Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

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REMOTE WORK PERFORMANCE AND LONELINESS DURING THE COVID-19 PANDEMIC

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN TASK-TECHNOLOGY FIT, LONELINESS AND WORK PERFORMANCE.

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Sammendrag

COVID-19-pandemien i 2020 har hatt store påvirkninger på hele verden (Cucinotta and Vanelli (2020)). Den har ført til alvorlige samfunnsmessige problemer, som høyt antall dødsfall, bedrifter som går konkurs og påbud om sosial distansering. På grunn av pandemien, jobber nå flere enn noen gang fra hjemmekontor (Brynjolfsson et al. (2020)), som har vist seg å føre til en høy grad av ensomhet på grunn av isolasjon fra venner og kolleger (Shah et al. (2020)). Pandemien førte til en ny type arbeidsmiljø som dannet grunnlaget for denne masteroppgaven, der vi undersøkte effekten som task-technology fit for programvare til møter, fokusert arbeid og samarbeid, hadde på opplevd ensomhet og arbeidsytelse.

Vi samlet data gjennom et spørreskjema, og fikk totalt 360 svar fra forskjellige deler av verden. Flertallet av svarene kom fra enten Norge (36,39%), USA (31,67%) eller India (22,50%). I tillegg viste kontekstuelle data en høy grad av computer self-efficacy (mestringstro) og task interdependence blant respondentene. Dataen og forskningsmodellen ble analysert med PLS-SEM-analyse, og vi fant en høy grad av pålitelighet og validitet i alle delene av modellen. I tillegg bidro vi med tillegg til tidligere forskning om det flerdimensjonale målet på arbeidsytelse, ved å demonstrere en god forklaringskraft for de underliggende dimensjonene.

Bootstrapping av dataene viste støtte for 5 av 7 hypoteser. Programvare for samarbeid og fokusert arbeid hadde betydelige dempende effekter på ensomhet og styrkende effekter på arbeidsytelse. Imidlertid fant vi ingen bevis for effekten av møter. Vi fant også ut at ensomhet har betydelig en negativ påvirkning på arbeidsytelsen til individer. Funnene våre bidrar til økt forståelse av menneske-maskin-interaksjon ved å bygge videre på forskning om task-technology fit. Dette gjorde vi ved å koble det mot arbeidsytelse på et høyere abstraksjonsnivå, noe som tillater mer generalisering av funn og åpner for nye typer sammenligninger. Vi bidrar også til forståelsen av arbeidssituasjonen under pandemien.

Preface

The delivery of this thesis marks the end of over six years of studies to obtain our master's degree in Computer Science at the Norwegian University of Science and Technology. We met on the first day of school in the beginning of august 2014, and have worked closely together since then. Early on in our studies, we identified problems with the way our university, professors and peers organised their digital resources, and we developed simple websites for ourselves in response. The fundamental idea of organising information on the internet in a meaningful way lead to the founding of our own startup, Metaito, in February 2019.

The thesis you're about to read is not the one we intended to write, originally. Our initial plan was to test theories of technology acceptance on our self-developed software, with both conscious and subconscious measurements. However, as we all know too well, the COVID-19 pandemic sent us all home, making in-person research methods unfeasible. This caused a lot of worry and frustration, as the thesis work was already planned out, and we had a solid foundation for the research model.

In our time of need, our supervisor helped us find a new direction. It was apparent that the pandemic was changing society in many ways, and we decided to "take advantage" of the situation by doing research on remote work. Since then, the process of writing this thesis has proved to be both difficult and rewarding. We found great interest in the research we read, and sometimes found ourselves lost in the depths of science. However, the reading of countless articles resulted in a solid foundation for our research. In the end, we made something that we feel proud of, although we were cutting it a bit close. The final touches, including the writing of the paragraph you're reading right now was done on the day of delivery.

We would like to thank our supervisor, Patrick Mikalef, for his invaluable help in finding a direction for our thesis, keeping us in check, and for guiding us in the direction of topics that we could find interesting. Throughout the process, he has been both interested and patient. We are looking forward to co-authoring a scientific article with him based on the findings in our thesis.

We want to thank our families for giving us the foundation on which we have built our lives and knowledge, and our friends for being there when we need them and for providing a sense of belonging in the city of Trondheim. We also want to give a special thanks to our friend Martin Dorber, who asked "Why?", repeatedly, and helped us structure and focus in the final week of writing our thesis.

We hope that you, the reader, find this thesis interesting, and that it provides new insights and ideas that you can incorporate in either your professional or personal life. Lastly, we hope that the results can contribute to a better understanding of work conditions during the COVID-19 pandemic.

Abstract

The COVID-19 pandemic of 2020 has impacted the entire world population (Cucinotta and Vanelli (2020)). It has had severe societal consequences such as high death counts, businesses going bankrupt and enforced social distancing. Furthermore, because of the pandemic more people than ever are now working remotely from home (Brynjolfsson et al. (2020)), which has been found to result in high degrees of loneliness due to isolation from friends and colleagues (Shah et al. (2020)). The new work environment that was caused by the pandemic formed the basis for our thesis research, where we examined the effects that the task-technology fit of meeting, focused work and collaboration software had on loneliness and work performance.

We gathered data through a questionnaire, and got a total of 360 respondents from different parts of the world. The majority of respondents were from either Norway (36.39%), The United States (31.67%) or India (22.50%). Additionally, contextual data showed a high degree of computer self-efficacy and task interdependence in the survey population. The data and research model was analysed with PLS-SEM analysis, which found a high degree of reliability and validity in all model constructs. Furthermore, we expanded on previous research on the multi-dimensional construct of work performance by demonstrating a good explanatory power for the underlying dimensions.

Bootstrapping with our survey samples found support for 5 out of 7 hypotheses. The fit of collaborative work and focused work was found to have significant dampening effects on loneliness, and increasing effects on work performance. However, our research found no evidence for the effects of meetings. Lastly, our findings found that loneliness has a significant negative impact on work performance. Our findings contribute to the understanding of human computer interaction by furthering the research on task technology fit by connecting it to performance with a higher abstraction level, which allows for new comparisons and generalization of findings. We are also contributing to the understanding of the work situation during the pandemic.

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Abbreviations

AVE	=	Average Variance Extracted
CA	=	Cronbach's Alpha
CB-SEM	=	Covariance-Based Structural Equation Modeling
COVID-19	=	Coronavirus disease 2019
CPW	=	Counter-Productive Work
CR	=	Composite Reliability
CSE	=	Computer Self-Efficacy
EEG	=	Electroencephalogram
EFPR	=	Eye Fixation-Related Potentials
FAM	=	Fit-Appropration Model
FFM	=	Five-Factor Model of Personality
GDSS	=	Group Decision Support Systems
HTMT	=	Heterotrait-Monotrait Ratio
ICT	=	Information Communication Technology
IS	=	Information System
IT	=	Information Technology
IWP	=	Individual Work Performance
NeuroIS	=	Neuro-Information-Systems
PLS-SEM	=	Partial Least Squares Structural Equation Modeling
TAM	=	Technology Acceptance Model
TTF	=	Task-Technology Fit (TTF)
UTAUT	=	Unified Theory of Acceptance and Use of Technology
VIF	=	Variance Inflection Factor
SELSA	=	Social and Emotional Loneliness Scale for Adults

Chapter 1

Introduction

March 11th 2020 marks one of the biggest events in history. It was the day that the World Health Organization declared that the world was hit by a pandemic. The subsequent weeks and months were filled with fear and uncertainty. People around the world rushed around to stores to secure that they had the essentials. After a while things settled down, and we were starting to enter the phase of what has been described as “the new normal”.

The situation is challenging, and there are obviously a lot of health concerns. But as governments are mandating closings, travel restrictions and encourage limited contact, it raises new challenges. People have to practice what has now become a common term in our daily lives - social distancing. It is impacting businesses and individuals in ways that we are only just starting to understand. Many have had to adopt technologies in order to stay connected. Technology is what people are falling back on, now that we have to keep physical distance. It allows both people and businesses to do some of the things that we did before. As the world is becoming more dependent on technology, it is crucial that we improve our understanding of the relationship between humans and technology.

In this thesis we show that it is important for businesses to use the right tools for collaboration and focused work. This choice impacts the psychological well-being of the employees and their performance. We hope our findings can serve as a starting point for future research and contribute to better decisions by politicians and business owners around the world. Together, we can come out even stronger on the other side.

1.1 Basis and Motivation

Our overarching topic of interest was to look at the individual’s way of working in a collaboration context. The original plan was to write a thesis about the effects of subconscious factors on technology acceptance, building on our master project (Abelsen and Vatne (2020)). Faced with the restrictions and challenges of the COVID-19 situation, we had to find a new direction for our research. Having felt challenges and issues when working remotely ourselves, we wanted to explore the challenges of the current work situation. We also wanted to build on the acquired knowledge, we therefore approached the research from a perspective of task technology fit and psychology, applying it to the current situation.

Research objectives:

1. *Collect data that is only possible to collect during the COVID-19 pandemic.* We want to contribute to research by both collecting and analysing data during the pandemic. This is a unique situation when looking back at this it will be important with data that was collected during the pandemic.

2. *Generate findings that are practically applicable for businesses, in order to contribute to the challenges of the pandemic.* We want to add to the ongoing research effort, by providing insight into how the situation is impacting individuals and companies, and thus contributing to better informed decisions during these challenging times.

3. *Contribute to the understanding of human computer interaction.* We want to investigate the relationship between loneliness, technology and performance. With this we aim to contribute to the wider understanding of the relationship between humans and technology.

4. *Bring a novel approach to Technology Acceptance Research and Task-Technology Fit.* Previous research has limitations due to its close coupling with specific technology, and we want to contribute with a new approach by approaching TTF with a higher abstraction level, thus allowing for a more holistic understanding of modern work environments.

5. *Support the creation of a scientific article.* We will submit an article as a response to Emerald Publishing's call for papers (Emerald-Publishing (2020)). With the article, we can potentially reach a broader audience and contribute to a better understanding of the current situation for both researchers and practitioners.

6. *Explore possibilities for future research on work remote work performance.* We want this paper to serve as a starting point for future research on remote work, which in our opinion has become an increasingly important research topic.

1.2 Research Context and Outline

The research in this paper is in the intersection of the fields of information systems, psychology and business management. More specifically it builds on previous research in the fields of management information systems and social psychology. The main focus of the paper is on task-technology fit, loneliness, remote work and performance.

The research is done in the broader context of an increasingly flexible work environment, enabled by a rapidly evolving technological landscape. The already quickly changing world of work has also been pushed even further by the COVID-19 pandemic, resulting in new developments and trends that we have only recently started to understand and deal with. Workers all over the world have been both forced and encouraged to change the way they work, often in the way of remote work from home.

Background: In this chapter we present the context in which this research is undertaken. First we set it in a scope related to the development in society and technology. We then portray the scientific foundation that is necessary to understand the theories on which the research builds on.

Hypotheses and Research Model: In this chapter we present and argue for our hypotheses. We then present a conceptual model and explain the reasoning behind it.

Research Method: In this chapter we explain the scientific methods that were used, from our initial literature search to the design of our a survey. Finally, the data collection method is described.

Descriptive Statistics In this chapter we present general statistics from the data collection, including demographics, response distributions. Finally we present some contextual statistics that relates the data with situational factors.

Results and Analysis: In this chapter we show the final results, by evaluating the hypotheses and assessing the structural model. We also explain how the results were analysed.

Discussion: In this chapter we dive into the meaning of the results and discuss the implications of our findings. We relate the findings to previous research and portray our scientific contributions. We then go on to explore the practical implications.

Future Work: In this chapter we look at potential avenues for future work. We explore the possibilities of a remote work performance framework, and portray some potential new perspectives.

Conclusion and Final Remarks: In the final chapter we address the research objectives and present a conclusion. Finally, we present some of our thoughts and opinions that were developed during the course of the research.

Chapter 2

Background

This chapter shows both situational and theoretical background for the thesis. Section 2.1 portrays theory and relevant development in society and technology, how the world has changed because of the COVID-19 pandemic, and how technology has enabled new ways of working, while also posing potential challenges. Finally, section 2.2 shows theoretical foundation for our research.

2.1 Society and Technological Development

2.1.1 The COVID-19 Pandemic

On March 11th 2020 the novel coronavirus was declared a global pandemic by the World Health Organization (Cucinotta and Vanelli (2020)). It has since then impacted society in many ways. Not only does it pose a challenge to the health of individuals, but it could also impact society in many different ways. The UN describes the situation as “a global health crisis unlike any in the 75-year history of the United Nations”. They point out that it is more than just a health crisis, as it also impacts humans economically and socially (UN (2020)).

Common government measures include school closings, travel restrictions, bans on public gatherings and emergency investments (Hale et al. (2020)). Maintaining a work-family balance has become increasingly challenging due to the school closings and remote working from home (Fisher et al. (2020)). Potentially, this can result in the blurring of boundaries between work and family life, which has been shown to have a significant impact on strain (Ayyagari et al. (2011)). This has implications for businesses and individuals.

In a nationally-representative study of the US population, Brynjolfsson et al. (2020) found that about half of people employed before Covid-19 are now working from home. This includes 35.2% that reported having switched to working from home. They also found that 10.1% report being laid-off or furloughed since the start of the pandemic. Most of these changes manifested by early April, indicating that the subsequent work environment stabilized with more remote work.

2.1.2 Web 1.0, Web 2.0 and Web 3.0

After the dot-com bubble in the autumn of 2001, many people concluded that the web was overhyped (O'reilly (2007)). In this early stage of the Web, information and content could be published in a static form, designed with text and images, with no interaction between the information and the consumer (Rudman and Bruwer (2016)). Since then a lot has happened, and internet based services are becoming an increasingly substantial part of society and the personal and professional lives of people. In 2007 the term Web 2.0 was coined by O'Reilly Media. The development presented an extension of the original ideals, principles and underlying structure. Web 2.0 is the network as a platform, spanning all connected devices and delivering software as a continually-updated service that gets better the more people use it (Tim O'Reilly, 2007). It has since then been described as the greater collaboration between consumers, programmers, service providers and organisations (Rudman and Bruwer (2016)). This has facilitated the creation of collaboration and communication software. Now, the Web is growing into a platform for linked data, where the shift to Web 3.0 is marked by computers generating most of the information (Rudman and Bruwer (2016)). The web has the potential to become the location of every possible information resource, person and organisation (Rudman and Bruwer (2016)).

2.1.3 Connectedness and Social Media

Smartphones and social media have massively changed how we live (Newport (2019)). Smartphones both enable and encourage constant connection (Ward et al. (2017)). These issues are increasingly becoming a part of the public discussion. The issue of constant connectedness is brought up in the recent documentary "The social dilemma" by Jeff Orlowski, that sounds the alarm about data mining and manipulative technologies (Girish (2020)).

The use of notifications allows digital services services to send updates to their users when new information arrives. The notifications have been shown to have negative effects on well-being and performance (Pielot and Rello (2017)), and even when people are successful at maintaining sustained attention the mere presence of smartphones reduces available cognitive capacity (Ward, 2017). Notification leaves us with the dilemma of on the one side reducing distraction and increasing productivity, and increasing connectivity and responsiveness on the other side (Pielot and Rello (2017)).

Broadcasting and browsing are common and necessary components for social media to function (Trottier, 2012), but these are not only loose approximations of social interactions (Brabham (2015)), they are not considered social interaction whatsoever by users themselves (Hall (2018)). Social media use is only rarely considered social interaction at all (Murphy et al. (2016)), and higher use has been linked to increased feelings of isolation (Primack et al. (2017)). It may be that what has been introduced as a solution to connect people is at risk of making us more lonely and isolated.

Eyal (2014) describes habit forming tactics in his book "Hooked". He describes how companies are making users regularly check in on their services by linking them to emotions. Uncontrolled or compulsive Internet use has been known to have negative effects on psychological well-being, such as depression and loneliness (Kim et al. (2009)). This shows the bi-directional nature of modern technology.

2.1.4 Digital Well-being

In recent years, the negative aspects of technology has lead to an increasing awareness of the influence that technology has on people. Companies are starting to adapt and create new services that address these issues. Tools that may help you take control and build better habits. Freedom [1] is an example of such an app. It allows you to block distractions across devices. Another one is Forest [2], which motivates you to put your phone down and reduce the use of distracting services. Even big companies like Apple, Google and Microsoft are now enabling users to investigate and manage their use of digital devices. Both Android and iOS phones allow you to both analyse what you have spent your time on, and to deliberately limit access to certain applications during specific time intervals. Similarly Microsoft has created a new service called MyAnalytics[3], which is aimed to help improve your focus, wellbeing, network, and collaboration.

Stress is an individually experienced cognitive state, and is a “reaction to the perceived imbalance between a person and the environment” (Tarafdar et al. (2010)). As digital devices become a bigger part of everyday lives, it becomes even more important to consider how they are impacting people as part of their environment. Technology is arguably becoming increasingly integrated into our lives, and services can be used across different contexts such as work and home.

2.1.5 Work Situation

The world of work is in a state of flux, with growing polarization in the workforce and promise of higher productivity enabled by new technologies (Manyika (2017)). Human work is becoming increasingly flexible (Richter and Richter (2020)), and the use of information and communication technology (ICT) in organizations is causing an increase in information overload and interruptions, which reduces individuals’ productivity at work (Tarafdar et al. (2010)). Davenport (2011) argues for imposing more structure in order to make technologies positively contribute to productivity, as the free-access approach of including technology is reaching diminishing returns.

In 1970 open office designs reached its high point, which was a result of the promise of increased morale and productivity. However, research has found open office design to be negatively related to worker satisfaction and perceived productivity. Similarly, we may be undergoing a similar transition in the digital world. Like open offices promised information sharing and flexibility, may the free-access approach to software have reached its peak. ICT technologies in organizations are increasingly resulting in information overload and interruptions (Tarafdar et al. (2010)), and the mere presence of smartphones have been found to reduce cognitive capacity (Ward et al. (2017)).

[1] https://freedom.to/

[2] https://www.forestapp.cc/

[3] https://www.microsoft.com/en-us/microsoft-365/business/myanalytics-personal-analytics

Davenport (2011) concludes that organizations need a radically different approach, which is supported by Cal Newport who suggests that we take steps to extract the good, while sidestepping what's bad (Newport (2019)).

The advancements in ICT has changed the ways we work. In particular, the emergence of co-working marks a general trend towards distributed, inter-organizational and collaborative knowledge work (Kojo and Nenonen (2016)). The dramatic story of the rise and fall of WeWork, which was at some point valued at an astonishing $47 billion (Mashayekhi (2020)), illustrates a trend of new ways of working. Another interesting trend that was increasing before the pandemic hit the world was the digital nomads, who are not tied to a specific working space or time, and distinguish themselves with their ability to self-manage (Richter and Richter (2020)). On a more general level, Tannenbaum et al. (2012) describe that the very nature of teams is changing, as more and more teams are experiencing dynamic compositions, geographic distancing and increased empowerment of the individual.

