frequently*) to examine how often they used the organization's own ICT support service. Additionally, individual training needs were assessed with three questions. First, employees indicated whether or not they wanted to receive ICT training (1 = *yes*, 2 = *no*). Second, they were asked how frequently such training should occur (1 = *not at all*, 2 = *once a year,* 3 = *twice a year*). Finally, they were asked what they thought would be a good duration for such a training session (1 = *no training*, 2 = *one hour,* 3 = *two to four hours*, 4 = *four to six hours*, 5 = *six to eight hours*).

3.3.2 Results

One subject had to be excluded from age analyses because of missing data. Otherwise, no employees had to be excluded from the dataset due to missing data, suspicion, or revision of their preliminary decision to participate.

Descriptive statistics for ICT usage behavior

Analyses of usage frequencies for the different digital devices revealed that laptops (M = 6.58, SD = 1.25) and conventional telephones (M = 4.57, SD = 1.75) were most frequently used by the employees. Moreover, frequency distributions revealed that smartphone and desktop computer usage behavior varied widely: 23% of the employees stated that they did not use smartphones at all, whereas 30% stated that they used them very frequently. For desktop computers, a full 60% of the employees reported not using them, whereas another 30% indicated very frequent use.

In addition, the usage behavior of the individual digital applications differed among the employees. The data revealed that most of them used e-mail programs (M = 6.82, SD = 0.61), intranet (M = 5.77, SD = 1.39) and Excel (M = 5.73, SD = 1.40) very frequently, whereas SMS (M = 1.89, SD = 1.24) and WhatsApp (M = 2.44, SD = 1.99) were used less often. All means and standard deviations are presented in Table 3.3.

Table 3.3

Frequency of employees' ICT usage in Study 2. Means and standard deviations.

	M	*SD*
Digital Devices		
Smartphone	4.34	2.39
Conventional telephone	4.57	1.75
Desktop computer	3.02	2.73
Laptop	6.58	1.25
Digital Applications		
Internet	5.55	1.56
Intranet	5.77	1.39
SMS	1.89	1.24
WhatsApp	2.44	1.99
Skype	5.11	1.85
E-mail programs (Outlook)	6.82	0.61
Excel	5.73	1.40
Word	4.43	1.71
PowerPoint	5.12	1.73
Business Software (SAP, ERP, CRM)	4.75	2.20
Business Platforms (Sharepoint)	4.79	1.70

Note. The scale range for all variables is 1-7.

Individual differences in digital usage behavior

With the rise of digital technologies in organizations, many researchers have examined whether working with modern ICT has beneficial or detrimental effects on employees' performance and wellbeing. However, many studies in this area treat

organizations as a unit, without examining different effects at different levels (Moore, 2007). Therefore, one aim of this research is to compare and contrast operating and managerial employees, and focus on how each group handles the usage of ICT at their workplace. Following previous research from other areas (e.g., Frazier, & Swiss, 2008; Moore, 2007; Sadig, 2014), and the fact that employees in operating and managerial positions have disparate remits, we assumed that their digital usage behavior would be different. To examine whether an employee's position would affect the frequency at which they used different digital devices, contrast analyses were performed.

The frequency of smartphone usage was significantly lower in the non-management employee groups than in the management groups, with a mean difference of 2.51 (SE = 0.30), $p < .001$. Data from a second contrast analysis showed a reversed pattern for the use of desktop computers. Thus, the frequency of desktop computer usage was significantly higher for the non-management employee groups than the management groups, with a mean difference of -1.38 (SE = 0.48), $p = .006$.

In a similar vein, employees' use of digital applications varied with their position. Non-management employee groups used SMS less often than the management groups did, with a mean difference of 1.10 (SE = 0.29), $p = .001$. A similar finding was also observed for PowerPoint. Non-management employee groups indicated lower frequencies of PowerPoint use than management groups, with a mean difference of 1.35 (SE = 0.23), $p < .001$. The means and standard deviations of the reported contrasts are provided in Table 3.4.

To check for the effect of age, age was first divided into three categories: younger age (35 years and younger), middle age (36 to 50 years of age), and higher age (51 years and older). This step was necessary for enabling a comparison between the datasets from Study 2 and Study 3, as the ages of the employees in Study 3 had to

be assessed in these three categories for data protection reasons. Moreover, these age-group categorizations enable a comparison between employees in different stages of life and work (e.g., Bruch et al., 2010).

A one-way ANOVA revealed that only smartphone usage behavior showed significant age differences ($F(2,245) = 4.61$, $p = .011$). Tukey post-hoc tests revealed that the frequency of smartphone usage increased significantly from young age to middle age (-.99, 95% CI[-1.66, -.32], $p = .004$) and from young age to high age (-.86, 95% CI[-1.68, -.07] $p = .039$).

Concerning gender, a *t*-test indicated that men ($M = 4.92$, $SD = 2.33$) used smartphones more frequently than women did ($M = 3.58$, $SD = 2.25$), $t(245) = 4.54$, $p < .001$, $d = 0.59$. However, women ($M = 3.49$, $SD = 2.85$) used desktop computers more frequently than men did ($M = 2.66$, $SD = 2.58$), $t(218.13) = -2.36$, $p = .019$, $d = 0.31$. Moreover, the business platform Sharepoint was used more frequently by men ($M = 5.04$, $SD = 1.64$) than by women ($M = 4.46$, $SD = 1.68$), $t(245) = 2.69$, $p = .008$, $d = 0.35$.

Table 3.4

Frequency of ICT use among employees in different positions in Study 2. Means and standard deviations.

Frequency of use	Assistants		Clerks		Middle Management		Higher Management	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Smartphone	2.82	1.94	3.94	2.47	5.49	1.87	6.29	1.07
Computer	4.09	2.89	3.18	2.81	2.16	2.25	2.36	2.37
SMS	1.73	1.35	1.64	1.02	2.28	1.29	3.29	1.73
PowerPoint	4.50	1.44	4.79	1.79	5.71	1.49	6.29	0.91

Note. The scale range for all variables is 1-7.

Detrimental effects of ICT usage

Pearson correlations were conducted to explore the interplay between the usage frequency of different digital devices, technostress (i.e., overload, complexity, uncertainty), and strain. Data showed that the frequency of smartphone usage was positively associated with uncertainty (r = .163, p = .010). Moreover, the usage frequencies of both conventional telephones (r = .130, p = .041) and desktop computers (r = .129, p = .043) were positively associated with overload.

Furthermore, among the digital applications, the frequency of intranet usage correlated positively with overload (r = .132, p = .039) and uncertainty (r = .201, p = .001), whereas the usage frequencies of both WhatsApp (r = .152, p = .017), and Skype (r = .140, p = .028) only correlated positively with uncertainty.

To examine whether an employee's position affects perceived technostress and strain, the same contrast analyses were performed. However, no significant differences were found between employees in non-management and management positions.

To check for age effects for technostress and strain, an additional one-way ANOVA was performed. Data indicated a significant effect for overload (F(2,245) = 12.97, p < .001). Tukey post-hoc analysis revealed significant differences between the young and middle age groups (-4.26, 95% CI[-6.80, -1.72], p < .001), as well as between the young and high age groups (-6.17, 95% CI[-9.29, -3.05], p < .001). As shown in Figure 3.2, perceived overload increased significantly from young age to middle age, and to high age. Analysis also revealed a significant effect for complexity (Welch's F(2,128.61) = 17.51, p < .001). Games-Howell post-hoc analysis revealed a significant difference between the complexity scores of all age groups. The mean level of perceived complexity increased from young to middle age (-2.41, 95% CI[-4.21, -0.60], p = .006), from young to high age (-5.54, 95% CI[-7.82, -3.26], p < .001), and from middle to high age (-3.14, 95% CI[-5.52, -0.75], p = .006; see Figure 3.3).

Uncertainty also differed significantly among the three age categories ($F(2,245) = 6.08$, $p = .003$). Tukey post-hoc analysis showed a significant increase of mean uncertainty levels between young and high age (-3.00, 95% CI[-5.08, -0.91], $p = .002$), and between middle and high age (-2.39, 95% CI[-4.38, -0.40], $p = .014$; see Figure 3.4).

A *t*-test revealed that men's level of strain ($M = 10.71$, $SD = 5.74$) did not differ from women's ($M = 10.60$, $SD = 5.42$), $t(245) = 0.14$, $p = .886$, $d = 0.02$. Nor were there any significant gender effects for overload (men: $M = 19.43$, $SD = 7.90$; women: $M = 18.54$, $SD = 7.69$), $t(245) = 0.89$, $p = .373$, $d = 0.11$; complexity (men: M = 12.86, SD = 5.77; women: $M = 12.69$, $SD = 6.06$), $t(245) = 0.21$, $p = .831$, $d = 0.03$; or uncertainty (men: $M = 15.19$, $SD = 4.93$; women: $M = 14.19$, $SD = 5.25$), $t(245) = 1.53$, $p = .128$, $d = 0.20$.

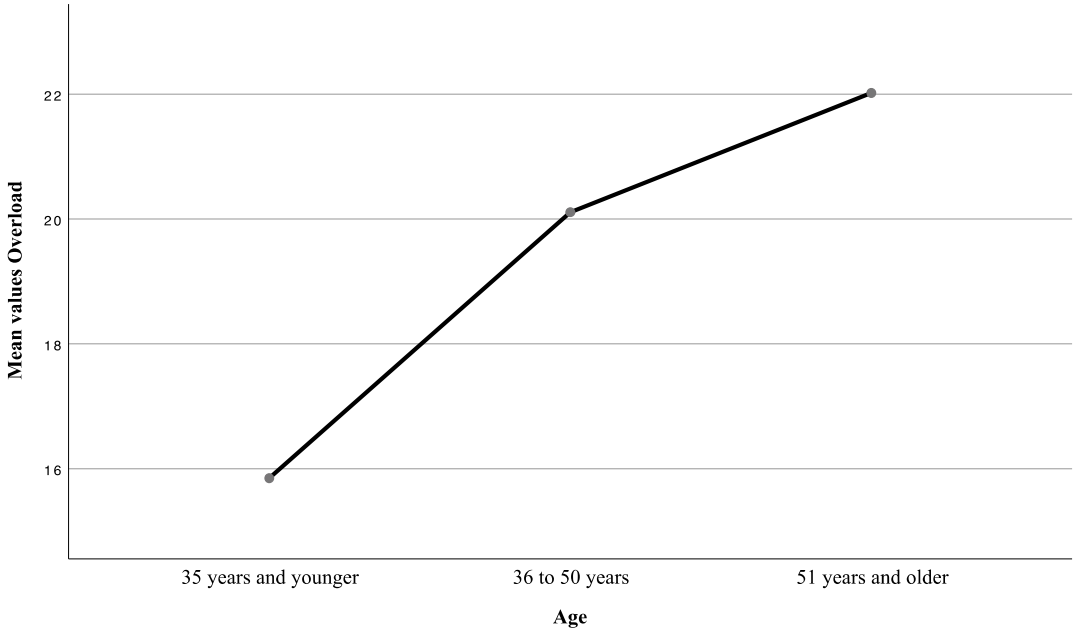

Figure 3.2. Means of overload for the three age categories in Study 2.

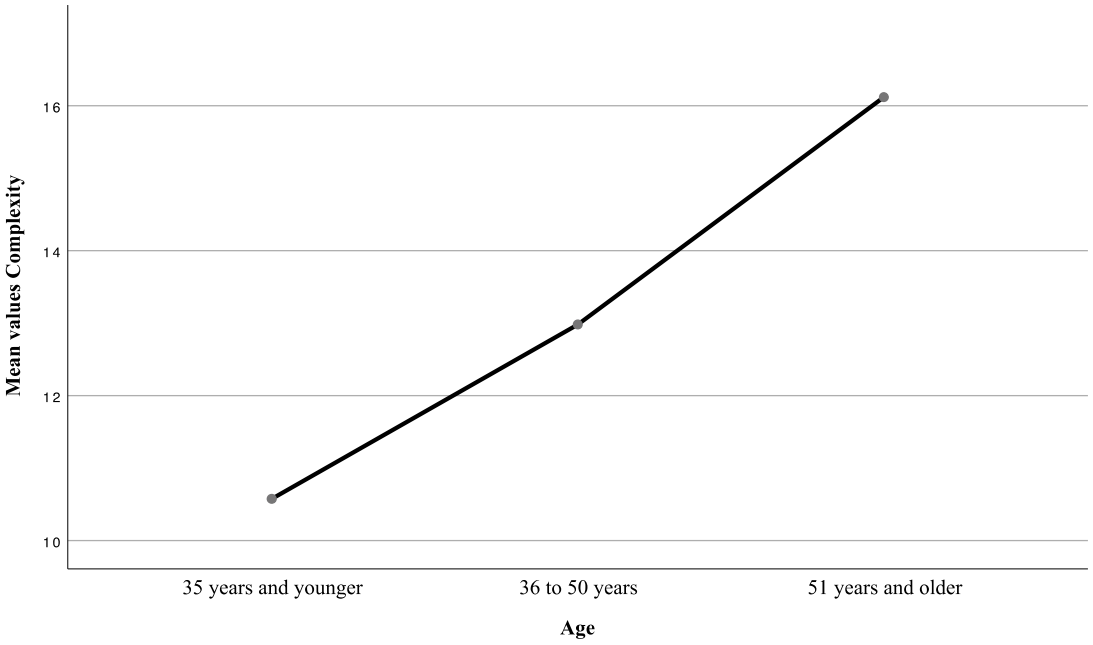

Figure 3.3. Means of complexity for the three age categories in Study 2.

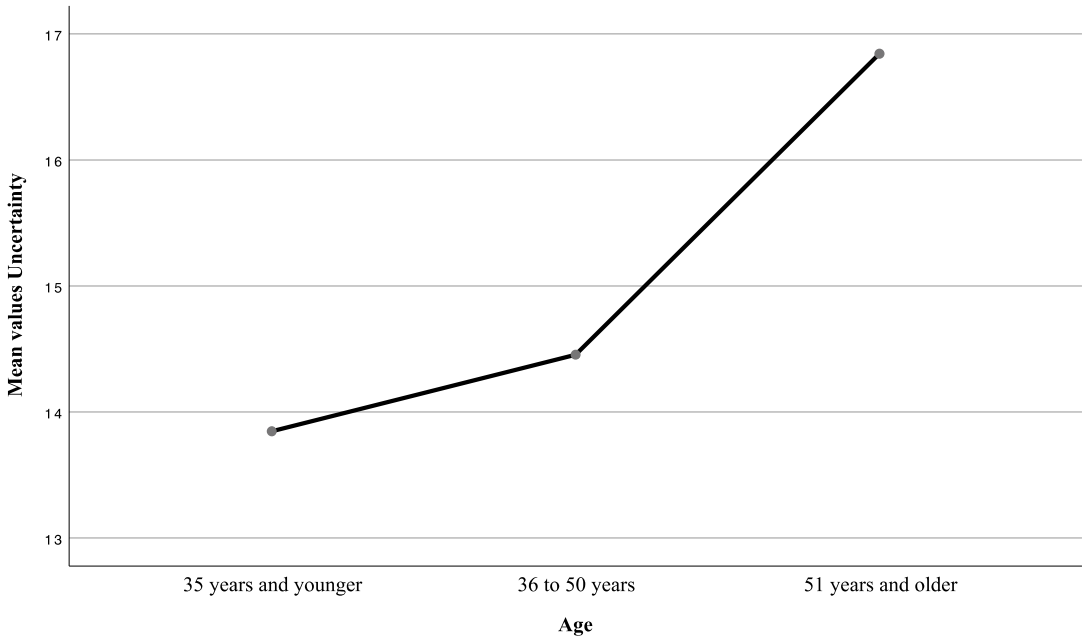

Figure 3.4. Means of uncertainty for the three age categories in Study 2.

Perceptions of the scenarios

Overall, employees rated scenario No. 8 as the most stressful (M = 4.88, SD = 1.62), and scenario No. 5 as the least stressful (M = 2.22, SD = 1.50). A full list of the scenarios, means, and standard deviations is provided in Table 3.5.

Contrast analyses were once more performed between employees in non-management and management positions. They revealed that some scenarios were assessed differently depending on position. Non-management employees reported a significantly higher level of stress for scenario No. 5 than did management employees, with a mean difference of -.75 (SE = 0.28), p = .007. A similar finding applied for scenario No. 10: non-management employees perceived a significantly higher level of stress in this situation than did those in management, with a mean difference of .77 (SE = 0.31), p = .014. The means and standard deviations for the reported contrasts are provided in Table 3.6.