In 2019, working from home had become a routine for many employees (Lippe et. al, 2019), and since the outbreak of COVID-19, many more have switched to remote work (Brynjolfsson et al. (2020)). Furthermore, according to Hern (2020), the pandemic might cause a permanent shift towards working from home (Hern (2020)).

2.2 Theoretical Background

2.2.1 Task-Technology Fit

The Task-Technology Fit (TTF) model was proposed by Goodhue and Thompson (1995), due to concerns that contemporary models lacked an understanding of how information systems (IS) affect individual performance. They define *fit* as the degree to which an IS matches the requirements of a portfolio of tasks. In the model, a task is defined as the behavioural requirements for accomplishing given goals (Zigurs and Buckland (1998)), and a technology as the tool that is utilized by a user to perform their tasks (Fuller and Dennis (2009)).

The Task-Technology Fit Model

The TTF model consists of four major constructs; task characteristics, technology characteristics (or functionality), task-technology fit, and technology utilization (Strong et al. (2006)). The model has been tested extensively, and it has been shown that the fit of technology to tasks both affects the usage of and the impact that an IS has on performance (Goodhue and Thompson (1995); Zigurs et al. (1999)). Further studies in the last few decades have provided further support for the positive relationship between TTF and individual performance impacts (Lee et al. (2007); Zhou et al. (2010); Cheng (2020))

Inclusion in other models

Goodhue and Thompson (1995) has criticised utilization-focused models for lacking explainability in contexts that lack voluntariness. In fact, they found that in the absence of voluntariness, task-technology fit shows a more significant impact on performance than

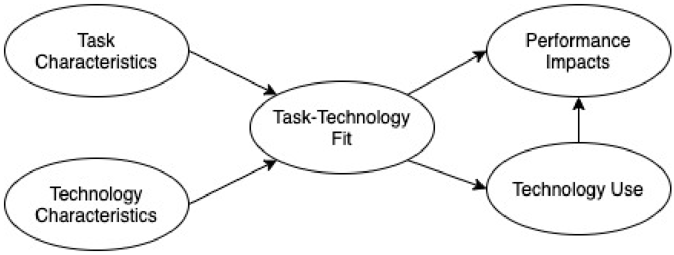


Figure 2.1: The general TTF Model (Goodhue and Thompson (1995))

utilization. The construct of task-technology fit has been missing or only implicitly included in models that seek to explain the *behavioural intention to use* technology, such as the Technology Acceptance Model (TAM) (Davis (1985)) and UTAUT (Venkatesh et al. (2003)). These models lack a focus on tasks, in that they fail to explain which functionality is needed to perform a task, and only manage to capture that a system is perceived as useful and easy to use (Dishaw and Strong (1998)). However, the explainability of the aforementioned models have been increased by the inclusion of TTF, most notably in combination with TAM, where multiple studies have found a clear positive relation between TTF and the TAM-constructs, perceived usefulness and perceived ease of use(Dishaw and Strong (1999); Wu and Chen (2017)).

The Fit-Appropriation Model

A common critique of TTF is that it does not take into account the fact that teams evolve over time in regards to how they solve certain problems. This could be a limitation for the predictive power of TTF, especially in the case of collaboration technologies (McGrath and Hollingshead (1994)). DeSanctis and Poole (1994) found that the performance of teams can be partially explained by the way they appropriate, i.e. choose how they use, the features of a technology. The Fit-Appropriation Model (FAM), proposed by Dennis et al. (2001), takes into account the appropriation aspect of technology-use and fit. To examine the effects of appropriation over time, i.e. following the evolution of teams, Fuller and Dennis (2009) used the FAM with multiple time phases, as shown in figure 2.2. They found that assessments of fit are temporary because teams adapt, and as such, the TTF measurement is likely not useful beyond the first use of the technology. Furthermore, they argue that teams have to understand how to adapt a technology to their needs, and that current theories have to reconsider the meaning of fit in the context of teams.

Patterns and Process-Fit

The TTF idea of "bundles of capabilities", i.e. teams can pick the capabilities they need to support their work, does not align with practice. Even with advanced collaboration software, teams often fall back on using email for communication (Zigurs and Khazanchi (2008)). DeSanctis and Poole (1994) argue that adoption within a team depends on the extent to which team members think that a given technology aids their collaboration efforts. As such, the adoption depends on the perception of team members.

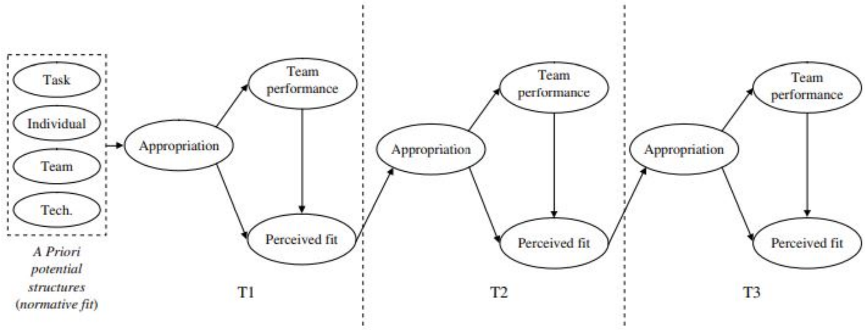


Figure 2.2: The Fit-Appropriation Model with time phases. The amount of phases (i.e. three) is arbitrary, and only serves to demonstrate development over time. (Fuller and Dennis (2009))

When teams evolve, they develop patterns to support the tasks they need to perform, and the supporting technology is not viewed as separate from the tasks (Zigurs and Khazanchi (2008)). As such, it is not enough to look at the characteristics of technology and tasks separately, but research has to consider the fact that technology and tasks have intricate relationships that affect the capabilities of the other. As technology advances, individuals might even start interacting with a technology as if it was a teammate. For example an employee might refer to a knowledge database before contacting a colleague. Technological advances might warrant the development of new patterns of behaviour (Tannenbaum et al. (2012)).

Whereas TTF and similar models have a view of context that promotes “taxonomic” or “separate” thinking (Dubé and Paré (2004)), process theory provides a strong explanation of the relationship between individual and organization perspectives on the use of technology (Malone et al. (2003)). These findings indicate that examining technology fit on a process level is beneficial in bridging the current gap in understanding Task-Technology Fit.

2.2.2 Remote Work

IT is enabling the creation of virtual organizations and remote work practices (Staples (2001)). This has resulted in many opportunities and allowed for flexibility in many workplaces. This new phenomenon raises questions about how technology is being used and how it impacts performance.

Khazanchi and Zigurs (2006) found that the most important dimension of technology in remote work was communication, beating both process structure and information processing needs. More frequent communications between manager and employee has been found to result in higher levels of interpersonal trust amongst remote workers (Staples (2001)). Further, instant messaging offers opportunities for remote employees to connect and socialize. The role of such systems in relation to performance is often downplayed, and the social side of work cannot easily be divorced from communication related to work (Hafermalz and Riemer (2016)). The importance of communication is also emphasized by

Pretti et al. (2020) who found that strong communication and trust between students and supervisors seemed to increase satisfaction and productivity in remote work arrangements. As, such communication software allows for collaboration and increases productivity.

Another dimension that has been found to be related to team effectiveness, especially during the first year of collaboration, is task interdependence (Hertel et al. (2004)). When workers are dependant on one another for performing tasks, it can have a positive effect. Interdependent tasks forces co-workers to collaborate, which then forces the important dimension of communication. Staples and Webster (2008) found that trust is more critical when task interdependence is low. As such, team effectiveness can be facilitated through either task interdependence or trust, depending on team characteristics.

Most findings in the literature show positive results in employee performance when working from home (van der Lippe and Lippényi (2020)). Flexibility has been one of the most cited advantages of remote working, and is thought to increase work-life balance and increase employee performance (Pretti et al. (2020)). Increasingly. However, flexibility may not be considered an advantage if employees are pushed or forced to work remotely.

The prevalence of remote work has drastically increased during the COVID-19 pandemic. Over one third of American workers switched from to remote work between February and May 2020 (Brynjolfsson et al. (2020)). There are industry differences, in both prevalence and productivity impacts, with highly paid and educated people reporting less perceived loss in productivity (Bartik et al. (2020)). In a member survey of academic researchers Gilmartin found that 60 percent of her colleagues reported that their greatest barrier to productivity was missing the daily face-to-face work and social interaction.

The new ways of virtual collaboration and digital work impact work in ways we are far from understanding (Richter and Richter (2020)). There are potential benefits, but also potential negatives. A frequent concern is that remote workers will experience social isolation (Hafermalz and Riemer (2016)).

2.2.3 Loneliness

While loneliness in general has been examined extensively, the research on work-related loneliness has seen little attention (Wright et al. (2006); Ozcelik and Barsade (2011)).

Loneliness is described in the literature as a psychological state that is caused by deficits in a person's social relationships (Perlman and Peplau (1982); Ditommaso et al. (2004)). However, the concept of loneliness is often confused with similar concepts such as isolation, solitude and the lack of social support. While isolation and solitude are objective descriptors of a social environment, loneliness is the individual perception of this environment.Expanding on previous understanding of loneliness, Cacioppo and Cacioppo (2018) argue that loneliness is a unique condition in which an individual perceives themselves to be socially isolated even when among other people. Similarly, social support can be defined as the lack of social assistance, while loneliness is the individual perception of these deficiencies (Wright et al. (2006)). As such, when applied to the work context, it is reasonable to assume that work loneliness refers to the perceived deficiencies of a workers environment and interpersonal relationships.

During the last decade, the rapid growth of digital tools have both facilitated and simplified remote work needs. Hafermalz and Riemer (2016) express concerns that remote workers will experience loneliness due to physical isolation. (Shah et al. (2020) suggests that digital technology should provide tools to improve social connectedness, reduce loneliness, and enable people at risk of loneliness to take measures to avoid social isolation during the COVID-19 pandemic. In light of the pandemic-induced remote work situation, it is reasonable to claim a significant uncertainty with regards to the effects this has on work-related loneliness, and its potential effect on work performance.

2.2.4 Individual Work Performance

Individual work performance (IWP) is conceptualized and operationalized differently in various disciplines, such as medicine, psychology and management research (Koopmans et al. (2011)). It has typically been assumed that what constitutes IWP differs from job to job. To tackle these issues, Koopmans et al. (2011) created a framework that allows us to investigate the concept across jobs and industries.

Further, performance can be confused with similar constructs. It should in particular be distinguished from work productivity, which is defined as input divided by output (Koopmans et al. (2011)). IWP focuses on the behaviours of employees and not the results. The performance should be under the control of the individual, excluding things that are constrained by the environment (van der Lippe and Lippényi (2020)). IWP can be defined as "behaviors or actions that are relevant to the goals of the organizations" (Koopmans et al. (2014)).

Work performance is an abstract, latent construct that cannot be pointed to or measured directly, and is made up of multiple components or dimensions, as shown in 2.3. These dimensions have associated indicators that can be measured directly, and are described by Koopmans et al. (2011) in the following way:

- **Task performance**: The Proficiency with which individuals perform the core substantive or technical tasks central to his or her job.
- **Contextual performance**: Behaviors that support the organizational, social and psychological environment in which the technical core must function.
- **Counterproductive work behavior**: Behavior that harms the well-being of the organization.

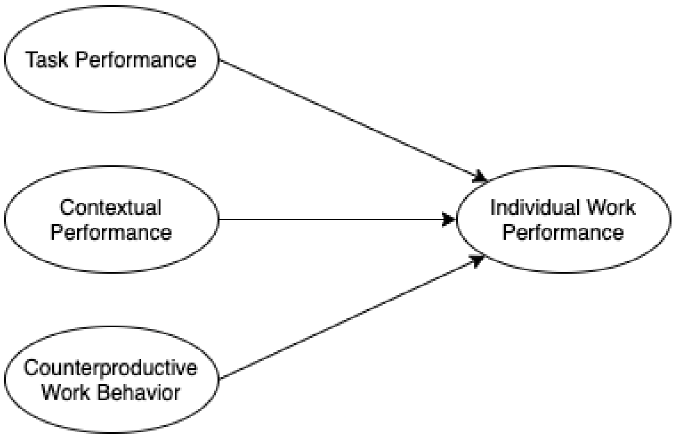


Figure 2.3: A visual representation of the IWP constructs.

Chapter 3

Hypotheses and Research Model

In this chapter we present our hypotheses and their scientific support. Section 3.1 presents the reasoning behind the hypotheses, section 3.2 presents the resulting conceptual model, and section 3.3 presents reasoning behind the inclusion of each model construct.

3.1 Hypotheses

In this section we present the hypotheses. For each hypothesis we explore relevant research, and then suggest a hypothesis.

3.1.1 Task-Technology Fit and Remote Work Performance

Communication technology has been expected to diminish the need for synchronous workplace meetings, but meeting activity has continued to rise. Kauffeld and Lehmann-Willenbrock (2012) found that better meetings lead to higher team productivity, and that the outcomes of the meeting process affected not only the outcomes of the team, but the organization as a whole. Despite the reported increase in activity, and the demonstrated impact of meetings, the meeting process has not received enough attention in research (Scott et al. (2012)). When using communication technology to conduct meetings, it is important to consider the need for transmitting complex information, such as values, emotions, and expectations (Hollingshead et al. (1993)). Furthermore, the software must support constructive problem-solving and negotiation, in order to both preserve satisfaction with the software and mitigate negative impacts on performance outcomes (Hollingshead et al. (1993); Kauffeld and Lehmann-Willenbrock (2012)). As such, argue that a good fit between the meeting process and the supporting software should result in increased perceived performance outcomes, and hypothesize the following:

- **H1**: Increased task-technology fit for meeting software leads to increased work performance.

According to van der Lippe and Lippényi (2020), a remote working environment provides new challenges, such as less feedback on possible mistakes and a higher chance of work avoidance, which could impact both individual and team performance. On the other hand, they also note that working remotely has been associated with fewer interruptions and higher employee autonomy, which is likely to increase productivity. Furthermore, Hertel et al. (2004) found task interdependence to be associated with an increase in effectiveness for virtual teams, especially during the first year of virtual teamwork. However, Quan-Haase et al. (2005) argue that with task interdependence, an effective mode of communication is needed, as individuals can get stuck if they depend on input from their peers before being able to continue their work. A good solution could be instant messaging technology, that has been shown to break down social barriers and allow individuals to utilise the knowledge of their peers, which can facilitate both innovation and increases in performance (Quan-Haase et al. (2005); Wang and Wang (2012)). As a consequence of the on-going pandemic, employees have been forced to work from home, often for the first time. As such, it can be argued that collaboration technology must support both close and effective communication in order to not hinder performance in this remote work environment. We argue that a good fit between collaboration technology and the requirements for collaboration should have a positive effect on remote work performance, and hypothesize that:

- **H2**: Increased task-technology fit for collaborative work software leads to increased work performance.

Humans are constrained by limited cognitive resources, i.e. senses, (Burleson and Greenbaum (2019)), and are only capable of processing a small amount of available information at a given time (Ward et al. (2017)). Irrelevant distractions can affect the ability to remain focused at work, and the extent to which an individual is affected depends on the information load of the task (Weast and Neiman (2010)). Furthermore, Tarafdar et al. (2010) found that in recent years, the use of ICT in organizations have caused negative cognitions in individuals, such as information overload and interruptions. In a similar vein, externally triggered interruptions have been shown to have negative impacts on both well-being and task performance (Rosen et al. (2013); Pielot and Rello (2017)). However, self-interruptions have been shown to be associated with higher productivity when properly managed (Mark et al. (2016)), and a moderate amount of multitasking can increase productivity (Burleson and Greenbaum (2019)). As such, we argue that a good fit between focused work and related software depends on how well it supports filtering and management of interruptions, both self-triggered and external. Furthermore, to ensure maximum productivity, the software must provide simple task switching with a minimal strain on cognitive resources. In turn, a good fit should have a positive affect on work performance, and we hypothesize that:

- **H3**: Increased task-technology fit for focused work software leads to increased work performance.

3.1.2 Task-Technology Fit and Loneliness

When team members are forced to work remotely, it leads to decreased in-person social interaction (Hertel et al. (2004)), and thus increases the risk of perceived loneliness (Twenge et al. (2019)). On the other hand, the use of technology can provide communication arenas that mitigate the feelings of loneliness (Shah et al. (2020)). Studies have found that use of communication technology can increase social connectedness (Deters and Mehl (2013)) and strengthen identification with the team (Sivunen (2006)), and thus reduce loneliness. Furthermore, Hafermalz and Riemer (2016) argue that the social elements of work communication have a positive effect on performance. However, other studies found that a high use of social media was associated with higher loneliness (Pittman and Reich (2016); Primack et al. (2017); Nowland et al. (2018)).

These conflicting findings indicate that while communication technology can mitigate perceived loneliness, the relationship between technology and loneliness is dependent on how the technology is utilised. The interaction in teams is often complex and dynamic, and the fit of the system has an effect on social interaction (DeSanctis and Poole (1994)). In order to mitigate loneliness while working remotely during Covid-19, the digital technology has to facilitate opportunities for social connection (Shah et al. (2020)), allow team members to prioritise messages from within the team (Sivunen (2006)), and build trust that there's someone available to help when having difficulties with tasks (Wright et al. (2006); Luchetti et al. (2020)).

Meetings and collaborative work sessions provide opportunities for social interaction, and based on the aforementioned findings, we argue that it is reasonable to expect a negative relation between process-technology fit and social loneliness during remote work. As such, we present the following hypotheses:

- **H4**: Increased task-technology fit for meeting software leads to a decrease in loneliness.

- **H5**: Increased task-technology fit for collaborative work software leads to a decrease in loneliness.

The process of focused work implies a reduction in social interaction and irrelevant distractions. However, lack of social interaction can increase feelings of loneliness (Twenge et al. (2019), and thus motivate people to reconnect with others (Cacioppo and Patrick, 2008). This can in turn lead to exposure to unwanted distractions (Pielot and Rello (2017). As argued for hypothesis H3 in section 3.1.1, the TTF of focused work software relies on effective management of such distractions, low-strain task switching and opportunities for meaningful social interaction. Therefore, a good fit between technology and the task group of focused work should have dampening effects on social loneliness, and we hypothesize that:

- **H6**: Increased task-technology fit for focused work software leads to a decrease in loneliness.

3.1.3 Loneliness and Remote Work Performance

An increase in loneliness can cause work alienation (Santas et al. (2016)), compulsive internet use behaviour (Kim et al. (2009), and an increased need for social distractions (Cacioppo and Patrick (2008)), which in turn affects productivity at work (Weast and Neiman (2010); Ozcelik and Barsade (2011)). Furthermore, remote work implies physical isolation during working hours, and can strengthen the negative affect of loneliness on work performance (Hafermalz and Riemer (2016); Shah et al. (2020)). As such, it is evident that perceived loneliness can trigger a variety of behaviours that have negative performance impacts. We therefore argue for a negative relationship between loneliness and remote work performance, and hypothesize the following:

- **H7**: Increased loneliness leads to decreased work performance.

3.2 Research Model

Figure 3.1 shows the research model used in this thesis, and is based on the hypotheses as described in section 3.1. The constructs in the model are based on background theory explained in section 2.2. The model contains three different constructs of Task-Technology Fit, that correspond to the three groupings of tasks that are reasoned in section 3.3.3, and described in table 3.1. Furthermore, the model contains a construct of loneliness adapted to the work context. Lastly, the construct of individual work performance consists of three dimensions, whereas one has a decreasing effect on work performance, i.e. counter-productive work behaviour. In order to test the model, we used survey items that are described in detail in section 4.2.1 in chapter 4.

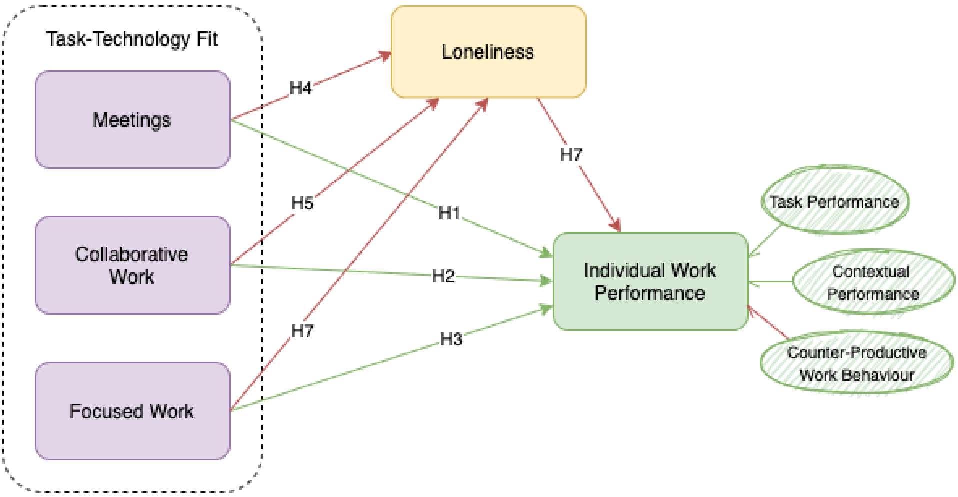


Figure 3.1: The final research model used in our thesis. A green path denotes an increasing effect, while a red path denotes a decreasing effect. The paths refer to hypotheses outlined in section 3.1.

3.3 Reasoning Behind The Model

3.3.1 Individual Work Performance

Performance is included as a concept from the perspective of the individual, as the perceived individual work performance. This was done due to two main reasons. Firstly, the survey participants were expected to have a high variety in the type of work they perform. As such, asking context-specific questions was impossible. Secondly, finding objective measures of work performance when everyone is working from home, and thus unavailable for observation, was not seen as feasible.

3.3.2 Omitting Voluntariness

When utilization of technology is not voluntary, the impacts on performance will rely more on task-technology fit than utilization (Goodhue and Thompson (1995)). Due to the Covid-19 pandemic resulting in government interventions and an increased need for partially or completely switching to remote work, the use of technology at work has arguably become a requirement. Factors of software usage that are ordinarily important, such as voluntariness and intention to use, are likely weakened and perhaps irrelevant for the purpose of measuring actual or perceived usage of software. Therefore, we chose to focus on task-technology fit, rather than intention to use and voluntariness. Our assumption is that a remote worker is forced to use software, thus giving grounds for omitting voluntariness from the research model.

3.3.3 Software and Task Groups

In order to measure task-technology fit without controlling the use of specific technologies, we chose to measure with a higher abstraction level. Specifically, we decided on testing the task-technology fit of categories of software, rather than specific instances. This was done to decouple the measure of fit from work processes related to specific software, and shed light on the general perception of the digitalisation efforts and results. The task groups were defined to support certain processed that were likely to be digitalised due to the change from physical to remote work.

Furthermore, as a process is a grouping of tasks, we argue that theory on the effects of TTF, and the related questionnaire items, should also apply to groups of tasks. The overall intention was to get a holistic view, but still keep the questions general enough to be relevant across industries. There was a motivation to consider the aspects that would give good insight during the COVID-19 pandemic.

We decided on separating the task contexts into three task groups rather than examining specific software. The task groups examined were; Meetings, collaborative work and focused work. These task groups are further explained in table 3.1. If we were to overcomplicate the definitions it could be perceived as confusing for the survey respondents. Potentially it could have resulted in participants not reading the definitions properly and rather basing their answers solely on their perception of the term.

Task Group	**Description**
Meetings	An assembly of people for a particular purpose, especially for formal discussion. The meetings can be for planning, updates or coordinating work.
Collaborative Work	Any type of work where you need to collaborate with others in order to finish a task. It is different from meetings in the sense that you are collectively working to produce something.
Focused Work	Any type of individual work where you perform better if you are not distracted by co-workers.

Table 3.1: Categories of software and their descriptions, as presented in the survey.

The selection of task groups was guided by considering the following factors:

1. Holistic view: Getting a good approximation to something that covers most of the productive work life of people, especially during the Covid-19 pandemic.
2. Business processes and software classification: Covering common business processes that are part of daily and weekly activities for most employees. Subsequently tools and services that aid in those activities should be covered. An important point here is to consider how people view, consider and search for tools in practice.
3. Brain functioning: We want the processes to differentiate between different modes of thought, be it focused, exploratory or collaboration.

Individual and Joint Work

We found it important to consider both individual work and joint work, where others are involved. For individual work the underlying idea was that sometimes employees need to focus and get tasks done. This could be generalized, firstly based on the underlying need for focus and lack of interaction with others. Secondly, due to the complexity of human relationships and interactions it was desirable to further specify types of joint work. In particular the challenges related to human interaction were deemed to be particularly interesting because the pandemic was expected to be particularly challenging when working together.

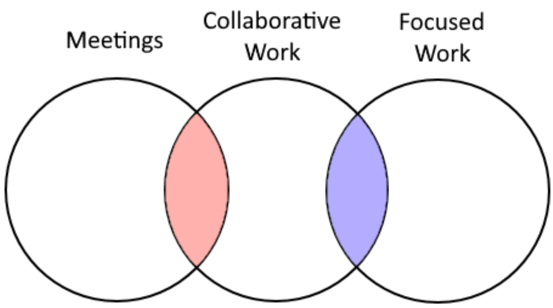


Figure 3.2: Task Groups. A graphical view of the overlap between task groups.

As can be seen in Figure 3.2, the task groups are overlapping to some extent, as is indicated by the red and blue areas. These overlapping areas symbolise characteristics that the task groups share, and the extent of the overlap is likely to vary greatly between individuals and teams. However, it is important to note that while they share characteristics, the task groups represent processes that are not run in parallel by an individual. Focused work and collaborate work share some characteristics (blue area), e.g. in that they involve some form of active problem solving and task completion. The shared characteristics (red area) and distinctions between meetings and collaborative work are discussed in the subsequent paragraphs.

Meetings and Collaborative Work

Theory on Group Decision Support Systems (GDSS), defined as systems that combine communication, computer and decision technologies in order to support problem solving in group meetings (Desanctis and Gallupe (1987)), suggests an importance on meetings and collaborative work in general. The importance of meeting software can furthermore be evidenced by the "explosion" in popularity for video conferencing software, due to the sudden change in organizational needs caused by the pandemic (Isaac and Frankel (2020)).

However, it can be argued that problem solving activities are not confined to meetings alone, but also happens both individually and in groups of specific people. This is supported by research, which indicates that group performance is improved when the information gathering process is limited to the employees that have capabilities in solving the specific problem (Davenport et al. (1996)). We therefore argue that meetings and collaborative work should be viewed as two separate processes, even though they have overlapping characteristics, e.g. discussions, brainstorming, progress updates.

Focused Work

Literature on multitasking shows evidence for a reduction in individual work performance when exposed to secondary tasks, i.e. tasks that are unrelated to the performance of the current work objective (Kiesel et al. (2010)). However, Adler and Benbunan-Fich (2012) found that workers had higher productivity performance with moderate amounts of multitasking. In a later research paper, the authors found that task-switching can be beneficial in work environments with predominantly simple tasks and less complex tasks (Adler and Benbunan-Fich (2015)). These findings suggest that a variation in tasks can have a positive effect on individual work performance under certain conditions.

While multitasking can be beneficial for productivity, it is important to leave periods of focused work. This is evidenced by Iqbal and Horvitz (2007), who found that selective filtering of notifications can have significant positive effects on overall productivity. For example, they showed that a single interruption, e.g. an email or instant message, can distract an employee for up to 15 minutes. This suggests that in order to ensure individual productivity, the software that is used by an employee must support filtering of external interruptions when focus is needed. This suggestion is further supported by McFarlane (2002), who found clear benefits in allowing individuals to determine when they want to receive an interruption, e.g. through a "do not disturb" function.

As such, we decided on three separate categories which are described in table 3.1. The descriptions match what the survey participants were shown.

Chapter 4

Research Method

This chapter presents our research method. Section 4.1 outlines the literature search process. Next, section 4.2 explains how the survey was designed, and includes an overview of survey items, considerations on the rigidity of the survey, and reasoning additional survey items. Finally, section 4.3 describes the data collection process.

4.1 Literature search

A literature search was conducted in order to find interesting research areas. The literature search performed in an exploratory manner, whereas the rest of the study can be described as explanatory, as the purpose of the survey data was to test theory and causal relations (Pinsonneault and Kraemer (1993)).

Based on the findings, we created a survey that captured constructs that were interesting to examine during the COVID-19 pandemic. Connections were expected based on the initial literature exploration. Next, hypotheses were created based on a deeper dive into the constructs, focusing on the connections that were deemed the most interesting to examine during a pandemic and most relevant for a master thesis in computer science.

In order to argue the hypotheses and create a survey, we used the following semi-structured exploratory approach:

1. **Exploration:** First a wide search was done, in order to find potential avenues for the research. We explored some of the papers that were used in the master project and looked through papers in adjacent fields.

2. **Limitation:** After exploring interesting avenues for the research, we created an overview of models. We then used this to look at potential connections between the different findings, resulting in an exploration model that was used for further exploration. This model can be found in appendix C.

3. **Survey Creation:** The search was then limited to articles that would help us create a questionnaire that could capture constructs in the exploration model. Finally a set of

constructs were selected based on the extent to which we could connect them to one another, and to the extent that we were able to capture them using a questionnaire.

4. **Hypothesis exploration:** The search was subsequently changed towards helping us specify hypotheses on the relationship between the constructs. Finally we settled on some hypotheses based on the avenues that seemed most interesting based on the literature and that also seemed the most interesting in relation to the COVID-19 pandemic.

5. **Depth Exploration:** After deciding on a smaller set of hypotheses and a concrete research model. The literature search was mainly focused on finding a wider set of articles related to the narrowed down focus.

4.2 Survey Design

In order to measure the constructs of the research model from chapter 3, we created a survey with questions for each construct. This is fitting, as our level of data analysis is at the level of an individual user of ICT tools. Using an online survey makes it easier to reach a large number of respondents, and thus, should provide a generalizable view of work performance impacts during the COVID-19 pandemic. A survey is a quantitative approach, which leads to easily quantifiable data with a low risk of subjective influence. As such, the results can be easily reproduced. However, we note that the specific characteristics that the COVID-19 pandemic imposes could be a possible challenge to reproduce. Furthermore, the collected data should result in a largely objective interpretation, and therefore constitutes a positivistic approach.

4.2.1 Survey Items

The survey consisted of six sets of questions, one for each construct in the model and one for demographics. An excerpt of important questions are presented in table 4.1, 4.2 and 4.3. The questions were sent out in English to all respondents, regardless of nationality or mother tongue. This was done to avoid the risk of translation errors from our side, which could lead to different understanding of the same construct questions, and to ensure a wide reach. Most of the constructs were based on previously published constructs and their corresponding questions were used to capture them.

The measures for demographics, i.e. age, country of residence and biological sex, were included to provide context to the data. However, the results were not used as part of the data analysis. Biological sex was measured using three categories: male, female and intersex. Age was measured using a numerical input, and country of residence was measured using a selection of countries.

The measures for the construct of *social loneliness* were adapted from Ditommaso et al. (2004). It is measured using five items of social loneliness, where ”friends” was exchanged with ”co-workers”, see table 4.1. Other sub-scales of loneliness were omitted, i.e. family and romantic loneliness, as to both keep the questionnaire short and focused on work-related behaviour.

Table 4.1: An overview of adapted survey items for measuring Social Loneliness. Items marked with * are scored reversely, while items marked with (d) were excluded from the final analysis

Construct	Item Code	Items
Social Loneliness	**LON1** *, (d)	I feel that I am part of a group of co-workers.
	LON2 *	My co-workers understand my motives and reasoning.
	LON3	I don't have any co-workers who share my views, but I wish I did.
	LON4 *	I am able to depend on my co-workers for help.
	LON5 *	I do not have any co-workers who understand me, but I wish I did.

In order to measure the TTF of the three outlined processes of table 3.1, we utilised a seven-item survey which was repeated and adapted for each process, i.e. 21 questions in total. The items were adapted from Lin and Huang (2008) and reduced to fit our case. The questions for each task group are included in table 4.2.

The measures for *individual work performance (IWP)* were based on the Individual Work Performance Questionnaire (IWPQ) by Koopmans et al. (2014), and consists of three dimensions, namely *task performance*, *contextual performance*, and *counter-productive work behaviour*. The questionnaire items were limited to five per dimension, in order to keep the questionnaire short and precise. The scale was developed to measure changes in IWP over time, and as such, it should be suitable to measure changes in IWP for remote workers during the pandemic. Furthermore, the questions were asked in context of the preceding month of work, i.e. ”*During the last month of work I ...*”.

4.2.2 Survey Rigidity

All the constructs in the final research model were adopted from prior literature and have therefore been previously been tested in empirical studies. This should increase the likelihood of the validity of the constructs themselves. The internal validity is considered important, as was pointed out by Straub et al. (2004).

Each construct of our survey, with the exception of demographics, were measured using a five-level Likert scale. i.e. Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. Each option was mapped to numerical values in the range 1-5, respectively. Chyung et al. (2017) note that while the five-level Likert scale is among the most popular response scales used in research, there is disagreement on whether or not you should include a mid-point. Based on their literature review, a potential limitation of the standard Likert scale is that a midpoint can be misused, i.e. it serves as a ”dumping ground” or ”easy way out” when respondents are uncertain. However, they conclude that the inclusion criteria depends on the type of questions and the familiarity with the topic. The questions of our survey largely pertains to the perception of individuals, and situations they should be familiar with as remote workers. As such, we argue that it is reasonable to assume that a neutral answer is accurate and not likely to be subject to misuse.

An informal pre-test was conducted with 5 participants to increase the likelihood that respondents would be able to comprehend the survey as intended. Some were native en-

Table 4.2: An overview of adapted survey items for measuring Task-Technology Fit for each task group. Items marked with (d) were excluded from the final analysis.

Construct	Item Code	Item Text
		For having meetings, the software we use…
TTF for Meetings	**TTFM1**	__ is very adequate for conducting meetings. *
	TTFM2	__ is very appropriate for conducting meetings. *
	TTFM3 (d)	__ is very useful for conducting meetings. *
	TTFM4	__ is very compatible with having meetings. *
	TTFM5	__ is very helpful when conducting meetings. *
	TTFM6	__ makes the meetings very easy. *
	TTFM7	__ is the one I prefer for meetings. *
		For doing focused work, the software I use…
TTF for Focused Work	**TTFF1**	__ is very adequate for focused work. *
	TTFF2	__ is very appropriate for focused work. *
	TTFF3	__ is very useful for focused work. *
	TTFF4	__ is very compatible with focused work. *
	TTFF5	__ is very helpful for focused work. *
	TTFF6	__ makes the focused work very easy. *
	TTFF7	__ is the one I prefer for focused work. *
		For doing collaborative work, the software I use…
TTF for Collaborative Work	**TTFC1**	__ is very adequate for collaborative work. *
	TTFC2	__ is very appropriate for collaborative work. *
	TTFC3	__ is very useful for collaborative work. *
	TTFC4	__ is very compatible with collaborative work. *
	TTFC5	__ is very helpful for collaborative work. *
	TTFC6	__ makes the collaborative work very easy. *
	TTFC7	__ is the one I prefer for collaborative work. *

glish speakers, while others had english as a secondary language. After completing the survey in the pre-test, the respondents were contacted and asked about the quality of the questions and the clarity of the terms used in the questionnaire. We made some minor modifications to the phrasing of questions and corrected some grammatical errors.

4.2.3 Considered Survey Items

During the literature search process, we identified several constructs that could have impacts on constructs in our research model. Some of them, and the reasoning behind their consideration, are listed below. While they were included in the survey, they were not used in the final research model and analysis. The primary reason was that they made the model too complex and unfocused.

Table 4.3: An overview of questionnaire items for each of the three dimensions used to measure Work Performance. Items marked with * are scored reversely, while (d) denotes an item that was excluded from the final analysis.

Construct	Item Code	Items
		During the last month of work, ...
Task Performance	**ITP1**	_ I managed to plan my work so that it was done on time.
	ITP2	_ I kept in mind the results that I had to achieve in my work.
	ITP3	_ I was able to prioritize the most important tasks.
	ITP4	_ I was able to perform my work well with minimal time and effort.
	ITP5	_ Collaboration with others was very productive.
Contextual Performance	**ICP1**	_ I started new tasks myself, when my old ones were finished.
	ICP2	_ I took on challenging work tasks, when available.
	ICP3	_ I worked at keeping my job knowledge up-to-date
	ICP4	_ I came up with creative solutions to new problems.
	ICP5 (d)	_ I actively participated in work meetings.
Counterproductive Work Behaviour	**ICWB1** *	_ I complained about unimportant matters at work.
	ICWB2 * (d)	_ I made problems greater than they were at work.
	ICWB3 *	_ I focused on the negative aspects of a work situation, instead of the positive aspects.
	ICWB4 *	_ I spoke with my colleagues about the negative aspects of my work.
	ICWB5 *	_ I spoke with people from outside the organization about the negative aspects of my work.

Computer Self-Efficacy

Computer Self-Efficacy (CSE) is a measure of the extent that an individual believes in their ability to use technology (Lee et al. (2007)). The construct has been included in research models on Task-Technology Fit, and has been found to improve the explaining power of the model (Strong et al. (2006); Lee et al. (2007); Lin and Huang (2008)). These findings prompted the inclusion in the survey. The question items as they were included in the survey can be seen in appendix A.

Task Interdependence

Task Interdependence is a measure of how mutually dependent team members are on each other. As explained in section 2.2.2, Staples and Webster (2008) found that interdependence has an effect on the productivity in teams, and that the positive effects are especially apparent in the first year of remote work (Hertel et al. (2004)). This prompted the inclusion of task interdependence in the survey, with questions adapted from Hertel et al.

(2004). However, we did not use the construct in our final research model as it made the model too complex. Refer to appendix A for a demonstration of how it was included in the survey.

The Five-Factor Model

The Five-Factor Model of Personality (FFM), also referred to as the Big Factor Model, is used to measure the personality traits of individuals. It consists of five dimensions; extroversion, neuroticism, openness to experience, agreeableness and conscientiousness (Svendsen et al. (2013)).