A one-way ANOVA revealed significant age effects for scenario No. 3 (F(2,245) = 4.46, p = .013). Tukey post-hoc analysis showed a significant increase in perceived stress between the young and high age groups (-0.91, 95% CI[-1.64, -0.19], p = .009).

A second significant effect was found for scenario No. 6 (F(2,245) = 6.16, p = .002). Tukey post-hoc analysis indicated that employees in the young age group perceived significantly more stress than those in the high age group (1.05, 95% CI[0.34, 1.76], p = .002).

Data also showed a third significant effect, for scenario No. 11 (F(2,245) = 5.57, p = .004). Tukey post-hoc analysis revealed that the perceived stress level in this scenario increased significantly between young and middle age (-0.64, 95% CI[-1.20, -0.08], p = .020) and between young and high age (-0.87, 95% CI[-1.56, -0.18], p = .009).

Concerning gender effects, a *t*-test revealed that women perceived scenarios No. 1 ($t(216.65) = -3.60$, $p < .001$, $d = -0.47$), No. 6 ($t(245) = -1.99$, $p = .048$, $d = -0.25$), No. 8 ($t(240.32) = -2.33$, $p = .021$, $d = -0.30$) and No. 10 ($t(245) = -2.17$, $p = .031$, $d = -0.27$) as being significantly more stressful than men did. Means and standard deviations are provided in Table 3.7.

Table 3.5

Employees' perceptions of the ICT usage scenarios in Study 2. Means and standard deviations.

No.	Scenario	*M*	*SD*
1.	One of your colleagues is facing problems with his computer, and asks you for help.	2.43	1.45
2.	You need a newer version of a piece of software, and you have to deal with it independently.	2.55	1.62
3.	The operating system has been updated, and you have to become acquainted with it independently.	3.14	1.76
4.	You have to obtain information about an issue, but neither your colleagues nor your supervisor can help you. You can only search online for information.	2.39	1.49
5.	You have to organize an online group meeting.	2.22	1.50
6.	Your smartphone vibrates again and again during a meeting, but you are unable to have a look at it.	3.89	1.74
7.	You have to switch off your smartphone to process a difficult task. Due to that, you might miss some important calls.	2.45	1.52
8.	You receive an urgent task while you are on the move. However, the reception in the area is poor, and the e-mails and e-mail attachments are not loading completely.	4.88	1.62
9.	You have to explain how to use Excel for a large project to a trainee.	2.94	1.63
10.	A project requires you to use a mobile tablet for the same tasks you'd normally perform on your computer.	3.20	1.68
11.	There is a new version of Office. You have to get used to it quickly so that you are able to help your colleagues in case of problems.	3.13	1.68

Note. The scale range for all scenarios is 1-7.

Table 3.6

Perceptions of ICT usage scenarios among employees in different positions in Study 2. Means and standard deviations.

No. Scenario	Assistants		Clerks		Middle Management		High Management	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
5.	2.68	1.62	2.30	1.57	1.91	1.30	1.57	1.09
10.	3.64	1.62	3.37	1.72	2.90	1.58	2.57	1.74

Note. The scale range for all scenarios is 1-7.

Table 3.7

Gender differences in stress perception in ICT usage scenarios in Study 2. Means and standard deviations.

No. Scenario	Women		Men	
	M	*SD*	*M*	*SD*
1.	2.81	1.50	2.14	1.34
6.	4.14	1.81	3.7	1.67
8.	5.15	1.50	4.68	1.68
10.	3.46	1.73	3.00	1.62

Note. The scale range for all scenarios is 1-7.

Serial multiple mediation model for the effect of ICT usage behavior on strain through organizational ICT support and technostress.

Based on theoretical reasoning and previous research (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011), a serial multiple mediation model was performed to explore the relationships between ICT usage behavior, organizational support, technostress and strain, using Hayes' (2018) PROCESS macro (model 6). As shown in Figure 3.5, the model contains one direct and three indirect effects of ICT usage behavior on strain. Data revealed no significant direct effect of ICT usage behavior on strain, $c' = -0.012$, $t(244) = -0.149$, $p = .881$, 95% CI [-0.17, 0.15].

However, employees who had a high ICT usage frequency reported using ICT support more often, $a_1 = 0.03$, $t(244) = 2.47$, $p = .014$, 95% CI [0.01, 0.04], though this increased support use was not associated with decreased strain, $b_1 = -0.44$, $t(242) = -0.82$, $p = .415$, 95% CI [-1.49, 0.62], independent of technostress. The bias-corrected bootstrap confidence interval based on 10,000 samples for this first indirect effect ($a_1b_1 = -0.01$) included zero (-0.04 to 0.02), indicating that using ICT support did not mediate the effect of ICT usage behavior on strain.

For the second path, data revealed that employees with a high ICT usage frequency perceived increased technostress, $a_2 = 0.48$, $t(243) = 2.05$, $p = .042$, 95% CI [0.02, 0.94]. In turn, this increased technostress level was associated with increased strain, $b_2 = 0.20$, $t(242) = 8.34$, $p < .001$, 95% CI [0.15, 0.25]. The bias-corrected bootstrap confidence interval for this second indirect effect ($a_2b_2 = 0.10$) did not include zero (0.01 to 0.19), and thus indicates that technostress mediated the effect of ICT usage behavior on strain.

The third path tested the indirect effect of ICT usage behavior on strain through ICT support and technostress serially. ICT support was modeled as affecting technostress, which would then influence strain. Data showed that employees with a high ICT usage frequency made use of ICT support more often (a_1), which was in turn associated with increased technostress, ($d_{21} = 3.48$, $t(243) = 2.56$, $p = .011$, 95% CI [0.80, 6.17]). Finally, this increased perception of technostress was associated with a higher level of strain (b_2). The bias-corrected bootstrap confidence interval for this third indirect effect ($a_1d_{21}b_2 = 0.18$) did not include zero (0.01 to 0.04), indicating that organizational ICT support and technostress indeed serially mediated the effect of ICT usage behavior on strain.

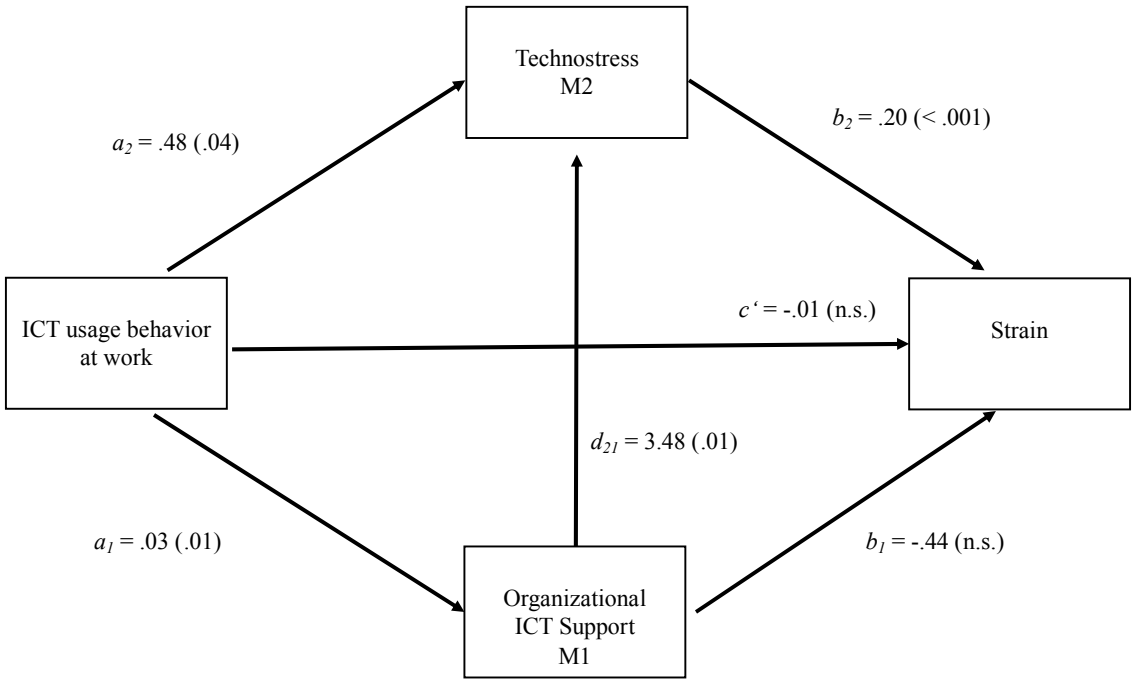

Figure 3.5. Serial multiple mediation model for Study 2.

Beneficial effects of ICT usage

Pearson correlations were conducted to explore the interplay between the usage frequencies of different digital devices, productivity, and innovation. Data showed that the frequency of smartphone usage was positively associated with both productivity (r = .125, p = .050) and innovation (r = .139, p = .028).

Among the digital applications, usage frequencies for the internet (r = .157, p = .013), WhatsApp (r = .139, p = .028), Skype (r = .128, p = .044) and Excel (r = .135, p = .034) were positively correlated with productivity. Moreover, the usage frequencies for WhatsApp (r = .209, p = .001), Skype (r = .140, p = .028) and PowerPoint (r = .126, p = .048) were positively associated with innovation.

Additionally, the frequency of internet usage (r = -.168, p = .008), Skype usage (r = -.146, p = .022), and Sharepoint usage (r = -.137, p = .031) was negatively associated with complexity.

Contrast analyses were performed to investigate whether perceived productivity and innovation varied between employees in different company positions, but no significant effect was found between the non-management and management employee groups.

To check for age effects, a one-way ANOVA was performed. However, data revealed neither a significant effect for productivity, $F(2,243) = 1.85$, $p = .159$, nor for innovation, $F(2,243) = 0.97$, $p = .382$.

Concerning gender effects, a *t*-test revealed that men's level of productivity ($M = 22.04$, $SD = 4.27$) did not differ significantly from women's ($M = 22.07$, $SD = 4.26$), $t(245) = -0.06$, $p = .955$, $d = -0.01$. Nor did men's level of innovation ($M = 14.36$, $SD = 4.62$) significantly differ from women's ($M = 14.38$, $SD = 4.71$), $t(245) = -0.03$, $p = .973$, $d = -0.01$.

Individual training needs and organizational ICT support

Although 26% of the employees felt that they had no need for ICT training, 54% of the employees indicated a preference for training once a year, and 20% for twice a year. Most of the employees considered a training session between two and four hours long to be appropriate. 28% believed one hour was enough, and only around 6% preferred an extended session lasting between four and eight hours. Regarding the ICT helpdesk, 52% of the employees admitted rarely using it, 41% occasionally, and only 7% frequently.

Analyses revealed no significant differences for the individual characteristics age, gender, and company position.

3.3.3 Discussion

In an organizational field study, Study 2 investigated the interplay between employees' individual ICT usage behavior, use of organizational ICT support, technostress, ICT-related strain, ICT-related productivity and innovation, and individual characteristics. Precisely, we examined whether employees' usage frequency for different digital devices would function as an antecedent of the technostress variables overload, complexity, and uncertainty. Employees' usage frequency of ICT support was also considered as an organizational inhibiting mechanism that might lower technostress. Moreover, we expected technostress to foster ICT-related strain.

Besides strain, potential beneficial effects of ICT usage in modern organizations were investigated via the measurement of employees' ICT-related productivity and innovation. Following previous research (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011), we also focused on individual differences to investigate whether employees' age, gender or current position had an effect on ICT usage and the other ICT-related variables. By developing organization-specific usage scenarios, we went beyond simply looking at ICT usage frequency, and explored whether specific ICT activities would affect employees' perceived stress.

The findings of Study 2 reveal that employees' digital usage behavior differs depending on their age, gender, and current position. For example, employees in management positions more frequently use smartphones, send text messages via SMS or use PowerPoint, whereas employees in non-management position more frequently work on a desktop computer. Moreover, older employees and male employees reported a significantly higher frequency of smartphone use than either younger employees or female employees. This is not very surprising, as it conceivable that (for example) activities change when a job position changes, and the related ICT-usage

frequencies might thus be different too. Moreover, organizational regulations may also have an effect; for example, company smartphones might be provided for employees in management positions, but not for operating employees.

Additional analyses of the specific ICT usage scenarios, which were created to assess employees' perceived stress in real working situations, also suggested effects of age, gender and position. For example, some activities, such as system updates, seemed to be more stressful for older employees than for younger ones. In contrast, younger employees perceived an inability to look at their ringing smartphone as being more stressful than older employees.

Taken together, the analyses of employees' ICT usage behavior underline how individualized the challenges employees face when working with ICT can be. In turn, this shows that ICT-support and organizational regulations need to fulfil several requirements that are tailored to certain situations. For an elaboration of this point, see the General Discussion in section 3.5.

Furthermore, the results indicate different detrimental effects of ICT usage in organizations. First, the usage frequency of different ICT (e.g., smartphone, desktop computer, intranet) was positively associated with technostress (i.e., overload, complexity, uncertainty).

Second, the results indicate significant age effects for technostress. In line with findings from Tu et al. (2005), but contrary to other prior studies (e.g., Tarafdar et al., 2011), the perceptions of overload, complexity, and uncertainty seem to be stronger among older employees than among younger employees.

Third, a serial multiple mediation model was performed to explore a potential underlying psychological process between employees' ICT usage frequency and strain. Following previous research, (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011) employees' usage of organizational ICT support and technostress creators (i.e.,

overload, complexity, and uncertainty) were included as potential mediators. Data revealed no significant direct effect between the usage frequency of different ICT and strain; however, the serial indirect paths of ICT support and technostress gained significance. Employees with a high ICT usage frequency seem to contact ICT support more often; this appears conclusive, as it is conceivable that they might have questions or experience difficulties more often than employees who use ICT sparingly. That a high rate of ICT support usage was associated with an increased level of technostress seems unintuitive at first, because one might expect ICT support to lower rather than foster technostress. On this point, the explorative model did not generate sufficient knowledge. It may be that the ICT support in this specific organization was not optimally adjusted to employees' needs, and could therefore benefit from improvements. Data from the explorative investigation of employees' training needs and expectations towards ICT support, discussed later in this section, supports this idea. However, the finding that a high level of technostress was associated with a high level of strain is consistent with prior findings (e.g., Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2011), and therefore supports our hypothesis.

Besides detrimental effects, results also indicate some beneficial outcomes of ICT usage in organizations. For example, some negative correlations suggest that using a few applications (i.e., Skype, Sharepoint, Internet) might be able to minimize complexity. Moreover, the usage frequency of some ICT (e.g., Internet, Skype, Excel, PowerPoint) is positively associated with productivity and innovation, which again underlines the paradoxical nature of ICT and its use.

The additional explorative investigation of employees' individual training needs and their expectations of technical support revealed that around 75% of the employees wished to receive training in working with ICT. Given that most of the employees considered a session between two and four hours appropriate, offering such

an opportunity to employees would not require disproportional effort on the part of the company. Nonetheless, considering employees' differing ICT usage behavior and demands, the question remains regarding what such a training session should be like. However, in this company, training expectations or preferences did not differ significantly depending on employees' age, gender, or current position.

3.4 Study 3

In line with recent statistics showing that working with modern ICT can differ between sectors (e.g., Statistisches Bundesamt, 2019a), the third study aimed to replicate the findings of Study 2 in a second organization. Therefore, a nearly identical procedure was utilized in an organization with a similar organizational structure, but in a different vocational sector.

As in Study 2, we focused on individual characteristics (i.e., age, company position) and predicted that employees' ICT-related behavior (i.e., usage frequency of different digital devices and applications) and psychological effects would differ between the named groups. We again hypothesized that there would be a relationship between ICT usage behavior and both beneficial and detrimental psychological outcomes. The serial multiple mediation model was performed, including organizational ICT support and technostress (i.e., overload, complexity, uncertainty), to compare the potential underlying psychological processes. Employees' training needs and expectations toward ICT support were collected exploratively.

3.4.1 Method

Participants and Design

The participants in Study 3 were 175 employees of an energy company. For data protection reasons, we were not allowed to assess the employees' gender. Moreover, as aforesaid, age had to be collected categorically. 37% of the employees were aged 35 years or younger, 40% between 36 and 50 years, and 23% 51 years or older. Table 3.2 presents a comparative overview of the sample's demographic characteristics (i.e., education, company position). Like the employees from Study 2, the majority of the employees were well educated. Around 90% were employed on a permanent basis, and 9% were in leadership positions. Over 90% indicated that they were typical office workers, and therefore capable of answering questions regarding ICT usage behavior at work, and the stress or facilitation induced by digital technologies. Analogous to Study 2, Study 3 was designed as a correlative field study.