The FFM has been shown to affect intention to use technology, performance and perceived usefulness of technology (Svendsen et al. (2013)), associated with loneliness (Ryan and Xenos (2011); Schutter et al. (2020)), and agreeableness and openness to experience has been found to affect computer self-efficacy (Saleem et al. (2011)).

These findings lead us to include the factors in the survey, both to compare to individuals to each other across demographics, and to add context to individual effects from remote work settings. The questions were based on the BFI-2-XS items by Soto and John (2017), and are shown as included in the survey in appendix A. The resulting answer distribution is shown in table D.3.

However, the factors were ultimately excluded from the research model, as the interconnections to multiple constructs made the model very complex. Further discussion on the FFM can be found in appendix E.

4.3 Data Collection

The data collection was conducted by using Nettskjema by the University of Oslo [1], as it was the one recommended by our university. It is a survey platform commonly used to collect responses to norwegian research studies, only allows users from academic institutions, and could help in giving the survey a professional appearance. The data collection was done using two samples, primarily to get a sufficient amount of responses to test the research model.

The first sample, which we will denote as the *Network sample*, was collected by sharing the survey in social media, sending e-mails to people we knew, and contacting municipality boards, workers unions and associations. This method of collection proved to be difficult, slow and tedious, and the response rate was lower than we would have hoped. However, by sending the survey to contact persons in bigger organizations and organizations, we were able to speed up the process. We contacted several worker unions in Norway, and the survey was successfully shared with member organizations in NHO and internally for employees at Tekna. We also contacted a some Norwegian counties, but we were not able to share the survey through their communication channels.

The second sample was collected using Amazon Mechanical Turk, which is a marketplace for outsourcing small tasks [2]. The nature of the platform requires a small payment to each respondent, which could be a potential cause of bias. However, research has

[1] https://nettskjema.no/
[2] https://www.mturk.com/

found data collection by using Mturk to both provide representative samples (Minton et al. (2013)), high-quality data (Buhrmester et al. (2016)) and reliable results consistent with traditional decision-making biases (Goodman et al. (2013)). As such, we deemed the data fit for inclusion in the study, and will refer to the collected data as the *Mturk sample* for purposes of discussion.

Chapter 5

Descriptive Statistics

This chapter presents a summary of the data collection from the survey. Section 5.1 portrays demographics from the Network and Mturk samples, as well as a combined view. Section 5.2 presents answer distributions for each of the first-order constructs in the model. Lastly, section 5.3 shows data that was not used as part of the model, but that can provide contextual information that helps understand the results in the structural model.

5.1 Sample Demographics

The Network sample contains 69 (44.23%) male respondents, and 87 (55.77%) female respondents, with a total of 156 respondents. Furthermore, the sample had an overwhelming majority of Norwegian respondents, specifically 131 (83.97%), see table 5.3.

The Mturk sample contains 134 (65.7%) male respondents, and 70 (34.3%) female respondents, with a total of 204. For country of origin, the sample had an overwhelming majority from either India or the USA. Specifically, the sample contains 81 (39.71%) Indian respondents, and 107 (52.45%) US citizens.

After combining the two samples, the number of respondents totaled at 360, with a distribution of 56.39% male and 43.61% female respondents, see table 5.1. Furthermore, the survey collected responses from a total of 21 countries, with an overwhelming majority of respondents living in Norway, United States and India. Refer to table 5.2 for exact numbers and remaining countries.

5.2 Model Construct Results

This section presents answer distributions for each of the first-order constructs in the research model. The distribution for loneliness is shown in section 5.2.1, while a comparison of the distributions of each Task-Technology Fit group is shown in section 5.2.2. Lastly, a data summary of the Work Performance dimensions are shown in section 5.2.3. Each subsection displays results from a different construct, and it is presented in the same way.

Table 5.1: An overview of the distribution of Biological Sex for the individual and combined samples.

	Combined		Network		Mturk	
Biological sex	*n*	%	*n*	%	*n*	%
Male	203	56.39%	69	44.23%	134	65.69%
Female	157	43.61%	87	55.77%	70	34.31%
Intersex	0	0.00%	0	0.00%	0	0.00%
Total	360		156		204	

Table 5.2: An overview of the distribution of Country of Residence among the respondents

Country	Percentage of Respondents
Norway	36.39%
United States	31.67%
India	22.50%
Germany, American Samoa	between 1% and 2%
Brazil, Mexico, United Kingdom	between 0.5% and 1%
Argentina, France, Spain, Canada, Chile, Czech Republic, Italy, Northern Mariana Islands, Switzerland, Bulgaria, Dominica, Greece, Ukraine	less than 0.5%

Table 5.3: An overview of the distribution of Country of Residence for the Combined, Network and Mturk sample. Only the most frequent countries are included.

	Combined		Network		Mturk	
Country	*n*	%	*n*	%	*n*	%
Norway	131	36.39%	131	83.97%	0	0.00%
United States	114	31.67%	7	4.49%	107	52.45%
India	81	22.50%	0	0.00%	81	39.71%
...	...	...	...	...	...	...
Total	360		156		204	

The *frequency of answers* are presented as graphs, where the likert-scale option are on the x-axis, and the number of responses for a given option on the y-axis. The labels correspond to item codes, and the questions themselves are presented in section 4.2.1. Specific values for the answer distributions can be found in section 10.1.

A statistical summary is provided for each construct, with values for min, max, mean, median and standard derivation. *Min* and *Max* denote the smallest and largest recorded value for a given construct questionnaire item. The *mean* and *median* represents where the values are centered. Lastly, the *standard deviation* gives an indication of how much values tend to deviate from the mean in either direction. As such, a large value denotes a large tendency, while a low value denotes centering on the mean.

Table 5.4: An overview of the distribution of age for the Combined, Network and Mturk samples.

Age Range	Combined		Network		Mturk	
	n	%	*n*	%	*n*	%
16-19	3	0.83%	2	1.28%	1	0.49%
20-24	44	12.22%	18	11.54%	26	12.75%
25-34	169	46.94%	58	37.18%	111	54.41%
35-44	46	12.78%	15	9.62%	31	15.20%
45-54	55	15.28%	38	24.36%	17	8.33%
55-64	34	9.44%	19	12.18%	15	7.35%
65-75	9	2.50%	6	3.85%	3	1.47%
Total	360		156		204	

5.2.1 Loneliness Results

This section presents the responses for the Loneliness construct. Figure 5.1 shows a graphical distribution for each item used to measure the construct, while table 5.5 shows a statistical summary. The question items are listed in table 4.1. For LON1, LON2 and LON4, a high score indicates low loneliness. As such, the results indicate that respondents have a low degree of loneliness. This is also reflected in the high mean and low standard deviation of these items.

The other two items, i.e. LON3 and LON5, have a lower mean and higher standard deviation. A high score on these indicate a low degree of loneliness. The distribution is ”M-shaped”, in that the responses are mirrored around the neutral option (3). Some possible causes for for this phenomenon are further discussed in section **??**.

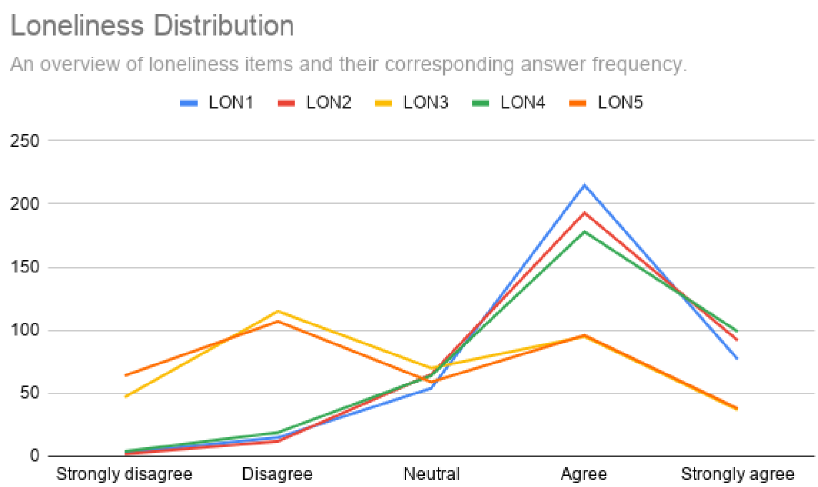


Figure 5.1: A distribution of answers for each item of the Loneliness construct.

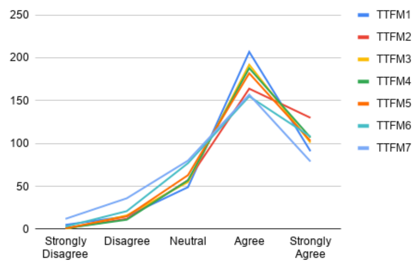
Table 5.5: A statistical summary of the responses on the Loneliness items

	Min	Max	Mean	Median	Std. Dev.
LON1	1	5	3.96	4	0.77
LON2	1	5	3.99	4	0.78
LON3	1	5	2.90	3	1.22
LON4	1	5	3.97	4	0.87
LON5	1	5	2.83	3	1.29

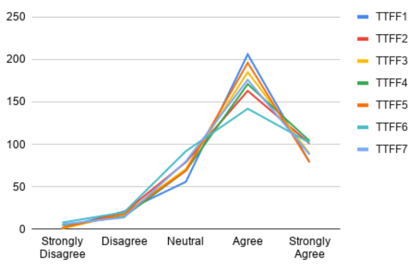
5.2.2 Task-Technology Fit Results

In this section, the responses related to the Task-Technology Fit constructs are presented. Figure 5.2a, 5.2b and 5.2c show a graphical distribution of the answers to questions on meetings, focused work and collaborative work, respectively. Table 5.6 displays a statistical summary of all items used to measure the aforementioned task groups. A full overview of items can be found in table 4.2.

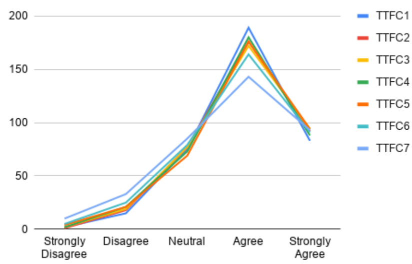
The graphs show that the task-technology fit is high for all three task groups, which is supported by a high mean and relatively low standard deviations. As such, this indicates that the fit of each task group is considered high for most survey respondents.



(a) TTF for Meetings



(b) TTF for Focused Work



(c) TTF for Collaborative Work

Figure 5.2: An overview of answer distributions for each individual TTF task group.

Table 5.6: A statistical summary of responses on the Task-Tecnology Fit items for all task groups.

	Min	Max	Mean	Median	Std. Dev.
TTFM1	1	5	4.02	4	0.78
TTFM2	1	5	4.13	4	0.81
TTFM3	2	5	4.04	4	0.78
TTFM4	1	5	4.07	4	0.77
TTFM5	1	5	4.02	4	0.81
TTFM6	1	5	3.95	4	0.90
TTFM7	1	5	3.71	4	1.02
TTFF1	1	5	3.93	4	0.81
TTFF2	1	5	3.94	4	0.86
TTFF3	1	5	3.94	4	0.82
TTFF4	1	5	3.98	4	0.88
TTFF5	1	5	3.91	4	0.81
TTFF6	1	5	3.85	4	0.97
TTFF7	1	5	3.89	4	0.87
TTFC1	1	5	3.93	4	0.80
TTFC2	1	5	3.94	4	0.82
TTFC3	1	5	3.93	4	0.85
TTFC4	1	5	3.92	4	0.84
TTFC5	1	5	3.92	4	0.88
TTFC6	1	5	3.86	4	0.92
TTFC7	1	5	3.76	4	1.02

5.2.3 Work Performance Results

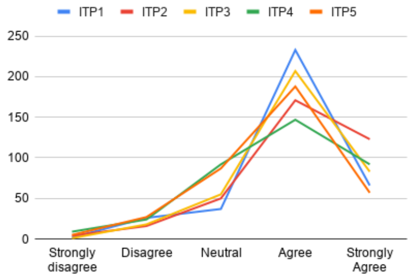
This section showcases results from the measurement of Work Performance. The answer distributions of the underlying dimensions of task performance, contextual performance and counter-productive work performance are shown in figure 5.3a, 5.3b and 5.3c, respectively. A statistical summary of the dimensions are given in table 5.7.

The responses for task and contextual performance both show a high consensus in the survey population, with a median of 4 for all items. However, the standard deviation for task performance is more fluctuating between items than for contextual performance. This indicates that the perceived performance of the task dimension is less stable than for the contextual dimension.

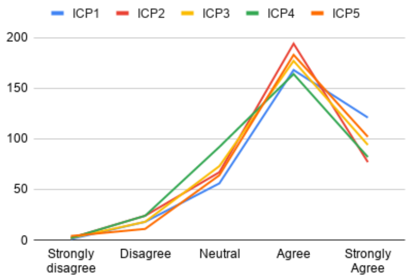
In the case of counter-productive work performance, the results are considerably more interesting. Figure 5.3c shows a mirroring around the neutral option, which is also indicated by the higher standard deviation than for the other dimensions. This indicates that the tendency of counter-productive work performance is harder to predict.

5.3 Contextual Statistics

This section displays graphical distributions of some constructs that were not included in the research model, but that were measured in the survey, and could shed light on the



(a) Task Performance



(b) Contextual Performance

(c) Counter-Productive Work Performance

Figure 5.3: An overview of answer distributions for each dimension of the Work Performance construct.

Table 5.7: A statistical summary of responses to each dimension of Work Performance.

	Min	Max	Mean	Median	Std. Dev.
ITP1	1	5	3.92	4	0.79
ITP2	1	5	4.08	4	0.87
ITP3	1	5	3.96	4	0.78
ITP4	1	5	3.79	4	0.98
ITP5	1	5	3.73	4	0.86
ICP1	1	5	4.07	4	0.84
ICP2	1	5	3.88	4	0.84
ICP3	1	5	3.94	4	0.84
ICP4	1	5	3.82	4	0.87
ICP5	1	5	4.01	4	0.83
ICWB1	1	5	3.15	3	1.25
ICWB2	1	5	3.02	3	1.31
ICWB3	1	5	3.15	3	1.27
ICWB4	1	5	3.34	4	1.22
ICWB5	1	5	3.34	4	1.26

interpretation of results.

5.3.1 Computer Self-Efficacy

The distribution of answers for Computer Self-Efficacy (CSE) are displayed in figure 5.4. The results indicate a high degree of computer self-efficacy in the survey population, and as such, it is reasonable to assume a moderate to high technological competence among respondents. Specific values for the distribution can be found in table D.1 in appendix D.

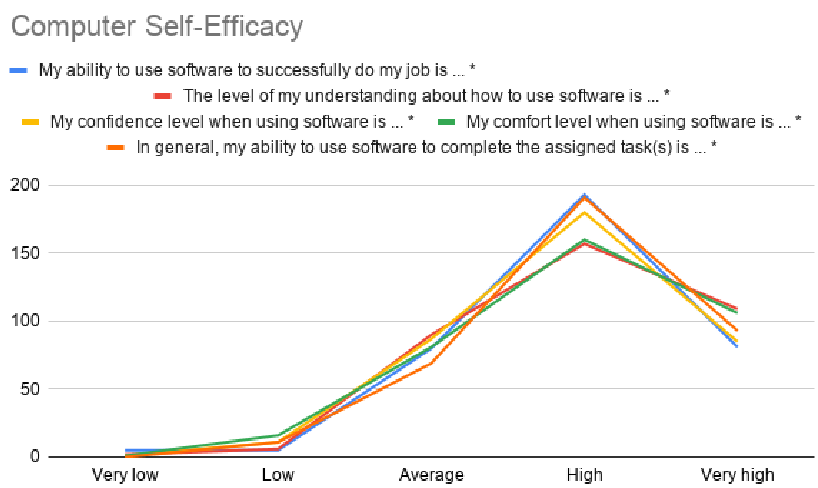


Figure 5.4: A distribution of respondent answers on Computer Self-Efficacy

5.3.2 Task Interdependence

Task Interdependence was measured in the survey, and the results are shown in fig 5.5. The results indicate a high degree of interdependence in the survey population, and as such, implies that the communication capabilities are especially important for the respondents in our samples. This could have possible implications on collaborative work and performance, and is called back to in the discussion of hypothesis 2 in section 7.1. Specific values for the distribution can be found in table D.2 in appendix D.

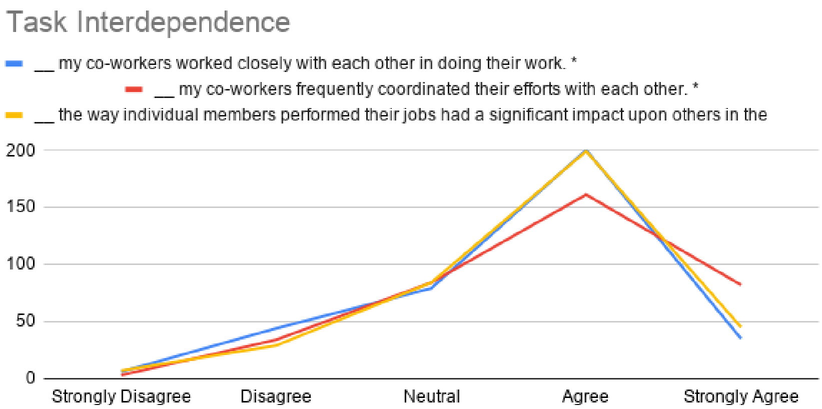


Figure 5.5: A distribution of respondent answers on Task Interdependence

Chapter 6

Results and Analysis

This chapter displays the results of statistical analyses of our research model. Section 6.2 details how the analysis was performed. Section 6.4 shows assessments on the reliability and validity of the model. Lastly, the assessment of the structural model is shown in Section 6.5.

6.1 Overview of Findings

This chapter is quite long and contains a lot of numbers and technical terms, and therefore, this section showcases the important findings. This ensures that the main findings are kept in mind for the following sections. The remaining sections explain the reasoning behind these conclusions. The conclusion for each hypothesis is displayed in table 6.1, where green denotes a supported hypothesis and red denotes a rejected hypothesis.

Table 6.1: An overview of hypotheses and whether they are supported.

Hypothesis	**Path**	**Supported**
H1	Meetings → Work Performance	No
H2	Collaborative Work → Work Performance	Yes
H3	Focused Work → Work Performance	Yes
H4	Meetings → Loneliness	No
H5	Collaborative Work → Loneliness	Yes
H6	Focused Work → Loneliness	Yes
H7	Loneliness → Work Performance	Yes

6.2 Analysis Method

For analysing the model, we used *Partial Least Squares Structural Equation Modeling* (PLS-SEM). To ease the calculation and reduce manual calculation errors, we utilised a software package called SmartPLS 3, which provides modeling capabilities as well as algorithms to measure and test the structural model (Ringle et al. (2015).

6.2.1 Evaluation of Analysis Methods

PLS-SEM was selected over alternative methods of analysis, such as *Covariance-Based Structural Equation Modeling* (CB-SEM). The reasons for are outlined below, where the reasoning is taken from Hair et al. (2011), unless otherwise specified:

1. The method is flexible in that it makes minimal assumptions about the model specifications and input data. E.g. the data doesn't have to be normally distributed, which is mostly the case for CB-SEM.