Materials and Procedure

We confirm that the procedure of Study 3 is in line with the Declaration of Helsinki and the APA's ethical guidelines. The materials and procedure were almost identical to those in Study 2. Employees were invited via e-mail to take part in the online survey. After clicking a link to start the survey, they read a short study description and the data declaration. ICT usage behavior, perceived stress during organizational usage scenarios, technostress, productivity, innovation, and strain were then assessed. The survey ended with some demographic questions (i.e., age, education), and the employees indicated their current company position, individual training needs, and their use of organizational ICT support.

Measures and Variables

The measured variables were almost identical to the ones in Study 2. Employees rated how often they used four types of ICT from Study 2 (smartphones, conventional telephones, desktop computers, and laptops), plus a further two types relevant to the organization (tablets and smartboards). They also rated their usage frequencies for a list of digital applications (i.e., internet, intranet, SMS, WhatsApp, Skype, e-mail programs such as Outlook, Excel, Word, PowerPoint, SAP, ERP or CRM, and Sharepoint). As before, the employees were able to add any additional applications they used to the list via an open field.

The working scenarios used to specify ICT usage behavior and assess perceived stress levels included the eleven scenarios from Study 2, plus four new, additional scenarios that were created based on internal company feedback. The additional scenarios addressed the usage of Sharepoint, video conferencing, possible difficulties when ICT support is unavailable, and a possible detachment problem (see Table 3.10). The psychological variables strain ($\alpha = .92$), overload ($\alpha = .82$), complexity ($\alpha = .83$), and uncertainty ($\alpha = .83$), as well as productivity ($\alpha = .91$) and innovation ($\alpha = .91$), were assessed via the same subscales utilized in Study 2. So were individual training needs, frequency of ICT support use (i.e., an ICT help desk), and both the frequency and duration of potential future training sessions.

3.4.2 Results

No employees had to be excluded from age analyses because of missing data. Furthermore, none had to be excluded from the dataset because of missing data, suspicion, or revision of their preliminary decision to participate.

Descriptive statistics for ICT usage behavior

As in Study 2, employees' usage frequency for the different types of ICT were analyzed. Once again, they indicated that laptops (M = 5.63, SD = 2.08) and conventional telephones (M = 5.28, SD = 1.60) were their most commonly used digital devices. Furthermore, the frequency distributions indicated a similar pattern to the desktop computer usage behavior in Study 2, which means that there was a large variance among the employees. Whereas 52% of the participants indicated not using desktop computers at all, 34% stated that they used them very frequently.

A large amount of variance was also found in the usage behavior of digital applications. The most frequently used applications were e-mail programs (M = 6.62, SD = 1.01), Excel (M = 5.71, SD = 1.35) and the internet (M = 5.61, SD = 1.55), and the least used were SMS (M = 1.64, SD = 1.06) and business platforms like Sharepoint (M = 2.87, SD = 1.84). All means and standard deviations are provided in Table 3.8.

Table 3.8

Frequency of employees' ICT usage in Study 3. Means and standard deviations

	M	*SD*
Digital Devices		
Smartphone	3.64	2.29
Telephone	5.28	1.60
Computer	3.59	2.85
Laptop	5.63	2.08
Tablet	1.75	1.75
Smartboard	1.41	0.94
Digital Applications		
Internet	5.61	1.55
Intranet	5.55	1.40
SMS	1.64	1.06
Skype	3.30	1.96
E-Mail programs (Outlook)	6.62	1.01
Excel	5.71	1.35
Word	5.43	1.50

PowerPoint	4.69	1.71
Business Software (SAP, ERP, CRM)	3.67	2.27
Business Platforms (Sharepoint)	2.87	1.84

Note. The scale range for all variables is 1-7.

Individual differences in ICT usage behavior

Although data specifications allowed no further differentiation between several non-management and management employee groups, contrast analyses were performed to investigate position effects.

Data revealed that there was only one significant position effect on ICT usage behavior, regarding the frequency of smartphone use. A significant contrast was found between non-management employees and those in managerial positions, with a mean difference of 1.72 (*SE* = 0.59), *p* = .004. The data showed that smartphones were more often used by the management; for all other devices, no significant contrast effects were found.

For the usage of digital applications, data revealed significant contrast effects for the usage frequencies of Skype, Outlook, Sharepoint, PowerPoint, and business software programs such as SAP, ERP or CRM. Non-management employees reported a significantly higher rate of Skype usage than the management did, with a mean difference of -0.80 (*SE* = 0.33), *p* = .022. However, Outlook, Sharepoint, PowerPoint and the business software programs were used significantly more frequently by the management group. For Outlook, data revealed a mean difference of 0.29 (*SE* = 0.12), *p* = .020; and for Sharepoint of 0.70 (*SE* = 0.34), *p* = .049. For PowerPoint, the mean difference in the contrast analyses reached 1.05 (*SE* = 0.31), *p* = .002, and for the business software programs such as SAP, it was 1.19 (*SE* = 0.46), *p* = .017. A comparison of the means and standard deviations is provided in Table 3.9.

Once again, we checked for age effects by comparing the three age categories. As in Study 2, age was divided into the subcategories young age (35 years and younger), middle age (36 to 50 years of age), and high age (51 years and older). A one-way ANOVA showed a significant difference only for the frequency of laptop usage (Welch's $F(2, 90.17) = 4.42$, $p = .015$). Games-Howell post-hoc analyses indicated that participants aged between 36 and 50 showed a significantly higher laptop usage frequency than participants aged 51 years and older (1.28, 95% CI[0.22, 2.33], $p = .014$).

Table 3.9

Frequency of ICT use among employees in different positions in Study 3. Means and standard deviations.

Frequency of use	Employees		Management	
	M	*SD*	*M*	*SD*
Smartphone	3.47	2.27	5.19	1.97
Skype	3.37	2.01	2.56	1.15
Outlook	6.59	1.05	6.88	0.34
Sharepoint	2.80	1.89	3.50	1.21
PowerPoint	4.58	1.73	5.63	1.09
Business Software	3.56	2.30	4.75	1.69

Note. The scale range for all variables is 1-7.

Detrimental effects of ICT usage

As in Study 2, Pearson correlations were conducted to investigate the interplay between the usage frequency of different digital devices, technostress (i.e., overload, complexity, uncertainty), and strain. Data showed that the frequency of conventional telephone usage was positively associated with strain ($r = .200$, $p = .008$), overload ($r = .355$, $p < .001$) and complexity ($r = .210$, $p = .005$). Moreover, the frequency of smartphone usage correlated positively with overload ($r = .161$, $p = .033$) and uncertainty ($r = .229$, $p = .002$).

Among the different digital applications, Pearson correlations revealed that the frequency of SMS usage was positively associated with complexity (r = .151, p = .046) and strain (r = .151, p = .046). The frequency of Word usage correlated positively with overload (r = .151, p = .047), as did the usage frequency of business software programs (r = .187, p = .013).

Contrast analyses were performed to investigate whether employees' positions affected technostress and strain. However, the contrasts between employees in operating and managerial positions were not significant for overload, complexity, uncertainty, or strain.

Age effects were again examined with a one-way ANOVA. The data indicated significant differences for perceived overload (F(2,174) = 4.85, p = .009). Tukey post-hoc analysis showed that overload increased significantly from the young age to the high age group (-3.85, 95% CI[-6.91, -0.79], p = .009; see Figure 3.6). A further significant effect was found for complexity (F(2,174) = 8.25, p < .001). Tukey post-hoc analysis indicated significant differences between young and high age (-4.16, 95% CI[-6.58, -1.74], p < .001), and between middle and high age (-2.49, 95% CI[-4.88, -0.11], p = .038). Again, the level of perceived complexity increased from young to high age, and from middle to high age (see Figure 3.7).

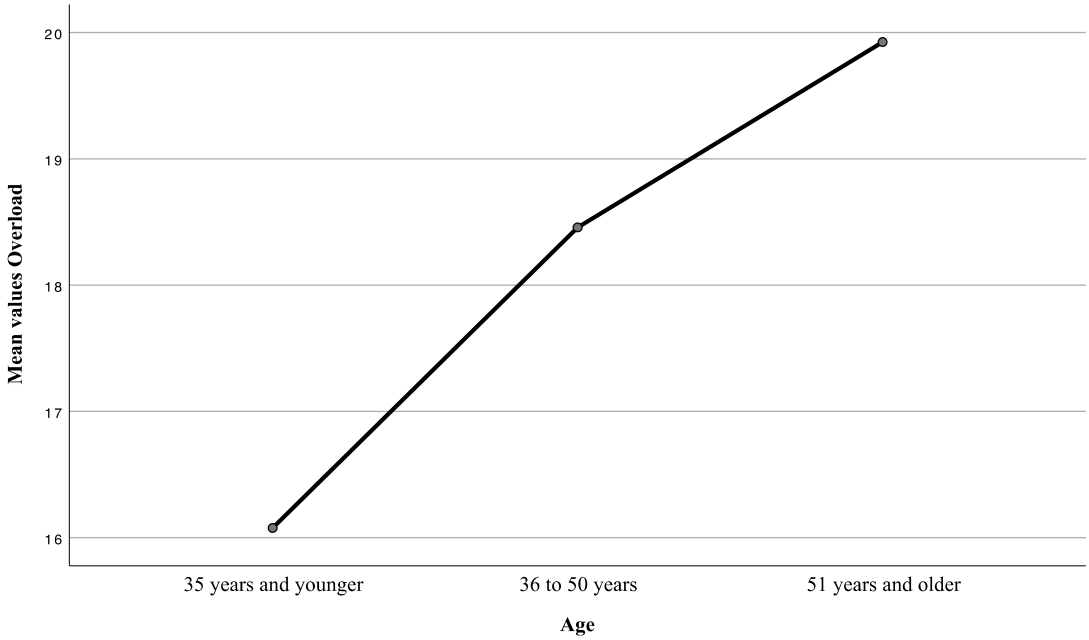

Figure 3.6. Means of overload for the three age categories in Study 3.

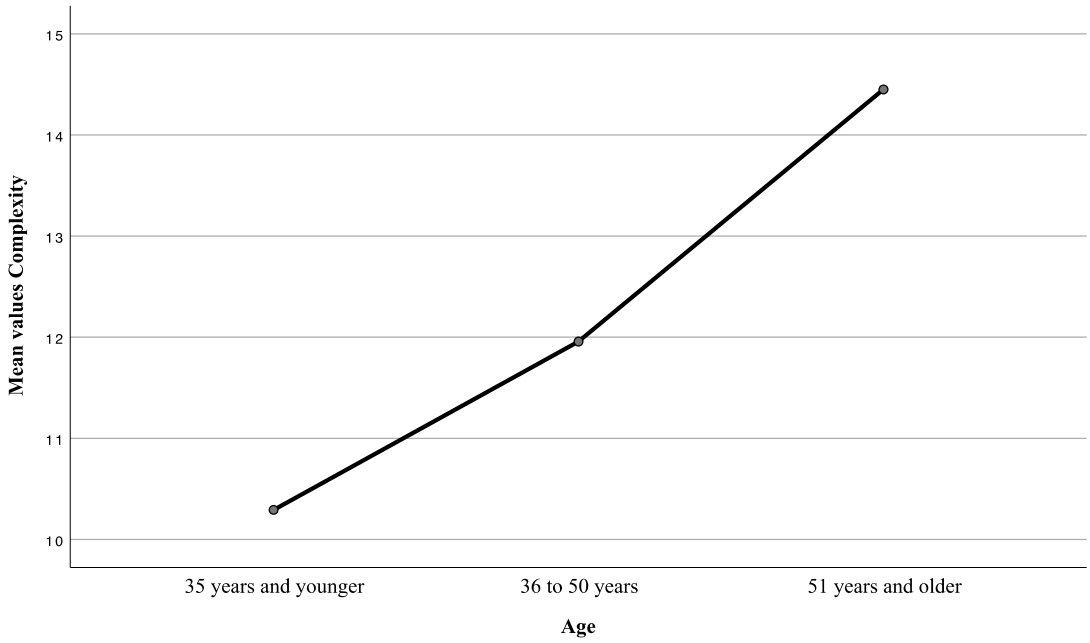

Figure 3.7. Means of complexity for the three age categories in Study 3.

Perceptions of the scenarios

Descriptive statistics showed that overall, employees perceived scenario No. 8 as the most stressful (M = 4.66, SD = 1.61), and Scenario No. 1 as the least stressful (M = 2.06, SD = 1.15). All of the scenarios, means, and deviations are provided in Table 3.10.

As in Study 2, contrast analyses were performed to examine whether some scenarios were assessed differently by non-management employees and managerial staff, but no significant effects were found.

To check for age effects, a one-way ANOVA was performed. The data revealed significant age effects for scenario No. 3 (F(2,174) = 3.98, p = .020). As in Study 2, Tukey post-hoc analysis indicated that the perceived stress level in scenario No. 3 increased significantly from young age to high age (-0.89, 95% CI[-1.63, -0.14], p = .015). A second significant effect was found for scenario No. 11 (Welch's F(2,95.63) = 3.94, p = .023). Games-Howell post-hoc analysis showed the perceived stress increased from the middle age group to the high age group (-0.93, 95% CI[-1.65, -0.20], p = .008).

Table 3.10

Employees' perceptions of the ICT usage scenarios in Study 3. Means and standard deviations.

No.	Scenario	*M*	*SD*
1.	One of your colleagues is facing problems with his computer, and asks you for help.	2.06	1.15
2.	You need a newer version of a piece of software, and you have to deal with it independently.	3.37	1.75
3.	The operating system has been updated, and you have to become acquainted with it independently.	2.75	1.59
4.	You have to obtain information about an issue, but neither your colleagues nor your supervisor can help you. You can only search online for information.	2.51	1.39
5.	You have to organize an online group meeting.	3.31	1.79

6.	Your smartphone vibrates again and again during a meeting, but you are unable to have a look at it.	3.59	1.67
7.	You have to switch off your smartphone to process a difficult task. Due to that, you might miss some important calls.	2.58	1.52
8.	You receive an urgent task while you are on the move. However, the reception in the area is poor, and the e-mails and e-mail attachments are not loading completely.	4.66	1.61
9.	You have to explain how to use Excel for a large project to a trainee.	2.67	1.47
10.	A project requires you to use a mobile tablet for the same tasks you'd normally perform on your computer.	3.53	1.71
11.	There is a new version of Office. You have to get used to it quickly, so that you are able to help your colleagues in case of problems.	3.08	1.58
12.	You get an e-mail from your supervisor after 7.00 p.m.	2.99	1.90
13.	You are at your desk before 8.00 a.m. and having problems with the computer, but the ICT support desk is not available.	3.76	1.84
14.	You have to organize a video conference with several participants in a large meeting room.	3.66	1.74
15.	You have to participate in a Sharepoint project, which means that all documents have to be edited in Sharepoint.	3.11	1.66

Note. The scale range for all scenarios is 1-7.

Serial multiple mediation model for the effect of ICT usage behavior on strain through organizational ICT support and technostress

Again, a serial multiple mediation model was performed using Hayes' (2018) PROCESS macro (model 6). ICT usage behavior, organizational support, technostress, and strain were included in the model to explore whether the relationships among these variables would be similar to those in Study 2.

Subsequently, the model contains one direct and three indirect effects of ICT usage behavior on strain. The direct path from ICT usage frequency to strain did not

reach significance. The bootstrap confidence interval included zero, c′ = 0.094, t(171) = 1.165, p = .246, 95% CI [-0.07, 0.25].

For the first indirect effect, data revealed that employees with a high usage frequency of digital devices did not report an increased usage frequency of ICT support, a_1 = 0.02, t(173) = 1.64, p = .104, 95% CI [-0.01, 0.03], and an increased use of ICT support was also not associated with decreased strain, b_1 = 0.28, t(171) = 0.47, p = .642, 95% CI [-0.91, 1.47], independent of technostress. The bias-corrected bootstrap confidence interval based on 10,000 samples for this indirect effect (a_1b_1 = 0.01) included zero (-0.02 to 0.03). This indicates that ICT support did not mediate the effect of ICT usage frequency on strain.

However, employees with a high usage frequency of digital devices reported an increased level of perceived technostress, a_2 = 0.76, t(172) = 3.57, p = .001, 95% CI [0.34, 1.18], and this increased level of technostress was itself associated with increased strain, b_2 = 0.19, t(171) = 5.79, p < .001, 95% CI [0.12, 0.25]. As the bias-corrected bootstrap confidence interval for this second indirect effect (a_2b_2 = 0.14) did not include zero (0.06 to 0.25), there is an indication that technostress mediated the effect of ICT usage frequency on strain in this study.