2. The method is a good fit for conceptual models where the goal is to explain or predict target constructs.

3. PLS-SEM has been used with great success for confirmatory theory testing.

4. The method allows for simultaneous analysis of both direct, indirect and total effects, easing the analysis process, while reducing the overall errors (Astrachan et al. (2014)).

5. PLS-SEM can use measures with few items, and can analyse very complex models, i.e. many constructs, indicators and relationships (Hair et al. (2016))

6.2.2 Sample Size Assessments

In order to determine the minimum sample size for PLS-SEM analysis, Hair et al. (2016) outlines two guiding factors:

1. The sample size should be ten times the amount of structural paths pointing at any given latent construct. In the case of our structural model, the maximum amount of paths to one construct is 4, i.e. work performance, setting a minimum sample size of 40, and as such, our sample size of 360 is more than sufficient.

2. The sample size should be ten times larger than the amount of indicators for a single construct. The Work Performance construct has 15 items, setting a minimum sample size of 150, and as such, our sample size is sufficient.

As such, given the reasoning above, our sample sizes are more than sufficient for the purposes of PLS-SEM analysis, and specifically, for use in testing our model.

6.3 Analysis Theory

6.3.1 Internal Consistency Reliability

Internal consistency reliability is a measure that says something about how consistent the indicators are when compared to each other. It was assessed by looking at *Cronbach's Alpha* and *Composite Reliability*.

Cronbach's Alpha is a traditional criterion for internal consistency, and provides an estimate of reliability by examining the correlations between observed indicator variables. However, the measure is considered conservative, in that it assumes an equal loading between indicators (Hair et al. (2016)). As such, Hair et al. (2016) argues that Composite Reliability might be a better measure, as it accounts for differing outer loadings, while it can be interpreted in a similar fashion to Cronbach's Alpha.

According to Fornell and Larcker (1981), the values for Cronbach's Alpha (CA) and Composite Reliability (CR) should be greater than 0.70. However, Hair et al. (2016) argue that values between 0.6 and 0.7 are acceptable in exploratory research models, but that the value should not exceed 0.9. Furthermore, they should ideally not exceed 0.9, as this could indicate that some indicators are measuring the same concept.

6.3.2 Convergent Validity

Convergent validity measures the extent to which a measure correlates positively with other reflective measures of the same construct Hair et al. (2016). A common way to do this is to look at the *outer loadings* of the indicators, and the resulting *average variance extracted* (AVE).

According to Hair et al. (2016), outer indicator loadings should be above 0.7. Furthermore, outer loadings below 0.4 should always be removed, while loadings between 0.4 and 0.7 should be removed if it increases composite reliablity and AVE to a value above the minimum threshold. For AVE, this minimum threshold is 0.5 (Fornell and Larcker (1981)). It takes indicator level measures (loadings) and gives an assessment of validity on a construct-level. Values above the minimum threshold indicate that the construct accounts for more than 50% of the variance in its related indicators.

6.3.3 Discriminant Validity

Discriminant validity is a measure of whether the items of a construct are more similar to each other than to items of other constructs, and establishing discriminant validity means that a construct is truly unique, in that it captures concepts not incorporated in other constructs.

A traditional method of measuring discriminant validity is *Cross-loadings*, where the outer loadings of indicators of one construct are compared to the cross-loadings with other constructs. A construct has sufficient discriminant validity when the outer loadings have higher values than the cross-loadings with indicators of other constructs (Farrell (2010)). Another measure of discriminant validity is the Fornell-Larcker criterion, which says that the square root of the AVE of every construct must be higher than the highest correlation with any other construct (Hair et al. (2016))

However, in their fairly recent study, Henseler et al. (2015) found that cross-loadings did not reliably assess discriminant validity issues. In response, they developed a new measure called *Heterotrait-Monotrait Ratio* (HTMT), which has been shown to be a strong and reliable indicator of discriminant validity. The values should not exceed 0.85 in order to still fulfill discriminant validity.

6.3.4 Multicollinearity

As the Work Performance construct is both second-order and formative, it requires a different measure of validity and reliability. Compared to reflective constructs, high internal consistency is undesirable, and high correlations between measures could indicate that the sub-dimensions are measuring overlapping aspects (Petter et al. (2007)). Furthermore, one can look at the weights and significance of underlying dimensions and the higher-order construct, in order to determine if indicators have to be removed to improve the model.

Variance Inflation Factor (VIF) is a statistic measure of high correlation between indicators of a formative construct. In order for multicollinearity to not be an issue, the threshold should be put at a value of 3.3 (Petter et al. (2007)).

6.4 Reliability and Validity of the Measurement Model

In order to assess the reliability and validity of the model, we estimated the first-order reflective latent constructs. This resulted in measurements of reliability, convergent validity and discriminant validity. The values are presented and discussed in section 1, 2 and 3, respectively.

6.4.1 Overview of Second-Order Analysis

The research model contains both first-order reflective constructs, and one second-order formative construct, namely Work Performance. For purposes of analysis, each dimension is considered a first-order construct, and the indicators, i.e. construct questionnaire items, are repeated for both the underlying dimensions and work performance. The resulting higher-order construct is visualised in figure 6.1.

6.4.2 Assessment of Internal Consistency Reliability

The values for Cronbach's Alpha and Composite Reliability are displayed in table 6.4. None of the values are below the threshold of 0.7, but some of them are above the ideal upper threshold of 0.9. In the case of Collaborative Work and Focused Work, the CR value is significantly above the recommended level. In the case of Loneliness, however, the value is far above, at 0.979. This could point to potential problems with the questionnaire items, as it could mean that some indicators are simply variations of the same concept.

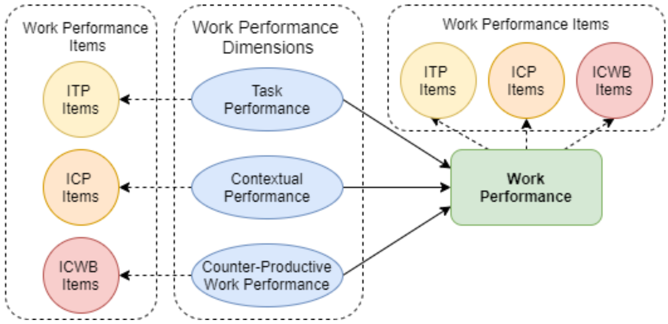


Figure 6.1: A visual representation of how the second-order Work Performance construct was analysed. Question items are coded with yellow/orange/red colors, and are used to analyse both work performance and its three dimensions.

Table 6.2: An overview of assessments of internal consistency of each model construct

Construct	Cronbach's Alpha	Composite Reliability
Collaborative Work	0.91	0.93
Focused Work	0.91	0.93
Meetings	0.87	0.89
Loneliness	0.78	0.979
Task Performance	0.89	0.91
Contextual Performance	0.88	0.90
CWB Performance (*R*)	0.82	0.87

6.4.3 Assessment of Convergent Validity

The result values for AVE are shown in table 6.3, while the outer loadings were moved to appendix B, due to the amount of values and to keep this section brief. Outer loadings with below-threshold values were removed in accordance with Hair et al. (2016), until the convergent validity was at a satisfactory level. The items that were removed from the structural model are displayed in table 6.4. All constructs had AVE values above the threshold of 0.5, and as such, can be considered to have convergent validity.

6.4.4 Assessment of Discriminant Validity

The cross-loadings of each construct are shown in table 6.5, where values marked in bold denote the corresponding construct's outer loading. We can gauge from the table that all construct outer loadings are greater than any corresponding cross-loading, and as such, indicates sufficient discriminant validity.

We also measured the Fornell-Larcker Criterion, and all diagonal values were found to be above 0.5, and higher than any value on the same row or column. As such, this also indicates good discriminant validity.

Lastly, the values from the HTMT assessment are shown in table 6.6. As we can see,

Table 6.3: An overview of assessments of the convergent validity of each model construct

Construct	**AVE**
Collaborative Work	0.64
Focused Work	0.66
Meetings	0.55
Loneliness	0.58
Task Performance	0.69
Contextual Performance	0.63
CWB Performance (*R*)	0.54

Table 6.4: An overview of items that were removed from the model to improve internal consistency reliability.

Construct	**Removed Item**
TTF for Meetings	TTFM3
Loneliness	LON1
Contextual Performance	ICP5
CWB Performance	ICWB2

Table 6.5: An overview of cross-loadings used to examine the discriminant validity of the reflective constructs.

Reflective Constructs	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
(1) Collaborative Work	**0.802**						
(2) Focused Work	0.659	**0.812**					
(3) Meetings	0.714	0.649	**0.742**				
(4) Loneliness	-0.425	-0.384	-0.351	**0.762**			
(5) Task Performance	0.529	0.513	0.544	-0.543	**0.832**		
(6) Contextual Performance	0.454	0.413	0.453	-0.574	0.634	**0.792**	
(7) CPW Performance (R)	0.529	0.472	0.452	-0.583	0.611	0.589	**0.734**

the values are all below the established upper threshold of 0.85, and as such, establishes discriminant validity between constructs.

6.4.5 Assessment of Multicollinearity between the Dimensions of Work Performance

Table 6.7 presents the weights and significance between Work Performance dimensions and the underlying constructs, as well as VIF measures. As we can see, all dimensions had significant weights. Furthermore, the VIF values are well below the threshold. As such, it is reasonable to conclude that the higher-order construct of Work Performance is valid and reliable enough to be used in further analysis.

Table 6.6: The Heterotrait-Monotrait measurement of discriminant validity. Green values denote that they are below the recommended threshold (0.85).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Collaborative Work							
(2) Focused Work	0.714						
(3) Meetings	0.733	0.701					
(4) Loneliness	0.522	0.457	0.411				
(5) Task Performance	0.578	0.563	0.511	0.789			
(6) Contextual Performance	0.511	0.534	0.567	0.764	0.782		
(7) CPW Performance (R)	0.526	0.513	0.546	0.752	0.777	0.745	

Table 6.7: An overview of validations of the work performance construct dimensions

Dimension	**Weight**	**Significance**	**VIF**
Task Performance	0.442	$p<0.001$	2.139
Contextual Performance	0.412	$p<0.001$	2.265
CP Work Performance (R)	0.346	$p<0.001$	2.753

6.5 Assessing the Structural Model

The structural analysis of the model was conducted by PLS analysis and Bootstrapping. The primary evaluation measures are standardized path coefficients (β), explained variance of endogenous variables (R^2), as well as the t-value of each structural path. The final results are shown in figure 6.2.

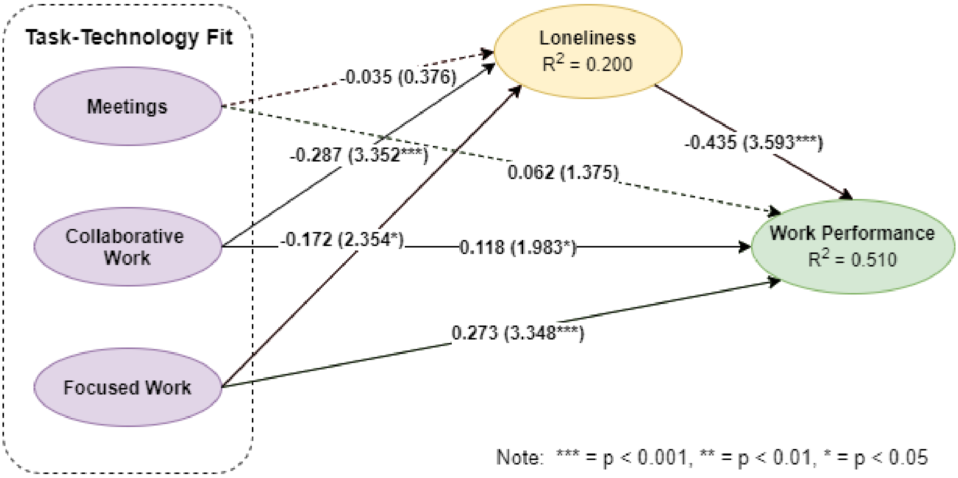


Figure 6.2: The structural model. The numbers on the paths represent path coefficients with t-values and significance in parentheses. R^2 values are shown for the relevant constructs.

The paths between constructs represent hypotheses, and the strength of the hypotheses are represented by the β-values on the path. The direction of the effect is determined by the sign of the coefficients, and the value can be in the range of -1 to 1, where a negative value signifies a negative effect. As an example, the model shows a negative β between loneliness and work performance, while the constructs of task-technology fit have a positive β on work performance, and thus overall positive effects.

However, Hair et al. (2016) note that path coefficients are not sufficient to determine if the hypotheses are significant, but that one needs to calculate t-values. As such, figure 6.2 shows t-values for each path in parentheses, along with their significance level. Some common significance levels are:

- 5%: $t > 1.960$ and $p < 0.05$, denoted by "$*$" in figures.
- 1%: $t > 2.576$ and $p < 0.01$, denoted by "$**$" in figures.
- 0.1%: $t > 3.291$ and $p < 0.001$, denoted by "$***$" in figures.

The numbers inside the constructs of Loneliness and Work Performance are R^2 values, which is a measure that shows the extent to which the variance in endogenous constructs is explained by their exogenous variables (Hair et al. (2016)).

The t-values of the paths were obtained by running a bootstrapping analysis with 500 re-samples, with a minimum significance level of 5%, i.e. we reject an hypothesis in the event that the p-value is above 0.05. The structural paths and their corresponding t-values and p-values are displayed in table 6.8. Green p-values denote that the structural path is significant, while a red path denotes that it's not.

Table 6.8: An overview of hypotheses, associated t-values, p-values and results.

Structural Path	t-value	p-value	Conclusion
Meetings → Work Performance	1.375	0.085	H1 Not supported.
Collaborative Work → Work Performance	1.983	0.024	H2 Supported.
Focused Work → Work Performance	3.348	0.000	H3 Supported.
Meetings → Loneliness	0.375	0.354	H4 Not supported.
Collaborative Work → Loneliness	3.352	0.000	H5 Supported.
Focused Work → Loneliness	2.354	0.001	H6 Supported.
Loneliness → Work Performance	3.593	0.000	H7 Supported.

Referring to table 6.8, we see that the task-technology fit (TTF) for collaborative work (H2) and focused work (H3) have significant and positive effects on work performance. However, the TTF of Meetings (H1) was not found to have a significant effect on Work Performance, even if it has a low positive effect. As such, H2 and H3 can be said to be supported by the results, while H1 is rejected.

When examining the indirect paths to work performance through loneliness, we found that the TTF of collaborative work (H5) and focused work (H6) had significant and negative effects on the social loneliness of individuals. However, the TTF of meetings (H4) is not significant. As such, the results show support for H5 and H6, but rejects H4. Lastly, the construct of loneliness was found to have a significant and negative effect on work performance. As such, there is support for H7.

As shown in figure 6.2, the R^2 for loneliness is 20%, and the R^2 for Work Performance is 51$\%$. These R^2 values indicate that the model has a predictive power that is between moderate and substantial (Hair et al. (2016)). These R^2 values indicate a moderate to significant predictive power in the structural model (Hair et al. (2016)). Furthermore, we assessed the model by use of effect size f^2, which is a measure of the contribution of exogenous constructs towards the R^2 of endogenous constructs, i.e. loneliness and work performance in our model. All values were found to be above the recommended thresholds of 0.15 (minimum) or 0.35 (ideal), and as such, we can conclude that all effect sizes are either moderate or high.

Chapter 7

Discussion

The results in this paper supports the notion that the COVID-19 pandemic is more than a just a health crisis, as presented by the UN. Highlighting the other impacts is important, in order to get through these challenging times as best as we can.

In this chapter we discuss the findings by assessing the hypotheses and evaluating the model. Section 7.1 contains discussion on the hypotheses and section 7.2 evaluates the constructs in the research model. Furthermore, section 7.3 further explores the process-level approach to TTF, while section 7.4 discusses possible limitations to our research. Finally, section 7.5 discuss research contributions, while section 7.6 proposes some implications of our findings.

7.1 Assessing the Hypotheses

Most of the hypotheses were supported, with p-values below the threshold of 0.05. The exception is the hypotheses on the effects of task-technology fit of meeting software. It was the only construct of the model that did not have any sizable influence.

Loneliness is clearly the most substantial predictor of performance in our model. And of its antecedents meeting TTF surprisingly did not have any significant effect, but focused work TTF did. It is clear that the impact that TTF has on performance can not be discarded either, as it affects performance both directly and indirectly through loneliness.

In this section we address the hypotheses. For each of them we will:

- Comment on the confirmation or rejection of the hypothesis and the degree of certainty.
- Explain what the findings really mean, what they don't mean and what they might imply.
- Discuss why the results are the way they are.
- Connect the findings to previous research, and comment on the similarities or differences.

H1: Increased task-technology fit for meeting software leads to increased work performance. (not supported)

This hypothesis was not supported by the data, with a $p_{value} > 0.05$ ($p = 0.085$) and path coefficient $\beta = 0.062$. The fit of meeting tasks was the only task group that was found to have little to no effects on work performance. However, we do note that the path coefficient is in the right direction, and that the p-value is fairly close to being below the 5% significance threshold. As such, it is still possible that the fit of meeting software could have a small effect on work performance.

Previous research found good task-technology fit for meetings to have positive effects on collaboration and work satisfaction (Chen et al. (2019)), increase team productivity, and affect outcomes for both teams and the organization as a whole (Kauffeld and Lehmann-Willenbrock (2012)). As such, The lack of significant effects from fit of meeting software to work performance is somewhat surprising.

In their recent study from the current pandemic, Fosslien and Duffy (2020) found that meeting software such as Zoom can cause a kind of fatigue they refer to as ”Zoom fatigue”, due to the way the software is designed. One problem is that digital meeting requires constant focus for an extend amount of time, and if an individual loses track of the conversation, it is hard to catch up again. Additionally, it is an unnatural situation where you have to constantly stare at the camera to indicate that you are paying attention, which differs from physical meetings, where you would alternate your gaze between different people and objects in the room.

These problems give context to the findings of this thesis, and support the lack of evidence for any effects of meeting tasks on work performance. As such, it is reasonable to argue that the examination of meeting software in a remote setting requires further and separate research from physical meetings. If further studies were to find a similar lack of effects, it could indicate that companies should distribute less time to meetings and more to collaborative and focused work.

H2: Increased task-technology fit for collaborative work software leads to increased work performance. (supported)

This hypothesis was supported by our results, with a significance level of 5%. The fit of collaborative work ($\beta = 0.118, t = 1.983$) is well below the threshold of significance, and indicate significant effects on work performance. However, the path coefficient is considerably lower than for focused work ($\beta = 0.273$), and as such, plays a smaller part in determining work performance.

As argued in section 3.1, collaboration technology must support close and effective communication in order to not impede performance in a remote work environment. Additionally, in situations with high task interdependence, individuals might require input before being able to continue their work (Quan-Haase et al. (2005)). Furthermore, van der Lippe and Lippényi (2020) expressed concerns that remote workers might experience high degrees of work avoidance and less opportunities for feedback.

In section 5.3, the contextual survey data revealed that the respondents had a high degree of task interdependence. As such, we argue that the results imply sufficient communication capabilities in the collaboration software used by the survey population. Likewise, the high task-technology fit and significant effects on work performance imply that remote workers were able to get necessary feedback in order to complete their work.

H3: Increased task-technology fit for focused work software leads to increased work performance. (supported)

The hypothesis was supported by our results, and found to be significant on the 0.01% level. The fit of focused work ($\beta = 0.273, t = 3.348$) had the most significant effect on work performance out of all the task groups, where the fit of collaborative work ($\beta = 0.118$) was significant on a lower level, while the fit of meetings ($\beta = 0.062$) had no significance at all. The fit of focused work also had a high effect size (f^2), and as such, it is reasonable to claim that the fit of focused work has very significant positive effects on remote work performance.

Work performance is improved by software when it facilitates focused attention (Lavie (2010)), but the mere presence of technology at work can make it harder to maintain sustained attention (Rosen and Samuel (2015); Ward et al. (2017)). However, Newport (2019) argues that recent technology has taken these problems into account, and as such can enhance concentration when designed correctly. The results show that this is likely to be the case, as evidenced by reported high fit of focused work software and significant effects on remote work performance. Furthermore, the significant effect indicates that the utilised software supports focused work in such a way that it improves work performance, by putting minimal strain on cognitive resources and allowing controlled exposure to distractions.

The results stress the importance of carefully selecting software for individual and focused work, i.e. software that facilitates individuals in performing their core tasks. In the case of a software engineer, a majority of their work is done in a code editor. As such, the code editor must support capabilities for maintaining focus and effective switching between related tasks. Additionally, the software engineer could utilise software that suppresses notifications until a certain amount of time has passed, in order to allow for full use of cognitive resources on the current work objectives (Burleson and Greenbaum (2019)). In other words, the total package of technologies used has a significant effect on the performance of tasks that require focus, as evidenced by the support for the hypothesis.

H4: Increased task-technology fit for meeting software leads to a decrease in loneliness. (not supported)

The hypothesis was not supported by our results, and as such, was the only task group category to have no evidence for effects on loneliness. This is somewhat surprising, as we found a high degree of fit and a relatively low standard deviation in section 5.2.2. As such, the findings indicate that while the survey population finds the meeting software adequate and fit to conduct meetings, it has minuscule effects on loneliness. We do note that the path coefficient of the hypothesis, $\beta = -0.035$, is in the same direction as the other task groups, even if it is not significant. Therefore, meetings are still likely to play a minor part in dampening the effects of loneliness during remote work, but the effects pale in comparison to that of collaborative ($\beta = -0.287$) or focused work ($\beta = -0.172$).

The fit of meeting software has no evidenced effects on loneliness. A meeting is a gathering of people, and as such is an arena for conversation, but it does not seem to play a part in mitigating deficits in the social deficits of remote workers. The findings are in accordance with Cacioppo and Cacioppo (2018), who found that loneliness can be perceived by individuals even when among other people. As such, for an interaction to help mitigate loneliness, it has to be perceived as adequately meaningful. This does not seem to be the case for the meeting process.

One possible reason for the insignificant effects, could be that a meeting is a gathering of usually many people, and as such gives little room for interaction between few individuals. Furthermore, the meeting is often headed by someone with authority to make decisions on behalf of the rest, and as such, could lead to an environment where the individual questions the importance of their input. This could in turn lead to not feeling connected to the team, which has been shown to be important to mitigate loneliness (Deters and Mehl (2013)).

H5: Increased task-technology fit for collaborative work software leads to a decrease in loneliness.

The hypothesis was supported by our results, with a significance level of 0.01%. H7 ($\beta = -0.287, t = 3.352$) had the strongest effect on loneliness out of all the Task-Technology Constructs, with H3 ($\beta = -0.172, t = 2.354$) for Collaborative Work being significant on the 5% level, and H1 for Meetings not being supported by our data at all.

The findings show that a good fit of collaboration software has a significant dampening effect on feelings of loneliness in individuals. The task group is general, and as such we are not able to tie the findings to specific activities, but the results indicate that the total of collaboration activities provides social interaction that is perceived as meaningful by individuals, even when working remotely.

Collaborative work has a tendency to be dynamic of nature, and usually has a less formal structure than a meeting process (DeSanctis and Poole (1994)). As such, collaborative work can more easily facilitate opportunities of social interaction beyond strictly work-related topics. When looking at existing software, one can identify cases where such interaction is encouraged. As an example, software such as Slack[1] provides informal communication arenas in the form of chat rooms and direct messages. This provides the individual with both an opportunity to communicate with their co-workers, but also the control of what they engage in and when they do it. The topic of a chat room can be anything the team finds worthwhile, e.g. entertainment or fun social media posts, and as such provides opportunities for social interaction that takes the mind of work.

Compared to meetings, collaborative work is an on-going process that is present in every work day, and as such, provides opportunities for ”taking a break” and building a common identity in the team. Common identity is pointed out by Sivunen (2006) as not only important for performance, but also for feeling like you are part of the team, and thus lowers the risk of alienation and perceived loneliness (Santas et al. (2016)). Our strong effect of collaboration software on loneliness therefore aligns with previous research, and showcases how important it is that businesses take loneliness into account when deciding

[1] https://slack.com/intl/en-no/

whether the software has a good fit for their company and teams.

H6: Increased task-technology fit for focused work software leads to a decrease in loneliness.

The hypothesis was supported by our data, and is significant on a 5% level, while being close to the threshold of being significant on a 1% level. As such, it is reasonable to claim that the fit of focused work software has a meaningful and dampening effect on loneliness.

Our findings are somewhat surprising, as focused work ($\beta = -0.172, t = 2.354$) was seen to have significant effects on loneliness, while meetings ($\beta = -0.035, t = 0.376$) had a very low effect. The nature of focused work involves reducing social interaction and distractions in order to work in a focused manner. As such, when the fit of focused work is shown to have a lowering effect on loneliness, it may imply that the focused work software encourages intermittent social interaction instead of enforcing long periods of solitary work.

This is in accordance with Lintern (2012), who found that focused work software tends to provide opportunities for social interaction, and thus decreases perceived loneliness. Furthermore, a good fit should give individuals the feeling of being productive, and thus perhaps, cause the social interaction to be perceived as deserved. A possible explanation for this is that a good fit should provide a clear separation between productive work and breaks.

H7: Increased loneliness leads to decreased work performance.

The hypothesis was supported by the results, as it was shown to be significant on a 0.01% level. As such, the data indicates a very strong negative effect of loneliness on work performance. Furthermore, H7 ($\beta = -0.435, t = 3.593$) is the strongest hypothesis in the model, as it has a stronger β than both H3 ($\beta = -0.172, t = 2.354$) and H5 ($\beta = 0.273, t = 3.348$), which were also significant on the 0.01% level. Lastly, the high effect size (f-squared) of the path supports the notion that H7 is very significant.

Referring back to the survey results in section 5.2.1, the data indicated a low to moderate degree of loneliness in the majority of the survey population. While this is a positive societal finding, as a high degree of loneliness was expected during the pandemic-induced isolation, the fact that loneliness is shown to have such a significant negative effect on work performance is interesting. Therefore, the findings show that when loneliness *does* occur in an individual, it can have severe consequences for their productivity at work. This stresses the importance of handling early signs of loneliness in individuals for businesses, by creating a remote environment with opportunities for meaningful social interaction.

7.2 Evaluating the Model Constructs

7.2.1 Task Groups

Our measurements of task-technology fit were conducted on a high abstraction level, with multiple general task groupings, and as such did not evaluate any specified characteristics beyond the question items. A possible concern is that the interpretation of the task group definition depends on the associations that an individual has at the time of filling out the survey. Another is that the task groups can be deemed too similar, i.e. for meetings and collaborative work, despite our effort to differentiate them clearly.

Interpretation and associations by survey participants are common concerns for constructs without objective measures, and as such is hard to control for. In relation to task group similarity, our results seem to indicate that the task groups are sufficiently different. This is especially apparent from the measure of discriminant validity, where both the method of cross-loadings (table 6.5 and the Heterotrait-Monotrait Ratio (6.6) indicate that the task groups measure mutually exclusive concepts.

When looking at internal consistency, both collaborative work and focused work have values slightly above the threshold (0.9) for Cronbach's alpha and composite reliability. In the case of meetings, the values are slightly below. As discussed in section 6.2, a value above the threshold indicates that some indicators are measuring the same concept. Coincidentally, an item was removed from the task-technology for meetings construct, which could explain the lower values. This indicates that if we had removed the corresponding items from the other task-technology fit constructs, it could have given less overlap between items.

Overall our results seem to justify the inclusion of our separate task groups, and that they are sufficiently different to provide interesting findings and opportunities for further research.

7.2.2 Loneliness

Loneliness was found to have significant effects on work performance. Furthermore, our results show sufficient discriminant and convergent validity. However, the values for internal consistency are somewhat troubling. As seen in table 6.2, the composite reliability of loneliness is 0.979. The recommended threshold is 0.9, and a value far above this indicates high overlap between the concepts that the items capture. When adjusting the model, we removed an item from the loneliness construct. As such, the analysis was run with only four items for loneliness. With such a high composite reliability, the construct could probably have benefited from more items to provide nuance.

7.2.3 Work Performance

Our results show good internal consistency, discriminant validity and convergent validity for all three dimensions of work performance. Furthermore, when examining correlations between the dimensions, we found sufficiently low variance inflection factors (VIFs). As such, we concluded that the higher-order construct of Work Performance had enough validity and reliability to be used in further analysis. The work performance scale adapted from the IWPQ questionnaire by Koopmans et al. (2014), who urged future research to test the validity and reliability of the dimensions. As such, it is reasonable to claim that we have contributed to furthering the understanding of the IWPQ dimensions.

7.3 Process Level Approach to TTF

Zigurs and Khazanchi (2008) argue that examining patterns of work is a fresh perspective that is particularly relevant in virtual contexts. As the world has become dependent on technology and remote work is now widespread, this statement becomes even more powerful. Looking at things from a pattern perspective allows for a higher abstraction level and potentially allows both researchers and practitioners to understand more of the bigger picture.

This approach also makes it possible to consider the greater context that modern workers are living in. They are not using tools in isolation, but rather as part of their digital ecosystem. This approach allows researchers to capture this fact, and measure the total effect of the broader selection of tools that workers are using to aid their business processes.

7.3.1 Enabling a Business First Perspective

Khazanchi and Zigurs (2006) found that virtual teams tend to choose practices that have been effective for them in the past, and use collaboration technologies to address their dominant concerns at any given point in time. Furthermore, the most important dimension of technology was communication, beating both process structure and information processing needs. This supports addressing TTF from a business first perspective, and keeping the specific tools as a secondary concern. As can bee seen by the [insert correct value & ref to results section] value of our constructs, it seems likely that this is further supported by the data in the survey.

7.3.2 Understanding The Big Picture

From a greater perspective, such as when deciding policies either in a big organization or in a country, the approach may be beneficial as such decisions are generally also kept at a higher abstraction level than that of each individual. As such, this type of research can potentially connect the understanding of individuals and organization. This is very beneficial, and could be used to monitor effects of higher level tactics and strategies. Another potential advantage is the ability to compare teams and organizations across industries. This may result in more information sharing, learning and innovation.

7.4 Limitations

7.4.1 Data Sample

A possible limitation is the use of data sampled from across the world. In the case that work cultures are different between countries, this could skew the results in the favor of dominant sample country of origins. Our samples contains data fairly evenly distributed between Norway, the USA and India. The maturity of internet technologies should ensure familiarity with software, and also to inform the need and benefits of using said software. As such, we argue that when examining on a general world-wide level, the country of origin is not very important except for curiosity and context.

7.4.2 Data Collection

Network Sample

Data collected through our personal and professional network. We expect that this may have resulted in the sample being biased towards highly educated people. There is also a chance that some of the respondents could be more vary of sharing personal information because they were afraid that we might access the information. The specificity of age and sex could be a factor that would make them identifiable. We do however believe that the use of the UiO survey and the overall professionality limited such effects. Further, we did specify that it was anonymous and the respondents were not asked to leave either contact information or emails.

Because we did not collect personally identifiable data, we are not able to verify the uniqueness of participants, and as such it does leave us susceptible for the potential of sabotage. We consider this to be unlikely, and we did not find anything in the data that would suggest that there were illegitimate participants in the data set.

Mturk Sample

Research has shown that Mturk surveys are reliable and sufficiently represents a ”real world sample”. As the pandemic forced people both into unemployment and home isolation, Mturk has seen a surge in users. However, a study during the pandemic indicates that the reliability and representation remains sufficient for use in research.

The Network sample was exposed to new technology in a larger degree than the Mturk sample. This could be caused by the differences in employement status, where the Network sample has predominantly employed respondents, while the Mturk sample has predominantly self-employed respondents. The Mturk respondents familirarity with collaboration technology could also be explained by their self-employment, where the nature of their work meant that they were already dependent on using software for administering their work.

7.4.3 The Loneliness Construct

When examining the answer distribution of the items used to measure the loneliness construct, we found a possible cause for questioning the semantics of the items. Figure 5.1 shows that for the items LON1, LON2 and LON4, the answers are fairly dominated by ”Agree”. A high answer on these items indicate a high degree on loneliness. However, LON3 and LON5 are more evenly distributed and ”M-shaped”. This could indicate that the respondents to the survey were confused by the wording of the indicators. The items, e.g. LON3 that reads ”I do not have any co-workers who share my views, but I wish I did”, could possibly be interpreted in two ways, depending on the understanding of ”, but I wish I did”. In the case of a disagreement, it either means that the respondent has coworkers who share their views, or that they don’t have any, but it doesn’t affect them. This calls back to the definition of loneliness in section 2.2.3, where being alone is not necessarily synonymous with feeling lonely.

The loneliness items were adapted from a short version of the Social and Emotional Loneliness scale for Adults (SELSA) (Ditommaso et al. (2004)), which consists of 15 items on social and emotional loneliness. However, during the survey design process, we made a decision to only include the five items on social loneliness. The reasons behind this was both to reduce the amount of questions in the survey, and thus avoid ”survey fatigue”, but also because the social dimension seemed the most applicable to a work context. Burleson and Greenbaum (2019) found that the negative effects of task-switching were stronger when the secondary task had a high degree of associated emotions. As such, by omitting the items of emotional loneliness, the model might lack an important aspect in its explaining power. This applies not only to the effects of loneliness on work performance, but could also add context to the exogenous effects of task-technology fit.

Another potential issue is the use of ”co-worker” instead of the original ”friend” in our survey. This could be confusing for people who reported to be self-employed, as they could assume that this means whoever they are collaborating with. However, it could also cause confusion in the respondents, and thus lead to inaccurate answers. A possible control for this confusion could have been to include another response option for when a statement is not applicable to their situation. The lack of such an option is also a common critique of likert-scales in general, as shown by Chyung et al. (2017).

7.4.4 Employment Status

Another limitation is a possible insufficient understanding of the nature of each applicants work. The survey assumes employment, remote work, a need for collaboration. Furthermore, we only explicitly check for whether the respondents are self-employed or employed. We did collect some data about the respondents working environment, which could be helpful in this regard. However, it was not incorporated in the model, and as such cannot be used to reason for its validity. As such, we assume that both self-employed and otherwise employed respondents have a need for collaboration and use of communication technology in a professional context. This does seem to be the case based on the task interdependence graph, refer to figure 5.5. In the case that this assumption is wrong, it could mean that our samples should have been analysed separately instead of combined.

However, the work performance construct is considered to be largely insensitive to the nature of occupation, but rather relies on a group level analysis. Furthermore, our task groups describe work on a high abstraction level, and as such does not tie the results to specific occupations or employment situations. Consequently, the performance values should not be used to draw specific conclusions, but rather be considered in relation to the full model and sample.

7.4.5 Resistance to Use

Previous studies of information and communications technology use in sectors like health care and education show that increased requirements for using certain digital tools is associated with use avoidance because users are not favorably disposed to them (Tarafdar et al. (2010)). During the COVID-19 pandemic, it is reasonable to assume that more people are forced to used digital tools, despite being reluctant to use them. It is therefore likely that there will be resistance from certain individuals. Since our sample shows a generally high computer self-efficacy, see figure 5.4, it can be argued that the likelihood of high resistance is low, at least in terms of feeling in control of the technology. However, the resistance to use technology should maybe be considered, especially in future studies where this assumption may not hold.

7.5 Scientific Contributions

We are contributing to the understanding of human computer interaction by showing the interesting relationship between loneliness, technology and performance. With two out of three task groups having a substantial impact on work performance, we are adding further support of the relationship between task-technology fit and individual performance as has been found in previous research (Lee et al. (2007); Zhou et al. (2010); Cheng (2020)). Notably we are further adding to the current understanding by having a novel process level focus utilizing task groups in the model, thus answering the critique of traditional technology acceptance models, as pointed out by Dubé and Paré (2004) and Malone et al. (2003).

We are adding to the research using the IWPQ in practice, which was created to need of a generalizable questionnaire that can be used across industries and that covers all the dimensions of IWP Koopmans et al. (2014). Using the questionnaire in practice both contributes by testing it in practice and by bringing awareness to the advantages of generelizability.

We are furthering the research efforts on the impacts of the COVID-19 pandemic. The pandemic may result in increased loneliness, and our results clearly show that loneliness has a substantial effect on work performance.

The paper is also supporting the creation of a research paper. We are currently working on the paper and will submit it to Emerald Publishing, in response to their call for papers Emerald-Publishing (2020). We believe that both the data and the research from this thesis can be used to additional scientific articles. Potentially, this could contribute to a better understanding of remote work, during and after the COVID-19 pandemic.

7.6 Practical Implications

7.6.1 Society

As the world is shifting into the era of Web 3.0 it is getting more important to understand the relationship between humans and technology. As businesses are designing software that is increasingly taking control over us, and influencing us for profit, it is already a difficult situation. And as the technology develops even further, it is natural to assume that this will be even more challenging. It seems important that we become more deliberate about our smart phone use.

Further, it is important to understand the complexity of the relationship. Performance is not only influenced by the technology and its fit to the task. It is also influenced to a great extent by the totality of the technological environment in which a user exists. And as the users are now rarely without their phones, and in particular in the context of the home office, have access to a wide set of technologies competing for their attention, this is becoming challenging. Evaluating each technology in relation to the task at hand may have been sufficient in the past, but that was before services in the attention economy were able to distract users through deliberate use of notifications. Not only does this seem to be bad for the well-being of people, but as seen from our results it may also be very bad for companies' performance, as their users are more distracted, lonely and therefore performing worse.

7.6.2 Technology

Our findings show that software that support business tasks can reduce loneliness. That should encourage software creators to understand the importance of what they are making, and understand that it actually influences people's psychology, and if done right, it can improve people's lives. The effects of loneliness on performance are also substantial, which should make it economically desirable to develop technology that counteracts loneliness.