The third path tested technical support and technostress as serial mediators. The indirect effect of ICT usage behavior on strain was investigated, with ICT support modeled as influencing technostress, and technostress affecting strain in turn. The data showed that although employees with a high usage frequency of digital devices did not make use of ICT support more often (a_1), increased use of ICT support was associated with increased technostress, (d_{21} = 3.30, t(172) = 2.22, p = .027, 95% CI [0.37, 6.23]). In turn, increased technostress was associated with a higher level of strain (b_2). However, this path ($a_1d_{21}b_2$ = 0.01) cannot be claimed as different from zero, as the bias-corrected bootstrap confidence interval straddles zero (-0.002 to 0.03).

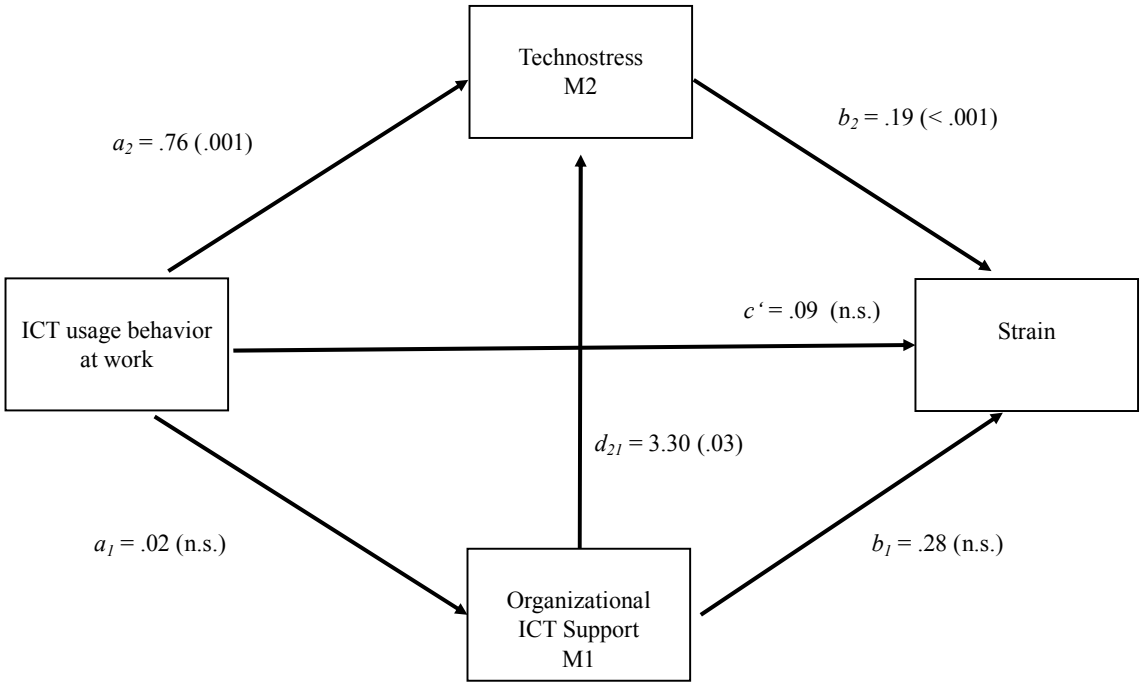

Figure 3.8. Serial multiple mediation model for Study 3.

Beneficial effects of ICT usage

Pearson correlations were conducted to explore the interplay between the usage frequency of different digital devices, productivity, and innovation. However, the correlations between productivity and the usage frequencies of smartphones, conventional telephones, desktop computers, laptops, tablets, and smartboards were not significant. Nor were the correlations between innovation and the usage frequencies of the named digital devices.

For the different digital applications, correlational analyses revealed that the frequency of intranet usage was positively associated with productivity (r = .237, p = .002) and innovation (r = .347, p < .001). Additionally, the frequency of Skype usage correlated positively with productivity (r = .316, p < .001) and innovation (r = .250, p = .001). Moreover, in contrast with the findings concerning the other applications, the

frequency of Skype usage was negatively associated with complexity (r = -.209, p = .005).

To check for position effects, the same contrast analyses were performed. However, the contrasts between employees in operating and managerial positions were significant for neither productivity nor innovation.

A one-way ANOVA revealed significant age differences for productivity (F(2,174) = 5.56, p = .005). Tukey post-hoc analyses revealed that the level of perceived productivity decreased significantly from young age to middle age (2.17, 95% CI[0.38, 3.96], p = .013) and from young age to high age (2.47, 95% CI[0.38, 4.55], p = .016; see Figure 3.9). A further significant effect was revealed for innovation (F(2,174) = 4.55, p = .012). Tukey post-hoc analyses showed that the perceived level of innovation decreased significantly from the young age group to the middle age group (2.06, 95% CI[0.44, 3.67], p = .008; see Figure 3.10).

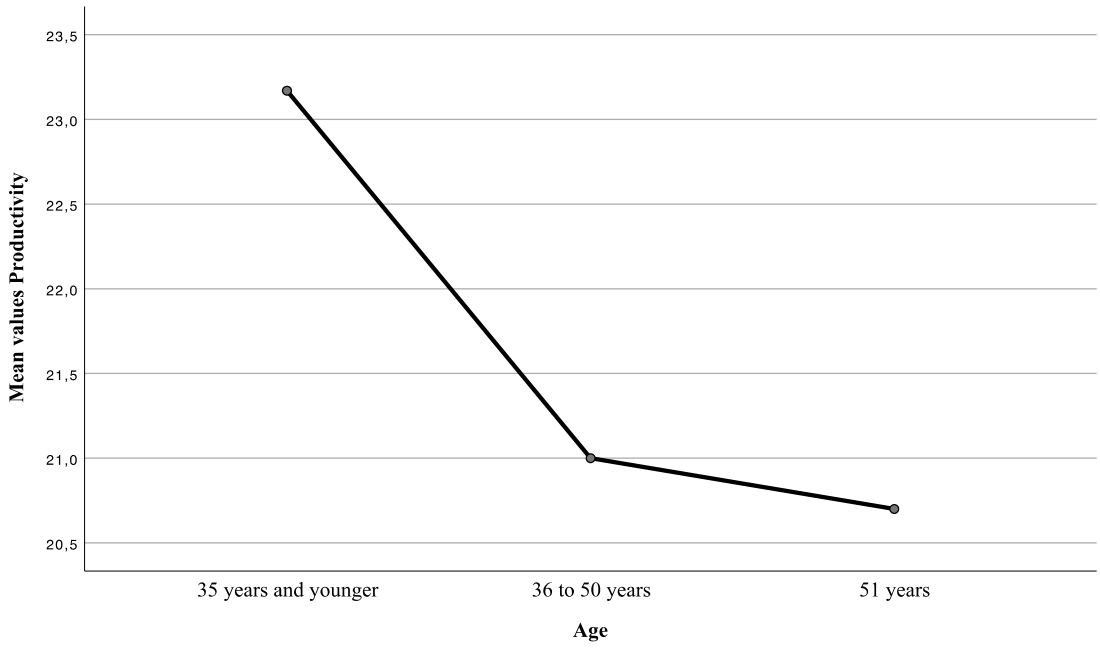

Figure 3.9. Means of productivity for the three age categories in Study 3.

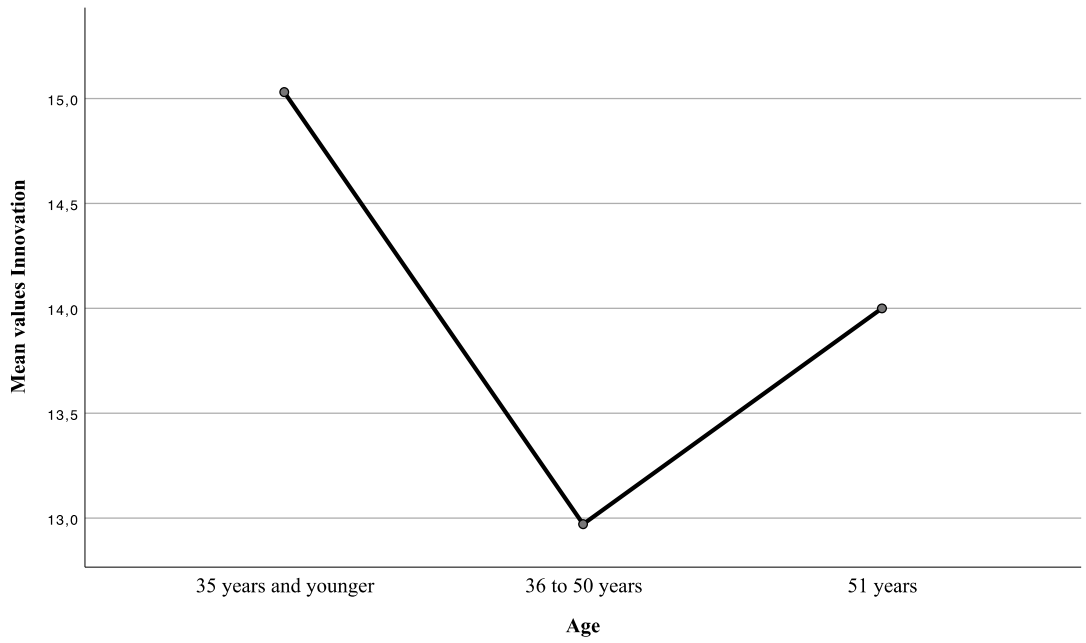

Figure 3.10. Means of innovation for the three age categories in Study 3.

Individual training needs and organizational ICT support

Overall, around 21% of the employees expressed no training needs, 57% wished to be trained in working with digital technologies once a year, and 22% desired training twice a year. 45% of the employees preferred a training session lasting between two and four hours, whereas 29% found one hour sufficient, and around 6% preferred a session between four and eight hours long. In the present organization, 5% of the participants indicated that they did not use ICT support (in the form of the ICT help desk) at all. 58% indicated using it rarely, 34% occasionally, and only 3% frequently.

To check whether an employee's position affected their training needs, contrast analyses were performed. The data revealed that significantly more managerial employees (M = 1.63, SD = 0.50) expressed training needs than employees in non-managerial positions (M 1.35, SD = 0.48), with a mean difference of 0.27 (SE = 0.13), p = .034.

Furthermore, a one-way ANOVA revealed significant age effects in the use of ICT support ($F(2,174) = 5.84$, $p = .004$). Tukey post-hoc analyses indicated differences between the young and middle age groups (-0.30, 95% CI[-0.55, -0.06], $p = .010$), and between the young and high age groups (-0.35, 95% CI[-0.63, -0.06], $p = .013$). Thus, the use of ICT support seems to increase with age.

3.4.3 Discussion

The results of Study 3 partially replicate the findings of Study 2. Usage behavior for digital devices and digital applications was partly similar to that of the employees in Study 2, but also differed in some ways. Data once again indicated significant differences in the usage frequency of digital devices and applications depending on employees' individual characteristics (i.e., age, current position). For example, employees with managerial positions used smartphones at a significantly higher frequency than non-management employees. However, whereas Study 2 found an age effect for smartphone usage frequency, Study 3 found an age effect only for laptops, with the frequency of laptop usage decreasing significantly from middle age to high age.

Regarding the ICT usage scenarios, the employee samples in both Study 2 and Study 3 rated scenario No. 8 as being the most stressful. For scenarios Nos. 3 and 11, data indicated significant age effects in both studies. For an elaboration of this point, see the General Discussion in section 3.5.

Analogous to Study 2, the results indicated different detrimental effects of employees' ICT usage at work. As before, the usage frequency of different ICT (e.g., smartphones, telephones, SMS, Word) was positively associated with the technostress variables overload, complexity, and uncertainty. Additionally, the frequencies of telephone and SMS usage correlated positively with strain.

Analyses for age effects suggest the employees in Study 3 also perceived more overload and complexity with increased age.

Again, a serial multiple mediation model was constructed to explore the interplay between employees' ICT usage behavior, ICT support, technostress, and strain. Given the high degree of similarity in the other results, we expected similar connections and effects. As in Study 2, the data revealed no significant direct effect of ICT usage frequency on strain. However, contrary to Study 2, the indirect path investigating ICT support and technostress as serial mediators in the relationship between ICT use and strain was insignificant. In Study 3, employees whose ICT usage frequency was high did not seem to make more use of ICT support services. Nonetheless, a high rate of ICT support usage was again associated with an increased level of technostress. Consistent with Study 2 and prior findings (e.g., Ayyagari et. al., 2011), a high level of technostress was associated with an increased level of strain. At this point, the explorative model leaves open a question regarding which other factors influence employees' decisions to use (or not use) ICT support. Moreover, even the *de novo* connection between increased ICT support usage and increased technostress remains unclear. It is hoped that future studies will address these topics, and explore the relationships among these variables in greater detail.

The Study 3 data also suggest some beneficial effects of ICT usage in the present organization. For example, the application Skype seems to minimize perceived complexity, while also encouraging productivity and innovation.

Nonetheless, analyses for age effects showed a significant decrease in productivity and innovation with age. Such a trend was already apparent in Study 1 and Study 2, but had not yet reached significance.

Concerning training needs and expectations, the employees in Study 3 expressed similar preferences to those in Study 2. Around 80% wished to receive ICT

training, and around 45% thought the session should last between two and four hours. However, contrary to Study 2, training needs and the frequency of ICT support usage differed depending on employees' individual characteristics. The expressed training needs seemed to be stronger among employees in management positions, and the frequency of ICT support usage increased with age. This appears consistent with the finding that detrimental effects of ICT usage also increase with age.

3.5 General Discussion

The present research supports the idea that employees' ICT usage behavior should be recognized as a potential antecedent of technostress and ICT-related outcomes (i.e., strain, facilitation) in organizations. Across two organizational field studies, we found indications that high usage frequencies of different digital devices and applications were associated with increased overload, complexity, uncertainty, and strain. In particular, the use of smartphones and conventional telephones seems to have detrimental effects, though most of these connections are tenuous to moderate.

Besides these detrimental effects, the data also suggest that some devices and applications (e.g., Skype) can lower perceived complexity and foster positive outcomes for employees (i.e., productivity, innovation). However, the finding that different types of ICT were differently associated with both beneficial and detrimental outcomes underlines the importance of taking a closer look at ICT usage behavior.

To get an idea of what really leads to stress while working with modern ICT, we focused not only on the frequencies at which employees spent time on different digital technologies, but also on ICT activity. Usage scenarios for different digital devices and applications were used to concurrently specify ICT usage behavior and assess employees' perceived stress in concrete working situations. The analyses in

both studies revealed that a scenario in which employees were unable to receive essential files was rated as the most stressful.

Previous studies from different areas (e.g., detachment, work-life balance and smartphone usage research) have already argued that an "always-on" environment is not as exclusively positive as it might initially appear (e.g., Elhai, Levine, Dvorak, & Hall, 2016; Major, 2006; Middleton, 2007; Park, Fritz & Jex, 2011). In social media research, there is even a new type of fear gaining increasing attention, the so-called "fear of missing out" (FOMO), which is characterized by a desire to stay continually connected with what others are doing (Elhai et al., 2016; Przybylski, Murayama, DeHaan, & Gladwell, 2013). This underlines how accustomed we have now become to having free access to data and information everywhere we go.

Moreover, our findings suggest that it is important to take individual characteristics (i.e., age, gender, employees' company position) into account when examining the challenges posed by working with modern ICT. Concerning age, the results consistently show that the amount of technostress experienced (i.e., overload, complexity, uncertainty) seems to increase with age. These results are in line with Tu et al.'s (2005) findings. In Study 3, older employees also reported less ICT-related productivity and innovation than younger employees did. On first sight, this finding seems to be intuitive: one might suppose that younger employees are simply more familiar with using digital ICT, and therefore experience less technostress. However, several other studies have indicated that older employees are better at handling ICT-induced stress for various reasons, such as maturity, longer organizational tenure, experience, or having the power to independently set the pace of their ICT use (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011).

The explorative analyses of the usage scenarios also suggested that the specific ICT activity might matter. Data revealed that older employees reported a higher stress

level in scenarios that described ICT-related changes such as the independent handling of a system update, or a new version of Office. In comparison, younger employees experienced more stress in situations where they were unable to look at their ringing smartphone. This finding is in line with previous research from other areas. For example, Przybylski et al. (2013) showed that younger participants (in particular, younger men) tended to report the highest levels of FOMO. Moreover, young adults who reported high levels of FOMO also paid greater attention to e-mails and text messages, and often looked at their Smartphones in the morning, before going to sleep, during meals, in lectures or even while driving.

Concerning gender, the findings were mixed. For example, technostress levels did not differ between women and men. This was not in line with previous findings from Ragu-Nathan et al. (2008), nor Tarafadar et al. (2011), which indicated that men experienced more technostress than women. However, analyses of the usage scenarios revealed some significant gender effects. The data showed that women experienced more stress than men in scenarios that required them to provide technical help, use an unusual digital device, or had them unable to answer a call or fully retrieve the necessary information for a task. What all these scenarios have in common is that they describe situations in which ICT are not easy to use. Therefore, the findings are in line with Venkatesh and Morris (2000), who revealed that women considered perceived ease of use to a greater extent than men when making decisions regarding the use of new technologies. Consequently, it seems consistent that they might struggle more with ICT in some of the described situations.

Moreover, we checked for effects of employees' positions in the company. Employees in non-management positions reported more stress than those in management when they had to imagine organizing an online meeting or using an

unusual digital device for a task. In Study 3, no significant position effects were found on technostress or ICT-related outcomes.

However, when taken together, the reported findings for individual characteristics provide essential implications. They underline that ICT support needs to fulfill several requirements that are tailored to both specific situations, and employees' individual needs. In a working environment that is increasingly utilizing modern technologies and continuously changing, targeted personnel development is an essential success strategy that can have a lasting effect on a company's future. It is only through this that it will be possible to alleviate or avoid having some employees benefitting less from technological changes, or even running the risk of ICT-related detrimental effects.

From a practical point of view, the present research provides a few further implications. First, the results of the two organizational field studies reveal that although ICT can have beneficial effects for employees (i.e., ICT-related productivity and innovation), it can also foster technostress, and in turn, detrimental outcomes such as strain. To protect employees' long-term health, organizations should not trivialize the potential downsides of rising ICT usage in the modern workplace.

Second, it is essential that organizations do not assume that providing ICT support facilities will automatically function as an inhibiting mechanism for technostress and strain. As demonstrated in the explorative serial multiple mediation model, a high usage rate of ICT support does not necessarily go hand in hand with lower technostress. Hence, it is insufficient for organizations to merely provide technical support. Instead, they should address employees' specific training needs and foster their competencies and ICT-related skills. Such training can, for example, help to reduce the perceived complexity of certain digital devices and applications, and reduce ICT-related uncertainty by addressing employees' problems and needs.

Although the efficient use of modern ICT has long been a key factor for modern organizations, the latest statistics show that at present, only 32% offer internal or external ICT training for their employees, who are working with ICT but are not ICT specialists themselves (Statistisches Bundesamt, 2019a).

Third, the explorative analyses concerning employees' training needs also support the idea that the training offered should change. In both organizations, the majority of the employees wished to receive training in working with digital devices. Furthermore, the majority of employees preferred for such training to occur once a year, with an optimal length of between two and four hours. Providing such an opportunity for employees would not seem to require too much effort for organizations, while simultaneously offering a solid basis for improvement.

Although the present research contributes to a better understanding of the wide-ranging effects of ICT usage in modern organizations, it has a few limitations. However, we believe that these limitations can offer potential starting points for fruitful future research.

First, the data is based on self-reports, and can therefore be prone to measurement errors (Holbrook, 2008; Naab et al., 2018; Sharkow, 2019). It is possible that there was a self-selection bias in the samples, since the employees were able to participate via clicking a link. Future studies could continue from this point, for example by using extended scales or objective measurements of performance data, or via independent assessments and monitoring of employees' ICT usage behavior (i.e., active observation of working with ICT, instead of usage scenarios). These also apply to the content and conduct of ICT support, which was only analyzed exploratively in the present studies.

Second, although cross-sectional studies can tell us whether or not particular variables have a specific relationship, alternative study designs would be interesting.

For example, researchers could develop longitudinal studies to measure the impact of ICT usage behavior on technostress and ICT-related outcomes over time. Intervention studies are also conceivable; for example, testing whether specific ICT training or a time limit placed on the use of certain digital devices would have an effect. Moreover, it would be interesting to investigate the concept of technostress in an experimental setting. Research could manipulate, for example, ICT usage frequency, and examine causal relationships between technostress and both beneficial and detrimental psychological outcomes. An experimental setting might also help to alleviate concerns regarding isolating ICT-related effects (Ayyagari et al., 2011). However, given that it is often difficult to obtain longitudinal or experimental data in organizations, researchers should carefully reflect on their choice of research design, and consider not only its strengths and pitfalls, but also those of the alternatives (Taris & Kompier, 2014).

Third, we compared data from two organizations and performed explorative serial multiple mediation models to address potential underlying psychological processes regarding technostress. However, these relationships might vary on an individual or organizational level, and thus pose a particular difficulty in developing a generalizable model. For example, whereas the employee sample from the Study 2 organization showed a significant indirect path between ICT support and technostress as serial mediators in the relationship between ICT usage and strain, the sample from the different organization in Study 3 did not. However, even though the model was explorative, it confirmed some relationships presumed in previous research, such as the interplay between technostress creators and strain (e.g., Ayyagari et al., 2011). Nonetheless, future research is needed to create a deeper understanding of the interplay between the use of ICT support and technostress.

Finally, the findings for individual differences may also be sample-specific, and thus cannot be generalized. Further research is needed to clarify the current data on the effects of individual characteristics (e.g., age, gender, position) on ICT usage, technostress, and ICT-related outcomes.

3.6 Conclusion

Digital technologies at work have increasingly become a matter-of-course for many employees, making it essential to understand the far-reaching consequences that they might have. The present research results indicate that besides facilitating productivity and innovation, digital technologies can also cause technostress and lead to ICT-related strain. They underline and extend prior findings by showing that technostress and ICT-related outcomes can vary depending on age, gender, and employee position. Moreover, the results suggest that it is insufficient for organizations to merely provide ICT support; instead, they affirm that organizations need to develop individualistic and context-specific approaches to handle their employees' needs.

Chapter 4

How do modern ICT shape our way of working?

An experimental study about the impact of digital information load on performance, technostress, and strain

4.1. Abstract

As conventional office workplaces become increasingly digitalized (characterized by the collective use of different digital devices), employees must learn how to deal with new information and communication technologies (ICT) and an increasing amount of digital information. Although ICT can bring beneficial effects such as greater working flexibility, previous research has also shown that it can interfere with the working process. For example, ICT can inhibit employee performance or encourage technostress and strain (e.g., Brooks, 2015; Nicholson, Nicholson, Parboteeah, & Valacich, 2009; Tarafdar et al., 2010). Nonetheless, the research to date has not examined the distracting nature of digital information load, and the potentially detrimental effects that can arise from ICT usage in an experimental setting. The present study addresses this gap by creating a digital inbox exercise in an office environment and manipulating the amount of digital information participants must deal with. We examined the effects of digital information load on performance, technostress, and strain. The results indicate that a large amount of digital information can cause interference, and therefore inhibit performance in various easy tasks. This held especially true for participants with a low level of computer self-efficacy. Moreover, the data suggest a significant correlation between technostress and strain, even though neither were influenced by the digital information load. The implications of these results for future research and the use of ICT in organizations are discussed together with the limitations of the experiment.

4.2 Introduction

Due to digitalization, today's workplace is undergoing a profound change. Whereas pens and paper were essential items at a typical office workplace some years ago, nowadays different electronic devices adorn our desks. Modern ICT are central components of contemporary life, and have become indispensable in many ways. For example, across business sectors, 94% of German companies work with computers, 93% have access to the internet, and 62% use additional work-related mobile devices. In some sectors, such as communication, service, and science, the rates can reach 100% (Statistisches Bundesamt, 2017). Therefore, making efficient use of modern ICT and its associated open access to information have become strategic key factors for organizations (Statistisches Bundesamt, 2019a).

The digital transformation has led to far-reaching changes, not only for organizations, but also for individuals. Many conventional workplaces have turned into digital workplaces, characterized by the collective use of connected devices, software, and interfaces, which influences employees' experience of work (Freed, 2015; for a detailed explanation of the digital workplace, see Chapter 1, section 1.1). An increasing expectation that employees are able to deal with large amounts of digital information is shaping the nature of work (Drake, 2010). Questions thus arise concerning the new challenges that digitalization poses for employees, and how modern ICT affects the performance and welfare of people at modern digital workplaces.

Given the practical relevance of this topic, a large body of research from several disciplines has pursued these questions. From an organizational psychological perspective, it is important to understand ICT-related stressors and outcomes in modern workplaces. Previous studies have examined both beneficial and detrimental factors of work-related ICT usage among employees (e.g. Chesley, 2010; Ninaus,

Diehl, Terlutter, Chan, & Huang, 2015, Tarafdar et al., 2011; Ter Hoeven, Zooner, & Fonner, 2016). However, many prior studies were correlational (e.g., Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2010), or used qualitative research methodology such as interviews (e.g., Ninaus et al., 2015). The goal of the present study is thus to contribute to the existing literature by experimentally testing the role of digital information load in affecting working individuals' performance and strain.

4.2.1 Effects of digital information load and ICT usage

Previous research in the area of work and organizational psychology showed that information processing comprises a multitude of sub-processes, such as decoding information, cognitive processing, evaluating information, decision-making processing, and initiating a concrete action (Frey & Irle, 2002). Through the increasing use of ICT, these processes are all being affected, as incoming information now arrives both more frequently and more quickly. Thus, a central issue is not only finding or providing a sufficient amount of information on a certain topic, but also distinguishing between important and unimportant input. To be more specific, effectively assessing the quality of content has become a core task now that access to information has become almost unlimited (Bawden & Robinson, 2009).

Decades ago, psychological research addressed the question of what happens when the amount of input entering a system exceeds its processing capacity (Milford & Perry, 1977). This body of research provided evidence of correlations between information overload and symptoms of sickness, general and mental fatigue, lowered fulfillment of job responsibilities, strained personal relationships, loss of identity, and tension with colleagues (e.g., Bawden & Robinson, 2009; De Rijk, Schreurs, & Bensing, 1999; Kirsh, 2000; Klausegger, Sinkovics, & "Joy" Zou, 2007; Oppenheim, 1997; Waddington, 1996). Hallowell (2005) even described a newly-recognized

neurological phenomenon called attention deficit trait (ADT), which is characterized by distractibility, inner frenzy, and impatience. Thus, too much input may cause a usually steady performer to turn into a harried underachiever.

More recently, research has focused on individual stress from using modern ICT (e.g., Ragu-Nathan et al., 2008; Tarafdar et al. 2011). This so-called technostress has been defined as a modern disease of adaptation caused by an inability to cope with new computer technologies in a healthy manner (Brod, 1984). Ragu-Nathan et al. (2008) identified five factors that can create technostress, and three factors that can inhibit it. The factors causing technostress are techno-invasion, techno-overload, techno-complexity, techno-uncertainty, and techno-insecurity. These factors can, for example, describe the experience of employees who are faced with more information than they can handle, are pressured to stay up-to-date in the jungle of various ICT, or feel unable to develop a solid base of experience for a specific type of ICT (e.g., Tarafdar et al., 2011). The factors that can inhibit technostress are literacy facilitation, technical support provision, and involvement facilitation (e.g., Ragu-Nathan et al., 2008). These factors can, for example, help employees to reduce techno-complexity or techno-uncertainty (for a detailed explanation of technostress, see Chapter 1, section 1.3.2).

Furthermore, prior research revealed beneficial and detrimental effects for ICT-enabled satisfaction (e.g., content, accuracy, output, ease of use, timeliness) and performance (e.g., productivity, innovation) depending on technological characteristics, the involvement of the users and organizational support mechanisms (Ayyagari et al., 2011; Tarafdar et al., 2010).

Moreover, previous findings pointed out that individual factors can affect technostress; for example, Tarafdar et al. (2011) suggest that individuals' demographics can influence how much technostress they experience. Besides age,

gender, and education, they took employees' computer efficacy and confidence into account. Their results indicate that professionals with high levels of computer confidence experience less technostress; this is because they have a stronger belief in their ability to handle disruptions arising from technostress-creating situations. Further studies support the idea that individual characteristics play an essential role in dealing with modern ICT. Findings from stress research suggest that aside from contextual variables such as ICT support services or social support, individual dispositions such as personality variables or self-efficacy can influence a person's coping abilities, and thereby act as potential buffer mechanisms in stressful situations (Ayyagari et al., 2011; Cooper et al., 2001).

4.2.2 Multi-tasking and interference management

Working with modern ICT can make it necessary to handle several tasks simultaneously (i.e., multi-tasking), and to deal with disturbances created by new, incoming digital information. Based on the assumption of cognitive load theory (CLT; Sweller, 1988), which argues that the cognitive capacity available in a specific situation is limited, it is conceivable that detrimental effects will occur when an individual has to make simultaneous use of different modalities (e.g., Brünken, Plass, & Leutner, 2004; Sweller, 2010). Indeed, a large amount of research has already investigated multi-tasking and interference management in the working context, and pointed out the effects of the type of interference, task complexity, attention management, and individual characteristics.

Concerning the type of interference, previous studies often differentiated between distractions and interruptions. For example, suppose that an employee is reading a research paper on their computer while the news is broadcast on the radio. The radio in the background can function as a distraction because the real task (i.e.,

reading the paper) and the interference (radio news) are not using the same sensory channel. However, a new incoming e-mail would represent an interruption in this scenario, because the real task and the interference are using the same sensory modality. In this case, it would be expected that the interruption by the e-mail would be more difficult to avoid than the distraction from the radio broadcast (Speier, Vessey, & Valacich, 2003).

Furthermore, prior findings suggest that the type and complexity of a task or activity should be noted. Depending on the task an individual is working on, an interruption or distraction can lead to positive or negative consequences. According to the distraction conflict theory (DCT; Baron, 1986), interference caused by another person or stimulus can lead to an attentional conflict between the actual task and the distraction. In the case of a simple task, this attentional conflict can be helpful for excluding irrelevant cues, and thereby improve performance. However, in the case of a complex task, the shift of attention can cause confusion (in working memory) or imply that essential cues were not processed, and therefore result in reduced performance (e.g., Schmandt, Marmasse, Marti, Sawhney, & Wheeler, 2000; Speier, Valacich, & Vessey, 1999; Speier et al., 2003).

With the increasing use of modern ICT, the number of possible distractions and interruptions is also growing, and this poses a challenge for attention management. For example, Ayyagari et al. (2011) described dealing with constant interruptions and conflicting demands as a major challenge of today. In addition, Davenport and Beck (2001) investigated the effect of internet and e-mail use. They pointed out that through internet and e-mail usage, the amount of information an individual can easily access has increased enormously, and that it is crucial to find better ways to manage attention.

Several recent studies have investigated the interference effects of e-mails, telephones, or mobile media, and provided evidence for both beneficial and

detrimental consequences. For example, the use of modern ICT can affect work security, work performance, productivity and academic success, but at the same time facilitate social interaction or social networking (e.g., Jackson, Dawson, & Wilson, 2001; Jacobsen & Forste, 2011; Levine, Waite, & Bowman, 2012). Brooks (2015) investigated the distracting effect of social media use on efficiency and well-being, finding that a high level of social media use was associated with lower task performance, increased technostress, and lower happiness.

Additionally, as addressed above, individual characteristics may play an important role in multi-tasking or interference management. Previous studies pointed out that people differ in their attitudes toward interruptions (i.e., tending to avoid interruption vs appreciating its usefulness), and that self-efficacy regarding multi-tasking and interruption management should be taken into account (Basoglu, Fuller, & Sweeney, 2009; Hudson, Christensen, Kellogg, & Erickson, 2002). For example, Basoglu et al. (2009) suggest that high levels of self-efficacy can reduce cognitive load, and therefore act as coping mechanisms in situations with frequent interruptions. Moreover, Shu, Tu, and Wang (2011) reported that employees with high computer self-efficacy showed lower levels of computer-related technostress.

Overall, the previous research on multi-tasking and interference management presents somewhat mixed findings, and raises the question of whether pros or cons are more prevalent for employees at the digital workplace.