As everything is becoming more interconnected and we are approaching the described Web 3.0 world, the web might become the location of every possible information resource, person and organization Rudman and Bruwer (2016). It is important that we try to understand the implications of the increased dependence and connectedness on the web. We should increase our efforts on evaluating the impact of the technology use. Notifications and constant connectedness are some of the potential challenges that we face. It is possible that the pandemic pushes the development towards the interconnected Web 3.0 to move even faster, and we not have much time if we are to properly consider the negative effects on digital well-being.

7.6.3 Management and Industry

There have been frequent concerns about social isolation among remote workers (Hafermalz and Riemer (2016)). Our research adds to this concern, with our results showing the large impact of loneliness we are adding to the understanding that the social aspect is necessary (Hafermalz and Riemer (2016)) in a work context. As loneliness has been shown to drastically reduce work performance, it also adds to previous evidence showing that loneliness should not be treated as a private problem, but should be addressed for the organizations sake as well as for the individual (Ozcelik and Barsade (2011)). By showing the impact that loneliness has on performance it may raise the awareness and push businesses to prioritize battling this important issue, which would be good for individuals and society as a whole.

7.6.4 Changing The World of Work

As described in section 2.1.5 the world of work is changing. More people are working remotely, and the COVID-19 pandemic has sped up changes, and might also change the direction of future work. The percentage of knowledge workers has steadily grown together with an increasing range of tools aimed at boosting their productivity (Davenport (2011)). It is often possible for knowledge work to be done remotely, as long as the organization enables it. Our research highlights the importance of evaluating the software that is being used in a remote setting, because of the potential effect on both loneliness and performance.

Successfully establishing new ways of work requires an alignment with the prevailing organizational culture and leadership paradigm (Richter and Richter (2020)). In relation to culture, it is possible that the acceptance for remote work higher than before, as it has been recommended and in some cases required by governments, to work from home. Leaders have had to adapt, and it is also possible that the pandemic will serve as a catalyst for a new leadership paradigm. Already before the pandemic a new style of leadership was emerging, with organizations increasingly allowing for flexible scheduling and placing an emphasis on work-life balance (Richter and Richter (2020)).

The previous trends of co-working and digital nomads may rise as the world opens up again, with both technology and industry leaders being more open towards collaboration software and the idea of remote workers. Both co-working and digital nomads are now limited due to travel restrictions, but it is possible that some people who have gotten experience working from home will eventually start looking for new ways to work. As society gradually opens up again it will be interesting to see how the world of work evolves.

7.6.5 Handling the COVID-19 pandemic

As was described in the theoretical background, loneliness is not the same as isolation. The perception of loneliness depends not only on the physical proximity, but rather the social connection that individuals feel. As such, loneliness is not given during the pandemic. Technology can be used to stay in touch and care fore one another. We do think that this depends on deliberate use of technology, as there are potential dangers of overexposure to technology. People in power, both in the public and private sector, need to consider that all measures have potential negative consequences, and that it will be important to balance and focus on the right areas. Our findings indicate that some of these focus areas should be on selecting appropriate software for collaboration and focused work. Also, factors that may impact loneliness should be high on the list of priorities.

Chapter 8

Future Work

This chapter presents potential avenues for future research. Section 8.1 discusses possible changes in sample composition for further research, while section 8.2 proposes further utilisation of our data or model. Next, section 8.3 discusses possible considerations for a remote work performance framework, while section 8.4 argues for an holistic approach to task-technology fit. Furthermore, section 8.5 explores the bi-directional relationship between humans and technology, as well as possible related research venues. Lastly, section 8.6 gives a short outline of our contributions to COVID-19 related research.

8.1 Different Sample Demographic

Our sample has a majority of respondents from Norway, India and the USA. It could be beneficial if other researchers would test the same or a similar model with a different sample demographic. Either with a different subset of countries, or bigger samples from a single country. Furthermore, it could be interesting to examine if the model results would change with a sample of people with lower computer self-efficacy, as our sample mostly consisted of people with high computer self-efficacy. The results are shown in figure 5.4. High computer self-efficacy has been shown to increase task-technology fit, and the ability to adapt new technologies to a users' needs.

In addition, it could be interesting to collect and examine data at a later stage of the COVID-19 pandemic than we did. As theory on fit-appropriation indicates, teams change quickly and so does their perceived task-technology fit. It is also reasonable to assume that remote workers would get more used to the technology later in the year, and find the optimal appropriation of the technologies both for themselves and their team.

8.2 Further Utilisation of the Collected Data

Our survey collected data that was excluded from the research model. The primary reason for this was either that it made the model too complex, by introducing many interconnections and thus making exogenous variables like task-technology fit endogenous. The other being that the effect of some constructs were hard to reason, as the literature search revealed split opinions on the direction of the effects. Even if we excluded the constructs from our model, it could be interesting for other purposes and research fields. The questions can be seen in the complete survey in appendix A. These are discussed in the following paragraphs.

The Five-Factor Model of Personality

The Five-Factor Model of Personality (FFM), also known as the Big-Five Model, is a model for measuring personality traits. It consists of five dimensions, i.e. extroversion, neuroticism, agreeableness, conscientousness, and openness to experience. This model is further discussed in appendix E, and some of the interconnections can be seen in the exploratory model in appendix C.

Our literature search revealed several possible effects of the FFM dimensions in our model, such as loneliness, task-technology fit and work performance. As an example, extroversion dimension could be interesting to explore, as they are generally thought to have a greater need for social interaction. In a normal situation, i.e. not during a pandemic, an extrovert would naturally seek social situations. However, during the pandemic, this has changed as social gatherings are either discouraged or not allowed at all, depending on local government policies. The other dimensions could have interesting changes during the pandemic as well. As such, we argue that it could be beneficial to examine the personality data in a different context, perhaps in the field of psychology.

Interruption Tendency

We collected some data on the working environment and tendency to be interrupted in our survey. However, it was difficult to find a definite effect direction to examine. Nevertheless, interruptions have been found likely to affect work performance by disturbing focused work, as discussed in both the reasoning for our model hypotheses (section 3.1) and in the final assessment of results (7.1). As such, it could be interesting to examine these effects in a different context or variation of our final research model.

Conditions for Remote Work

Our data asked questions about conditions for remote work before and after being impacted by the COVID-19 pandemic. Among these were facilitating conditions, and items on voluntariness and whether it was a choice to work remotely. As the pandemic has evidently changed the world drastically, this data could shed light on how this changed for workers changing to a remote environment.

In relation to the long term development of the world of work, it is necessary to think about both the positive and negative sides of remote work. In addition to investigating challenges, such as the increased risk of loneliness, research should look into how teams working remotely can utilize technology for optimal performance (Tannenbaum et al. (2012)).

8.3 Create a Remote Work Performance Framework

Our research model shows good results for all included constructs. However, work performance is likely to benefit from the inclusion of additional constructs. We encourage future research to build on our findings and develop a generic framework that can be used across organizations and industries. We believe that our model can serve as a good starting point.

Future improvements to the model could include:

- Expanding the loneliness construct to include the emotional dimension (Ditommaso et al. (2004)).
- Testing other task groups.
- Add antecedents for Task-Technology Fit like Computer Self-Efficacy.
- Add possible antecedents to loneliness, such as remote work environment or tendency to be interrupted.

Another improvement could be to incorporate the ideas from our research model with fit-appropriation over time, as suggested in the Fit-Appropriation Model (see figure 2.2). Appropriation, i.e. how teams choose to use and combine technologies, has been shown to not only have an effect on task-technology fit, but also on team performance. Additionally, the nature of the appropriation might change over time as the needs of the team changes, and as such, affects both task-technology fit and performance outcomes in turn.

8.4 Holistic Approach

The technological landscape is evolving and growing at a rapid pace, which creates opportunities for switching between tools and services as needed for each specific situation. Measuring fit with concrete tasks has limitations, as in the case of businesses, the tasks themselves often come second to a set of business goals and processes. In other words, tasks are usually not the starting point, and it could be difficult to correctly evaluate the fitness of software with specific tasks. As such, maintaining a more holistic view of the modern employee's work day could help in capturing their whole problem solving space. Future research might benefit from doing research with general task groups rather than specific task characteristics, or use our findings as a starting point for a completely new approach.

8.5 The Bi-directional Relationship Between Humans and Technology

The idea that technology provides ”bundles of capabilities” has been a core part of research on task-technology fit (Goodhue and Thompson (1995)). As such, these capabilities are expected to shape the way people are working. However, research on appropriation of technology shows that this shaping is not unilateral. In fact, as individuals and teams use technology, they adapt and choose which functionality they need to aid their collaboration effort (DeSanctis and Poole (1994)). Furthermore, Zigurs and Khazanchi (2008) found that as teams evolve, they develop patterns of work which are viewed as indistinguishable from the technology used to support them.

Theories on patterns and appropriation are closely related to habits, which is defined by Verplanken et al. (1997) as ”learned sequences of acts that become automatic responses to a specific situation which may be functional in obtaining certain goals or end-states”. However, while appropriation and formation of patterns happens with some degree of deliberation, habits are defined as automatic responses, i.e. subconscious. Furthermore, Riedl et al. (2010) argue that behaviour is influenced by both deliberate and automatic processes. As such, it is reasonable to argue that it would be interesting to examine the interplay between appropriation and habit formation.

While appropriation and patterns can be measured with self-reported measures, the habit construct cannot be accurately portrayed in this way (Polites (2009)). In our master project, we identified several methods to measure the unconscious. We concluded that Electroencephalography (EEG) was the most appropriate for information systems research, as it was both among the most successfully applied methods, and also the least invasive on the user (Abelsen and Vatne (2020)). EEG can measure brain activity during use of technology, and thus give insight into the automatic responses in the brain, and thus serve to predict habit formation.

We note that the measurement of habit is a lot more involved than survey-based studies. Habits require time to form, and as such, the measurement of habit has to happen in multiple phases. EEG also requires physical access to people, which is not possible during a pandemic. However, once the pandemic passes, and conditions work back to normal. Future research could look into the measurement of habits and the effects on task-technology fit (Abelsen and Vatne (2020)).

8.6 Contributing to the COVID-19 Pandemic

Future research should further investigate the impact that the pandemic has on individuals and businesses, both in terms of the virus itself and the impact of the measures taken in place both enforced by government and voluntarily by individuals and businesses.

In order to make the results of our thesis available to a global research community, and make the findings of our thesis more easily digestible, we are planning to publish a research paper in a journal on productivity impacts during the pandemic by Emerald Publishing. As such, our work contributes to the overall research efforts to understand the impacts of COVID-19 on businesses and individuals.

Chapter 9

Conclusion and Final Remarks

9.1 Conclusion

Our thesis work started by exploring previous research in order to find constructs that were interesting to examine in a work context affected by the pandemic. This culminated in a research model that examined the effect of task-technology fit on both loneliness and work performance, as well as the effects of loneliness on work performance.

The research model examined three different task groups; meetings, collaborative work, and focused work. Our analysis found that the fit of collaborative and focused work software had significant effects on both loneliness and work performance, while the fit of meeting software was found to have no significant effects on either. As such, our results imply that meetings are ineffective in the remote work context. Further research is required to further examine if this is consistently the case, and to find the cause for the lack of effects.

The fit of collaborative work software was found to have the most significant effect on loneliness, and thus indicates a high degree of meaningful social interaction in collaborative work. However, the fit of focused work software was found to be the biggest contributor to work performance. This implies that focused work has the biggest impact of the task groups in terms of raw performance.

Furthermore, our model shows that loneliness has significant decreasing effects on work performance. In fact, this hypothesis had the strongest path coefficient in the model. This finding indicates stresses the importance of accounting for loneliness among employees for businesses, and especially so in the remote work environment. Overall, our results support both the distinction between and inclusion of all task groups.

Lastly, we examined the higher-order construct of work performance, and found low levels of correlation in the underlying dimensions. This indicates high validity and reliability in the work performance construct. As such, we contributed to the research on the construct, as urged by Koopmans et al. (2014).

9.2 Final Remarks

Zigurs and Khazanchi (2008) found that teams often fall back on using email for communication. We did the same with our supervisor. The challenges of this was apparent during the last days of finalizing our thesis, with long email threads going back and forth, sometimes excluding one of us in the process. There are better solutions, but we fell back on the simplest common denominator as often happens. We believe that awareness is necessary for transitioning to better solutions. People need to take the time to reflect on the way they are using technology.

It is important that research not only examines on the capabilities that technology provides, but also considers the influence that it has on us (Ayyagari et al. (2011)). Both software creators and users should aim to understand the intricate and bi-directional relationship between humans and technology. As our daily lives become more an more dependent on software for fundamental human contact, we must understand what we are exposing ourselves to. The advantages are often apparent and in many cases even advertised, but the negatives are often neglected.

“If you yourself don’t choose what thoughts and images you expose yourself to, someone else will.” — Epictetus

Chapter 10

Supplementary Results

This chapter contains supplementary descriptive results that were deemed too detailed to include in the preceding chapters, but too important to put in the appendix.

10.1 Descriptive Survey Results

This section contains an overview of the responses collected during the survey process. Each subsection presents the distribution of answers for each question item, where the most common response for each item is marked bold. Section 10.1.1 displays result for loneliness items, Section 10.1.2 shows results for TTF on each task group, and finally, section 10.1.3 shows the answers for each dimension of Work Performance.

10.1.1 Loneliness Items

Table 10.1 shows the answer distribution for the items of the loneliness construct. The responses implies a low degree of loneliness in the survey population.

Table 10.1: Distribution of answers for the loneliness survey items. Items marked with * are reversed, meaning that a high score indicates less loneliness.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
LON1 *	3	15	54	**215**	77
LON2 *	2	12	65	**193**	92
LON3	47	**115**	70	95	37
LON4 *	4	19	64	**178**	99
LON5	64	**107**	59	96	38

10.1.2 Task-Technology Fit Items

Table 10.4, 10.3 and 10.2 display answer distributions for meetings, focused work and collaborative work, respectively. The results shows a high degree of fit for all task groups.

Table 10.2: Distribution of answers for the collaborative work survey items

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
TTFC1	2	15	75	**189**	83
TTFC2	1	18	77	**176**	92
TTFC3	2	19	77	**172**	94
TTFC4	2	21	73	**180**	88
TTFC5	4	21	69	**176**	94
TTFC6	5	25	79	**164**	91
TTFC7	10	33	85	**143**	93

Table 10.3: Distribution of answers for the focused work survey items

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
TTFF1	2	21	56	**206**	79
TTFF2	1	20	79	**163**	101
TTFF3	1	18	71	**185**	89
TTFF4	5	15	69	**171**	104
TTFF5	2	18	69	**196**	79
TTFF6	8	20	92	**142**	102
TTFF7	6	14	80	**176**	88

Table 10.4: Distribution of answers for the meeting survey items

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
TTFM1	5	15	49	**207**	91
TTFM2	1	12	57	**164**	130
TTFM3	0	16	55	**192**	101
TTFM4	1	11	57	**188**	107
TTFM5	1	15	63	**182**	103
TTFM6	3	21	77	**155**	108
TTFM7	12	36	80	**157**	79

10.1.3 Work Performance Items

Table 10.5, 10.6 and 10.7 display answer distributions for the task, contextual and counter-productive work dimensions of work performance, respectively. For the task and contextual dimension, the responses indicate a high degree of performance. However, for the counter-productive work dimension, the results are mirrored around the neutral option. Furthermore, this dimension is reversed compared to the two others, meaning that a high score in counter-productive behaviour indicates decreased rather than higher overall performance.

Table 10.5: Distribution of answers for the task dimension of work performance

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
ITP1	2	26	37	**233**	66
ITP2	4	16	50	**171**	123
ITP3	1	18	55	**207**	83
ITP4	9	24	92	**147**	92
ITP5	5	27	87	**188**	57

Table 10.6: Distribution of answers for the contextual dimension of work performance

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
ICP1	1	18	56	**168**	121
ICP2	2	24	67	**194**	77
ICP3	2	18	73	**177**	94
ICP4	2	24	92	**164**	82
ICP5	4	11	64	**183**	102

Table 10.7: Distribution of answers for the counter-productive behavior dimension of work performance.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
ICWB1 *	37	92	70	**108**	57
ICWB2 *	52	**99**	61	95	57
ICWB3 *	40	91	68	**106**	59
ICWB4 *	30	74	66	**129**	65
ICWB5 *	39	66	59	**133**	67

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Appendix A

Complete Survey

This appendix shows the complete survey as it was sent out to respondents.

This form is anonymous. Read more.

Remote work during the Covid-19 pandemic

This questionnaire is part of a research project at the Norwegian University of Science and Technology. The results will be used to better understand the effects that remote work* has on work performance during the COVID-19 pandemic.

Estimated time: **8-12 minutes**

The pandemic has changed the world dramatically, and we are facing many new challenges. Many people now have to work remotely, meaning that they are not able to go to the office or meet physically. This research project is examining which factors influence the work performance of individuals in remote teams. With this knowledge, we hope to contribute to companies and individuals, by giving insight into factors that are important to consider when working remotely. In addition, the research will contribute to understanding the working conditions and its effects on employees during the pandemic.

The results from the questionnaire will be used to write a scientific article in collaboration with NTNU and the University of Hertfordshire, answering a call for papers from Emerald Publishing. It will also be used as a basis for a master thesis on the subject of remote work performance.
Emerald: Call for papers

We appreciate your contribution to understand how we can improve the remote work situation. You are contributing to our collective knowledge, so that we can make the best of the situation and adapt together.

All collected data is treated anonymously, and will under no circumstances be used for purposes other than research. If you have any further questions about the study, please feel free to contact Simen Nordbø Abelsen at
simennab@stud.ntnu.no.

* Remote work: Working with others without being in the same physical space.

I accept that the data collected in this survey can be used for research purposes *

- ○ Yes
- ○ No

Biological sex *

- ○ Male
- ○ Female
- ○ Intersex

Country of residence *

Which country do you work in?

Choose ...

Age *

How old are you?

Are you self-employed? *

Self-employed: You are working for yourself as a freelancer or in a single person company, rather than for another business.