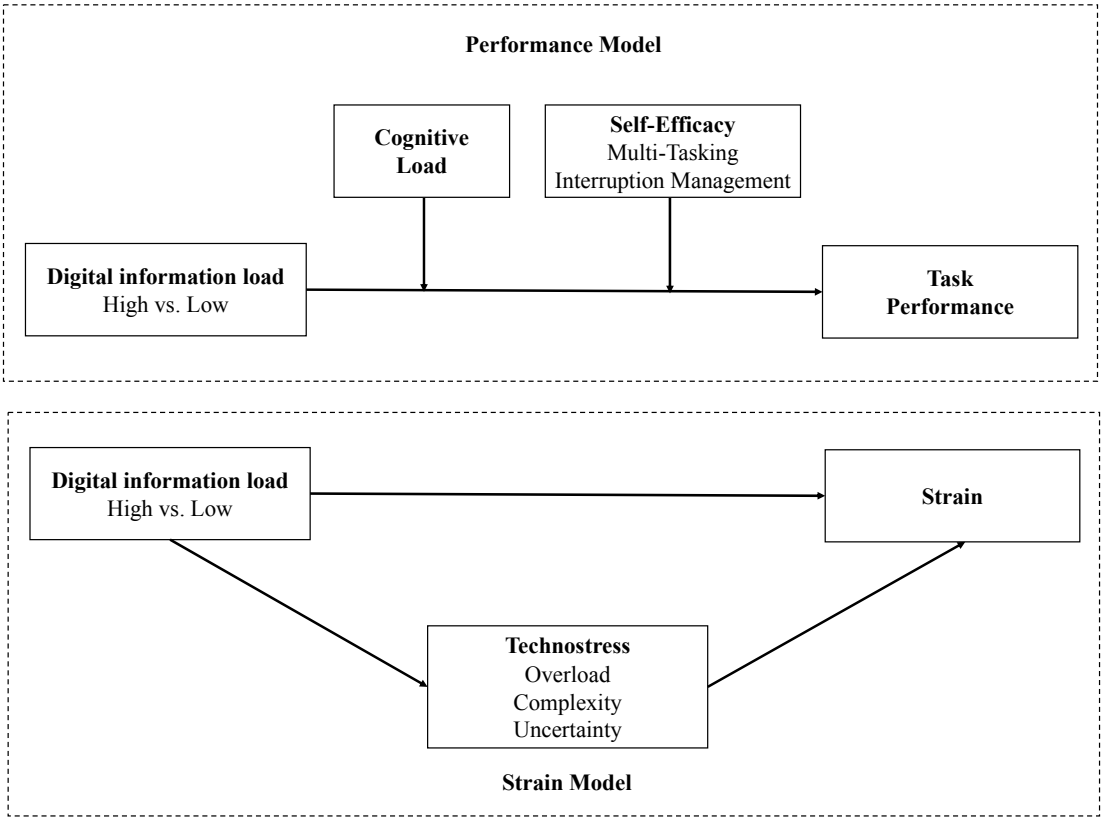

Figure 4.1. Proposed research models of Study 4.

4.2.3 The Present Research

Due to the ongoing digitalization of the workplace, employees have had to learn how to deal with modern ICT and an increasing amount of digital information. In the present study, we focused on the possible detrimental effects of a high level of digital information load on individuals at a digitalized workplace. The study was designed as an experimental laboratory study to examine the impact of digital information load on performance, technostress, and strain under controlled conditions (see Figure 4.1). To the best of our knowledge, this is the first attempt to actively manipulate digital information load and establish causality. Previous studies gained great insight into the concept and possible consequences of technostress and information overload, but were either correlative in nature (e.g., Ayyagari et al., 2011;

Ragu-Nathan et al., 2008; Tarafdar et al., 2010), or only controlled the amount of digital information, rather than manipulating it (Brooks, 2015).

Moreover, the study extends existing experimental research on multi-tasking and interference management by (1) using different ICT for interruptions and distractions (e.g., Jackson et al., 2001; Nicholson et al., 2009); (2) measuring performance via utilizing different types of tasks (rather than only decision-making tasks; e.g., Basoglu et al., 2009; Speier et al., 2003); and (3) measuring performance with objective criteria rather than self-reports (e.g., Jacobsen & Forste, 2011).

In the experimental setting, participants worked on a digital inbox exercise, being either undisturbed (low digital information load condition) or faced with periodically incoming new pieces of digital information (high digital information load condition). Drawing on DCT (Baron, 1986), it was hypothesized that participants in the experimental conditions would differ in their performance depending on the degree of task complexity in the digital inbox exercise. Participants' computer self-efficacy (i.e., the ability to manage interruptions and multi-task) and (exploratively) cognitive load were considered as possible moderators. Moreover, it was predicted that participants in the low digital information load setting would show less strain than participants faced with a high digital information load. Analogous to the prior studies (i.e., Study 1, Study 2, Study 3) technostress (i.e., overload, complexity, and uncertainty) was tested as a potential mediator in the relationship between digital information load and strain.

4.3 Study 4

4.3.1 Method

Participants and design

140 participants (109 women, 31 men) were recruited at a German University (M_{age} = 22.6, SD_{age} = 3.47, age range: 17–45 years). The laboratory experiment was based on a one-factorial design with two between-subjects conditions (digital information load: low vs. high).

Materials and Procedure

The experiment took place in a laboratory at the University of Regensburg, which was fully equipped with two computer desks, simulating a modern office workplace. Participants were welcomed, allocated to one of the computer desks and informed that they would be taking part in an experiment, which would be structured in three sections: (1) a short questionnaire, (2) a digital inbox exercise, and (3) a second, broader questionnaire, followed by the debriefing. A detailed overview of the procedure is given in Figure 4.2.

Digital inbox exercise. In order to both obtain an objective performance measurement and manipulate the amount of digital information participants had to deal with, we created a digital inbox exercise. Conventional inbox exercises are often used as selection and support tools in assessment centers. In such tasks, individuals have to cope with an "inbox", including about 15 to 25 documents with different tasks, problems, and time limits (see Obermann, 2013). At the modern workplace, work tasks often happen online, and require only a computer. We thus tried to update the concept of the conventional inbox exercise by creating a digital inbox exercise.

First, participants had to read a fictional workplace scenario, including the inbox exercise instructions. They were asked to imagine that they were the employee introduced in the scenario, and had to work on the assigned tasks. Then, a Microsoft Office Outlook 2007 inbox was presented, containing 21 e-mail messages (eleven marked as read, and ten unread). The ten unread e-mail messages contained ten tasks that participants had to work on to complete the exercise (see Figure 4.3).

Digital information load manipulation. To manipulate the digital information load and investigate the effects of modern ICT at work, we generated two experimental conditions, which participants were randomly assigned to. In the low digital information load condition, participants worked undisturbed on the digital inbox tasks. In the high digital information load condition, the experimenter used the second computer in the laboratory to covertly send the participant a new, task-irrelevant piece of digital information (e.g., short additional e-mail messages, text messages via Skype, Outlook appointment reminders, telephone calls) every minute. These interruptions and distractions were continued until the end of the exercise.

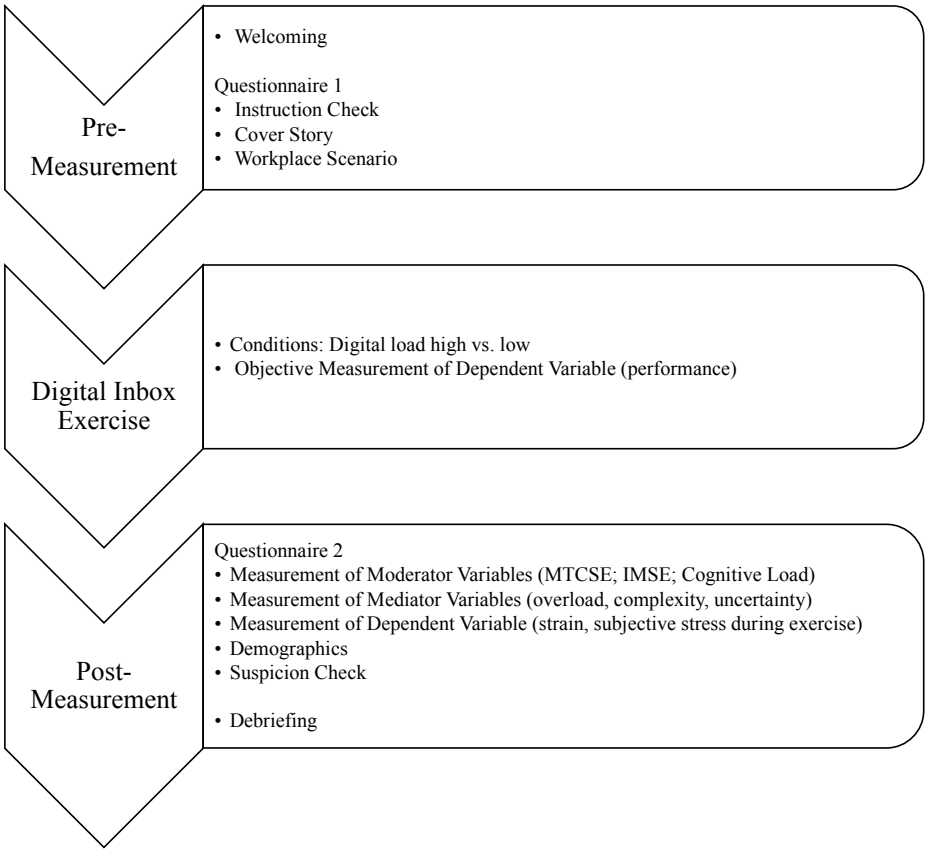

Figure 4.2. Procedure of Study 4.

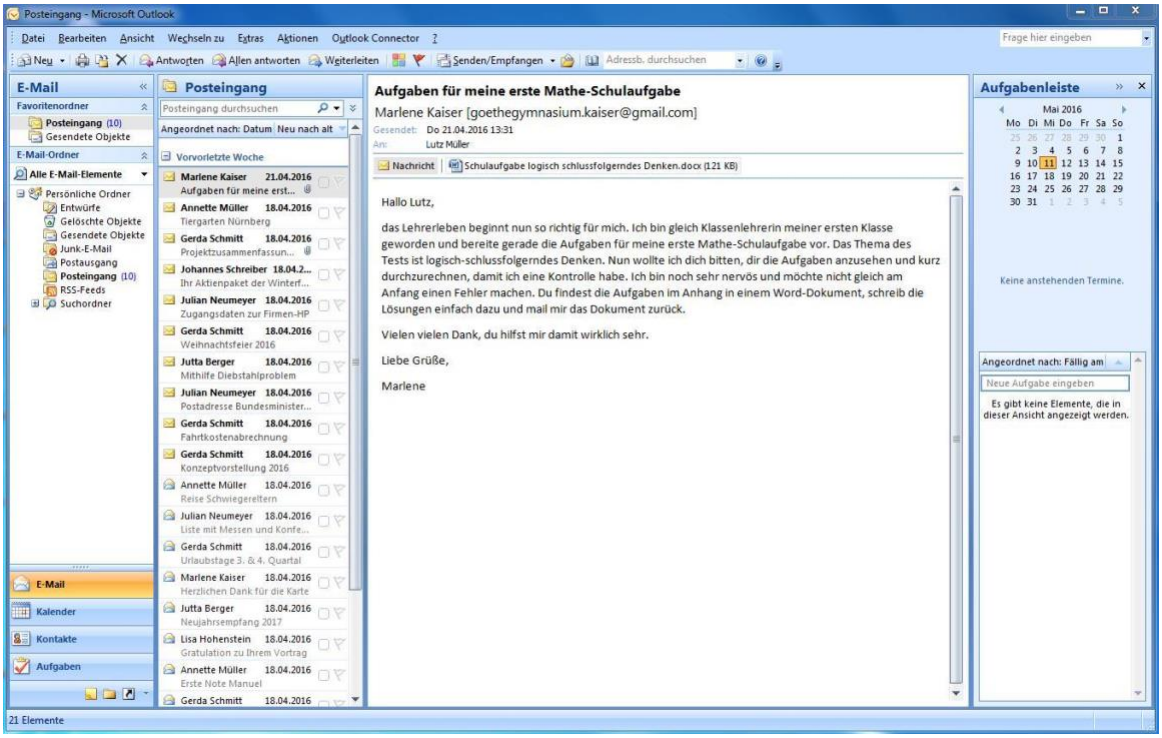

Figure 4.3. Digital inbox used for the experiment in Study 4.

Dependent variables

Performance. The ten tasks in the digital inbox exercise were used as objective criteria to assess performance. Based on the ratings of three independent reviewers, the tasks were categorized as being easy, medium, or complex. Easy tasks required actions like saving a file in a specific folder; medium tasks things like searching for information on the internet, and complex tasks actions like completing a short test about logical deduction, reasoning, or finding solutions for a given problem. For the easy tasks, the medium tasks, and the complex tasks about logical deduction and reasoning, the number of correctly answered tasks was totaled to create a sum score. For the complex problem-solving task, the number of proposed solutions was used as a quantitative performance measure. Additionally, participants were asked to assess their individual performance on a 7-point Likert scale (1 = *very bad*, 7 = *very good*) after they had finished the digital inbox exercise.

Strain. As in the prior studies, the translated subscale from Ayyagari et al. (2011) was used in the second questionnaire (α = .90; all presented α-values are Cronbach α-values) to examine the ICT-induced strain felt by participants. Participants rated how often they felt tired, burdened, or exhausted from the use of digital ICT (1 = *never*, 7 = *daily*). Additionally, they were asked to indicate the extent to which they experienced stress during the digital inbox exercise (1 = *very low*, 7 = *very high*).

Moderator variables

Based on previous research (e.g., Ayyagari et al. 2011; Brooks, 2015), we expected that individual computer self-efficacy would moderate the relationship between the digital information load and performance in the digital inbox exercise. Two translated subscales from Basoglu et al. (2009) focusing on computer-based multi-tasking (Multi-Tasking Computer Self-Efficacy Scale; MTCS) and interruption-

management (Interruption-Management Self-Efficacy Scale; IMSE) were integrated into an overall scale (α = .93), which was used to measure participants' perceptions of their computer efficacy. Participants evaluated the extent to which they agreed or disagreed with statements like "I believe I can work on several different tasks simultaneously." (Item from the MTCS subscale; 1 = *strongly disagree*, 7 = *strongly agree*).

Following Basoglu et al. (2009), participants were exploratively asked to what extent they experienced cognitive load during the digital inbox exercise (1 = *very low*, 7 = *very high*).

Mediator variables

To specify the relationship between digital information load and strain, the three technostress variables overload, complexity, and uncertainty were considered as possible mediators. Again, the adapted subscales from Ragu-Nathan et al. (2008) were used (overload: α = .87; complexity: α = .88; uncertainty: α = .87) and integrated into an overall scale (α = .87). Participants rated how much they agreed or disagreed with statements such as "There are always new developments in the technologies we use." (1 = *strongly disagree*, 7 = *strongly agree*; contextual definition about modern technologies was given; item from the uncertainty subscale).

4.3.2 Results

No subjects had to be excluded from the dataset due to missing data, suspicion or revision of their preliminary decision to participate.

Effects of digital information load on performance

Following previous research into the effects of information overload and ICT usage (e.g., Brooks, 2015; Kirsh, 2000; Klausegger, 2007; Levine, 2012), as well as the DCT (Baron, 1986), we assumed that performance scores in the two experimental conditions (low digital load vs. high digital load) would differ depending on task complexity (easy tasks vs. complex tasks). Therefore, contrast analyses were performed.

Data revealed a significant difference in the sum score for simple tasks between the groups with low (M = 2.43, SD = 0.63) and high (M = 2.04, SD = 0.73) digital information load, with a mean difference of -0.39 (SE = 0.12), p = .001. Participants in the low information load condition thus performed better at simple tasks than participants in the high information load condition. Contrary to our assumptions, for the sum score of the complex tasks (i.e., logical deduction and reasoning, problem solving), no significant difference was found (MD = -0.60, SE = 0.33, p = .071) between the two experimental groups (low digital load: M = 6.86, SD = 1.82; high digital load: M = 6.23, SD = 1.90). Descriptive statistics showed non-significant tendencies for performance to decrease from the low digital information load condition to the high information load condition in all tasks.

An additional contrast analysis (low digital load vs. high digital load) was performed to assess whether participants' perceptions of their performance would differ between the two experimental conditions. It was found that participants in the high digital load condition (M = 4.01, SD = 1.14) reported a significantly lower level of perceived performance than participants in the low digital information load condition (M = 4.47, SD = 1.32), with a mean difference of -0.46 (SE = 0.21), p = .029.

A *t*-test also indicated a significant effect of gender on subjective performance, ($t(138) = 2.23$, $p = .027$, $d = 0.44$),.with men ($M = 4.68$, $SD = 1.35$) rating their performance significantly higher than women ($M = 4.12$, $SD = 1.19$).

Moderation analysis for the impact of computer self-efficacy on performance

To assess whether participants' perceptions of their own computer efficacy moderated the effect of digital load on performance, a moderation analysis was performed using Hayes' (2018) PROCESS macro (model 1). Following the assumption of item response theory (Lord, 1980) that medium tasks have the best discriminatory power, they were used as the dependent variable. The data showed that the interaction between digital load and computer self-efficacy was statistically significantly different from zero ($\beta = .026$, $t(136) = 2.541$, $p = .012$, R^2-*Incr.* = 4.3%), meaning that computer self-efficacy functioned as a moderator of the effect of digital load on performance. Furthermore, conditional regression coefficients revealed that when computer self-efficacy was either above average (one standard deviation above the mean) or average, digital load was not a significant predictor of performance (above average: $\beta = .113$, $p = .464$; at average: $\beta = -.149$, $p = .181$). However, when computer self-efficacy was below average (one standard deviation below the mean), digital load significantly predicted performance, $\beta = -.474$, $p = .005$. See also Figure 4.4.

Moreover, following Basoglu et al. (2009), an exploratory multiple moderation analysis was performed to assess whether perceived cognitive load acts as an additional moderator. However, no significant effect was found.

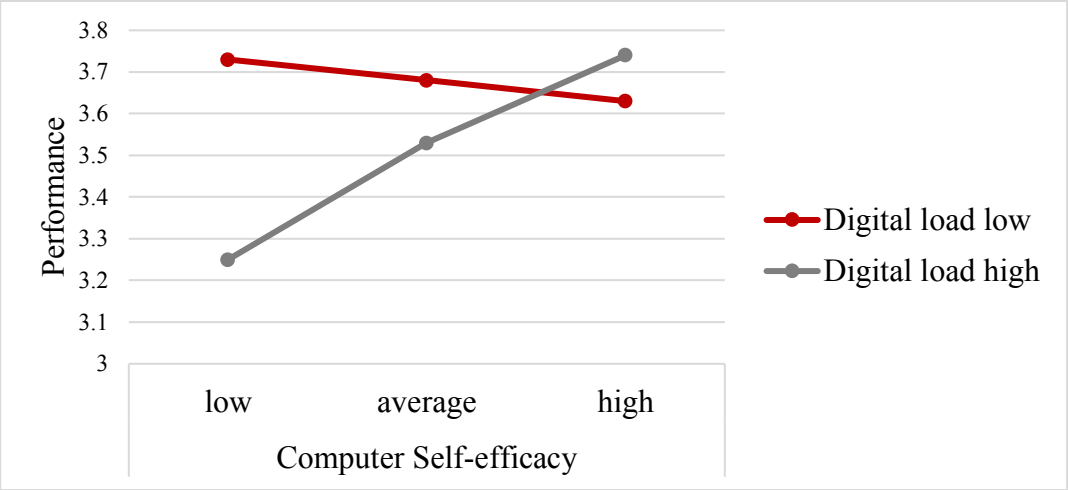

Figure 4.4. Task performance between conditions when computer self-efficacy is low, average, and high in Study 4.

Effects of digital information load on strain

The same contrast analyses (low digital load vs. high digital load) were then performed to investigate whether the experimental condition affected the level of strain participants felt, and their level of perceived stress during the inbox exercise. Data revealed that the level of strain did not differ significantly between participants in the high digital load condition (M = 12.01, SD = 5.06) and participants in the low digital load condition (M = 12.20, SD = 5.03), with a mean difference of -0.19 (SE = 0.85), p = .828. The perceived stress level did not significantly differ between the two groups, either (high digital load: M = 3.54, SD = 1.46; low digital load: M = 3.31, SD = 1.31), with a mean difference of 0.23 (SE = 0.24), p = .332.

To check for gender effects, further t-tests were performed, but no significant difference was found between women (M = 12.50, SD = 5.11) and men (M = 10.74, SD = 4.55) for strain (t(138) = -1.73, p = .087, d = -0.36). Nor was there a significant difference in perceived stress level during the inbox exercise between women (M = 3.51, SD = 1.41) and men (M = 3.13, SD = 1.28), t(138) = -1.37, p = .175, d = -0.28.

Mediational analysis for the impact of technostress creators on strain

Even though the data showed no significant direct effect of digital load on strain, a mediation analysis was performed using Hayes' (2018) PROCESS macro (model 4) to assess whether an indirect effect could be found. Specifically, it was tested whether the level of digital load would predict strain, and whether the direct path would be mediated by the perceived technostress variables overload, complexity, and uncertainty. Bootstrapping with 5000 samples and heteroscedasticity consistent standard errors (Davidson & MacKinnon, 1993) was used to compute the confidence intervals and inferential statistics.

The data revealed that participants faced with a high level of digital load did not show an increased level of technostress, a = -0.61, $t(138)$ = -0.27, p = .784, 95% CI [-5.03, 3.81]. However, participants who perceived a high level of technostress reported increased strain, b = 0.15, $t(137)$ = 5.20, $p < .001$, 95% CI [0.09, 0.21]. The bias-corrected bootstrap confidence interval for the indirect effect of technostress on strain (ab = -0.09) included zero (-0.80 to 0.55). This indicates that the perceived technostress did not mediate the effect of digital load on strain.

4.3.3 Discussion

The results of the present experimental study provide indications that the digital information load individuals are faced with at a digital workplace can influence their performance. A high digital information load was found to affect performance in easy tasks negatively, but not in complex tasks. These findings are contrary to our assumptions. Based on DCT (Baron, 1986), we expected that in simple tasks, a high digital information load might help exclude irrelevant cues, and therefore facilitate performance. However, the data suggest that participants' performance in simple tasks

was in sum significantly lower in the high digital information load condition than in the low digital information load condition.

Following the DCT (Baron, 1986), in the case of complex tasks, a high digital load may lead to missing essential cues, and therefore inhibit performance. In the present study, participants' performance in the complex tasks was not overall lower in the high digital load condition compared to the low digital load condition.

However, there were a number of heterogeneous effects even in previous research. For example, Nicholson et al. (2009) investigated the effect of distractions (i.e., a tape of the world news as low distraction; a tape of students discussing college life as high distraction) and task complexity on participants' productivity. In line with the DCT, they found that as the distraction level increased, the arousal created by the distraction and task complexity had a negative effect on performance. However, in simple tasks, contrary to their prediction and the DCT, participants in the no distraction condition showed better performance than participants in the low distraction condition, and also outperformed participants in the high distraction condition. To explain this, it was argued that perhaps the simple tasks were not simple enough, leading participants' performance to be affected. This could be a possible explanation for the present findings, too. However, like Nicholson et al. (2009), we do not favor this explanation, especially because there was no significant effect on complex tasks in our data.

Moreover, we also found that a high level of computer self-efficacy did not reduce cognitive load (e.g., Basoglu et al., 2009). Concerning the moderating role of the individual's computer self-efficacy (i.e., the ability to manage interruptions and multi-task), the data revealed a significant effect. The model showed that there was a negative effect of digital information load on performance, but only when participants believed that they were bad at managing interruptions and multi-tasking (i.e., their

computer self-efficacy was below average). Some prior studies have not found a significant moderator effect for multi-tasking (e.g., Brooks, 2015); they interpreted these results as support for the common assumption that people are not as good at multi-tasking as they think they are. However, our results add to the existing literature by conversely suggesting that peoples' perceptions of their competences should be taken into account, primarily when they attribute shortfalls to themselves.

Concerning the strain model, contrast analyses revealed no significant effect of digital information load on either technostress or strain. Participants in the high digital information load condition did not report a significantly higher level of perceived stress during the digital inbox exercise, nor a significantly higher level of strain.

The mediational analysis, which aimed to test technostress as a potential mediator in the relationship between digital load and strain, showed that participants faced with a high digital load did not perceive increased technostress, even though a high level of technostress leads to increased strain. Although the mediation analysis did not gain significance, the correlation between technostress and strain is in line with prior findings (e.g., Ayyagari et al., 2011; Tarafdar et al. 2011).

However, there are different conceivable explanations for these unanticipated results. First, it is possible that the kind of exercise affected participants' responses regarding technostress and strain. As the inbox exercise is known for being an assessment center tool, it is possible that participants felt challenged and did not want to report feelings like stress or strain. We attempted to obviate such an effect by using a cover story. To be more specific, participants were told at the beginning of the experiment that the study intended to evaluate and optimize a digital version of the inbox exercise, and that it was thus crucial that they answer openly. Nonetheless, perhaps it would have been better to use a different kind of dependent variable. For example, Brooks (2015) examined the relationship between social media usage,

technostress, and happiness, and found significant effects. Thus, happiness may be an appropriate inverse equivalent for strain, even for the present model.

Second, the digital load manipulation we employed might have been too weak to trigger technostress or strain. However, this seems somewhat improbable, as we used different kinds of interruptions and distractions to simulate an authentic work environment in a modern organization. A further reason to the contrary is the negative effect of digital load in the performance model, particularly the finding that participants in the high digital load condition rated their performance significantly lower than participants in the low digital load condition. This suggests a sufficient manipulation. However, perhaps with an additional, specific manipulation check, future studies can avoid this issue.

Third, it is possible that participants' ages affected the findings. With a mean age of around 23 years, participants were rather young, and might thus be less prone to technostress than older people. The findings from Study 1, Study 2 and Study 3 showing that technostress can increase with age support this potential explanation, as does previous research on technostress (e.g., Burton-Jones & Hubona, 2005; Tu et al., 2005).

Theoretical and practical implications

Previous research has already provided great insight into the concepts of technostress and information overload, as well as their potential antecedents and consequences. The present study can be considered an extension of this work, by creating an experimental setting for studying these concepts and effects. To the best of our knowledge, the present study is the first one to look at the potential negatives that can result from a high digital load in an experimental office work environment. The findings extend previous correlational research and contribute to a better

understanding of relationships (i.e., between digital load and performance or strain) and potential underlying psychological processes (i.e., self-efficacy; technostress). Furthermore, as far as we are aware, the present study may be the first one showing a causal link between digital information load and performance losses.

Beyond this, the presented digital inbox exercise is easy to apply and can be used for future studies, especially in experimental settings. Given that the exercise is designed in Office Outlook, which is a standard e-mail program used in many organizations, it is conceivable that a multitude of employees and organizations could be tested without expecting major difficulties. Moreover, the task-containing e-mails make it easy to operationalize objective performance measurements. The e-mails (as well as the distractions and interruptions used for the digital load manipulation) can also be easily adapted to a new research concern or organizational issue.

Moreover, the study extends the DCT literature (Baron, 1986) by addressing the effects that distractions caused by the usage of different ICT can have on an individuals' performance in easy and complex tasks; primarily by showing that an attentional conflict caused by incoming digital information did not necessarily help to exclude irrelevant cues. Thus, it contributes to the current scientific debate and supports the continued development of existing models.

From a practical point of view, the research contributes to a better understanding of digital technologies' impact on organizations. It provides a look at some potential adverse outcomes of the increasing digital load that employees are having to deal with at modern office workplaces. Our findings indicate that in an environment characterized by the collective use of different digital devices, the digital load can function as an interference and impair individuals' performance, especially when their computer self-efficacy is low.

Due to ongoing digitalization, organizations have a strong focus on the implementation of digital technologies in working routines. For example, they aim to simplify processes, support their employees in working more effectively, or facilitate quicker responses to requests or changes. This issue has been successful in many cases, and the increasing use of digital ICT provides many benefits for individuals. However, it can also create some hindrances to success, as the present findings underline.

Therefore, clear regulations of ICT usage in organizations should be considered, so that the potential benefits digital devices bring to employees can be fully realized. Organizations should address the question of how a working environment should be shaped so that it has a beneficial impact on employees' workflow. Our findings support recommendations that have already been made by previous research (e.g., Kirsh, 2002), such as the importance of clarifying how individuals in a digital workplace coordinate their activities, plan their next moves, clear clutter and get on with sub-tasks, or mark their progress to enable the quick resumption of a task they might have had to abruptly stop. Moreover, specialized training and mentoring programs on self-management may help bolster employees' knowledge base when it comes to handling the distracting nature of modern ICT, and thus strengthen their computer self-efficacy (e.g., Davis, 2000; Hallowell, 2005).

Limitations and Future Directions

The present research is limited in a few ways, but these limitations can nevertheless be fruitful starting points for future research. First, using a primarily student sample can lead to issues regarding the generalization of the results. most notably for the findings concerning technostress. Given that the mean age in our sample was quite young, and younger people may be less prone to technostress, a

question rises concerning whether the results would be the same for older participants. We would thus encourage future research to focus on improving generalizability by replicating the study across various samples (e.g., older participants, professionals from different organizations, sectors, or positions).

Second, following Nicholson et al. (2009), it is likely that different types of distractions and interruptions can lead to different effects on task performance. For example, self-chosen soft background music may have fewer detrimental effects on employee performance than the sounds of a street musician, which cannot be controlled or influenced. In terms of the present study, all of the interferences were uncontrollable for the participants, and additionally, used different sensory modalities (i.e., distractions and interruptions). By proceeding in this way, we wanted to ensure that participants would perceive a high level of digital load in the high digital load condition. Nonetheless, it is not possible to isolate the specific effects of each individual interference.

Third, the type of tasks may also have an effect, and have interplay with the interferences. However, using different tasks can strengthen a study (e.g., Wells & Windschitl, 1999).

Fourth, all of these effects are likely to be influenced by individual characteristics (e.g., affect, experiences). As the experimental setting includes different kinds of interferences and different kinds of tasks, it is not possible to isolate individual effects. In terms of future research, further studies are needed to clarify how individuals respond to different types of distractions and interruptions, and how these affect different types of tasks in turn.

Finally, a further aspect might be that we only looked at task performance (i.e., the correctness of tasks) and did not take the time participants needed to complete the tasks into account. Nicholson et al. (2009) only found a significant difference between

their no distraction and low distraction conditions by examining overall productivity (i.e., correctness and time). Thus, measuring productivity (and not just performance alone) might have an impact on the size of the found effects. Even though no definite explanation for the current findings can be given, the present results are of use to the current debate. Moreover, future studies can address these points in the development of experimental settings.

Lastly, many of the path weights reported in the present study may be considered statistically low. As Brooks (2015) described, the investigation of broad constructs such as performance and strain as dependent variables entail that many other constructs would also have an effect on them.

By showing in an experimental setting that the digital load individuals have to deal with at an office workplace can affect performance, the present study made one step forward in ICT research. Future studies should adapt and extend the used models to identify more influencing factors, and thereby expand the existing literature.

Taken together, the present study offers fertile ground for further investigations, and each of its limitations can provide an interesting starting point for future research.

4.4 Conclusion

The usage of different digital devices and applications in the workplace offers numerous new opportunities, and can make work smarter and more efficient. However, these digital companions can come with downsides. The experimental research reported in this study addresses the question of how digital load (i.e., different kinds of digital distractions and interruptions) influences performance and the strain felt by individuals at a modern office workplace. Results showed that participants' performance in easy tasks was negatively affected by a high digital load. This held

especially true for participants with low computer self-efficacy. A significant effect of digital load on strain could not be found. However, in line with prior findings (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011) technostress was positively associated with strain. Given that ongoing digitalization will continue to increase the digital load working individuals are faced with, further research is needed to gain better understanding of this phenomenon.

5. General Conclusion

5.1 Summary

The present dissertation aims to provide a deeper understanding of the interplay of different factors to predict the psychological outcomes of employees' ICT usage in modern work environments. Concretely, four studies (i.e., three field studies and one experimental laboratory study) were conducted to empirically explore (1) the role of ICT usage time and ICT usage frequency as potential antecedents of technostress; (2) the interplay between individual ICT usage behavior, individual characteristics, organizational ICT support, technostress, and ICT-related psychological outcomes (i.e., strain, detachment, productivity, and innovation); and (3) the impact of digital information load on individuals' performance and strain in an experimental setting.

The purpose of the field study presented in ***Chapter 2*** was to investigate (1) the role of employees' digital ICT usage time as a potential antecedent of technostress, and (2) the interplay of individual characteristics (i.e., age, gender) with ICT usage time, technostress and psychological outcomes (i.e., strain, productivity, innovation, and detachment). The results revealed significant differences in employees' digital usage behavior (i,e., usage time of different digital devices) in the private and working contexts. Moreover, significant gender and age differences were found. Concerning detrimental effects of ICT usage, the results indicated that having a high rate of smartphone usage at work was particularly associated with technostress (i.e., overload, complexity, uncertainty), and that in turn, technostress functioned as a predictor of ICT-related strain. In line with Tu et al. (2005), the reported technostress level was higher among employees aged 50 years or older. However, it was also found that

young people showed smartphone overuse tendencies, and thereby struggled with detachment problems. Concerning the beneficial effects of ICT use, data showed that smartphone usage at work was positively associated with productivity and innovation. Gender comparisons showed that men rated their productivity and innovation levels as being significantly higher than women did.

The two organizational field studies in ***Chapter 3*** aimed to replicate and expand the findings of Study 1. Study 2 and Study 3 focused on the role of employees' ICT usage frequency and individual characteristics (i.e., age, gender, employees' current position in the company) and their interplay with technostress (i.e., overload, complexity, uncertainty) and psychological outcomes (i.e., strain, productivity, innovation). Additionally, practical ICT usage scenarios were used to assess employees' perceived stress levels in working situations (i.e., during different ICT activities). As an organizational context variable, employees' ICT support usage rate was considered as a potential inhibiting mechanism.