- ○ Yes
- ○ No

Relationship to technology

	Very low	Low	Average	High	Very high
My ability to use software to successfully do my job is ... *	○	○	○	○	○
The level of my understanding about how to use software is ... *	○	○	○	○	○
My confidence level when using software is ... *	○	○	○	○	○
My comfort level when using software is ... *	○	○	○	○	○
In general, my ability to use software to complete the assigned task(s) is ... *	○	○	○	○	○

Personality traits

In general, I am someone who ...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
__ tends to be quiet. *	○	○	○	○	○
__ is compassionate, has a soft heart. *	○	○	○	○	○
__ tends to be disorganized. *	○	○	○	○	○
__ worries a lot. *	○	○	○	○	○
__ is fascinated by art, music, or literature. *	○	○	○	○	○
__ is sometimes rude to others. *	○	○	○	○	○
__ has difficulty getting started on tasks. *	○	○	○	○	○
__ tends to feel depressed, blue. *	○	○	○	○	○
__ has little interest in abstract ideas. *	○	○	○	○	○
__ is full of energy. *	○	○	○	○	○
__ assumes the best about people. *	○	○	○	○	○
__ is reliable, can always be counted on. *	○	○	○	○	○
__ is emotionally stable, not easily upset. *	○	○	○	○	○
__ is original, comes up with new ideas. *	○	○	○	○	○
__ is dominant, acts as a leader. *	○	○	○	○	○

Relation to co-workers

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel that I am part of a group of co-workers. *	○	○	○	○	○
My co-workers understand my motives and reasoning. *	○	○	○	○	○
I do not have any co-workers who share my views, but I wish I did. *	○	○	○	○	○
I am able to depend on my co-workers for help. *	○	○	○	○	○
I do not have any co-workers who understand me, but I wish I did. *	○	○	○	○	○

Work environment

During the last month of work, ...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
__ I have had a lot of privacy in my workspace. *	○	○	○	○	○
__ my work space was often used for tasks that are not work related. *	○	○	○	○	○
__ the technological devices I used were mostly used for work related purposes. *	○	○	○	○	○
__ I have often been interrupted by notifications from social media. *	○	○	○	○	○
__ I have often been interrupted by family or other people living in my house/apartment. *	○	○	○	○	○
__ I have often been interrupted by co-workers when working on focused tasks. *	○	○	○	○	○

Conditions for remote work

Before my organization was impacted by the Covid-19 pandemic, ...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
__ I was able to work remotely from home. *	○	○	○	○	○
__ it was my choice whether or not to work remotely. *	○	○	○	○	○
__ guidance was made available to me for finding appropriate software for working remotely. *	○	○	○	○	○
__ I had the necessary knowledge to use software for remote work. *	○	○	○	○	○
__ a specific person (or group) was available for assistance with software difficulties. *	○	○	○	○	○

After my organization was impacted by the Covid-19 pandemic, ...

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
__ I have been able to work remotely from home. *	○	○	○	○	○
__ it has been my choice whether or not to work remotely. *	○	○	○	○	○
__ guidance has been available to me for finding appropriate software for working remotely. *	○	○	○	○	○
__ I have the necessary knowledge to use software for remote work. *	○	○	○	○	○
__ a specific person (or group) has been available for assistance with software difficulties. *	○	○	○	○	○

Collaboration

During the last month, ...

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
__ my co-workers worked closely with each other in doing their work. *	○	○	○	○	○
__ my co-workers frequently coordinated their efforts with each other. *	○	○	○	○	○
__ the way individual members performed their jobs had a significant impact upon others in the group. *	○	○	○	○	○

Meetings

Meetings: An assembly of people for a particular purpose, especially for formal discussion. The meetings can be for planning, updates or coordinating work.

In the following statements, consider the start of the pandemic as the time when the new government policies in your country started impacting businesses.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Since the start of the pandemic, I have been very dependent on using technology for meetings. *	○	○	○	○	○
Since the start of the pandemic, I have voluntarily used the chosen technology to conduct meetings. *	○	○	○	○	○
I often used the same type of technology to have meetings before the start of the pandemic. *	○	○	○	○	○

The software we use…

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
__ is very adequate for conducting meetings. *	○	○	○	○	○
__ is very appropriate for conducting meetings. *	○	○	○	○	○
__ is very useful for conducting meetings. *	○	○	○	○	○
__ is very compatible with having meetings. *	○	○	○	○	○
__ is very helpful when conducting meetings. *	○	○	○	○	○
__ makes the meetings very easy. *	○	○	○	○	○
__ is the one I prefer for meetings. *	○	○	○	○	○

Focused work

Focused work: Any type of individual work where you perform better if you are not distracted by co-workers.

In the following statements, consider the start of the pandemic as the time when the new government policies in your country started impacting businesses.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Since the start of the pandemic, I have been very dependent on using technology for focused work. *	○	○	○	○	○
Since the start of the pandemic, I have voluntarily used the chosen technology to do focused work. *	○	○	○	○	○
I often used the same type of technology to do focused work before the pandemic. *	○	○	○	○	○

The software I use…

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
__ is very adequate for focused work. *	○	○	○	○	○
__ is very appropriate for focused work. *	○	○	○	○	○
__ is very useful for focused work. *	○	○	○	○	○
__ is very compatible with focused work. *	○	○	○	○	○
__ is very helpful for focused work. *	○	○	○	○	○
__ makes the focused work very easy. *	○	○	○	○	○
__ is the one I prefer for focused work. *	○	○	○	○	○

Collaborative work

Collaborative work: Any type of work where you need to collaborate with others in order to finish a task. It is different from meetings in the sense that you are collectively working to produce something.

In the following statements, consider the start of the pandemic as the time when the new government policies in your country started impacting businesses.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Since the start of the pandemic, I have been very dependent on using technology for collaborative work. *	○	○	○	○	○
Since the start of the pandemic, I have voluntarily used the chosen technology to do collaborative work. *	○	○	○	○	○
I often used the same type of technology to do collaborative work before the pandemic. *	○	○	○	○	○

The software we use…

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
__ is very adequate for collaborative work. *	○	○	○	○	○
__ is very appropriate for collaborative work. *	○	○	○	○	○
__ is very useful for collaborative work. *	○	○	○	○	○
__ is very compatible with collaborative work. *	○	○	○	○	○
__ is very helpful for collaborative work. *	○	○	○	○	○
__ makes the collaborative work very easy. *	○	○	○	○	○
__ is the one I prefer for collaborative work. *	○	○	○	○	○

Work performance

During the last month of work, ...

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
__ I managed to plan my work so that it was done on time. *	○	○	○	○	○

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
__ I kept in mind the results that I had to achieve in my work. *	○	○	○	○	○
__ I was able to prioritize the most important tasks. *	○	○	○	○	○
__ I was able to perform my work well with minimal time and effort. *	○	○	○	○	○
__ Collaboration with others was very productive. *	○	○	○	○	○
__ I started new tasks myself, when my old ones were finished. *	○	○	○	○	○
__ I took on challenging work tasks, when available. *	○	○	○	○	○
__ I worked at keeping my job knowledge up-to-date *	○	○	○	○	○
__ I came up with creative solutions to new problems. *	○	○	○	○	○
__ I actively participated in work meetings. *	○	○	○	○	○
__ I complained about unimportant matters at work. *	○	○	○	○	○
__ I made problems greater than they were at work. *	○	○	○	○	○
__ I focused on the negative aspects of a work situation, instead of the positive aspects. *	○	○	○	○	○
__ I spoke with my colleagues about the negative aspects of my work. *	○	○	○	○	○
__ I spoke with people from outside the organization about the negative aspects of my work. *	○	○	○	○	○

Submit   Cancel

Responsible for the form: simennab@stud.ntnu.no.

See recent changes in Nettskjema (v1039_0rc330)

Appendix B

Outer Loadings

This appendix presents the outer loadings for each question item used in our research model.

Table B.1: An overview of outer loadings for each construct item in the structural model

	Collaborative	Focused	Meetings	Loneliness	Task Performance	Contextual Performance	CPW Performance (R)
TTFC1	**0.811**	0.496	0.583	-0.36	0.372	0.383	0.361
TTFC2	**0.795**	0.512	0.576	-0.328	0.364	0.392	0.401
TTFC3	**0.812**	0.51	0.566	-0.288	0.388	0.388	0.381
TTFC4	**0.805**	0.511	0.586	-0.286	0.391	0.401	0.385
TTFC5	**0.793**	0.5	0.546	-0.272	0.363	0.375	0.379
TTFC6	**0.811**	0.556	0.577	-0.397	0.417	0.482	0.491
TTFC7	**0.787**	0.59	0.57	-0.412	0.448	0.488	0.412
TTFF1	0.514	**0.812**	0.526	-0.203	0.421	0.381	0.392
TTFF2	0.523	**0.807**	0.54	-0.347	0.423	0.412	0.457
TTFF3	0.559	**0.813**	0.529	-0.281	0.401	0.399	0.45
TTFF4	0.549	**0.832**	0.525	-0.344	0.433	0.345	0.483
TTFF5	0.487	**0.785**	0.468	-0.21	0.392	0.384	0.372
TTFF6	0.557	**0.833**	0.579	-0.38	0.482	0.491	0.541
TTFF7	0.547	**0.801**	0.506	-0.356	0.412	0.389	0.434
TTFM1	0.497	0.5	**0.728**	-0.179	0.338	0.235	0.316
TTFM2	0.534	0.408	**0.755**	-0.237	0.256	0.338	0.322
TTFM4	0.53	0.449	**0.78**	-0.27	0.304	0.197	0.246
TTFM5	0.54	0.47	**0.755**	-0.211	0.347	0.304	0.342
TTFM6	0.56	0.53	**0.78**	-0.357	0.463	0.331	0.345
TTFM7	0.556	0.524	**0.723**	-0.325	0.425	0.434	0.434
LON2	0.259	0.282	0.341	**-0.711**	0.217	0.367	0.422
LON3	0.349	0.308	0.39	**-0.704**	0.393	0.364	0.322
LON4	0.179	0.163	0.056	**-0.74**	0.324	0.411	0.357
LON5	0.288	0.24	0.253	**-0.721**	0.274	0.282	0.389
ITP1	0.312	0.407	0.301	-0.189	**0.712**	0.512	0.478
ITP2	0.333	0.433	0.299	-0.278	**0.813**	0.563	0.428
ITP3	0.254	0.356	0.305	-0.286	**0.801**	0.522	0.401
ITP4	0.387	0.434	0.333	-0.361	**0.856**	0.589	0.399
ITP5	0.401	0.289	0.404	-0.302	**0.817**	0.512	0.469
ICP1	0.279	0.404	0.308	-0.174	0.566	**0.702**	0.489
ICP2	0.343	0.451	0.365	-0.322	0.586	**0.733**	0.463
ICP3	0.235	0.335	0.277	-0.197	0.499	**0.803**	0.424
ICP4	0.329	0.448	0.317	-0.372	0.523	**0.794**	0.489
ICWB1	0.212	0.163	0.156	-0.473	0.502	0.522	**0.733**
ICWB3	0.167	0.167	0.102	-0.467	0.511	0.511	**0.758**
ICWB4	0.193	0.102	0.123	-0.471	0.468	0.489	**0.822**
ICWB5	0.156	0.133	0.092	-0.401	0.479	0.461	**0.845**

Appendix C

Exploratory Survey Model

The model in figure C.1 was used as part of the initial literature search. It gives some insight into our process of exploring links between several constructs. In addition to this model, we kept an overview of literature supporting the different links between the different constructs.

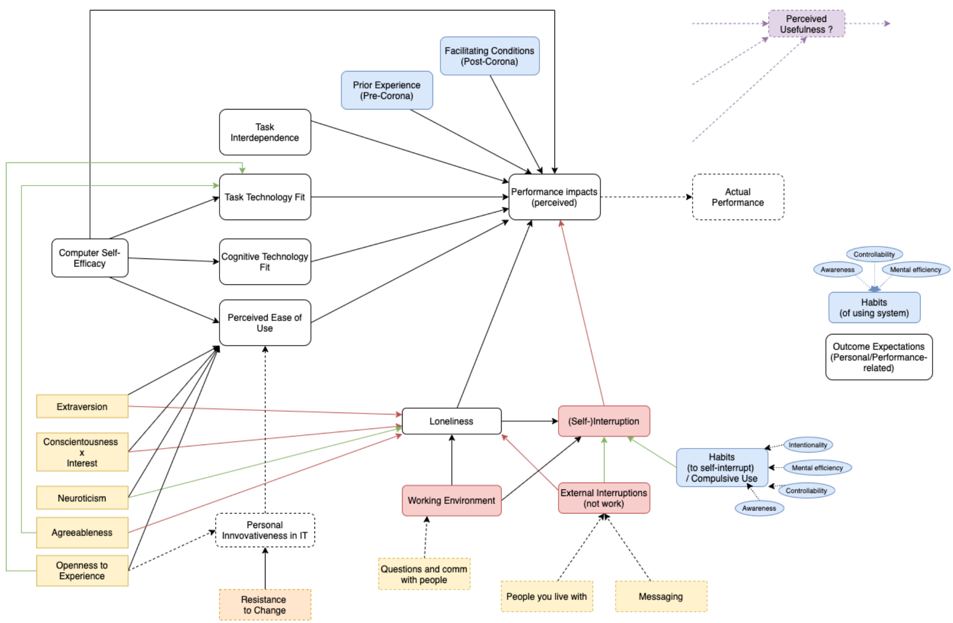

Figure C.1: Exploration model. Created and used during the literature search.

Appendix D

Contextual Survey Results

This appendix contains some answer distributions for question items that were not used in the final research model, but that provide context to the situation of remote workers.

Table D.1: An overview of answer distributions for the items of Computer Self-Efficacy.

	(1)	(2)	(3)	(4)	(5)
My ability to use software to successfully do my job is ... *	5	5	80	193	81
The level of my understanding about how to use software is ... *	2	6	90	157	109
My confidence level when using software is ... *	1	11	87	180	85
My comfort level when using software is ... *	1	16	81	160	106
In general, my ability to use software to complete the assigned task(s) is ... *	0	11	69	191	93

Table D.2: An overview of answer distributions for the items of Task Interdependence.

Items	(1)	(2)	(3)	(4)	(5)
__ my co-workers worked closely with each other in doing their work. *	6	44	79	200	35
__ my co-workers frequently coordinated their efforts with each other. *	3	34	84	161	82
__ the way individual members performed their jobs had a significant impact upon others in the group. *	7	29	84	199	45

Table D.3: An overview of answer distributions for the items of the Five-Factor Model.

Question Items	(1)	(2)	(3)	(4)	(5)
__ tends to be quiet. *	19	78	71	158	38
__ is compassionate, has a soft heart. *	2	18	87	162	95
__ tends to be disorganized. *	44	104	79	103	34
__ worries a lot. *	41	76	99	88	60
__ is fascinated by art, music, or literature. *	5	21	75	196	67
__ is sometimes rude to others. *	51	103	68	84	58
__ has difficulty getting started on tasks. *	31	85	82	127	39
__ tends to feel depressed, blue. *	43	102	80	83	56
__ has little interest in abstract ideas. *	43	81	97	113	30
__ is full of energy. *	2	32	97	141	92
__ assumes the best about people. *	4	22	84	182	72
__ is reliable, can always be counted on. *	2	6	50	189	117
__ is emotionally stable, not easily upset. *	9	31	80	178	66
__ is original, comes up with new ideas. *	3	29	85	171	76
__ is dominant, acts as a leader. *	10	47	84	159	64

Table D.4: An overview of the answer distribution for conditions for remote work before being impacted by the covid-19 pandemic.

Question Items	(1)	(2)	(3)	(4)	(5)
Before my organization was impacted by the Covid-19 pandemic, ...					
_ I was able to work remotely from home. *	9	4	33	120	38
_ it was my choice whether or not to work remotely. *	11	16	40	78	59
_ guidance was made available to me for finding appropriate software for working remotely. *	6	9	38	111	40
_ I had the necessary knowledge to use software for remote work. *	0	10	40	85	69
_ a specific person (or group) was available for assistance with software difficulties. *	2	12	30	110	50

Table D.5: An overview of the answer distribution for conditions for remote work after being impacted by the covid-19 pandemic.

Question Items	(1)	(2)	(3)	(4)	(5)
After my organization was impacted by the Covid-19 pandemic, ...					
_ I have been able to work remotely from home. *	5	11	36	177	135
_ it has been my choice whether or not to work remotely. *	43	67	60	116	78
_ guidance has been available to me for finding appropriate software for working remotely. *	8	22	76	176	82
_ I have the necessary knowledge to use software for remote work. *	3	10	42	189	120
_ a specific person (or group) has been available for assistance with software difficulties. *	10	22	74	171	87

Appendix E

Considerations on the Five-Factor Model of Personality

In our study we considered the Five Factor Model of Personality (FFM), also referred to as the Big Five Model, to measure the personality traits of individuals, both to compare individuals to each other across demographics, and as an attempt to explain the individual effects from the remote work settings.

The FFM has been shown to outperform other personality models, such as the MBTI, when measuring internet use (McElroy et al. (2007)). While the FFM has been critiqued for being both atheoretical, inflexible and incomplete (Epstein (2010); Boag (2011)), the field of personality research has arrived on a consensus that the FFM provides a general classification of personality (John et al. (2008)). This is supported by Wiggins and Trapnell (1997), who found that the FFM has a high level of comprehensiveness due to its relation to all other models of personality.

Furthermore, McElroy et al. (2007) urges future research to incorporate personal factors in models of IS adoption and use, as they can help give a better or alternate prediction of IS adoption behaviour. Svendsen et al. (2013) found that the BF personality traits had effects on the behavioural intention (BI) to use technology. However, given the current situation of the pandemic and the business context, it is reasonable to assume that behavioural intent is weakened or negligible, due to the forced use of remote work software for company employees.

As the BFM is shown to have effects on the perceived usefulness, ease of use and use of technology, it is reasonable to argue that the BFM also affects the work performance of individuals in the remote work context.

This assumption lead to the formulation of the following early hypotheses:

1. Extroversion has a positive relation to Work Performance
2. Conscientiousness has a positive relation to Work Performance
3. Openness to Experience will be positively related to Work Performance

4. Neuroticism will be negatively related to Work Performance

Previous studies on personality traits, TAM and UTAUT have not shown that Agreeableness has any significant effects on acceptance or usage of technology (McElroy et al. (2007); Svendsen et al. (2013)). However, agreeableness is included in the model for completeness. Barnett et al. (2015) found no significant effects on either actual, perceived or intended use of technology.

Due to the utilisation of an online questionnaire, the data could be biased towards users with high computer self-efficacy, as pointed out by Svendsen et al. (2013). In addition, Saleem et al. (2011) found that all factors in the FFM, with the exception of neuroticism, had significant effects on CSE. As such, it could be preferential to include links between FFM factors and CSE if a sample bias is expected.

Appendix F

Excerpt from Master Project

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The master project was supposed to be the basis for our master thesis, but because of the COVID-19 pandemic we were not able to do our planned EEG [1] measurements.

Abstract:

The development of technology acceptance research has stagnated over the last few decades. New frameworks and models only achieve marginal higher explanatory power, despite multiple attempts at adjusting and extending existing research models. Researchers are examining the underlying assumptions and principles that the models are based on, and argue that it is necessary to reconsider the foundations on which the models are built and take subconscious factors into account. This is due to a lack of progress, and possibly the increased use and exposure of technology in society. These factors make the study of habit and automatic behaviours an interesting direction for research.

During the last decade there has been a growing focus on the utilization of neuroscientific methods in research concerning the relationship between humans and technology, which has inspired a new scientific field called NeuroIS. Applications in studies of technology acceptance and continued use are particularly promising. We argue that methods from neuroscience can support new ways of including the habit construct in acceptance research. Rather than exclusively viewing habits as a byproduct or an antecedent to behavioural intention, we believe that habit is as significant as behavioural intention when predicting technology use and acceptance. Our findings indicate that conscious and subconscious factors interact in complex ways, and that the passing of time affects this relationship substantially.

[1] Electroencephalogram: Measurement method that has been pointed out as promising for capturing subconscious factors in relation to NeuroIS research.

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