Across the two studies, results revealed that employees' ICT usage behavior (i.e., ICT usage frequency and perceptions of the ICT usage scenarios) differed depending on their age, gender, and current position in the company. Organizational comparisons indicated similar usage tendencies for employees in both companies.

Concerning the detrimental effects of ICT usage, data from both studies suggest an interplay between ICT usage frequency and technostress. Analogous to Study 1, the perceived technostress level was higher among older employees.

With regard to the beneficial effects of ICT usage, it was found that in both studies, the usage frequency of certain digital devices and applications (e.g., Sharepoint, Skype) was positively associated with increased productivity and innovation, and decreased complexity.

A serial multiple mediation model was then performed in both studies, with the aim of exploring potential underlying psychological processes. In Study 2, no significant direct effect of ICT usage frequency on strain could be found, but the indirect path, which investigated ICT support and technostress as serial mediators, gained significance. The data suggested that the more employees used digital ICT, the more they made use of ICT support, and the higher their perceived technostress was. In turn, this predicted strain. In Study 3, neither the direct nor indirect paths reached significance, with the two mediators being investigated in series. Employees from the Study 3 organization did not use ICT support more often, even though a high ICT support usage rate was associated with increased technostress, and thus with increased strain.

Explorative analyses of employees' ICT training needs and organizational ICT support revealed that there were unmet needs in both organizations (i.e., in Study 2 and Study 3).

The purpose of the laboratory study in ***Chapter 4*** was to experimentally investigate the distracting nature of digital information load, and the potentially detrimental effects (i.e., increased strain, reduced performance) that can arise when individuals use ICT in a digital workplace. The results of Study 4 indicate that being continuously confronted with new, incoming digital information (i.e., high digital information load) can cause interference, and thus negatively influence performance in various objectively measured easy tasks. Contrary to expectations and the DCT (Baron, 1986), no effect was found for complex tasks. Moderation analyses revealed that the negative effect held particularly for participants with a low level of computer self-efficacy (i.e., those who saw themselves as being less skilled at computer-based multi-tasking and managing interruptions). Moreover, participants' perceptions of their performance were also lower in the high digital load condition.

No significant effect of digital information load could be found concerning the strain model for either technostress or strain. Mediation analyses suggest that participants in the high digital load condition did not perceive a higher level of technostress, even though increased technostress led to increased strain.

5.2 Implications of the Present Thesis

The present thesis' findings provide a deeper understanding of the interplay of different factors in predicting the psychological outcomes of employees' ICT usage in modern organizations. These findings have significant theoretical implications for future research on ICT usage. Moreover, they provide practical implications for handling ICT in organizations. With the specific implications of the interplay between ICT usage behavior (i.e., usage time, usage frequency), technostress (i.e., overload, complexity, uncertainty), detrimental ICT-related outcomes (i.e., strain, detachment problems), beneficial ICT-related outcomes (i.e., productivity, innovation), individual characteristics (i.e., age, gender, position in the company), digital information load, and self-efficacy having been addressed in detail in the previous chapters, this section focuses on the theoretical and practical implications of the present research as a whole.

5.2.1 Theoretical Implications

First, the results of the present thesis provide important theoretical implications for research on ICT usage in modern organizations. Previous research has provided great insights into the concept of technostress and its impact on individuals and organizations (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011). However, the majority of these studies either developed broad, aggregated statistical models to investigate technostress, which did not consider employees' usage behavior of different ICT (e.g., Ayyagari et al., 2011; Tarafdar et al., 2011); or selectively focused

on the use of one type of digital device, such as smartphones (e.g., Derks & Bakker, 2014; Volkmer & Lermer, 2019). Given that employees at a modern workplace use different ICT in their daily working routines, the present thesis explored employees' usage behavior of the most common ICT (Statistisches Bundesamt, 2019a). To the best of our knowledge, its findings are among the first ones highlighting the roles of the usage time and usage frequency of different ICT as potential antecedents of technostress. Across three studies, the findings indicate an interplay between employees' ICT usage behavior (i.e., usage time or usage frequency of different ICT), technostress, and ICT-related psychological outcomes (i.e., strain, detachment, productivity, innovation). Future research will need to further focus on employees' ICT usage behavior and the interplay of different ICT at modern workplaces to clarify, for example, the relevant circumstances under which the named beneficial and detrimental effects of ICT usage occur.

Second, the present research contributes to a limited body of research exploring potential moderators and mediators in the interplay of ICT usage, technostress, and ICT-related psychological outcomes. In Study 1, a moderator analysis was performed to specify the relationship between smartphone usage at work and detachment. In this study, smartphone overuse tendencies in after-work hours moderated these effects. Although previous research on smartphone usage had already explored the moderating role of smartphone overuse in the context of work-home interference and detachment (e.g., Derks & Bakker, 2014), to the best of our knowledge, they had not yet established a connection between smartphone usage time at work, smartphone overuse tendencies in after-work hours, and detachment.

In Study 4, a further moderator analysis was performed to clarify the relationship between digital information load and performance. In this study, computer self-efficacy moderated this effect. As far as we are aware, previous research in the

context of ICT usage had focused on computer self-efficacy as a potential moderator (e.g., Brooks, 2015), but had not examined it an experimental study before, whereby the amount of digital information load could be manipulated, and performance measured objectively. Thus, in both Study 1 and Study 4, the explorative moderator analyses contribute to extending the existing literature.

Concerning mediation effects, the studies in the present thesis show somewhat mixed findings. In Study 1, technostress mediated the relationship between smartphone usage at work and strain. In Study 2 and Study 3, organizational ICT support and technostress were explored as serial mediators in the relationship between employees' ICT usage behavior and strain. In Study 2, the indirect paths testing the serial mediation effect of ICT support and technostress gained significance, whereas in Study 3, they did not. In the experimental Study 4, neither a significant relationship between digital load and strain nor a significant mediation effect of technostress were found.

It is important to emphasize that we clearly restricted the inferences of these effects to the specific studies. The present research's mediation tests were based on theoretical reasoning and previous findings (e.g., Ajzen, 2001; Ayyagari et al., 2011; Brooks, 2015; Fishbein & Ajzen, 1975). Following Fiedler, Harris, and Schott (2018), we are fully aware that a significant mediator result does not reflect a general law, nor does it go beyond the specific finding obtained in the respective study. Fiedler at al. (2018) argued that it is unwarranted to draw general conclusions from a significant test of selective variables integrated into selective models, as it is logically impossible to rule out all of the potential alternative mediators and models. In sum, the present findings illustrate the complexity of the interplay between ICT usage, organizational impacts, individual psychological stressors, and individual psychological outcomes.

Thus, they underline the importance of future research in exploring potential alternative mediators and causal models in the context of employees' ICT usage.

Third, the findings of the present thesis contribute to the debate concerning questions such as who is most likely to be affected by technostress; struggle the most with detrimental psychological outcomes; or profit the least from the beneficial outcomes of ICT usage. The results across the three field studies indicate that technostress and psychological outcomes can differ depending on employees' individual characteristics (i.e., age, gender, and current position; for a more detailed discussion, see Chapter 2 and Chapter 3). Concerning age, the three studies' findings continuously showed that perceived technostress was the highest among employees aged 50 or older. These results are in line with some previous findings (e.g., Burton-Jones & Hubona, 2005; Tu et al., 2005). However, within the context of ICT research, it is striking that a large body of previous studies paid particular attention to young people. Various research focuses on the younger generations' ICT usage behavior, as so-called "digital natives" (Prensky, 2001). They are entirely at home in the world of digital devices and applications, and are often characterized as "native speakers" of the digital language of computers, video games, and the internet (Colbert et al., 2016; Prensky, 2001). Some predict that these new generations will revolutionize the future workplace within a few years, due to their different expectations of work and work practices (e.g., Colbert et al., 2016). Even though this may seem quite positive at first glance, it raises the question of what exactly will happen with older generations, the so-called "digital immigrants" (Prensky, 2001), who were not born into the digital world. Given that they represent the majority of the current working population, they should not be neglected, neither in research nor organizational practice.

Moreover, it is important to mention that an increasing body of research also highlights the negative effects of the "always-on" ICT usage behavior of the younger

generations. Nass (2013), for example, argues that young people's constant digital multi-tasking wastes more time than it saves, and that it may be killing concentration and creativity, too.

The findings of the present thesis' Study 1 also contribute to discussing potential downsides of ICT usage, by showing that the young employees had stronger tendencies to overuse their smartphones, and were thus more likely to struggle with detachment problems. Additionally, data from the experimental Study 4 showed that even among young people, perceived computer self-efficacy varied considerably. Given that the participants' mean age in Study 4 was relatively young, these findings suggest that young people can still struggle with a high digital information load and experience subsequent performance losses, especially when their perceived computer self-efficacy is low.

In sum, our findings underline that it is important to focus on the individual when examining how increasing ICT usage influences people's ways of working. Similarly, although we have a digital education mission for young people; we should also assume responsibility for providing such education to older people. The section concerning practical implications will further discuss this issue, and provide a detailed discussion of how it might be addressed in organizations.

Taken together, the results of the present thesis suggest that if we want to predict the psychological outcomes of ICT usage at a digitalized workplace, it is important to focus on the interplay of different factors; amongst others, on individuals' ICT usage behavior, individuals' personal characteristics, and organizational support mechanisms.

5.2.2 Practical Implications

Beyond its theoretical implications, the present research also provides starting points for potential improvements in organizational practice. When working at a digitalized workplace, people often deal with different digital devices without scrutinizing their usage behavior. For example, simultaneously working on a specific project, keeping an eye on an e-mail inbox, and monitoring different business platforms (e.g., Slack, Sharepoint), has become a natural and integral part of many employees' daily working routines. Given that two computer screens are a common feature at many modern workplaces, this usage behavior does not even constitute an aggravating circumstance. However, our findings suggest that using different digital devices for a long time or with great frequency can foster negative psychological effects such as technostress, strain, or detachment problems. Moreover, a high digital information load can function as a promoting factor for performance losses by causing work interference. Thus, to provide a healthy long-term work environment, the present research suggests that organizations should not solely count on employees' self-responsibility concerning their ICT usage. In line with the implications from previous literature, which suggest that employees' work behavior should be better monitored (e.g., Ayyagari et al., 2011; Cross and Gray, 2013; Ragu-Nathan et al., 2008), our results emphasize the importance of making employees aware of the potential downsides of working with digital devices. Furthermore, organizations should work on the development of collaborative strategies concerning improving ICT use.

In the same vein, organizations could benefit from evaluating technostress. Following the present and previous research (e.g., Tarafdar et al., 2011), organizations could, for example, determine how "technostressed" their employees are by examining their digital information load, or assessing their ICT-related multi-tasking behavior (i.e., information overload). Additionally, organizations could consider whether or not

employees find working with the available digital devices and applications challenging (i.e., complexity), or feel unsettled by ICT-related changes such as continuous upgrades (i.e., uncertainty). Also, an "always on" mentality among employees (i.e., invasion), or signs that they feel uncomfortable from working with ICT (i.e., insecurity) could be indications of critical technostress-creating conditions within the organization. To summarize, a targeted evaluation would allow organizations to detect potential detrimental factors early on, analyze them, and take appropriate countermeasures.

The current findings can also be used to better optimize ICT support within organizations. Previous research described technical support provision as an organizational mechanism that can offset the intensity and outcomes of technostress-creating conditions (Tarafdar et al., 2011). Nonetheless, current statistics reveal that only 32% of Germany's organizations offer employees who are not themselves ICT specialists ICT-related training (Statistisches Bundesamt, 2019a). Given that most employees are now using ICT for their daily work across many sectors, this seems meagre. Furthermore, our findings indicate, in line with previous research (for a review, see Köffer & Urbach, 2016), that merely providing ICT support services (e.g., a help desk) might not be enough. The explorative analyses of employees' ICT training needs in Study 2 and Study 3 revealed unmet needs in both organizations. Even though these results might be claimed to be sample-specific and organization-dependent, the current national statistics indicate that this might not be a rare phenomenon. This is further highlighted by our data demonstrating that ICT support and training needs can vary among employees depending on their individual characteristics (e.g., age, current position in the company). In other words, the findings emphasize, in line with previous research (e.g., Maruping, & Magni 2015; Mayer, Bischoff, Winter, & Weitzel, 2012; Srivastava, Chandra, & Shirish, 2015), that "one

fits all" solutions are inadequate for supporting employees in solving the challenges presented by working with modern ICT. The findings call for individual approaches and solutions that better target employees' preferences, job roles, and work behaviors (Köffer & Urbach, 2016).

For example, with regard to the present result that younger employees experience less technostress than older employees, a specific practical approach could be to provide a forum that invites younger and older employees to exchange knowledge, ideas, or suggestions for their current ICT-related challenges. Such communication and networking platforms could be useful in various ways, enabling young employees to share information and insights about the modern ICT they have grown up with, and older employees to share the knowledge they have gained from their experiences (e.g., knowledge concerning the organizational history or culture). Within a team, for example, "tandems" could be formed to facilitate such dialog, and enable it to also address more area-specific topics.

To summarize, providing support services without analyzing employees' ICT usage behavior and their demands runs the risk of organizations spending large amounts of money on something that may be insufficient for addressing their employees' real needs. Instead, organizations should invest in their employees, and offer tailored training and communication/networking platforms, supporting them in developing their competencies and ICT-related skills.

5.3 Limitations

Although the present research has provided new insights into the interplay of different factors in predicting psychological outcomes of ICT usage at a digitalized workplace, it has some limitations that need to be discussed. With the specific limitations of each study being discussed in their respective chapters, this section will address the present research's overall limitations.

One such flaw is that the conceptualization of ICT usage behavior (i.e., conceptualized as usage time in Study 1, and usage frequency in Study 2 and Study 3) may itself be an issue. As Goodhue and Thomson (1995) stated, to know that a person used a system three times means one thing if there were four tasks, but something entirely different if there were 20 tasks. Thus, future studies should try to examine individuals' digital usage behavior with alternate conceptualizations (i.e., the utilization period, divided by the number of processed tasks) or alternative methods, such as independent assessments or monitoring behavior (e.g., observation of working with ICT, instead of self-reports and usage scenarios).

Another limitation is that the presented studies focused on a limited selection of ICT. Even though we (1) based our selection on current statistics of German employees' most commonly used ICT (Statistisches Bundesamt, 2019a), and (2) considered organizational conditions in Study 2 and Study 3, this selection cannot cover the full variety of ICT that are now potential components of a digitalized workplace. Therefore, future studies should investigate the usage of various other ICT, and focus on replicating the current findings.

Moreover, the findings are limited due to the presented data being collected at only one point in time. Thus, long-term effects were not assessed. Even though some relationships had already been assessed in longitudinal studies, such as that between stressors and strain (Moore, 2000), it would be interesting for future research to

investigate the interplay of ICT usage behavior and the considered beneficial and detrimental psychological outcomes over time. Concerning the effects of organizational ICT support, specific intervention studies would help determine promising approaches for improvements.

Finally, it must be mentioned that the current findings of the field studies (Study 1, Study 2, Study 3) might have limitations concerning the isolation of ICT effects. Although particular emphasis was laid on creating a clear contextual framework for the respondents (i.e., their ICT usage), it cannot be ruled out that employee assessments might have been affected by other causes. For example, even though we clearly addressed ICT-related strain, it is possible that employees could not fully exclude other causes when making their responses. With Study 4, a first attempt was made to alleviate such concerns, by using an experimental setting.

Taken together, even though the present thesis has provided insights into the questions of whether and how different individual factors interact with technostress as well as both beneficial and detrimental psychological outcomes, further research is needed to reach a deeper understanding of possible antecedents and consequences of ICT usage in modern organizations.

5.4 Future Directions

The present thesis aims to provide a deeper understanding of the interplay of different factors in predicting the psychological outcomes of ICT usage at a digital workplace. The findings highlight the role of individuals' ICT usage behavior (i.e., ICT usage time and frequency), and individuals' personal characteristics (i.e., age, gender, position in the company) in examining technostress, as well as beneficial and detrimental ICT-related psychological outcomes. The results emphasize that even though modern ICT provide numerous new opportunities, it is also important to

recognize the potential downsides they can cause. Thus, returning to Drake's (2010) statement in the introduction: the present research underlines that ICT have changed working routines and working habits in a truly revolutionary manner during recent years. Further research is needed to not only examine the paradoxical psychological effects of ICT, but also to give direction to organizations concerning how to deal with them healthily, and thus to guide the nature of future work itself.

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